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HADRONIC MATHEMATICS, MECHANICS AND CHEMISTRY

Volume II: Experimental Verifications, Theoretical Advances and Industrial Applications

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This volume is dedicated to the memory of

Professor Jaak Lôhmus

of the Estonia Academy of Sciences, Tartu, one of the greatest experts in nonassociative algebras of the 20-th century, for nominating the author among the most illustrious applied mathematicians of all times, the only Italian name appearing in the list, for his paternity on the initiation in 1967 of research on the most general possible algebras as defined in mathematics, the Lie-admissible algebras, that are at the foundation of the covering hadronic mechanics. The nomination was done in 1990 during communist times without any advance contact with or knowledge by the author, although, after the collapse of the communist era, the author was one of the firsts to visit Tartu with his wife Carla to express his appreciation, following a rather memorable trip by train from Moscow and return, while the former USSR was in disarray. The nomination is here reported also to honor the memory of the American mathematician **A. A. Albert** *who conceived the Lie-admissible algebras in 1947, although without detailed study. It is regrettable that, following Prof. Lôhmus death in 2006, the Estonia Academy of Sciences has been under criticisms by organized interests opposing the research reported in these volumes for evident personal gains.*

Figure 0.1. The front page of the nomination in Russian.

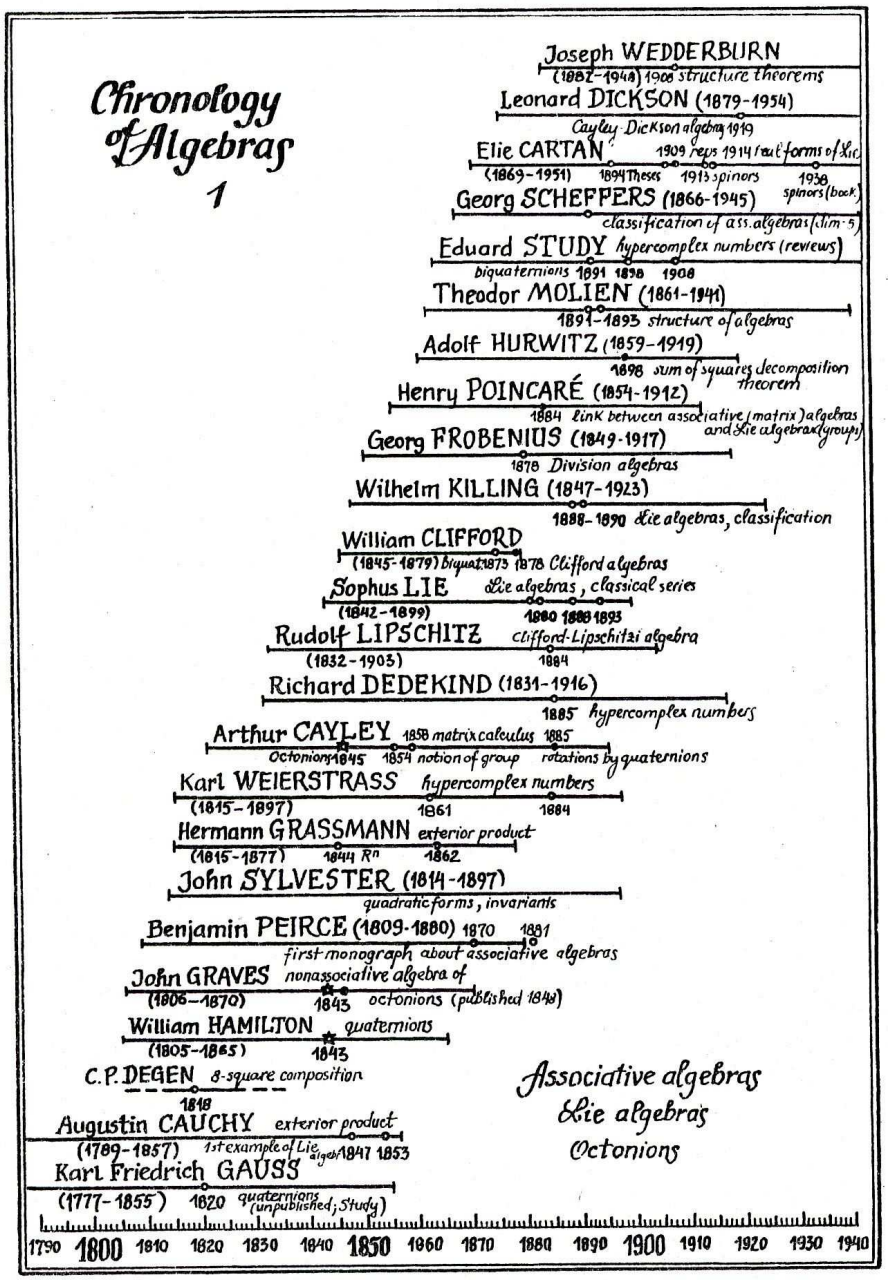

Figure 0.2. The second page of the nomination.

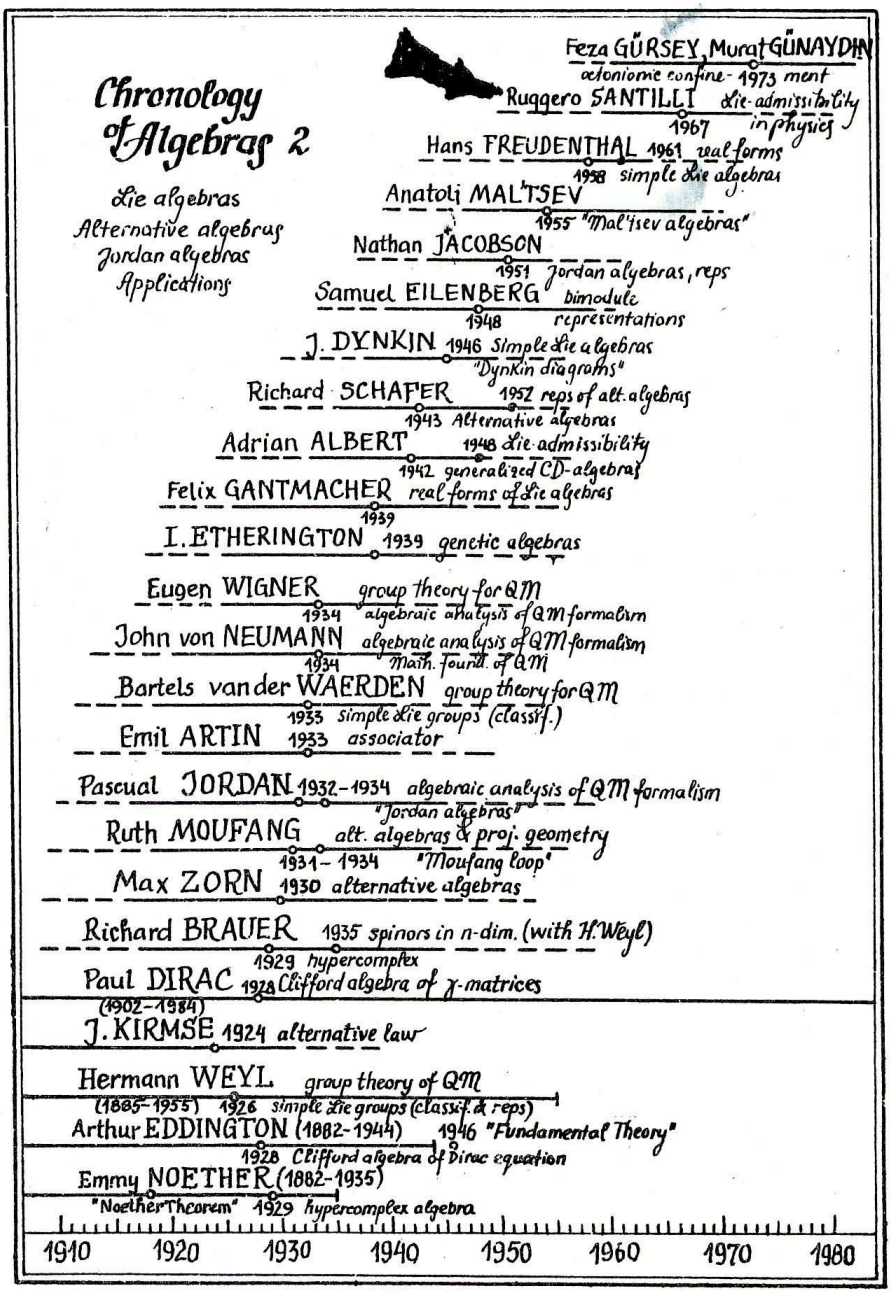

Figure 0.3. The second page of the nomination referring to a lifetime of research following the first article in the deformation of Lie algebras into Lie-admissible algebras appeared in a physics journal following only three articles in pure mathematics journals, R. M. Santilli, Nuovo Cimento **51**, 570 (1967).

Foreword

These days, science is playing an ever increasing rle in the lives of each and every one of us. The public is being lectured on climate change by very authoritative sounding people; the problems of the energy requirements of the world as a whole are being discussed quite openly and widely; more and more scientific topics are being discussed openly by people in positions of authority. What is not emphasised, in fact is rarely mentioned, however, is that at the centre of all these various discussions is physics. In the world of science, physics plays a crucial, all-pervading role. If science is viewed as a bicycle wheel, physics forms the hub at the centre; all the other branches of science act as the spokes of the wheel leading outwards from this central hub. In this context, mathematics is the language of physics and must always be subservient to the physics. Chemistry is merely one branch of physics; engineering may be viewed as the practical manifestation of physical principles; physics is seen by all to be playing a bigger and bigger rle in medicine; in biology even, physics is becoming important particularly through the influence of thermodynamic principles, including that of entropy, in the examination of the theory of evolution. Hence, it is certainly not unreasonable to claim an all-pervading influence of physics in science. It must always be remembered, but frequently isnt, that physics is concerned with describing, and gaining an understanding of, the world around us. It follows that any models devised by man to achieve this are only as good as their ability to achieve this goal. Mans models will always be approximate and, therefore, always flawed. It is this which spurred Ruggero Santilli to attempt to extend the theory behind quantum mechanics and relativity when he realised that neither was, in fact, complete as a theory.

The first volume of this two volume set was devoted to the mathematical theory developed by Ruggero Santilli over a period of years in an attempt to make headway with the enormous task he had set for himself, for he had always realised that, to make any progress at all, some new mathematics would need to be developed. Mathematics as a tool of physics will always have a potential to restrict progress in physics since it is a purely manmade tool. Also, if one looks back through history to the likes of Newton and Einstein, it is apparent that each developed or introduced new mathematics in order to proceed with prodigious advances in physics. The mathematics introduced in the first volume might reasonably be considered a separate piece of work to be considered and appreciated in its own right. However, its purpose had always been to provide

a new tool to help us all in our quest to describe our universe and all that it contains. This means making the mathematics subservient to the physics; relegating the mathematics however beautiful it may be in its own right to a place on a spoke of that wheel of science referred to above. Once it takes on this rle, any results obtained theoretically are only as good as their ability to accurately portray physical phenomena. In this second volume, the link up of theory with experimental results and observation is presented. It is for the general scientific community and any other readers of this work to adjudicate on its success or failure but this judgement, which could be so crucial to us all, must be made with open minds.

The areas in which this new work may be applied are varied. At the present time, possibly the most important application might seem to be the prediction of new clean energies. This could help solve the problems of energy supply and atmospheric pollution if the predictions prove correct. Already, however, a new clean energy, magnegas, has been produced and tested independently. This fact alone must lend credence to the theory presented and should surely provide an impetus to moves to examine the other predictions in great detail on a much wider scale. This is especially important since, on the basis of our present scientific knowledge, the only realistic method of fulfilling the worlds energy needs in the not-too-distant future is via nuclear power. As well as offering possible alternatives, the new theory also offers a possible means of dealing with nuclear waste safely. This, one would have thought, would have been something governments throughout the world would have wanted to investigate as a matter of urgency. It is to be hoped that the publication of this book will refocus attention on this vitally important topic and produce the necessary reaction from around the world.

However, the new theory is not restricted in its application to matters of energy resources. For example, it also offers alternative explanations for problems in astrophysics and cosmology. One fascinating aspect of these two areas of intense scientific endeavour is that, although many observations are made, both are subject to theoretical speculation which can never be completely verified or totally disproved because the time scales involved are far too long; for example, no-one lives anywhere near long enough to truly know the full facts concerning the birth, life and death of any star the theory in that case may be beautiful, it may appear to be a reasonable explanation of all we see, but one can never be certain it is absolutely correct. This is another area where open minds are essential. However, Halton Arps observations relating to quasars caused great consternation among conventionally thinking astronomers to the extent that he has become largely ostracised by the astronomical community. It is interesting that Ruggero Santillis work leads to a possible explanation for Arps findings which should not offend those conventional astronomers too much if they view

the ideas with open minds. Again, the same body of work offers an important contribution to the debate surrounding the existence of dark matter and dark energy. This lifes work truly makes contributions to thought in diverse areas of human endeavour and should be examined far more widely than it is.

It is often said that behind every great man there is a great woman. This is true of Ruggero Santilli. It is for history, not me, to label anyone great or not but it is undoubtedly true that he has benefitted from the unswerving support and encouragement of his wife Carla. It is doubtful he would have achieved so much without this seemingly unquestioning devotion. As I wrote earlier, all Ruggero Santillis scientific achievements may be seen to be the result of tremendous teamwork; a team comprising Ruggero himself and Carla Gandiglio in Santilli.

When anyone reaches the end of these two volumes then, and only then, will they be in a position to reflect on the work as a whole and think about coming to a conclusion. As stated previously, the theoretical framework is elegant but it is here to be judged on the basis of its use in physics, since that was the reason for its genesis. View the experimental and observational evidence, as well as the basic theoretical background, with open minds before coming to any final decision. Many, probably the majority, will then regard these two volumes as representing a truly monumental piece of work which deserves dissemination to a much wider circle of people scientists, politicians, the business community, and, most of all, the general populace which ultimately pays for all scientific work, whether successful or not! The general public needs to be aware of all that is on the table for consideration, not simply those little titbits which are released for ulterior motives.

Jeremy Dunning-Davies,
Physics Department,
University of Hull,
England.
October 8, 2007

Preface

In Volume I, we have identified the conditions of exact validity of quantum mechanics (qm) , point-like particles and electromagnetic waves propagating in vacuum, as it is the case for the structure of the hydrogen atoms hereinafter represented as $H = (p^+, e^-)_{qm}$, particles in accelerators, the study of crystals, and numerous other systems. In Volume I, we then presented the iso-, geno- and hyper-structural branches of the covering hadronic mechanics for particles at mutual distances of the order of 1 $fm = 10^{-13}$ cm, and their isoduals for antiparticles.

We have stressed the covering character of hadronic over quantum mechanics since, by conception and construction, the former recovers the latter identically and uniquely for all mutual; distances of particles significantly bigger than 1 fm. In this way. hadronic mechanics can be conceived as a form of "completion" of quantum mechanics solely applicable at short mutual distances of particles, but much along the celebrated argument by Einstein, Podolsky and Rosen.

In this Volume II, we present experimental verifications, theoretical advances, industrial applications and proposed basic tests of hadronic mechanics in particle physics, nuclear physics, superconductivity, chemistry, biology, astrophysics and cosmology. The entire accumulated knowledge is then applied to the conception and industrial development of new clean energies and fuels so much needed by mankind.

The experimental verifications of hadronic mechanics, considered most important by the author, is the achievement of the first known quantitative model of electron valence bonds in molecular structures, including the first known identification of their *attractive* force, the first known achievement of a numerically exact representation of molecular binding energies from first unadulterated principles, and other advances presented in Chapter 9. These advances are simply impossible for quantum mechanics for numerous reasons, e.g., the two identical electrons in a valence bond should *repel,* and definitely *not* attract each others, and numerous other limitations or sheer inconsistencies of quantum mechanics in chemistry identified in Volume I.

The remaining experimental verifications of hadronic mechanics are a mere derivation of the preceding ones in molecular structures because all having the same basic conditions: a deep mutual penetration of the wavepackets and/or charge distributions of particles at short mutual distances, with consequential emergence of non-Hamiltonian effects, namely, effects not entirely representable

with the sole use of a Hamiltonian, and consequential; need for a nonunitary covering theory.

In view of its "direct universality" (studied in detail in Volume I), hadronic mechanics emerges as applicable to all conditions considered, without exclusion known to the author. Thanks to the necessary discovery and use of new appropriate mathematics, the invariance of the theory for non-Hamiltonian conditions renders hadronic mechanics uniquely applicable. Any other invariant theory with a nonunitary structure can be easily proved to be a particular case of hadronic mechanics due to the extremely brad foundations. Researchers claiming novel alternative coverings of quantum mechanics should be warned to avoid claims of plagiarism and paternity fraud identified in the subsequent Legal Notice.

The application of hadronic mechanics, considered most significant by the author, is the achievement of the first known axiomatically consistent and invariant grand unification of electroweak and gravitational interactions presented in Chapter 14, that was achieved thanks to:

1) A structural reformulation of gravitation without curvature as a prerequisite to achieve the universal Poincaré-Santilli isosymmetry for gravitation and related compatibility with the symmetries of electroweak interactions, as well as the first known axiomatically consistent operator form of gravity;

3) The first known inclusion of antimatter in grand unifications for both electroweak and gravitational interactions; and other advances.

The above grand unification is so diversified that numerous additional advances permitted by hadronic mechanics are simple particular cases, such as the reconstruction at the level of the Lie-Santilli isotheory of spacetime and internal symmetries erroneously considered as broken due to the use of an excessively elementary mathematics, including:

α) The reconstruction of the exact parity for weak interactions;

β) The reconstruction of the exact $SU(2)$-isospin symmetry in nuclear physics;

γ) The reconstruction of the exact rotational, Lorentz, and Poincaré symmetries for mutated spacetimes;

δ) The reconstruction of the exact $SU(3)$ symmetry when believed to be broken for strong interactions; and others.

The proposed experiments, considered most important by the author, are: the verification whether or not light emitted by antimatter has the novel features predicated by the isodual theory, which verification would allow the first quantitative study whether far away galaxies and quasars are made up of matter or of antimatter; the verification whether or not sunlight at sunset has a partial iso-Doppler shift, that would confirm dramatically different cosmological redshifts for physically connected galaxies and quasars; the verification whether or not there are deviation from the Lorentz symmetry and special relativity within the hyperdense medium inside hadrons, in which case the covering Lorentz-Santilli

isosymmetry and isorelativity would be exact and have, far reaching implications for all of science, including the elimination of the need for dark matter in the Universe; the verification of the prediction of the isodual theory on the existence of antigravity as the gravitational repulsion experienced by antiparticles in the field of matter and vice versa, with implications beyond the most vivid imagination at this time.

As well known, nuclear, atomic and molecular physics have made historical contributions to mankind, while hadron physics has made absolutely no practical contribution whatever, and none is conceivable in the immediate future, because the former contributions are based on the capability of producing free nuclear, atomic and molecular constituents, while the hadron physics of the 20-th century was based on quark constituents that, by conception, cannot be produced free.

Additionally, the history of science has established the need for *two* different, yet compatible models in the study of nuclei, atoms and molecules, one model for their *classification* into family, and a different, but compatible model for the structure of individual elements of a given family, This historical teaching was violated by quark conjectures since they have attempted the achievement with one single theory of both, the classification of hadrons into families, as well as the structure of each individual hadron of a given family, with catastrophic insufficiencies, inconsistencies and theological. beliefs identified in Chapters 1 and 7.

One of the biggest contributions of hadronic mechanics to particle physics is the resolution of the above scientific imbalance and the initiation of actual industrial applications of hadron physics via:

I) The acceptance and confirmation of the $SU(3)$-color *classification* of hadrons into families or, more generally, of the so-called standard model;

II) The acceptance and confirmation of the need, for the elaboration of $SU(3)$ theories, of quarks as defined on serious scientific grounds, purely mathematical representations of purely mathematical, symmetries on purely mathematical internal spaces;

III) The denial that quarks are physical particles due to the impossibility of their definition in our spacetime, with consequential impossibility for quarks to have gravity or inertial, and the replacement of quarks with actual physical particles as hadronic *constituents* that can be produced free, generally in the spontaneous decays with the lowest mode.

The crucial contribution of hadronic mechanics is that possibility III is impossible for quantum mechanics, while being readily possible in a consistent and invariant way for the covering hadronic mechanics.

This occurrence confirms the additional teaching of scientific history that, no matter how exact a given theory is for given physical conditions, its validity for more complex physical conditions should not be taken for granted without a

serious scrutiny. In fact, the theory that proved to be fully valid for the Mendeleev *classification* of atoms into families, classical mechanics, had to be replaced with a covering theory, quantum mechanics, for the dramatically different conditions of the structure of each individual atom of a given Mendeleev family.

It appears that history is repeating itself for the case of hadrons because the theory so effective for their *classification* into families, quantum mechanics, has to be replaced with a covering theory for the dramatically different problem of the *structure* of individual hadrons of a given $SU(3)$ family. This is the case for numerous reasons studied in these volumes, such as:

a) Quantum mechanics can only represent particles as dimensionless points, which feature is fully acceptable for the classification of hadrons but fundamentally insufficient for the hadronic structure since the constituents have extended wavepackets in condition of total mutual penetration;

b) The fundamental Galileo and Poincaré symmetries of quantum mechanics are indeed fully effective for a planetary-type classification of point-like hadrons, but they are basically insufficient for the structure because, for instance, hadrons do not have keplerian nuclei;

c) Action-at-a-distance, Hamiltonian interactions are fully sufficient for the classification of hadrons as point-particles moving in vacuum (as empty space), while being dramatically insufficient for the dynamics within the densest media measured by mankind in laboratory until now, the hyperdense media in the interior of hadrons.

In the same way as quantum mechanics made historical contributions to mankind that were unthinkable with Newtonian mechanics, hadronic mechanics has already permitted industrial contributions there are unthinkable with quantum mechanics, and additional contributions are under study, precisely in view of the possibility of stimulating hadronic constituents to be produced free, thus permitting the conception of basically new clean energies.

Another important contribution of hadronic mechanics is the termination of the ongoing theological beliefs on neutrinos and their replacement with quantitative science. Enrico Fermi introduced the hypothesis of the neutrino (meaning "little neutron" in Italian) for the specific intent of salvaging the validity of quantum mechanics in the synthesis of the neutron, $p^+ + e^- \to n + \nu$, because quantum mechanics does not allow the spin 1/2 of the neutron from any possible quantum bound state of two particles each having spin 1/2. This signaled the birth of the theory of weak interactions that is now part of history.

However, Ruggero Maria Santilli pointed out in 1978 that, despite the neutrino hypothesis, quantum mechanics remains fundamentally and completely inapplicable for the neutron synthesis because the mass of the neutron is 0.78 MeV *bigger* than the sum of the rest energies of the proton and of the electron, under which conditions the Schrodingerś equation does not give physical solutions due

to the need of a *positive* binding energy, while all consistent quantum bound state require a *negative* binding energy.

The above inapplicability of quantum mechanics motivated the birth of hadronic mechanics proposed by the author in 1978 as a *nonunitary* covering of quantum mechanics for the reasons indicated above. Subsequent studies proved hadronic mechanics to permit consistent and invariant *structure equations* yielding an exact numerical representations of *all* characteristics of the neutron as a hadronic bound state of a proton and an electron, including characteristics not representable by $SU(3)$ models and weak interactions, such as an exact numerical representation of the neutron charge radius, density and meanlife.

The outcome of these studies is that neutrinos do indeed remain useful for conventional elaborations but, exactly as it is the case for quarks, neutrinos are not particles existing in our spacetime. Alternatively, the new scientific scene is that Fermi's theory of weak interactions and related neutrino conjectures are indeed valid, but only as *external* theories similar to Mendeleev-type classifications, with no connection to the *structure* problem.

In fact, there is no need at all for neutrinos in the synthesis of the neutron via the covering hadronic mechanics (hm). We simply have the "compressed hydrogen atom" exactly as originally conception by Rutherford, $n = (p^+, e^-)_{hm}$, in which:

i) The electron is compressed in singlet coupling within the hyperdense medium inside the proton;

ii) In so doing, the electron is forced to orbit with the proton spin so as to avoid the impossibility of moving within and against said hyperdense medium;

iii) The total angular momentum of the electron inside the proton is identically null and the neutron spin coincides with the proton spin.

Fermi was forced to introduce the neutrino conjecture because fractional angular momenta are anathema for quantum mechanics (they violate unitary and causality to say the least). Santilli did not need the neutrino conjecture for the neutron synthesis because the same fractional angular momenta are fully admitted by the covering iso-Hilbert spaces in a fully causal way.

There comes a moment in life in which realities have to be faced with their consequences. Researchers believing in the existence of quarks and neutrino as physical particles, while operating under public financial support, are warned to exercise caution so as to avoid the violation of federal laws for improper use of public funds due to excessively implausible, *yet unspoken,* consequences, such as: the belief that the permanently stable proton and the electron simply "disappear" by academic will (sic!) at the time of the neutron synthesis to be replaced by hypothetical quarks and neutrinos; and, then, again, the proton and the electron mysteriously "reappear" by academic will (sic!) at the time of the spontaneous decay of the neutron. There is a limit in the use of theological beliefs in publicly

funded research, without the identification of its implausible character, beyond which legal prosecutions are warranted so has to mandate serious science when suppressed for personal gains in money, prestige, and power.

Despite all the above, by far the biggest possibility offered by hadronic mechanics for future developments is that in regard to what will be, unquestionably, the ultimate frontiers of physics of the entire third millennium: space. In fact, *hadronic mechanics is the only axiomatically consistent and invariant theory known to the author permitting quantitative studies on the possible interconnection between matter and space (or the ether), the latter conceived as a universal medium with very high energy density.* In fact, the transition from the Hilbert space of quantum mechanics to the covering iso-Hilbert space of hadronic mechanics is the transition from the description of matter to that of ether as a universal medium.

To give a glimpse of future possibilities, rather than denying experimental data on neutrinos, hadronic mechanics permits their re-interpretation as *longitudinal impulses* propagating in space that, being longitudinal, are expected to propagate at a speed millions of times bigger than that of conventional (transversal) light, thus rendering at least conceivable interstellar communications. Similarly, there is the emergence of new forms of isogeometric propulsions relegating to the Middle Ages current propulsions all based on centuries old Newton's principle of action and reaction.

In short, by maintaining the notions of quarks and neutrino for the exterior, non-structural roles for which they were conceived, and by replacing them with new scientific vistas solely permitted by new mathematics, there is the possibility of confirming the teaching of history according to which, if seeded in a supporting environment, scientific advances can surpass the most imaginary science fiction of the past.

Ruggero Maria Santilli
Carignano (Torino), Italy
July 9, 2007

Ethnic Note

The author has repeatedly stated in his works that Albert Einstein is, unquestionably, the greatest scientist of the 20-th century, but he is also the most exploited scientist in history to date, because a large number of researchers have exploited Einstein's name for personal gains in money, prestige, and power .

In these two volumes, we shall honor Einstein's name as much as scientifically possible, but we shall jointly express the strongest possible criticisms of some of Einstein's followers ,by presenting a plethora of cases in which Einstein's name has been abused for conditions dramatically beyond those conceived by Einstein, under which conditions his theories are inapplicable (rather than violated) because not intended for.

In so doing, Einstein's followers have created one of the biggest scientific obscurantism in history, superior to that caused by the Vatican during Galileo's time. This obscurantism has to be contained, initiating with open denunciations, and then resolved via advances beyond Einstein's theories, for the very survival of our society since, as technically shown in these volumes, the resolution of our current environmental problems requires new scientific vistas.

As known by all, Albert Einstein was Jewish. The countless denunciations of Einstein's followers presented and technically motivated in these volumes will likely spark debates to keep historians occupied for generations. It is my pleasant duty to indicated that Jewish scientists have been among the best supporters of the authors' research, as established by the following facts:

1) The author had the privilege of participating to the Marcel Grossmann Meeting on General Relativity held at the Hebrew University, Jerusalem, in June 1997, with a contribution showing various inconsistencies of Einstein gravitation and proposing an alternative theory with gravitation embedded in a generalized treatment of the unit. Unfortunately, the author had to cancel his trip to Jerusalem at the last moment. Nevertheless, the organizers of the meeting had the chairman of the session read the author's transparencies and did indeed publish his paper in the proceedings.

2) One of the first formal meetings "beyond Einstein" was organized in Israel at Ben Gurion University, in 1998, under the gentle title of "Modern Modified Theories of Gravitation and Cosmology," in which the author had the privilege of participating with a contributed paper criticizing and going beyond Einstein's theories.

3) Numerous Jewish mathematicians, theoreticians and experimentalists have collaborated with and/or supported the author in the development of hadronic mechanics, as we see in many of the papers reviewed throughout the presentation.

As a matter of fact, the author has received to date more support from Jewish scientists than that from Italian colleagues, the author being a U. S. citizen of Italian birth and education. Such a statement should not be surprising to readers who know the Italian culture as being based on the most virulent possible mutual criticisms that are perhaps a reason for the greatness of Italian contributions to society.

Needless to say, the denial of a Jewish component in the scientific controversies raging on Einstein followers would be a damaging hypocrisy, but we are referring to a very small segment of of the Jewish scientific community as established by 1), 2), 3) and additional vast evidence. At any rate, we have similar ethnic components: in Italy, for Galileo's initiation of quantitative science; in England, for Newton's historical discoveries; in Germany, for Heisenberg's quantum studies; in Japan, for Yukawa's advances in strong interactions; in France, for de Broglie's pioneering research; in Russia, for Bogoliubov's advances; in India, for Bose's pioneering discoveries; and so on.

The point the author wants to stress with clarity, and document with his personal experience, is that, in no way, this variety of small ethnic components may affect scientific advances because, unlike politics, science belongs to all of mankind, positively without any ethnic or other barrier.

Ruggero Maria Santilli
Palm Harbor, Florida, October 27, 2007

Legal Notice

The underwriter Ruggero Maria Santilli states the following:

1) To be the sole person responsible for the content of *Hadronic Mathematics, Mechanics and Chemistry,* Volumes I and II; to be the sole owner of the Copyrights on these two volumes; and to have recorded, beginning with 1992, the copyright ownership of a number of his main contributions in the field.

2) The undersigned hereby authorizes anybody to copy, and/or use, and/or study, and/or criticize and /or develop, and/or apply any desired part of these volumes without any advance authorization by the Copyrights owner under the sole condition of implementing known rules of scientific ethics, namely: 2A) The originating papers are clearly quoted in the initial parts; 2B) Scientific paternity are clearly identified and documented; and 2C) Any desired additional papers are additionally quoted at will, provided that they are directly relevant and quoted in chronological order. Violators of these known ethical rules will be notified with a request of immediate corrections essentially consisting publishing missed basic references. In the event of delays or undocumented excuses, authors who violate the above standard rules of scientific ethics will be prosecuted in the U. S. Federal Court jointly with their affiliations and funding sources.

3) There are insisting rumors that organized interests in science are waiting or the author's death to initiate premeditated and organized actions for paternity fraud via the known scheme, often used in the past, based on new papers in the field without the identification of the author's paternity, which papers are then quickly quoted as originating papers by pre-set accomplices and the fraud is then accepted by often naive or ignorant followers merely blinded by the academic credibility of the schemers. Members of these rumored rings should be aware that the industrial applications of hadronic mathematics, mechanics and chemistry have already provided sufficient wealth to set up a Paternity Protection Trust solely funded to file lawsuits against immoral academicians attempting paternity fraud, their affiliations and their funding agencies.

This legal notice has been made necessary because, as shown in Section 1.5, the author has been dubbed "the most plagiarized scientist of the 20-th century," as it is the case of the thousands of papers in deformations published without any quotation of their origination by the author in 1967. These, and other attempted paternity frauds, have forced the author to initiate legal action reported in web site [1].

In summary, honest scientists are encouraged to copy, and/or study, and/or criticize, and/or develop, and/or apply the formulations presented in these volumes in any way desired without any need of advance authorization by the copyrights owner, under the sole conditions of implementing standard ethical rules 2A, 2B, 2C. Dishonest academicians, paternity fraud dreamers, and other schemers are warned that legal actions to enforce scientific ethics are already under way [1], and will be continued after the author's death.

In faith

Ruggero Maria Santilli

U. S. Citizen acting under the protection of the First Amendment of the U. S. Constitution guaranteeing freedom of expression particularly when used to contain asocial misconducts.

Tarpon Springs, Florida, U. S. A.

October 11, 2007

[1] International Committee on Scientific Ethics and Accountability
http://www.scientificethics.org

Acknowledgments

The author expresses his deepest appreciation in memory of: the late British philosopher Carl Popper, for his strong support in the construction of hadronic mechanics, as shown in the Preface of his last book *Quantum Theory and the Schism in Physics;* the late Nobel Laureate Ilya Prigogine, for pioneering the need of nonunitary broadening of quantum theory and his personal support for the organization of the *Hadronic Journal* since its inception; the late Italian physicist Piero Caldirola, for his pioneering work in noncanonical broadening of conventional canonical theories as well as support for the construction of hadronic mechanics; the Greek mathematician Grigorios Tsagas, for fundamental contributions in the Lie-isotopic methods underlying hadronic mechanics; the late Italian physicist Giuliano Preparata, for pioneering anisotropic departures from the geometric structure of special relativity, extended by hadronic mechanics into anisotropic and inhomogeneous media; the late mathematician Robert Oehmke for pioneering work on the Lie-admissible structure of hadronic mechanics; the mathematician Jaak Löhmus whose studies on nonassociative algebras, with particular reference to the octonion algebra, have been particularly inspiring for the construction of hadronic mechanics; and other scholars who will be remembered by the author until the end of his life.

The author expresses his appreciation for invaluable comments to all participants of: the *International Workshop on Antimatter Gravity and Anti-Hydrogen Atom Spectroscopy* held in Sepino, Molise, Italy, in May 1996; the *Conference of the International Association for Relativistic Dynamics,* held in Washington, D.C., in June 2002; the *International Congress of Mathematicians,* held in Hong Kong, in August 2002; the *International Conference on Physical Interpretation of Relativity Theories,* held in London, September 2002, and 2004; and the *XVIII Workshop on Hadronic Mechanics* held in Karlstad, Sweden, in June 2005.

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Chapter 6

EXPERIMENTAL VERIFICATIONS AND APPLICATIONS IN PARTICLE PHYSICS, ASTROPHYSICS AND COSMOLOGY

6.1 EXPERIMENTAL VERIFICATIONS IN CLASSICAL AND PARTICLE PHYSICS

6.1.1 Introduction

As stated in Volume I, we assume the exact validity of *special relativity,* and *quantum mechanics* for all possible *exterior dynamical problem* as conceived at the beginning of the 20-th century (and thereafter ignored), namely, point-like particles at large mutual distances and/or electromagnetic waves propagating in *vacuum* hereinafter referred to a universal substratum underlying all events in the universe visible to mankind.

Typical cases of exterior dynamical problems are the propagation of light in vacuum, the structure of the hydrogen atom, particles in particle accelerators, and various other systems for which conventional theories are assumed to be exactly valid.

In this chapter, we present a number of experimental evidence in various fields establishing the exact validity of the covering *isorelativity* and *hadronic mechanics* for the more general *interior dynamical problems* as also conceived at the beginning of the 20-th century (and thereafter regrettably ignored)

Typical cases of interior dynamical problems are given by: the propagation of light within transparent physical media; physical media opaque to light missing the central pillar of special relativity, the propagation of light; the structure of hadrons, nuclei and stars; deep inelastic scatterings; and other cases of extended, generally nonspherical and deformable particles at mutual distances of the order of 1 $fm = 10^{-13}$ cm or less, in which case we have the partial or total mutual penetration of the wavepackets and/or the charge distributions of particles.

In Volume I, we have established the impossibility for special relativity and quantum mechanics to be exactly valid for interior conditions due to numerous

evidence, such as: the absence of a Keplerian structure in the interior of hadrons, nuclei and stars with consequential impossibility of the Poincaré symmetry to be as exact as for a Keplerian or planetary systems; the emergence of nonlinear, nonlocal and nonpotential interactions that are dramatically beyond any possible representation by a Hamiltonian, let alone incompatible with the underlying conventional topology and related mathematics at large; and other evidence.

In reading this chapter, a clear understanding is that the *approximate* validity of special relativity and quantum mechanics for interior dynamical conditions remains beyond scientific doubt. However, as we shall see, the exact representation achieved by the covering isorelativity and hadronic mechanics have far reaching implications, such as: the lack of necessary existence in our spacetime of quarks, neutrinos, dark matter and other conjectures formulated to salvage orthodox doctrines; the conception and industrial development of much needed new clean energies and fuels simply inconceivable inconceivable with conventional doctrines; and other much needed theoretical, experimental and industrial advances. [1]

6.1.2 Space, the Final Frontier of Knowledge

As it is well known, we would not be able to hear each other's voices without our atmosphere, because sound is wave that, as such, requires a medium for its existence and propagation. In particular, sound is a *longitudinal wave,*[2] thus requiring a compressible medium, as it is the case for our gaseous atmosphere.

---

[1]The author has repeatedly stated that *no basic advances are possible in the contemporary physics community without a joint consideration of scientific ethics and accountability.* To further illustrate the gravity of the condition, the author has expressed the view that *our contemporary society is at a stage similar to that of the Roman empire prior to the setting of the Roman Laws,* because of the lack of a Code of Scientific Laws, to such an extent that scientific lawsuits cannot be even understood by judges and attorneys alike (see the web site www.scientificethics.org).

The condition of our contemporary society is illustrated by the fact that, an old lady shoplifting out of need is immediately sent to jain, while physics professors can perpetrate huge manipulations of scientific knowledge for personal gains in money, prestige and power, in absolute impunity. The problem for our contemporary society is the the "crime" committed by the latter (intended in the Latin meaning of damage to society) is much bigger than that of the former.

In view of the above condition of our contemporary science, established by fifty years of personal experience by the author, the presentation of these two volumes would constitute *per se* a crime without a denounciations of the incredible acts of organized academic oppositions against the development of hadronic mechanics, in full documented awareness of the need for new clean energies and fuels that can be solely developed via new disciplines. Hence, in the footnote of this second volume we shall continue to outline and document episodes of organized obstruction suffered by the author around the world.

The hope is that politicians, educators, and taxpayers will eventually understand the gravity of the condition of our society and the consequential, perhaps already irreparable damaged caused by uncontrolled academic manipulations of science, for, in the final analysis, it is written in history that people have the system that either want or deserve.

Above all, it is hoped that politicians, educators and taxpayers will understand the dimension of the now inevitable condemnation by posterity, because the lack of solution of the increasingly cataclysmic climactic events is due precisely to organize academic corruption on pre-established doctrines for personal gains, on complete oblivious of the need by society of their ethical conduct.

[2]In a longitudinal wave, the oscillations occur in the direction of propagation

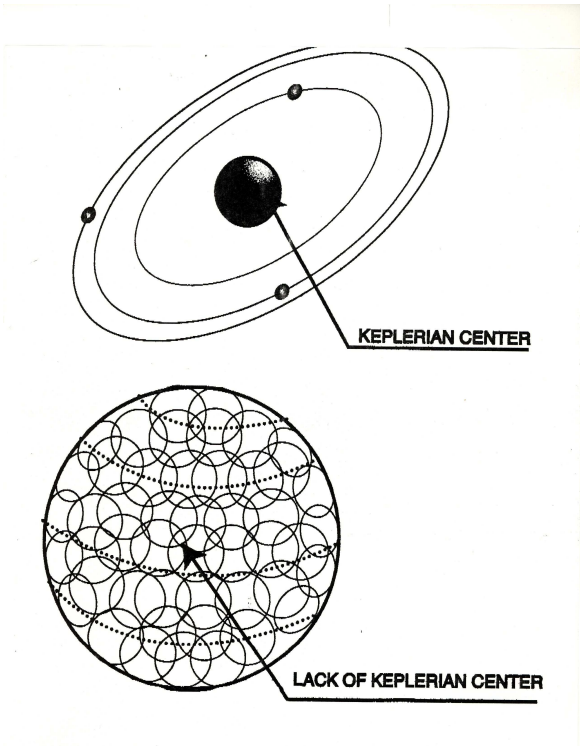

Figure 6.1. A schematic view of one of several impossibilities for special relativity and quantum mechanics to be exactly va;lid for interior dynamical problems. The figure depicts the general lack of a Keplerian structure as well as of a Keplerian center in the transition from a planetary system to the structure of one of its planets, such as Jupiter, with consequential impossibility for the central pillar of special relativity, the Poincaré symmetry, to be exact. When considering operator interior problems such as the structure of hadrons, nuclei and stars, besides the loss of the Keplerian structure, we have the additional impossibility of identifying clearly quantized orbits, thus losing the very notion of a quantum in favor of covering vistas. The theoretical studies conducted over decades, presented in detail in EHM-I, EHM-II, Volume I and briefly summarized in this chapter, have achieved a covering of the mathematical and physical foundations of special relativity and quantum mechanics permitting an invariant formulation of interior dynamical systems without Keplerian structure and Keplerian center. This volume is dedicated to their experimental formulations, theoretical advances, and industrial applications.

Similarly, we would not be able to see each other's faces without the *aether* (also called *ether,* or *space,* or *universal substratum,* or *vacuum*) conceived as a universal medium because light is also a wave, thus equally requiring a medium for its existence and propagation. In particular, light is a *transversal wave,*[3] thus

[3]In a transversal wave, the oscillations occur in the direction perpendicular to that of propagation

requiring a medium with characteristics similar to very high rigidity due to the very big value of the speed of light.[4]

The elimination of the universal substratum in the physics of the 20-th century is an excellent topic for investigation by ethically sound historians, because it is a clear illustration how physical evidence is manipulated to fit preferred theories, and how widely such manipulations are accepted.

Some fifty years ago, the author decided to dedicate his life to "scientific research" intended as the unobstructed, quantitative pursue of new scientific knowledge. As such, the author never did and never will adapt evidence to preferred theories, but always did and always will adapt theories to physical reality.

Einstein special relativity does not admit an absolute frame of reference, as well known. As equally well known, a universal substratum requires an absolute frame of reference. Consequently, the physics of the 20-th century decided that the universal substratum does not exist because not permitted by Einsteinian doctrines, so as to adapt nature to preferred theories.

The "arguments" used to eliminate the universal substratum should be, per se, reason for investigation by ethically sound historians, because a vivid illustration on how physics, a discipline intended to be quantitative and objective, is turned into political dogmas.

By leaving details to historians, a first argument for the elimination of the universal substratum was the reduction of light to photons that, as such, propagate like particles, thus not requiring any medium for their existence and propagation. The political character of this "argument," particularly when proffered by experts, is soon unmasked because radio waves with, say, one meter in wavelength, cannot possibly be reduced to photons in any credible way. Yet, the reduction of all electromagnetic waves to photons for the purpose of maintaining the validity of Einsteinian doctrines, was widely accepted during the 20-th century.

Another argument used to adapt nature to preferred theories was the so-called *aethereal (or ethereal) wind,* namely, the evidence that Earth encounters no "wind" (that is, no resistance) during its motion through space. Therefore, the universal substratum does not exist, according to this "argument."

The first paper written by the author back in 1956 [1] (when a high school student), was intended to eliminated the aethereal wind and stress the need, not only for a universal medium, but also for a vacuum with features similar to high rigidity and energy density (See Ref. [2] for historical account).

As it is well known, the electron is a pure oscillation with the well known frequency of 1.236×10^{20} Hz, thus requiring a universal medium for its very exis-

[4]Contrary to a number of popular views, the transversal character of light excludes the possibility that space is compressible or that it has characteristics similar to that of a liquid. Alternatively, no theory on space as a universal medium can be considered plausible unless it permits a quantitative representation of the transversal character of light, due to its evident fundamental character.

tence, since no ordinary "little mass" or other "little material entity" oscillates, as proved by Schrödinger to be the case for the variable x in Dirac's equation for the electron. In the structure of the electron, we merely have a dimensionless point of the universal substratum (or medium) that oscillates at the given frequency.

Ref. [54] indicated that, when the electron moves, it "cannot" experience any aethereal wind because we merely move its characteristic oscillation from one point of the aether others. Ref. [54] then suggested that the inertia (from which we compute the mass) is in actuality a tendency of the aether to oppose variations in the propagation of said oscillations.

The view presented in paper [1] is that exactly the same occurrence holds for all other elementary and composite particles. Consequently, the aether as a universal medium is necessary not only for the existence and propagation of electromagnetic waves, but also for the very existence of all elementary and composite particles and, therefore, of matter as perceived by our senses.

The main conclusion of paper [1] is that, *contrary to our sensory perception, matter is "entirely empty" and space is "entirely full,"* because mass can be entirely reduced to oscillations of the aether. To be more specific in this important point, it is generally believed that matter is "mostly empty," in the sense that, for any material substance, interatomic distances are large and then the distances between electrons and nuclei are proportionately equivalent to planetary distances. The terms "entirely empty" are referred to the fact that, following the reduction of matter to electrons, protons and neutrons, these particles too result to be empty, that is, lacking any material entity, because they are "pure oscillations" of space, that is oscillations of its point without any oscillating mass.

When initiating his academic life in the late 1960s, the author soon discovered that any mention of the aether as a universal medium would imply instant disqualification and loss of academic jobs due to organized academic interests on Einsteinian doctrines in control of the world wide physics community. Consequently, the author had to dedicate himself to other studies.

Nevertheless, *physical veritas* is not established by academic power, but by evidence. No matter how beloved and supported a theory may be a given time, no relativity can resist the test of time without a serious addressing of the existence of the universal substratum and its universal reference frame.

In this volume, *we shall assume that space is a universal medium characterized by the superposition of very high equal densities of positive and negative energies* that, according tol the isodual theory of antimatter, exist in physically different spaces, the conventional space over conventional numbers (with positive unit) for

positive energies and the isodual space on isodual numbers (with negative units) for negative energies (see Chapters I.2 and 1.3 for details on the isodual theory).[5]

In regard to the historical problem of compatibility of any given relativity with space conceived as a universal medium, we shall assume the pragmatic position that *no material system known to date can possibly identify the absolute reference frame at rest with respect to the universal medium. Hence, all issues pertaining to compatibility with the absolute reference frame will be deferred to epistemological;l studies not contemplated at this time.*

6.1.3 The Far Reaching Implications of Space as a Universal Medium

Far from claiming final knowledge one way or the other, the position assumed in these volumes is that *the existence of space (or ether) as a universal substratum for all events occurring in the universe is supported by sufficient evidence to be plausible, and its systematic study is warranted because of implications simply beyond our imagination at this time,* such as:

1) As studied in detail in this volume, the rest energy of the neutron is 0.78 MeV bigger than the sum of the rest energies of the proton and of the electron. As a result, the synthesis of the neutron inside stars, $p^+ + e^- \to n + \nu$, requires a minimum of 0.78 MeV (in which case there is no energy left for the neutrino). Evidently, this "missing energy" can be provided by the environment inside a star. However, due to the extreme density in the core of a star, the proton and the electron are expected to be at rest during said synthesis. It is then possible that the "missing energy" of 0.78 MeV originates from space as a universal medium with high energy density. Alternatively, the old hypothesis of continuous creation of matter in the universe could see its realization in the synthesis of the neutron inside stars, with far reaching implications. As an illustration, the quantitative study of space as a universal medium with high energy density eliminates the need for neutrino, quarks and dark matter as physical entities in our spacetime, obliterate current cosmological views as primordial, and replace them with broader vistas presented in Volume II.

2) As we shall see in Volume II, quantum mechanics is inapplicable for the synthesis $p^+ + e^- \to n + \nu$ because the Schrödinger equation fails to provide physical solutions for "positive binding energies", as it is the case for the neutron synthesis.

[5]In facing the progressively increasing novelties of this volume, when treating the hyperstructural branch of hadronic mechanics, the reader should keep in mind that the existence of matter and antimatter in separate, yet coexisting spaces is the first example of our hyperstructures. Note that in the physics of the 20-th century, matter and antimatter were conceived as existing in the same space,. but this lead to a large scientific imbalance, that matter could be treated at all levels while antimatter could be treated only at the level of second quantization. This imbalance of clear historical proportions could be solved solely via the indicated hyperstructure.

The non-expert reader is encouraged to verify this occurrence by attempting to solve any quantum bound state in which the usual "negative" potential is turned into a "positive" value. In fact, all physically consistent, quantum bound states (such as nuclei, atoms and molecules) have a "negative" binding energy. Hadronic mechanics was proposed by the author in memoir [5] of 1978 precisely for the achievement of a quantitative representation of the synthesis of the neutron inside stars. This objective was achieved in its entirety with the numerically exact representation of all characteristics of the neutron and its spontaneous decay (see Volume II). Hence, the understanding of these volumes requires the knowledge that *hadronic mechanics is the first and only known invariant theory permitting quantitative studies of the possible interplay between matter and the universal substratum.*

3) When compared to interstellar distances, our contemporary communications via electromagnetic waves can be compared to the communications with smoke signals during prehistoric times, evidently due to interstellar distances rendering the speed of light excessively slow. Hence, serious studies on future interstellar communications require the search for *new* communications with a speed dramatically bigger than that of light, among which, the first possibility is the conception, quantitative treatment, and subsequent realization of *longitudinal waves propagating through space.*In fact, due to the very high rigidity of the universal substratum, longitudinal waves are predicted to propagate in space with speeds millions of times bigger than the (transversal) speed of light. As well known, longitudinal waves are not predicted by Einstein special relativity (because not admitted by Maxwell's electrodynamics). However, the dismissal of the possible existence of longitudinal waves in space just because not predicted by Einsteinian doctrine is purely political and such a dismissal should itself be dismissed because nonscientific (see in Volume II).[6]

4) Space has emerged in recent studies as possessing an energy density beyond our imagination, to the extreme that one cubic centimeter of space may contain

[6]When at the Massachusetts Institute of Technology in the mid 1970s, the author heard a report on SETI (the search for extraterrestrial intelligence) with the conclusion (still valid today) that "there is no sign of extraterrestrial intelligent life," at which point the author asked "where, here or out there?" Like all other scientific activities of the 20-th century, the SETI program too was (and remains) restricted, beginning with its funding, to comply with Einsteinian doctrines. Hence, the search is specifically restricted to comply with Einsteinian doctrines. In explicit terms, the assumption of the SETI program is essentially that possible extraterrestrial civilizations can only use conventional electromagnetic waves for communications. Hence, if we do not detect the latter from far away stars, there is no extraterrestrial intelligent life. The author disagrees with this view because political (in fact, his stay at MIT was quite short). Our technological civilization is just about 150 years old. By comparison, other civilizations can have millions of years of technological evolution. Under these conditions. the denial of the existence of these civilizations on grounds that we do not detect electromagnetic signals from them is preposterous, because advanced extraterrestrial intelligent life may have abandoned them hundreds of thousands of years ago in favor of other forms of communications. Longitudinal waves propagating in space are only one possibility among several others, all permitting speeds immensely bigger than the speed of light.

more energy than that of the entire Sun. The isodual theory has established that negative energy exist in a spacetime different, yet coexisting, with that of positive energies. Hence, the isodual theory implies that space may be characterized by a a superposition of extreme equal values of positive and negative energies, with far reaching implications, such as the elimination of discontinuities at creation of the universe, the elimination of the very meaning of the search of the "age of the universe",[7] and other implications.

5) In the 20-th century, famous scientists claimed that it would be impossible for mankind to go to the ,moon and return safely. Scientific and technological advances proved them wrong. Nowadays, other scientists are on record with the claim that mankind will never travel to far away stars, and return, due to excessive distances. The claim is based, not only on the time required for such a travel, but also by the need of a fuel tank as big as the entire solar system. Evidently, both claims are based on the (tacit) assumption of the final validity of Einsteinian theories for all of the universe because, when said theories are assumed to have limitations, a number of possibilities emerge as conceivable already at our primitive stage of scientific evolution. Often, the science fictionof a given time has been proved to be surpassed by subsequent scientific advances. With the clear understanding that serious scientific studies on interstellar travel may well require the entire third millennium, the possible existence of space as a universal medium of the above type resolves, at this time on purely mathematical grounds, all the above objections. In fact, the above conception of space as a universal medium of extremely high equal amount of positive and negative energies allows the *spacetime isogeometric locomotion* studied in Chapter 14 of Volume II for which: a) there is no need for any "fuel tank" since space is universal reservoir of energy tappable via neutron synthesis or other yet unknown means; b) there is no limitation to speeds because the locomotion is not Newtonian[8] and occurs via a control of distances predicted by isogeometries; and c) motion is necessarily in both space and time, since any deformation of the former requires that of the latter, and vice-versa.

It is hoped that, besides the desire of stimulating young minds of any age, the above comments illustrates a main viewpoint conveyed in these volumes: *rather than having reached final character as proffered by political interests on Einsteinian doctrines, studies on relativity laws are at their infancy, and so much remains to be understood as well as discovered.*

[7]Because the "total age" of mater and (isodual) antimatter is zero.
[8]Namely, without action and reaction.

6.1.4 Rudiments of Santilli Isorelativity

For minimal self-sufficiency of this volume, let us recall that special relativity and relativistic quantum mechanics are based on the "universal constancy of the speed of light" c_o that is achieved via the invariance of the line element in the *Minkowskian spacetime* $M(x, \eta, R)$ (Section I.3.5.3)

$$x^2 = (x_\mu \times \eta_{\mu\nu} \times x^\nu) \times I =$$
$$= (x^1 \times x^1 + x^2 \times x^2 + x^3 \times x^3 - x^4 \times x^4) \times I \in R,$$
$$x^4 = c_o \times t, \quad I = Diag.(1, 1, 1, 1), \tag{6.1.1}$$

under the celebrated *Lorentz symmetry* $O(3.1)$ characterized by the *Lorentz transformations* here expressed for simplicity in the $(3, 4)$ coordinates

$$x^{1'} = x^1, \quad x^{2'} = x^2, \tag{6.1.2a}$$

$$x^{3'} = \gamma \times (x^3 - \beta \times x^4), \quad x^{4'} = \gamma \times (x^4 - \beta \times x^3), \tag{6.1.2b}$$

$$\gamma = (1 - \beta^2)^{-1/2}, \quad \beta = v^2/c_o^2, \tag{6.1.2c}$$

where: $\times$ is the conventional associative product; $+$ is the conventional sum; $I = Diag.(1, 1, 1, 1)$ is the fundamental unit of the Lorentz symmetry $O(3.1)$; for consistency, I is assumed as the unit of the base field of real numbers $R = R(n, +, \times)$; and the multiplication of the line element by I is then necessary for x^2 to be an element of the assumed base field.

However, the "universal constancy of the speed of light" is a manipulation of scientific reality, particularly when ventured by experts, whenever said statement is proffered without the crucial addition "in vacuum." The "universal constancy of the speed of light in vacuum" (namely, in exterior conditions), has been experimentally established beyond scientific or otherwise useful doubt. When this statement is contracted into "universal constancy of the speed of light" it is referred to all possible conditions existing in the universe, including interior conditions. In the latter case, not only we have no experimental evidence at all, but have robust evidence on the lack of constancy of the speed of light. Hence, when experts venture the statement of the "universal constancy of the speed of light" without the crucial specification "in vacuum" they perpetrate a manipulation of science intended to extend the validity of special relativity to all possible conditions existing in the universe.

For all cases of interior dynamical problems within a physical medium, experimental evidence establishes that *the speed of light c is a local variable* depending on the density d, temperature τ, frequency ω, and other characteristics of the medium considered, $c = c(d, \tau, \omega, ...)$, as expressed by the historical form studied in high school

$$c = c(d, \tau, \omega, ...) = \frac{c_o}{n} = \frac{c_o}{n(d, \tau, \omega, ...)}. \tag{6.1.3}$$

Organized interests on Einsteinian doctrines have attempted to dismiss the local character of the speed of light via the reduction of light to photons scattering among atoms, in which case photons propagate in vacuum, hence at the speed c_o. In Chapter I.1, we have shown the nonscientific character of this claim on various grounds, such as: the impossibility of reducing to photons electromagnetic waves with one meter wavelength; the inability of the reduction to photons for speeds bigger than c_o nowadays experimentally established beyond credible doubt (see below); the collapse of the axioms of special relativity even for a simple case of propagation of light in water, due to either the violation of causality (because ordinary electrons can propagate in water at speeds bigger than the local speed $c = 2 \times c_o/3$) or the violation of the axiom of relativistic sums of speeds of light; and other evidence.

The only possible scientific statement is that *special relativity and, consequently, relativistic quantum mechanics, are inapplicable (rather than violated) for interior dynamical systems* because not conceived for them. To prevent exiting from the boundaries of science, the broader relativity and related mechanics can indeed be subjected to scientific debates, but not their need.

To the author's best knowledge, the first studies on the invariance of the locally varying character of the speed of light were conducted by Lorentz [3] in 1895 via Eq. (6.1.3). These studies were ignored throughout the 20-th century evidently because not aligned with organized interests on special relativity, although Lorentz studies [1] did not escape Pauli's attention who quoted them in a footnote of his book [2].

Regrettably, Lorentz failed to achieve the invariance of $c = c_o/n(d, \tau, \omega, ...)$ and was forced to study the simpler case $c = c_o =$ constant in which case he did achieve the historical symmetry transformations (6.1.2).

The author has dedicated his research life to Lorentz's legacy [3] via decades of laborious studies reported in Volume I (as well as in the preceding volumes EHM-I and II). In essence, it emerged already at the time of the author's graduate studies in physics of the late 1960s that *Lorentz failed to achieve the invariance of the locally varying speed of light because the mathematics he used, Lie's theory, was indeed effective for the case of $c = c_o =$ constant, but basically insufficient for the broader case $c = c_o/n(d, \tau, \omega, ...)$.*

Hence, the author dedicated his efforts, firstly, to a structural generalization (called *lifting*) of Lie's theory, today known as the *Lie-Santilli iso-, geno- and hyper theory* for closed single-valued, open single-valued, and open multi-valued conditions of matter and their *isoduals* for antimatter (see Volume I for a review and EHM-I and II for detailed studies).

In particular, the author discovered that invariance was achieved if and only if any structural generalization of Lie's theory was formulated via a compatible lifting of the *totality* of the underlying mathematics, including numbers, prod-

ucts, fields, spaces, topologies, functional analysis, differential calculus, etc. The resulting new formulations are today known as *Santilli iso-, geno-, and hyper-mathematics* for matter and their *isoduals* for antimatter.

As now familiar in the field, these broader mathematics are based on the lifting of the basic unit of Lorentz symmetry, $I = Diag.(1, 1, 1, 1)$, into the most general possible units $\hat{I}, \hat{I}^{>}, \hat{I}^{\{>\}}$, called *Santilli iso-, geno- and hyper-units,* respectively, with compatible lifting of the product and of the entire conventional mathematics.

By ignoring to avoid excessive complexities the open, irreversible, single-valued case (used for the invariance of light during its absorption) and the open, irreversible, multi-valued case (used for biological processes), we here briefly outline for self-sufficiency the main lines of the isotopic lifting of the Lorentz symmetry.

The transition from the Minkowski metric for the propagation of light in vacuum, $\eta = Diag.(1, 1, 1, -c_o^2)$, to the generalized Minkowski-Santilli isometric for the propagation of light within transparent physical media, $\hat{\eta} = Diag.(1, 1, 1, -c^2)$, $c = c_o/n$ is necessarily a *noncanonical transformation* at the classical level or a *nonunitary transformation* at the operator level,

$$\eta = (1, 1, 1, -c_o^2) \to \hat{\eta} = Diag.(1, 1, 1, -c_o^2/n^2) = Z \times \eta \times Z^\dagger, \tag{6.1.4a}$$

$$Z = Diag(1, 1, 1, i/n), \quad Z \times Z^\dagger \neq I. \tag{6.1.4b}$$

The use of rotations and Lorentz transforms then yields a lifting of all remaining components of the isometric. The Lie-Santilli isotheory is constructed by applying, for reasons clarified below, the inverse of the metric transform to the totality of the mathematics underlying Lie's theory, resulting in expressions of the type

$$U \times U^\dagger = (Z \times Z^\dagger)^{-1} = Diag.(1/b_1^2, 1/b_2^2, 1/b_3^2, 1/b_4^2), =$$
$$= Diag.(n_1^2, n_2^2, n_3^2, n_4^2) \tag{6.1.5a}$$

$$I \to \hat{I} = U \times I \times U^\dagger = Diag.(1/b_1^2, 1/b_2^2, 1/b_3^2, 1/b_4^2) = Diag.(n_1^2, n_2^2, n_3^2, n_4^2),$$
$$n_\alpha = n_\alpha(\mu, \tau, \omega, ...), n_4 = n, \tag{6.1.5b}$$

$$n \in R \to \hat{n} = U \times n \times U^\dagger = n \times (U \times U^\dagger) = n \times \hat{I} \in \hat{R}, \tag{6,1.5c}$$

$$n \times m \to \hat{n}\hat{\times}\hat{m} = U \times (n \times m) \times U^\dagger = \hat{n} \times \hat{T} \times \hat{m}, \quad \hat{T} = 1/U \times U^\dagger, \tag{6,1.5d}$$

$$[X_i, X_j] = X_i \times X_j - X_j \times X_i \to [\hat{X}_i, \hat{X}_j] = \hat{X}_i \hat{\times} \hat{X}_j - \hat{X}_j \hat{\times} \hat{X}_i = U \times [X_i, X_j \times U^\dagger, \tag{6.1.5e}$$

$$e^X \to \hat{e}^{\hat{X}} = U \times (e^X) \times U^\dagger = (e^{X \times \hat{T}}) \times \hat{I} = \hat{I} \times (e^{\hat{T} \times X}), \ \ etc. \tag{6.1.5f}$$

The invariance under additional nonunitary transforms is assured, provided that it is studied within the context of *isomathematics* and not that of conventional mathematics. This requires the identical reformulation of a given nonunitary transform into the *isounitary transform*,

$$W \times W^\dagger \neq I, \quad W = \hat{W} \times \hat{T}^{1/2}, \quad W \times W^\dagger \equiv \hat{W} \hat{\times} \hat{W}^{\hat{\dagger}} = \hat{W}^{\hat{\dagger}} \times \hat{W} = \hat{I}, \tag{6.1.6}$$

under which we have the invariance laws

$$\hat{I} \to \hat{W}\hat{\times}\hat{I}\hat{\times}\hat{W}^{\hat{\dagger}} \equiv \hat{I}, \tag{6.1.7a}$$

$$\hat{X}_i\hat{\times}\hat{X}_j \to \hat{W}\hat{\times}(\hat{X}_i\hat{\times}\hat{X}_j)\hat{\times}\hat{W}^{\hat{\dagger}} = \hat{X}'_i \times \hat{T} \times \hat{X}'_j = \hat{X}'_i\hat{\times}\hat{X}'_j, \quad etc. \tag{6.1.7b}$$

from which all other invariances follow. Note the *invariance of the numerical value of the isounit* $\hat{I}$ *and of the isoproduct represented by the numerical invariance of* $\hat{T}$.

The application of the above formalism to the invariance of locally varying speeds of light was achieved for the first time by R. M. Santilli in paper [3] of 1983 at the classical level and in paper [4] of the same year for the operator counterpart. These studies achieved the invariance of the following universal *isoline isoelement* on the *Minkowski-Santilli isospace* $\hat{M}(\hat{x}, \hat{\eta}, \hat{R})$

$$\hat{x}^{\hat{2}} = \hat{x}^\mu\hat{\times}\hat{\eta}_{\mu\nu}\hat{\times}\hat{x}^\nu = [x^\mu \times \hat{\eta}_{\mu\nu}(x, d, \tau, \omega, ...) \times x^\nu] \times \hat{I} =$$

$$= [x^\mu \times g_{\mu\nu}(x, d, \tau, \omega, ...) \times x^\nu] \times \hat{I} = [x^\mu \times \hat{T}^\rho_\mu(x, d, \tau, \omega, ...) \times \eta_{\rho\nu} \times x^\nu] \times \hat{I} =$$

$$= (x^1 \times x^1/n_1^2 + x^2 \times x^2/n_2^2 + x^3 \times x^3/n_3^2 - x^4 \times x^4/n_4^2) \times \hat{I} =$$

$$= (x^1 \times x^1 \times b_1^2 + x^2 \times x^2 \times b_2^2 + x^3 \times x^3 \times b_3^2 - x^4 \times x^4 \times b_4^2) \times \hat{I} \quad \in \hat{R}, \tag{6.1.8}$$

where the n's or the b's are called the *characteristic quantities* of the medium considered and they are normalized to the corresponding values in vacuum, i.e. in vacuum we have for the index of refraction $n_4 = 1/b_4 = 1$ for which $c = c_o$, and the space components are normalized to the value of the perfect sphere (the unit of the Euclidean geometry), $n_1 = n_2 = n_3 = 1/b_1 = 1/b_2 = 1/b_3 = 1$. Note that for mathematical rigor, we should have used in Eqs. (6.1.8) the *isoquotient* $\hat{/} = / \times \hat{I}$ and all characteristic quantities should have been *isonumbers,* e.g., $\hat{n}_\alpha = n_\alpha \times \hat{I}$, resulting in the simplification used in the preceding isoelement $\hat{/}\hat{n}_\alpha = /n_\alpha$.

It should be noted that *the characteristic quantities provide a direct geometrization (that is, a geometrization via the isometric) of the deviation from the Minkowskian geometry for the vacuum caused by physical media.* Hence, the characteristic quantities $b_k = 1/n_k$, $k = 1, 2, 3$, characterize the geometric deviations from the Euclidean space for the motion of extended particle or electromagnetic waves within physical media, while the quantity $b_4 = 1/n_4$ characterizes the deviation from the Minkowskian time.[9]

[9]Paper [5] on the first derivation of the invariance of line element (6.1.8) was published by the Italian Physical Society; follow up paper [6] was published by the Moscow Physical Society; and subsequent papers and monographs were published by other physical societies, including important publications in Israel the author will identify later on in this volume (and express his appreciation). Various papers

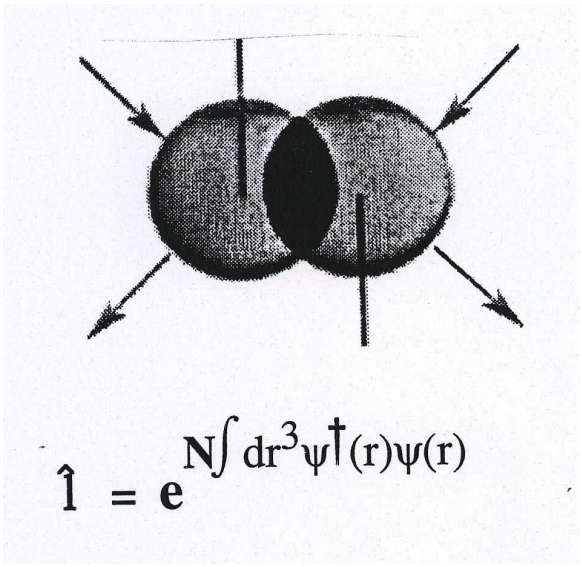

Figure 6.2. A schematic view of the *new interactions* studied in these volumes: the contact, zero-range, nonlinear, nonlocal and nonpotential interactions typical of all interior dynamical problems originating in deep mutual penetration of the wavepackets and/or charge distributions of particles as occurring in the hadronic structure, inelastic scattering, electron valence bonds, and numerous other events. Special relativity and quantum mechanics can only represent *dimensionless point-like particles,* as expected to be admitted by experts to qualify as such. Additionally, their Hamiltonians can only represent action-at-a-distance interactions derivable from a potential. Consequently, it was popularly believed throughout the 20-th century that the interactions herein considered do not exist resulting in a plethora of assumptions, insufficiencies or inconsistencies studied in details in Chapter I.1. The studies reported in these volumes required decades of research because of the difficulties, not only in representing interactions outside the capabilities of the Hamiltonian, but also achieving their *invariant representation,* i.e., a representation that would not change over time and other symmetry transformations. Following numerous trials and errors, the only consistent solution identified by the author is the representation of all non-Hamiltonian interactions and effects with a generalization of the basic unit, today known as *Santilli isounit* because the unit is the most fundamental invariant of all theories.

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in related fields were also published up to 1983 by the American and British Physical Societies (the latter known as "Institute of Physics"). However, ALL papers submitted from 1984 to date to these societies by the author and his associates (for a total of over 100 submissions) were rejected on purely political arguments without visible scientific content. A routine "argument" for rejection was that "the characteristic quantities are arbitrary parameters with no physical value." Hence, the representations of the spheroidal shape of a hadron via the semiaxes $1/n_1^2, 1/n_2^2, 1/n_3^2$ and its density with the value $1/n_4^2$ (given by the rest energy divided by the volume) were rejected because dubbed arbitrary. Yet, the same societies routinely accepted as physical the true parameter q in thousands of ;publications in the q-deformations $AB - qBA$; or said societies accepted as physical different values of neutrino and quark

Note the *direct universality* of the isoline (6.1.8) in the sense that it includes as particular cases all possible line elements with signature $(+,+,+,-)$, thus including the Minkowskian, Riemannian, Finslerian, and any other possible line elements. Such a universality is said to be direct because it occurs in the space-time of the experimenter without any need for coordinate transforms. Note that, also for simplicity, we have used the *diagonal* form of the isoline isoelement. For the general nondiagonal form the interested reader may study EHM-II.

The reconstruction of the Lorentz symmetry for the invariance of the above universal isoline isoelement was done in Ref. [4a] at the classical level and in Ref. [4b] at the operator level, both of 1983, via isounit (6.1.5a), isoalgebra (6.1.5e) and isotransformations (6.1.5f), and lead to the *Lorentz-Santilli isosymmetry* $\hat{O}(3.1)$ with the fundamental *isotransformations* (I.3.5.20) that we write for motion in the $(3,4)$ plane (see EHM-II for the general case)

$$x^{1'} = x^1, \quad x^{2'} = x^2, \tag{6.1.9a}$$

$$x^{3'} = \hat{\gamma} \times (x^3 - \frac{n_4}{n_3} \times \hat{\beta} \times x^4) = \hat{\gamma} \times (x^3 - \frac{b_3}{b_4} \times \hat{\beta} \times x^4), \tag{6.1.9b}$$

$$x^{4'} = \hat{\gamma} \times (x^4 - \frac{n_3}{n_4} \times \hat{\beta} \times x^3) = \hat{\gamma} \times (x^4 - \frac{b_4}{b_3} \times \hat{\beta} \times x^3), \tag{6.1.9c}$$

$$\hat{\gamma} = (1 - \hat{\beta}^2)^{-1/2}, \quad \hat{\beta} = v \times b_3/c_o \times b_4 = v \times n_4/c_o \times n_3, \tag{6, 1.9d}$$

$$\hat{I} = Diag.(1/b_1^2, 1/b_2^2, 1/b_3^2, 1/bs_4^2) = Diag.(n_1^2, n_2^2, n_3^2, n_4^2), \tag{6.1.9r}$$

formulated on ordinary space, rather than isospace, for simplicity.

Systematic studies were then done in Ref.s [5], including the isotopies of: rotational symmetry [5a,5b]; SU(2)-spin symmetry [5c,5d]; Poincaré symmetry [5e,5f]; and spinorial covering of the Poincaré symmetry [5g] (see monographs [6] for a comprehensive study as of 1991, and EHM, Vols. I and II, as well as Volume I of this series for details).

Note that, by conception and construction, the Lorentz-Santilli isosymmetry is locally isomorphic to the conventional Lorentz symmetry, $\hat{O}(3.1) \approx O(3.1)$. Hence, the author introduced the word "isotopies" to denote, in the Greeck meaning of the word, the preservation of the original axioms.

An important property, also discovered by R. M. Santilli [5], is that, contrary to popular beliefs, *the Lorentz symmetry is seven and not six dimensional.* This is due to the new *isotopic invariance* here expressed for a constant number $z \in R$

$$x^2 = (x^\mu \times \eta_{\mu\nu} \times x^\nu) \times I \equiv [x^\mu \times (z^2 \times \eta_{\mu\nu}) \times x^\nu] \times (z^{-2} \times I) = (x^\mu \times \hat{\eta}_{\mu\nu} \times x^\nu) \times \hat{I}. \tag{6.1.10}$$

masses. The problem for said societies is that the shape and density of hadrons are indeed physical because experimentally measured, while neutrino and quark masses are purely hypothetical since they cannot be directly measured.

As we shall see, and as expected for any new invariance in our spacetime, the novel invariance (6.1.10) carries fundamental implications at all levels of study, from particle physics to cosmology, including far reaching advances such as the first known axiomatically consistent grand unification of electroweak and gravitational interactions studied in Chapter 14.

The fact that the new isoinvariance (6.1.10) remained un-noticed throughout the 20-th century until identified in Ref. [5] should not be surprising because its identification required the prior discovery of *new numbers,* Santilli's isonumbers with arbitrary positive-definite unit $\hat{I}$.

From now on we shall use the following terminology: the use of conventional terms, such as speed, mass, energy, etc., eill denote conventional quantities defined on the conventional Minkowski space over the conventional field of real numbers. Terms such as *isospeed, isomass, isoenergy, etc.* will denote quantities defined on the Minkowski-Santilli isospace over the isofield of real numbers.

Santilli isorelativity (see Volume I as well as monographs [6] (as well as EHM-II and HM-I) and original references quoted therein) is based on the Poincaré-Santilli isosymmetry and the following isoaxioms (see Section I.3.5 for details):

ISOAXIOM I. The projection in our spacetime of the maximal causal invariant speed is given by:

$$V_{max} = c_o \times \frac{b_4}{b_3} = c_o \times \frac{n_3}{n_4} = \frac{c}{b_3} = c \times n_3 = c_o \times \frac{g_{44}^{1/2}}{g_{33}^{1/2}}. \tag{6.1.11}$$

ISOAXIOM II. The projection in our spacetime of the isorelativistic addition of speeds within physical media is given by:

$$v_{tot} = \frac{v_1 + v_2}{1 + \frac{v_1 \times b_3^2 \times v_2}{c_o \times b_4^2 \times c_o}} = \frac{v_1 + v_2}{1 + \frac{v_1 \times n_4^2 \times v_2}{c_o \times n_3^2 \times c_o}} = \frac{v_1 + v_2}{1 + \frac{v_1 \times g_{33} \times v_2}{c_o \times g_{44} \times c_o}}. \tag{6.1.12}$$

ISOAXIOM III. The projection in our spacetime of the isorelativistic laws of dilation of time $t_\circ$, contraction of length $\ell_\circ$ and variation of mass $m_\circ$ with speed are given respectively by:

$$t = \hat{\gamma} \times t_\circ, \tag{6.1.13a}$$

$$\ell = \hat{\gamma}^{-1} \times \ell_\circ, \tag{6.1.13b}$$

$$m = \hat{\gamma} \times m_\circ. \tag{6.1.13c}$$

ISOAXIOM IV. The projection in our spacetime of the Doppler-Santilli isolaw is given by the law (here formulated for simplicity for 90° angle of aberration):

$$\omega = \omega_o \times \frac{1 - \hat{\beta} \times c\hat{o}s\hat{\theta}}{\sqrt{1 - hatbeta^2}}, \tag{6.1.14}$$

ISOAXIOM V. The projection in our spacetime of the isorelativistic law of equivalence of mass and energy is given by:[10]

$$E = m \times V_{max}^2 = m \times c_o^2 \times \frac{b_4^2}{b_3^2} = m \times c_o^2 \times \frac{n_3^2}{n_4^2}. \tag{6.1.15}$$

In the above isoaxioms we have

$$\hat{\beta} = v \times b_3/c_o \times b_4 = v \times n_4/c_o \times n_3 = v/V_{max}, \hat{cos}\hat{\theta} = cos(\theta \times b_s) \tag{6.1.16}$$

Since v is always smaller than or equal to the maximal causal speed V_{max}, $\hat{\beta}$ is always smaller than or equal to one and $\hat{\gamma} = (1 - \hat{\beta}^2)^{-1/2}$ cannot take imaginary values as it is the case for special relativity. For isotrigonometric functions, we refer the reader for brevity to EHM Vol. I. For detailed studies of the iso-Doppler law, one may consult EHM Vol./ II, Section 8.5.F.

Note that *the isoaxioms are not isotopies of the corresponding axioms of special relativity, because they characterize major structural departures, such as; the the maximal local speed is not, in general, the speed of light; the energy equivalence is not given by the familiar expression* $E = m \times c^2$*; etc.* These structural deviations emerge only within physical media and have major implications we shall study later on, such as the elimination of any need for dark matter..

As we shall see, these deviations are requested by experimental evidence. For instance, in the event the maximal causal speed would be the local speed of light, isorelativity would be violated by water where ordinary electrons can propagate faster than the local speed of light. On the contrary, water is homogeneous and isotropic. Consequently, for water we have $b_3 = b_4$ and the maximal causal speed *in water* is given by the speed of light *in vacuum.* In this case isorelativity verifies causality laws because ordinary electrons travels in water at speeds smaller then the local maximal causal speed. The other axioms are equally verified, such as the isorelativistic sum of speeds (see Section 6.1.7 for details).

The above structural deviations from special relativity can be understood by noting that the main meaning of the new isoaxioms is isogeometrical. Recall that the isotopies reconstruct on isospaces over isofield "all" original axioms identically. For instance, the isoimage of an hyperboloid is the perfect isosphere, the

[10]As indicated in Section 3.5, the initial formulation of Isoaxiom V was

$$E = m \times c^2 = m \times c_o^2 \times b_4^2 = \frac{m \times c_o^2}{n_4^2}.$$

However, experimental verifications of isorelativity proved this formulation to be wrong, and had to be replaced with isolaw (6.1.15). The occurrence reinforced the view that, contrary to poular beliefs in the 20-th century, *the speed of light is not, in general, the maxima. causal speed because physical media are generally opaque lo light, in which case the use of the speed of light has no mathematical or physical meaning.* It happens that in vacuum $b_3 = b_4 = 1$ and in water $b_3 = b_4$, in which case $V_{max} = c_o$, but this is a mere particular case without universal validity.

isoimage of the deformation of the light cone caused by variable speeds of light is the perfect light isocone, etc. These exact reconstructions are, evidently, at the foundations of the reconstruction of exact spacetime and internal symmetries when popularly believed to be broken due to the use of excessively elementary mathematics.

The mechanism of achieving this reconstruction is given by the lifting of any given physical quantity, say, $v^2 \to v^2 \times b_3^2$ while the corresp[onding unit is lifted of the *inverse* amount, $I = 1 \to \hat{I} = 1/b_3^2$. The exact reconstruction then follows from isoinvariance (6.1.10).

By the same argument, *the isotopic image of all physical media is given by the perfect isovacuum, that is, the vacuum referred to the Minkowski-Santilli isospace lover isofields.* In fact, the maximal causal speed on isospaces over isofields is the speed of light *in vacuum,* otherwise the Lorentz-Santilli isosymmetry could not be isomorphic to the conventional Lorentz symmetry.

ISOMINKOWSKIAN CLASSIFICATION OF PHYSICAL MEDIA

GROUP I: $\hat{\beta} \equiv \beta$, $\hat{\gamma} = \gamma$;
- **TYPE 1:** $n_S = n_4$, $n_4 = 1$;
- **TYPE 2:** $n_S = n_4$, $n_4 > 1$;
- **TYPE 3:** $n_S = n_4$, $n_4 < 1$;

GROUP II: $\hat{\beta} > \beta$, $\hat{\gamma} \leqq \gamma$;
- **TYPE 4:** $n_S < n_4$, $n_4 = 1$;
- **TYPE 5:** $n_S < n_4$, $n_4 > 1$;
- **TYPE 6:** $n_S < n_4$, $n_4 < 1$;

GROUP III: $\hat{\beta} < \beta$, $\hat{\gamma} > \gamma$;
- **TYPE 7:** $n_S > n_4$, $n_4 = 1$;
- **TYPE 8:** $n_S > n_4$, $n_4 > 1$;
- **TYPE 9:** $n_S > n_4$, $n_4 < 1$;

Figure 6.3. A view of the classification of physical media permitted by the Minkowski-Santilli isogeometry first proposed in Ref. [6] of 1991 (see also Figure 8.5.1 of EHM-II and Ref. [63]).

Under such isogeometrization of physical media, the projection in our spacetime of the maximal causal isospeed is not the local speed of light $c = c_o \times b_4$ but instead it is given by the maximal causal speed $V_{max} = c_o \times b_4/b_3$, since isotopies preserve the axiomatic character, the speed of light being an ordinary locally variable quantity under isotopy.

The Minkwski-Santilli isogeometry permits an important classification of pohysical media (see Figure 6.3) under the following basic characterizations:

1) Spherical symmetry is represented which $b_k = b_s = 1/n_s = 1/n_s,\ k = 1, 2, 3$, normalized to the value $b_s = n_s = 1$ for the vacuum. Alternatively, n_s can be given in certain cases by the average of the $n_k, k = 1, 2, 3$.

2) The first direct geometric representation known to the author ("direct" because done directly with the metric) of the *density* of the medium considered is done with $b_4 = 1/n_4$ also normalized to the value $b_4 = n_4 = 1$ for the vacuum;

3) The direct geometric representation of the general *inhomogeneity* of the medium is done via a dependence of the characteristic quantities on the local radial distance r and other variables, $b_s = b_s(r, ...) = 1/n_s(r, ...)$. Such a local variations can be averaged to constants for simplicity.

4) The direct geometric representation of the general *anisotropy* is done via a difference between the space and time characteristic quantities, $b_s \neq b_4,\ n_s \neq n_4$.

5) The direct geometric representation of the *locally varying speed of light*, the maximal causal speed and the other features of isorelativity are done via Isoaxioms I to V.

The above characterizations provide the following *classical iso-Minkowskianclassification of physical media* first presented in Ref. [6] of 1991, Section IV-10 (see also Ref. [63] and EHM II):

GROUP I: characterized by $n_s = n_4,\ n_4 = 1, > 1, < 1$.
These media possess the same homogeneity and isotropy of space (vacuum).

GROUP II: characterized by $n_s < n_4,\ n_4 = 1, > 1, < 1$.
These media are inhomogeneous and isotropic with low density.

GROUP III: characterized by $n_s > n_4,\ n_4 = 1, > 1, < 1$.
These media are inhomogeneous and anisotropic with high density.

GROUP I, TYPE 1: $n_s = n_4,\ n_4 = 1,\ \hat{\beta} = \beta,\ \hat{\gamma} = \gamma,\ c = c_o,\ V_{max} = c_o,\ V_{max} = c,\ V_{max} = c$.
This case represents empty space (vacuum);

GROUP I, TYPE 2: $n_s = n_4,\ n_4 > 1,\ \hat{\beta} = \beta,\ \hat{\gamma} = \gamma,\ c < c_o,\ V_{max} = c_o,\ V_{max} > c$.
These homogeneous and isotropic media originate from the isotopic invariance of the line element, Eq. (6.1.10), for $z^2 < 1$; they are transparent to light (because $V_{max} > c$); and they represent ordinary homogeneous and isotropic media such as water, or transparent liquids in general.

GROUP I, TYPE 3: $n_s = n_4,\ n_4 < 1,\ \hat{\beta} = \beta,\ \hat{\gamma} = \gamma,\ c > c_o,\ V_{max} = c_o,\ V_{max} < c$,
These homogeneous and isotropic media also originate from isotopic invariance (6.1.10) for $z^2 > 1$, and they constitute the *new media* predicted by isorelativity.

A possible candidate is given by *superconductors,* as studied in Chapter 8 with electrons moving at the maximal causal speed $V_{max} = c_o$. These media can be either opaque to light (because $V_{max} < c$), or be transparent, in which case $c_{max} = V_{max}$ because the speed of light is not the maximal causal speed, but an ordinary local speed, thus being bounded by V_{max}. In case the media are opaque to light, $b_4 = 1/n_4$ preserves its meaning as a geometrization of the density with significant meaning, such as the fact that media of Type 3 are more dense than those of Type 2 (because $c_{I,3} > c_{I,2}$.

GROUP II, TYPE 4: $n_s < n_4,\ n_4 = 1,\ \hat{\beta} < \beta,\ \hat{\gamma} > \gamma,\ c = c_o,\ V_{max} < c_o,\ V_{max} < c$.

These media are the first to be non trivial, in the sense that they cannot be derived from the isotopic invariance (6.1.10). Hence, they are are inhomogeneous and anisotropic, and they are generally transparent to light, in which case $c_{max} = V_{max}$, although the case of media opaque to light (with $V_{max} < c$ should not be excluded. Expected candidates for these media are planetary atmospheres or astrophysical chromospheres because they are of generally low denmsity, inhomogeneous (due to the radial variation of the density) and anisotropic (due to rotations establishing a preferred direction in space). These features require a necessary departure from the Minkowskian spacetime with deep astrophysical implications, e.g., in current unfounded beliefs on cosmological redshits. Another expected case is given by the media inside light unstable particles, such as pions, as studied in Section 6.1.7. Other expected media of this type are given by ordinary conductors.[11]

GROUP II, TYPE 5: $n_s < n_4,\ n_4 > 1,\ \hat{\beta} < \beta,\ \hat{\gamma} > \gamma,\ c < c_o,\ V_{max} < c_o,\ V_{max} \leq c$.

These are inhomogeneous and anisotropic media of generally low to moderate density (because the maximal possible speed of light is smaller than that in vacuum). As such, these media are significant for astrophysical chromospheres and other interior bodies. In fact, we shall show in Section 6.1.11 that the huge inhomogeneous and anisotropic chromospheres of quasars are media precisely of this type. Intriguoingly, the same holds for the mediua inside light hadrons, as shown in Section 6.1.8.

[11]By ignoring all other arguments and experimental evidence studied in these volumes, the sole previledged space directions possessed by atmospheres or chromospheres, particles such as hadrons, and conductors at large is sufficient to prohibit the exact validity of Einsteinian doctrines due to their stricty isotropic charactrer, since anisotropy has deep geometric and dynamical implications. The appropriate broadening of Einsteinian doctrines that is applicable for basic advances in the representation of anisotropic systems, is indeed open to scientific debates, by the denial of its need is scientific corruption for personal gain in mantaining pre-established doctrines.

GROUP II, TYPE 6: $n_s < n_4,\ n_4 < 1,\ \hat{\beta} < \beta,\ \hat{\gamma} > \gamma,\ c > c_o,\ V_{max} < c_o,\ V_{max} < c.$

These media too are inhomogeneous and anisotropic with expected low to moderate density. Examples are given by nuclei that are indeed, inhomopgeneous and anisotropic, yet treated with the homogeneous and isotropic Minkowskian spacetime and related Poincaré symmetry, despite the fact that nuclei have no nuclei (Figure 6.1) in which case the assumption of the exact Poincaré symmetry and special relativity is mere theological, as studied in Chapter 7. The differences between media of Group II, Types 4, 5, 6 are expected to represent significant geometric differences ignored during the 20-th century because, again, nature was adapted to the homogeneous and isotropic spacetime of special relativity.

GROUP III, TYPE 7: $n_s > n_4,\ n_4 = 1,\ \hat{\beta} < \beta,\ \hat{\gamma} > \gamma,\ c = c_o,\ V_{max} > c_o,\ V_{max} > c.$

This is the first of three inhomogeneous and anisotropic media of highden sity that are of primary relevance for hadronic mechansics because representing the hyperdense media inside hadrons, stars, quasars and other internal astrophysical problems. All media of this group have $V_{max} > c_o$ and $V_{max} > c$. The first of these three media has the geometric significance that the speed of light is the same as that in vacuum, $c = c_o$.

GROUP III, TYPE 8: $n_s > n_4,\ n_4 > 1,\ \hat{\beta} < \beta,\ \hat{\gamma} > \gamma,\ c < c_o,\ V_{max} > c_o,\ V_{max} > c.$

This is a second type of inhomogeneous and anisotropic media of high density that is conceivable for extreme astrophysical conditions, such as those in the interior of black holes, in which the maximal causal speed is expected to have no limit, but the speed of light is expected to be much smaller than that in vacuum, assuming that light can even propagate in media of such extreme densities.

GROUP III, TYPE 9: $n_s > n_4,\ n_4 < 1,\ \hat{\beta} < \beta,\ \hat{\gamma} > \gamma,\ c > c_o,\ V_{max} > c_o,\ V_{max} > c,\ V_{max} > c.$

These media are experimentally verified in the interior of heavy hadrons (Section 6.1.7, 6.1.8, 6.1.9), in the interior of the fireball of the Bose-Einstein correlation (Section 6.1.10) and other hyperdense inhomogeneous and anisotropic media. As we shall see, these last media do indeed permit the prediction, quantitative development and industrial realization of basically "new" clean energies, such as energies originating from mechanism in the interior of the neutron, rather than in a nuclear structure. Due to their societal need, readers are alerted that *technical* criticisms are solicited, welcome and appreciated as part of a serious scientific

process, but opposition based on tangential issues without technical relevance will be denounced as a threat to society.[12]

Santilli isodual isorelativity for the characterization of antimatter can be easily constructed via the isodual map of Chapter I.3, and its explicit study is left to the interested reader for brevity. For recent studies on Santilli isorelativity one may consult A. K. Aringazin [7], J. F. Kadeisvili [8], K. Masuda [9], and monographs [19-24].

The reader should remember from Volume I that isorelativity unifies the special and the general into one single relativity. The unification is done beginning at the level of unification of the Minkowskian and Riemannian geometries [10] and carries over at all subsequent levels. In fact, isoelement (6.1.8) is inclusive of all possible Riemannian line elements as indicated earlier, and the Lorentz-Santilli isosymmetry $\hat{O}(3,1)$ is the universal symmetry of all possible Riemannian gravitation, first presented in Ref. [5].

However, a necessary condition for the achievement of a universal *symmetry* for all gravitational models is the abandonment of curvature since gravitation is represented in the Minkowski-Santilli isospace that is isoflat. This occurrence can also be seen from the fat that *isogravitation* [11] is characterized by

1) Factorizing any Riemannian $g(x)$ metric into a 4×4 matrix $\hat{T}(x)$ and the Minkowskian metric,

$$g_{\mu\nu} = \hat{T}^{\rho}_{\mu}(x) \times \eta_{\rho\nu}, \tag{6.1.17}$$

2) Assuming $\hat{T}(x)$ as the inverse of the new isounit,

$$\hat{I}(x) = 1/\hat{T}(x), \tag{6.1.18}$$

[12]When exposed to possible deviations from Einsteinian doctrines, a decreasing number of academicians usually retort to criticisms on tangential issues of no scientific meaning of values, evidently due to the lack of technical arguments caused by gross ignorance mixed with bad faith. As one among too many illustrations, the last "criticism " moved against the author's studies is that "the public records in Tallahassee, Florida, shows the Institute for Basic Research has having Santilli and his wife as the sole officers." This type of "criticism" is ventured by amoral and asocial academicians abusing their temporary academic credibility granted by naive people, who are solely interested in exploting and dishonoring the name of Albert Einstein for personal gains in money, prestige and power. The originators of such "criticisms" will be publicly denounced hereon with their actual names; petitions will be filed at their colleges for investigations by ethics committees; and they will be prosecuted, whenever possible, in the U. S. Federal Court if acting under public financial support. This harsh response is necessary, not only in view of the social need to surpass Einsteinian doctrines as a necessary condition to conceive and devbelop "new" clean energies, but also because the "crime" (intended as damage to society) perpetrated by an academician in manipulating a scientific process for personal gain is much bigger than ordinary crimes, such as gun pointed stealing of money at a grocery store. For the record, the Statute of the Institute for Basic Research prohibits the disclosure of its members (numbering over 100 around the world) so as to prevent that their family and academic lives be disrupted by the organized scientific crime on Einsteinian doctrines, as it has been attempted against the author' personal and academic life for decades with no avail (see also www.scientificethsics.org).

3) Formulating the line element with Riemannian isometric $g(x) = \hat{T}(x) \times \eta$ as an *isonumber,* that is, with respect to the isounit $\hat{I}(x) = \hat{T}(x)$,

$$\hat{x^2} = [x^t \times (\hat{T} \times \eta) \times x] \times \hat{I}, \tag{6.1.19}$$

in which case the curvature represented by $\hat{T}(x)$ is essentially "cancelled out" by its inverse $\hat{I}(x)$.

The noninitiated reader should be aware that the conventional formulation of gravity, that on a curved manifold, is afflicted by numerous theorems of catastrophic mathematical and physical inconsistencies studied in details in Chapter I.1., Ref. [13], and briefly outlined in Section I.1.4. Isogravitation was formulated as the only way known to the author to bypass these inconsistency theorems, that by eliminating curvature in favor of broader geometric views [10].

A main result is the achievement in Ref. [14] of the apparently first known, axiomatically consistent grand unification of electroweak and gravitational interactions, where "axiomatically consistency" is referred to the inclusion of both matter and antimatter (the latter being rather universally ignored in grand unifications), the use of a consistent operator formulation of gravity [11], e.g., verifying the PCT theorem, and admitting compatible symmetries.

A central objective of this volume is to present a variety of experimental verifications of isorelativity for interior dynamical conditions in different fields.

6.1.5 Rudiments of Hadronic Mechanics

For minimal self-sufficiency of this volume, let us also recall that the*isotopic branch of nonrelativistic or relativistic hadronic mechanics* (first proposed in memoirs [15] of 1978) can be constructed via techniques similar to those of the preceding subsection. Any given quantum model can be lifted into the covering hadronic version via the use of a nonsingular, positive-definite, nonunitary transform on a *Hilbert space* $\mathcal{H}$ over the field of complex numbers C.

We first have the lifting of *Planck's constant* into a isounit that is positive definite (thus invertible) but otherwise possesses an unrestricted functional dependence on time t, local coordinates r, linear momentum p, wavefunctions ψ, and any other needed variable,

$$\hbar \to \hat{I}(t, r, p, E, \psi, ...) = 1/\hat{T}(t, r, p, \psi, ...) = U \times U^\dagger > 0, \tag{6.1.20}$$

where the dependence on energy E is trivially derived from the unrestricted dependence on the linear momentum and coordinates (see EHM-II).

The above lifting represents the impossibility of conventional quantum orbits in the hyperdense medium inside hadrons, nuclei and stars (if nothing else, due to the absence of a Keplerian structure and the consequential inapplicability of conventional Poincaré symmetry), and as verified in this volume.

Lifting (6.1.20) is restricted to verify the general condition

$$Lim\hat{I}_{r>>1\ fm} \equiv \hbar \tag{6.1.21}$$

assuring that hadronic mechanics recovers quantum mechanics uniquely and identically at sufficiently large mutual distances of particles., thus including the recovering of conventional quantized orbits (that exist only for distances much bigger than 1 fm).

Compatibility conditions (6.1.21) will soon appear crucial for the understanding of the compatibility of our structure model of the neutron as a hadronic bound states of a proton and an electron and the conventional structure of the hydrogen atom.

We then have the lifting of $\mathcal{H}$ into the *Hilbert-Santilli isospace* $\hat{\mathcal{H}}$ expressible via the following lifting of states. inner products and expectation values of a (Hermitean operator A

$$|\psi > \ \in \ \ \mathcal{H} \to |\hat{\psi} >= U \times |\psi > \in \hat{\mathcal{H}}, \tag{6.1.22a}$$

$$< \psi| \times |\psi > \times I \ \ \in \ \ R \to U \times (< \psi| \times |\psi > \times I) \times U^{\dagger} =$$
$$=< \psi| \times U^{\dagger} \times (U \times U^{\dagger})^{-1} \times U \times |\psi > \times U \times I \times U^{\dagger} =$$
$$=< \hat{\psi}|\hat{\times}|\hat{\psi} > \times \hat{I} \ \ \in \hat{C}, \tag{6.1.22b}$$

$$< A >=< \psi| \times A \times |\psi > \times I \to U \times (< \psi| \times A \times |\psi > \times I) \times U^{\dagger} =$$
$$=< \hat{\psi}|\hat{\times}\hat{A}\hat{\times}|\hat{\psi} > \times \hat{I} =< \hat{A} > . \tag{6.1.22c}$$

We then have we have the identity

$$< \hat{I} >\equiv \hbar = I \tag{6.1.23}$$

illustrating the fact that deviations from conventional quantization processes are *internal* and not detectable in exterior conditions.

Similarly, we have the lifting of Heisenberg's equations into the *Heisenberg-Santilli isoequations* (first proposed in Ref. [13] of 1978, see memoir [14 of 1996 for the first formulation via the isodifferential calculus)

$$i \times \frac{dA}{dt} = [A, H] \to U \times (i \times \frac{dA}{dt}) \times U^{\dagger} =$$

$$= \hat{i}\hat{\times}\frac{\hat{d}\hat{A}}{\hat{d}\hat{t}} = i \times \hat{I}_t \times \frac{d\hat{A}}{d\hat{t}} =$$
$$= U \times [A.H] \times U^{\dagger} = [\hat{A}\hat{,}\hat{H}] = \hat{A} \times \hat{T}_r \times \hat{H} - \hat{H} \times \hat{T}_r \times \hat{A}, \tag{6.1.24}$$

where one should note isounits of time and space denoted with the subindeces t, r, respectively (generally ignored whenever there is no ambiguity), and one should note the use of the *isodifferential calculus* first introduced in memoir [15] of 1996.

Similarly, we have the lifting of canonical commutation rules into *isocanonical isocommutation rules* also introduced for the first time in memoir [14]

$$[r^i, p^j] = i \times \delta^i_j \to [\hat{r}^i \hat{,} \hat{p}_j] = \hat{i}\hat{\delta}^i_j = i \times \hat{I} \times \delta^i_j, \tag{6.1.25}$$

Similarly, we have the lifting of the Schrödinger equations into the *Schrödinger-Santilli isoequations* first formulated in an invariant form in memoir [15]

$$i \times \hbar \times \frac{\partial}{\partial t}|\psi >= H \times |\psi > \to$$

$$\to \hat{i}\hat{\times}\frac{\hat{\partial}}{\hat{\partial}\hat{t}}|\hat{\psi}(\hat{t},\hat{r}) >= i \times \hat{I}_t \times \frac{\partial}{\partial \hat{t}} =$$

$$= \hat{H}\hat{\times}|\hat{\psi} >= \hat{H}(\hat{r},\hat{p}) \times \hat{T}_r(\hat{t},\hat{r},\hat{p},\hat{\psi},...) \times |\hat{\psi} > . \tag{6.1.26}$$

and the lifting of the linear momentum into *isolinear isomomentum* (reached for the first time in memoir [15] following decades of search due to the preceding absence of the isodifferential calculus

$$p_k \times |\psi >= -i \times \hbar \times \partial_k |\psi > \to U \times (p_k \times |\psi >) =$$

$$= U \times p_k \times (U \times I^\dagger)^{-1} \times U \times |\psi >= \hat{p}_k \hat{\times} |\hat{\psi} >= -U \times (i \times \hbar \times \partial |\psi >) =$$

$$= -\hat{i}\hat{\times}\hat{\partial}_k|\hat{\psi} >= -i \times \hat{I}^i_k \times \partial_i |\hat{\psi} >, \tag{6.1.27}$$

We should also recall the new invariance of the conventional inner product under isotopic transforms here expressed for a non-null constant $z \in R$

$$< \psi| \times |\psi > \times I \equiv < \psi| \times z^2 \times | \, psi > \times (z^- 2 \times I) \equiv < \psi| \hat{\times} | \, psi > \times \hat{I}, \tag{6.1.28}$$

with extension to an arbitrary positive-definite nonunitary transform and isounit $U \times U^\dagger = \hat{I} > 0$ via the techniques of HM-I.

Note the *abstract identity of hadronic and quantum mechanics* as illustrated by the property that all relative equations and physical laws are merely differentiated by a "hat" denoting the existence of a *broader realization* of the same axioms.

The above occurrences forcefully establishes the validity of nonrelativistic and relativistic hadronic mechanics in the conditions of their applicability, evidently because of the preservation of the conventional axioms of quantum mechanics. In turn, this forcefully establishes the validity of the Minkowski-Santilli isospaces for interior particle conditions as verified below.

Alternatively, the preservation of the abstract axioms in the transition from quantum to hadronic mechanics renders nonscientific the aprioristic selection of

any of them, since the only scientific selection of the truly applicable mechanics for given conditions is the experimental verification,

Note that the preceding isoequations also provide an explicit realization of *operator isogravity*, first submitted at the Marcel Grossmann meeting of 1998 [12] under the mere realization of the isounit and isotopic elements as the gravitational forms (6.1.18), (6.1.9). The consistency of operator isogravity, including the verification of the PCT theorem, is assured by the preservation of the abstract axioms of conventional relativistic quantum mechanics.

Independent reviews of hadronic mechanics are provided by monographs [19-24]. A large number of independent papers written during the bast three decades can be found in the general bibliography at the end of this volume.

6.1.6 Catastrophic Mathematical and Physical Inconsistencies of Noncanonical and Nonunitary Theories

As it is well known, classical canonical theories, or operator unitary theories, are Hamiltonian in the sense that they represent the entire system considered via the sole knowledge of a Hamiltonian. Consequently, the representation of new effects beyond the representational capabilities of a Hamiltonian, such as nonpotential interactions, has requested the use of noncanonical or nonunitary theories, e.g., theories whose time evolution verifies condition

$$U(t) \times U(t)^\dagger \neq I, \tag{6.1.29}$$

formulated on conventional mathematics.

A knowledge truly crucial for the understanding of this volume (studied in details in Section I.1.5 Theorem I.1.5.2) is that the latter theories are afflicted by the following catastrophic inconsistencies:

THEOREM 6.1 [25-32]: All noncanonical and nonunitary theories formulated via the mathematics of canonical or unitary theories (conventional numbers, spaces, functional analysis, etc.) are afflicted by catastrophic mathematical and physical inconsistencies.

On mathematical grounds, by their very definition, noncanonical and nonunitary theories do not preserve the unit,

$$I \to I' = U \times I \times U^\dagger \neq I. \tag{6.1.30}$$

Consequently, noncanonical and nonunitary theories do not preserve over time the unit I of their base fields, with consequential catastrophic collapse over time of the entire mathematical structure, including spaces, algebras, geometries, symmetries, etc. since all of them remain formulated over a base field no longer

applicable at later time. An identical situation occurs under all other automorphism

On physical grounds, units of Lie symmetries represent units of measurements. For instance, the unit of the Euclidean geometry $I = Diag.1, 1, 1)$ represents in an abstract dimensionless form units actually used in tests, such as $I = Diag.(1\ \ cm, 1\ \ cm, 1\ \ cm)$. Consequently, a theory with a noncanonical or nonunitary time evolution necessarily alters the numerical values of the basic units used in measurements, such as, for in stance, in the case

$$I = Diag.(1\ \ cm, 1\ \ cm, 1\ \ cm) \to U \times I \times U^\dagger = I =$$

$$= Diag.(7.3\ \ cm, 345\ \ cm, 0.003\ \ cm), \tag{6.1.31}$$

thus preventing any meaningful application in dynamics.

Noncanonical and nonunitary theories have additional catastrophic physical inconsistencies, such as they do not preserve over time the Hermiticity and, hence, the observability of physical quantities, namely, an operator H that is Hermitean at the initial time is not necessarily Hermitean at a subsequent time (this property is known as the *Lopez Lemma* [26,27), Eq. (I.1.5.52), i.e.

$$[< \psi| \times U^\dagger \times (U \times U^\dagger)^{-1} \times U \times H \times U^\dagger] \times U|\psi >=$$

$$=< \psi| \times U^\dagger \times [(U \times H \times U^\dagger) \times (U \times U^\dagger)^{-1} \times U|\psi >] =$$

$$= (< \hat{\psi} \times T \times H'^\dagger) \times |\hat{\psi}\rangle = \langle\hat{\psi}| \times (\hat{H} \times T \times |\hat{\psi} >), \tag{6.1.32a}$$

$$|\hat{\psi}\rangle = U \times |\psi\rangle,\ \ T = (U \times U^\dagger)^{-1} = T^\dagger, \tag{6.1.32b}$$

$$H'^\dagger = T^{-1} \times \hat{H} \times T \neq H. \tag{1.5.52c}$$

where the loss of observability follows from the general lack of commutativity of H and T. Similarly, noncanonical and nonunitary theories generally violate causality (we teach in first year graduate school of physics that the causality verified by quantum mechanics is due to its unitary structure), and other serious catastrophes.

In view of these occurrences, all papers with a noncanonical or nonunitary structure formulated with conventional mathematics, are catastrophically inconsistent and should not be considered for any serious scientific study.

Isorelativity and hadronic mechanics avoid these inconsistencies thanks to the prior discovery of new mathematics specifically constructed for the task, Santilli iso-, geno- and hyper-mathematics for matter and their isoduals for antimatter for closed single-valued, open single-valued and open multi-valued conditions, respectively. Theorem 6.1 is bypassed because the new mathematics reconstruct canonicity or unitarity on iso-, geno- and hyper-spaces over iso-, geno-, and hyper-fields, respectively (for brevity see HM-I).

The above mathematical and [physical inconsistencies are typically suffered by the so-called *q-deformations* with *deformed Lie product* $(A, B) = A \times B - q \times B \times A$, where q is a non-null number. In fact, in this case we have the time evolution in the following infinitesimal and finite form

$$i \times \frac{dA}{dt} = A \times H - q \times H \times A, \tag{6.1.33a}$$

$$A(t) = U \times A(0) \times W^{\dagger} = (e^{i \times t \times q \times H}) \times A(0) \times (e^{-i \times t \times H}). \tag{6.1.33b}$$

directly activating Theorem 6.1.

These deformations were initiated by R. M. Santilli via paper [33] of 1967 in their broader form $(A, B) = p \times A \times B - q \times B \times A$, where p and q are non-null scalars; they were resumed in 1986 by L. C. Biedenharn [34] and A. J. Macdarlane [35] in the reduced form of the q-deformations; and they subsequently resulted in a river of papers in the field.[13] Ironically, by the time Biedenharn and Macfairlane elected to study the q-deformations, Santilli had long abandoned the field because of the catastrophic mathematical and physical inconsistencies herein considered.

Another illustration of catastrophically inconsistent theories is given by Ref. [36] of 1999 dealing with a structure dubbed by the authors "deformed Minkowski space" that is entirely identical to the Minkowski-Santilli isospace previously introduced by Santilli [3] in 1983 (including the use of exactly the same symbols!). But this "deformed space" is formulated on conventional fields and elaborated with conventional mathematics, thus being catastrophically inconsistent on mathematical and physical grounds.[14]

In general, *all* theories departing from the conventional structure of Lie's theory (that characterized by unitary transformations on a Hilbert space over the field of complex numbers) verify Theorem 6.1, as it is the case of the *supersymmetries* [37] (see Section I.1.5 for details).

$$(A, B) = \alpha \times (A \times B - B \times A) + \beta \times (A \times B + B \times A) = \alpha \times [A, B] + \beta \times \{A, B\}, \tag{6.1.34}$$

where α, β are suitable factors depending on the model at hand.[15]

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[13] L. C. Biedenharn and A. J. Macfarlane were fully aware of the initiation of the q-deformations by Santilli [33] some twenty years earlier, as proven by the fact that in the early 1980 Biedenharn and Santilli applied for a joint DOE grant, but there was no quotation of the origination [33] in papers [34,35] because of reported ascientific pressures from the Cantabridgean academic community. As a result of this multi-faced ascientific episode, Santilli has been called *the most plagiarized physicist of the 20-th century.*

[14] A lawsuit for plagiarism, scientific fraud, abuse of public funds and other claims was filed on February 2007 at the U. S. federal Court against F. Cardone, R. Mignani, their funding institutions and other defendants, due to the impossibility over decades to have them quote the origination paper [3] and at least address the catastrophic inconsistencies of their work conducted under public financial support, of which one of them had been an originator [29].

[15] Supersymmetric theories are a trivial particular case of Santilli Lie-admissible theory with product

$$(A, B) = A \times P \times B - B \times Q \times A =$$

The reader with a young mind of any age as well as independence from orthodox interests can now understand the reason for gravitation defined on a Riemannian space to be catastrophically inconsistent [13] at both the classical and operator levels. In fact, curvature necessarily implies that the time evolution of the theory is necessarily noncanonical at the classical level and nonunitary at the operator level, with direct activation of Theorem 6.1 (dee Ref. [13] for a total of *nine theorems of catastrophic inconsistencies of general relativity*). At any rate, general relativity admits no distinction whatever between neutral matter and antimatter. Consequently, any attempt at achieving a consistent operator theory of gravity is doomed to failure.

To avoid a mathematical treatment that may appear excessive to readers due to the applied character of this volume, in this volume we shall study experimental verifications and industrial applications formulated via the *projection* of the formulations in our conventional spacetime over conventional fields, with the clear understanding that their sole correct formulation is on iso-, geno- and hyper-spacetime over iso-, geno- and hyperfields.

6.1.7 Experimental Verifications for Arbitrary Speeds of Light

Isorelativity resolves the inconsistencies of special relativity for classical particles and electromagnetic waves propagating within physical media, including media transparent to light, such as water. In particular, isorelativity provides an *invariant* representation of locally varying speeds of light, while preserving the abstract axioms of special relativity. Since the latter is manifestly inapplicable within physical media, the physical evidence supporting the validity of isorelativity in classical mechanics over special relativity is beyond credible doubt.

Let us consider first the case of water (studied in detail in EHM-II). This medium is homogeneous and isotropic with $c < c_o$ (c in water is about 2/3 of c_o). hence, *water is an iso-Minkowskian medium of Group I, Type 2* (Figure 6.3), thus requiring that Isoaxioms I, Eqs. (6.1.11), holds for $b_3 = b_4$, as a result of which

$$V_{max} = c_o \times \frac{b_4}{b_3} = c_o \tag{6.1.35}$$

namely, *the maximal causal speed in water is the speed of light in vacuum.* This resolves the violation of causality suffered by special relativity because electrons in water can travel faster than the local speed of light, but they keep traveling at speeds smaller than the maximal causal speed.

$$= (A \times T \times B - B \times T \times A) + (A \times V \times B + B \times QV \times A) =$$
$$= [A\hat{,}B] + \{A\hat{,}B\}, \;\; P - Q = T, \;\; P - Q = V.$$

Invariance is then achieved via elaborations based on genomathematics (see [18] for brevity).

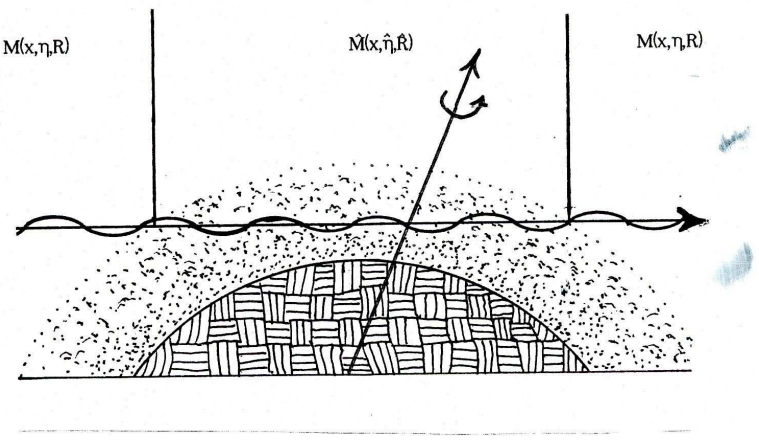

Figure 6.4. An illustration of the spacetime geometries used for the description of electromagnetic waves passing through Earth's atmosphere: the conventional Minkowski geometry is used for propagation in vacuum (exterior problem), and the Minkowski-Santilli isogeometry is used for propagation in Earth's atmosphere (interior problems). The isogeometry has been constructed for a representation of the deviations from the geometry of empty space caused by a physical medium. These deviations do not exist for special relativity because the theory abstracts all particles as idealized points for which physical media do not exist. However, the deviations emerge quite forcefully when particles are represented with their actual extended size, thus rendering inevitable contact, zero-range, nonlocal, nonlinear and nonpotential forces, e.g., of resistive type as experienced by a missile in atmosphere or, equivalently, by an electron moving within the interior of a hadron, or a proton moving in the interior of a star. In Volume I we presented No-Reduction Theorems preventing a consistent reduction of a macroscopic system with contact nonpotential interactions to a hypothetical ensemble of point-like abstractions of particles all in conservative conditions. This established that the contact nonpotential interactions existing in our physical environment originate at the ultimate level of particles, thus establishing the foundations for hadronic mechanics. In this volume we shall present numerous experimental verifications of deviations from the Minkowskian spacetime caused by physical media and then show that said deviations permit the conception and industrial development of new clean energies and fuels that are simply unthinkable for point-like abstractions of particles and their wavepackets.

Isoaxiom II, Eqs. (6.1.12), on the isorelativistic sums of speeds is also verified. For instance, the maximal causal speed verifies the isolaw

$$V_{tot} = \frac{V_{max} + V_{max}}{1 + \frac{V_{max}}{V_{max}}} \equiv V_{max}, \tag{6.1.36}$$

and this resolves the second inconsistency of special relativity in water, the fact that the sum of two maximal causal speeds in water (assumed by special relativity to be necessarily c_o to avoid violation of causality) does not yield the maximal causal speed,

$$V_{tot} = \frac{\frac{2}{3} \times c_o + \frac{2}{3} \times c_o}{1 + \frac{4 \times c_o^2/9}{c_o^2}} = \frac{12}{13} \times c_o \neq c_o. \tag{6.1.37}$$

Note that the above resolutions require *the abandonment of the speed of light as the maximal causal speed for motion within physical media, and its replacement with the maximal causal speed* (6.1.11). In fact, physical media are generally opaque to light. It happens that in vacuum these two speeds coincide. However, even in vacuum the correct maximal causal speed remains Eq. (6.1.11) and *not* that of light, as generally believed.

At any rate, to extend the applicability of special relativity beyond the conditions of its original conception, it is popularly believed that the speed of light in vacuum is the maximal causal speed also within physical media in which light cannot propagate. Such a belief has no scientific value or credibility.

The case of classical physical media opaque to light follows the same lines. Special relativity has no meaning when light cannot propagate. Isorelativity applies because physical media represented with conventional spaces over conventional fields are geometrize into a form equivalent to the vacuum when formulated on isospaces over isofields. In fact, the maximal causal speed on isospaces over isofields is c_o and not c (see Volume I for technical aspects). Alternatively, we can say that the vacuum formulated on isospaces over isofields, when projected in our space over conventional fields, characterizes physical media.

The most forceful classical verification of isorelativity is provided by the experimental evidence that electromagnetic waves can propagate within certain guides and other conditions at speeds bigger than the speed of light in vacuum [38,39] conducted at the University of Cologne, Germany, today known as the *Cologne experiment*. These experiments were confirmed via independent tests conducted in Italy (Florence), U.S.A. (Berkeley), Austria (Wien) and France (Orsay and Rennes) (see review [40] of all experimental data on $c > c_o$ up to 2000). Hence, *the existence of electromagnetic waves propagating at speeds bigger than that of light in vacuum is, nowadays, an experimental reality beyond scientific or credible doubt.*

At any rate, an entire Beethoven symphony has been transmitted at speeds $c > c_o$. Any claim of validity of special relativity for these experimental results would be sheer corruption, for which reasons experimental evidence of speeds

$c > c_o$ is often ignored in high energy physics, thus causing problems of scientific ethics and accountability of potentially historical proportions.[16]

The validity of isorelativity and relativistic hadronic mechanics for all possible speeds $c > c_o$ is established quite forcefully by the following facts:

i) Isorelativity applies for any possible local speed of light c, irrespective of whether smaller or bigger than c_o, the case $c = c_o$ being a trivial particular case;

ii) Isorelativity is the sole theory providing the invariance of arbitrary local speeds of light;

iii) Isorelativity is "directly universal," that is, including all conceivably possible (nonsingular) theories for arbitrary speeds of light (universality), directly in the spacetime of the observer without any need to use transformations of local coordinates (direct universality). This is due to the fact that, on one side, the transition from the speed of light in vacuum to locally varying speeds requires noncanonical transformations (Subsection 6.1.2) while, on the other side, isorelativity includes the most general possible noncanonical transforms.

iv) Isorelativity is the only known theory bypassing the theorems of catastrophic inconsistencies of noncanonical theories (Subsection 6.1.4) thanks to its underlying novel isomathematics;

v) Isorelativity is the sole new relativity that has permitted scientific and industrial advances on new clean energies ands fuels simply inconceivable with special relativity.

The invariant geometrization of speeds $c > c_o$ permitted by isorelativity and relativistic hadronic mechanics is elementary. With reference to experiments [38,39], in the following we outline the treatment via *the isotopic branch of hadronic mechanics,* or *isomechanics,* [8], treated via the *Minkowski-Santilli isogeometry,* although solely referred to the steady segment of the tests, that in between the guides.

The geometrization of the entire process, that starting from propagation in vacuum and then passing though guides, requires the *genotopic branch of hadronic mechanics,* or *genomechanics,* treated via the *Minkowski-Santilli genogeometry* [18] studied in detail in Volume I (see also EHM-II). The latter treatment is excessively advanced for the applied character of this volume and will be presented elsewhere.

To set up notations, let us recall the rudiments of the propagation of monochromatic electromagnetic waves in vacuum. The geometry is characterized by the conventional Minkowskian spacetime $M(x, \eta, R)$ with metric, coordinates, wavevec-

[16]The established experimental evidence on electromagnetic waves propagating in certain guides at speeds $c > c_o$ is sufficient, per se, to render equivocal the use of public funds in high energy physics experiments at Fermilab, CERN, and other laboratories all based on the assumption of the exact validity of Einsteinian doctrines within media dramatically denser than *waveguides*, such as the media inside hadrons.

tor, and related invariants,

$$(\eta_{\mu\nu}) = (\eta^{\mu\nu}) = Diag.(1, 1, 1, -1), \eta_{\mu\alpha} \times \eta^{\alpha\nu} = \delta_\mu^\nu, \tag{6.1.38a}$$

$$x = (x^\mu) = (r^k, x_4) = (r^i, c_o \times t), K = (K_\mu) = (k_i, \frac{\omega}{c_o}), i = 1, 2, 3, \tag{6.1.38b}$$

$$x^2 = (x^\mu \times \eta_{\mu\nu} \times x^\nu) \times I = (r^i \times r^i - c_o^2 \times t^2) \times I, \tag{6.1.38c}$$

$$K^2 = (K_\mu \times \eta^{\mu\nu} \times K_\nu) \times I = (k_i \times k_i - \frac{\omega^2}{c_o^2} \times I, \tag{6.1.38d}$$

where, in accordance with our formalism (Section 6.1.2), we multiply the invariants by the unit of the base field R to assure their scalar character on rigorous mathematical grounds, but such a multiplication will be ignored thereafter for notational simplicity.

An elementary electromagnetic wave propagating in empty space can be represented on a conventional Hilbert space $\mathcal{H}$ over C via the familiar wavefunction

$$\psi = e^{i \times K_\mu \times x^\mu} = e^{i \times k_i \times r^i - \omega \times t}. \tag{6.1.39}$$

We then have the linear momentum eigenvalue equation

$$p_\mu \times \psi = -i \times \partial_\mu \psi = K_\mu \times \psi, \tag{6.1.40}$$

and the well known wave equations

$$\eta^{mu\nu} \times p_\mu \times p_\nu \times \psi = \eta^{\mu\nu} \times K_\mu \times K_\nu = (k_i \times k_i - \frac{\omega^2}{c_o^2} \times \psi = 0. \tag{6.1.41}$$

The speed of electromagnetic waves in vacuum can then be represented via the known expressions

$$\frac{dr}{dt} \approx \frac{d\omega}{dk} = c_o, \tag{.6.1.42}$$

confirming that c_o is indeed the maxima;l causal speed *in vacuum,* as well known.

Recall that *isotopies are axiom-preserving.* Hence, the representation of electromagnetic waves of tests [38,39] traveling faster than c_o can be done with *exactly the same expressions* (6.1.38)-(6.1.42), only subjected to a broader realization (or interpretation). Nevertheless, for clarify, we write down the representation explicitly.

The basic space is the Minkowski-Santilli isospace $\hat{M}(\hat{x}, \hat{\eta}, \hat{R})$ [3] with isometric, isocoordinates, isowavevector,and related isoinvariants (see EHM-II, Volume I and the short review in Section 6.1.2)

$$(\hat{\eta}_{\mu\nu}) = (\hat{T}_\mu^\alpha \times \eta_{\alpha\nu}) = Diag.(b_1^2, b_2^2, b_3^2, b_4^2),$$

$$(\hat{\eta}^{\mu\nu}) = (\hat{I}^{\mu}_{\alpha} \times \eta^{\alpha\nu} = Diag.(b_1^{-2}, b_2^{-2}, b_3^{-2}, b_4^{-2}), \hat{\eta}_{\mu\rho} \times \hat{\eta}^{\rho\nu} = \delta^{\nu}_{\mu}, \tag{6.1.43a}$$

$$\hat{x} = (\hat{x}^{\mu}) = (\hat{r}^{i}, \hat{x}_4) = (\hat{r}^{i}, c_o \times \hat{t}), \hat{K} = (\hat{K}_{\mu}) = (\hat{k}_i, \frac{\hat{\omega}}{c_o}), \tag{6.1.43b}$$

$$\hat{x}^{\hat{2}} = (\hat{x}^{\mu} \times \hat{\eta}_{\mu\nu} \times \hat{x}^{\nu}) \times \hat{I} = (\hat{r}^{i} \times \hat{r}^{i} \times b_i^2 - c_0^2 \times \hat{t}^2 \times b_4^2) \times I, \tag{6.1.43c}$$

$$\hat{K}^{\hat{2}} = (\hat{K}_{\mu} \times \hat{\eta}^{\mu\nu} \times \hat{K}_{\nu}) \times \hat{I} = (\hat{k}_i \times \hat{k}_i \times b_i^{-2} - \frac{\hat{\omega}^2}{c_o^2} \times b_4^{-2}) \times \hat{I}, \tag{6.1.43d}$$

where the reader should keep in mind that $\hat{x}$ and $\hat{K}$ are now defined on $\hat{M}(\hat{x}, \hat{\eta}, \hat{R})$, and that the speed of light on isospace over isofields is c_o and not $c = c_o \times b_4$ (Volume I and EHM-II).

A monochromatic electromagnetic wave propagating through the guides of the Cologne experiment can be represented on a Hilbert-Santilli isospace $\hat{\mathcal{H}}$ over the isofield $\hat{C}$ via the elementary isowavefunction (the isoexponentiation (6.1.5f) and EHM-II)

$$\hat{\psi} = e^{i \times \hat{K}_{\mu} \times \hat{x}^{\mu} \times b_{\mu}^2} = e^{i \times \hat{k}_i \times r^i \times b_i^2 - \omega \times t}, \tag{6.1.44}$$

where we have ignored the multiplication by $\hat{I}$ for simplicity.

We then have the *isolinear isomomentum* equation of hadronic mechanics [15]

$$\hat{p}_{\mu} \hat{\times} \hat{\psi} = \hat{p}_{\mu} \times \hat{T} \times \hat{\psi} = -i \times \hat{\partial}_{\mu} \hat{\psi} = \hat{K}_{\mu} \times \hat{\psi}, \tag{6.1.45}$$

with isowave isoequations

$$\hat{\eta}^{mu\nu} \times p_{\mu} \times p_{\nu} \times \psi = \eta^{\mu\nu} \times K_{\mu} \times K_{\nu} = (k_i \times k_i \times b_i^{-2} - \frac{\omega^2}{c_o^2 \times b_4^{-2}} \times \times \psi = 0. \tag{6.1.46}$$

At this point we assume that the space component of the guides of tests [38.39] is isotropic, thus representable with one single space characteristic quantity, and that the symmetry axis of the tests is along the z-axis, thus allowing us to ignore the x and y components,

$$b_1 = b_2 = b_3 = b_s, r^1 = r^2 = k_1 = k_2 = 0. \tag{6.1.47}$$

We also assume that, for the steady conditions here considered, the characteristic quantities are constants or can be averaged into constants.

In correspondence of Eq. (6.1.42) we then have the expression (expressed in terms of conventional differential calculus)

$$\frac{d\hat{r}}{d\hat{t}} \approx \frac{d\hat{\omega}}{d\hat{k}} = c_o \times \frac{b_s}{b_4} = c \times b_s = V_{max}, \tag{.6.1.48}$$

namely, *the maximal causal speed of the Cologne experiment is that of isorelativity,* Eq. (6.1.11), thus providing a significant confirmation of the axiomatic structure

of isorelativity. The re-derivation of law 6.1.48) via the isodifferential calculus [15] is an instructive exercise for the reader expert on quantum mechanics, yet with insufficient knowledge of the covering hadronic mechanics.

The simp;lest possible fit of Eqs. (6.1.48) is given by assuming $b_s = 1$, as a result of which the numerical value of b_4 is trivially given by the numerical data of Refs. [38,39] for c, such as

$$b_4 = \frac{c}{c_o} = 1.5. \tag{6.1.49}$$

However, we note that *a mutation of the geometry of space requires a corresponding mutation of time and vice versa.* Hence, we exclude that we have $b_s = o$ in the Cologne experiment. Rather than being a drawback, the occurrence renders tests [38,39] quite intriguing. In fact, *depending on the assumed geometry, the Minkowski-Santilli isospace predicts that the Cologne experiment can be conducted for speeds both bigger as well as smaller than that of light in vacuum,* according to the following classification of possibilities:

$$V_{max} > c_o, I : c_o \leq c \leq V_{max}, II : c \leq c_o, \tag{6.1.50a}$$

$$V_{max} = c_o, III : c \leq c_o, \tag{6.1.50b}$$

$$V_{max} < c_o, IV : c \leq V_{max}. \tag{6.1.50c}$$

It appears that the set up of the Cologne experiment has realized only Case I of the above possibilities. The remaining cases are important, e.g., to see whether ordinary particles can travel in between the guides at speeds bigger than $c > c_o$, but smaller than V_{max}. If verified, this occurrence would constitute a superluminal reproduction of the occurrence in water in which electron travel faster than the local speed of light but slower than the maximal causal speed.

We finally mention that the *mutation*[17] of the geometry caused by the Cologne experiment is conceptually quite simple. Tests [38,39] essentially deal with the interactions at the very foundations of isorelativity and hadronic mechanics, the contact, zero-range interactions that are extended over a volume (thus being nonlocal of integral type) and not representable with a potential (thus being non-Hamiltonian hence requiring nonunitary theories), the latter condition being absolutely crucial to allow speeds $c > c_o$.[18]

[17]"mutations" are referred to invariant alterations of the spacetime geometry referred to isospaces over isofields as first introduced by Santilli [33] in 1967, while "deformations" are referred to non-invariant, thus catastrophically inconsistent alterations of the geometry referred to conventional spaces and fields.
[18]It is easy to prove that for a fully Hamiltonian theory, speeds $c > c_o$ cannot exist. In fact, orthodox physicists still deny speeds $c > c_o$ on grounds that they are not admitted by their beloved theories, a view that is both, correct, yet corrupt because based on the assumption that the old doctrines of the 20-th century, above all Einsteinian theories, are the final doctrines for all of the future history of mankind.

In turn, said non-Hamiltonian interactions cause a mutation in our terminology, namely, they change the very structure of the wavepackets, for instance, by decreasing its amplitude, with consequential decrease of the frequency $\hat{o}mega < \omega$, and increase of the speed $c > c_o$. Once the geometry of the mutation is understood, it should be possible for interested experimentalists to attempt the other cases predicted by isorelativity and hadronic mechanics, Eqs. (6.'1.50).

In conclusion, the Cologne experiments [39,40] and their numerous re-runs [40] constitute a direct experimental verification of the ultimate mathematical and physical foundations of isorelativity and relativistic hadronic mechanics with rather deep implications that will better transpire in the following analysis.
[19]

The serious scholar seriously interested to science should keep in mind that Albert Einstein clearly identified the limits of applicability of special relativity, "point-like particles and electromagnetic waves propagating in vacuum." The extension of the applicability of special relativity beyond the conditions limpidly identified by Einstein has been done by *Einstein's followers* for their personal gains, and not by Einstein.

6.1.8 Experimental Verifications in the Interior of Hadrons

We now study the dynamics within the hyperdense media in the interior of hadrons, nuclei and stars, hereinafter referred as *hadronic media*.

Once the evidence of the inapplicability of special relativity and its underlying Minkowskian geometry is admitted for physical media of low density such as Earth's atmosphere (Figure 6.4), the belief of their exact validity within hadronic media is nonscientific. The selection of the applicable theory is indeed open to scientific debates, by the denial of the need to surpass Einsteinian theories within hadronic media is a scientific manipulation for personal gains. This is due to numerous reasons studied in Volume I, such as:

[19]The reader should be made aware of adulterations of the above treatment existing in the literature, such as that by F. Cardone and R. Mignani, Phys. Lett. A **306**, 265 (2003). In fact, this paper: assumes $b_4 = 1$ in which case there cannot be a superluminal speed because one can prove that $c = c_o \times b_4 = c_o$ via the Lorentz-Santilli isosymmetry and the entire paper makes no sense; conventional differential equations are altered in contradiction with the rigid requirements of the Minkowski-Santilli isogeometry, as proved by the fact that they do not constitute an (axiom-preserving) isotopy; and the paper is catastrophically inconsistent because it deals with a noncanonical - nonunitary formulated via conventional mathematics (Section 6.4). As indicated in an earlier footnote, said authors call the framework "deformed Minkowski space" or "deformed special relativity" and avoid any quotation of the vast preceding literature documentedly known to them (see R. Mignani, Physics Essays **5**, 531 (1992) where the space is called "Santilli isospace"). For these and other reasons, the author filed on February 2007 at the United States Federal Court lawsuit number 8:07-CV-00308-T-23MSS available in the web site of the U. S. Federal Court or in the mirror site http://www.scientificethics.org/Lawsuit-Cardone-Mignani.htm

1) The impossibility for photons to propagate for any finite length within hyperdense hadronic media as they propagate in vacuum, with consequential collapse of the entire special relativity, including the impossibility to assume c_o as the maximal causal speed within the media considered;

2) The experimentally established absence within hadrons of a Keplerian structure with a Keplerian center, with consequential well established impossibility for the pillar of special relativity, the Poincaré symmetry, to be exact (Figure 6.1);

3) The inapplicability within hadrons of the mathematics used by special relativity, due to its strict local-differential character, with consequential sole applicability to the nonlocal-integral character of the hadronic structure; and other reasons (see Volume I for details).

The use of conjectures not directly verifiable, such as those based on the hypothetical quarks and neutrinos (see next section), is also a manipulation of science for personal gains when used in their widespread intent: preserve the exact validity of orthodox theories while opposing professional studies on alternative views.

The reader is suggested to meditate a moment on the very large amount of public money that is spent nowadays in particle physics laboratories around the world (estimated in the range of billions of dollars per year) on the assumption that special relativity and the Minkowskian geometry are exact in the interior of the hyperdense hadrons. In this way the reader has a chance of deciding whether to be part of an expected condemnation by posterity, or pursue new physical knowledge.

The epistemological, phenomenological and experimental studies on the impossibility for special relativity and the Minkowskian spacetime to be exact in the interior of hadrons can be summarized as follows. R. M. Santilli [41] submitted the hypothesis in 1982 that *the maximal causal speed in the interior of hadrons is generally bigger than that in vacuum as an intrinsic feature of strong interactions at large.*

The main argument of Ref. [41] is that the maximal possible speed under *action-at-a-distance* interactions is indeed c_o, as well-known and experimentally established, e.g.,in particle accelerators. However, under *contact zero-range* interactions, the maximal causal speed can be arbitrary because the energy balance of the latter is dramatically different than that of the former, as classically verified, e.g., in the acceleration of a balloon by Earth's atmosphere.

Strong interactions occur at mutual distances of the order of $1fm = 10^{-13}cm$, that is also the size of all strongly interacting particles. Hence, the activation of strong interactions requires the mutual penetration and overlapping of the wavepackets and/or charge distributions of particles at short mutual distances, with ensuing contact, zero-range, nonpotential interactions. The prediction of Ref. [41] for speeds c bigger than that of light in vacuum, c_o, then applies for strong interactions at large.

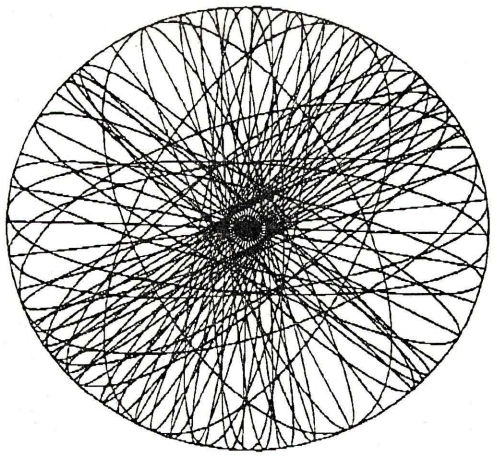

Figure 6.5. A schematic view of the *hadronic medium,* namely, the hyperdense medium inside hadrons, nuclei and stars. When combining the mathematical, theoretical and experimental evidence collected in these volumes, the belief that special relativity and quantum mechanics are "exactly" valid in the interior of hadrons is qualified as a theology without any scientific credibility. In these review lines, it is sufficient to note the impossibility for the Poincaré symmetry to be exact for the interior of hadrons due to the absence of a Keplerian structure and related Keplerian center (Figure 6.1), the impossibility for a photon to propagate in the hyperdense hadronic media in the same way as it propagates in vacuum (Figure 6.4), and numerous other evidence. Of course, when all particles and their wavepackets are abstracted as being points, the hyperdense media in the interior of hadrons disappear, although reappearing via a plethora of directly unverifiable abstractions, conjectures, beliefs and controversies, such as the belief the hadronic constituents are given by the hypothetical undetectable *point-like* quarks without any possible gravity, inertia or confinement (Chapter I.1).

Subsequently, V. de Sabbata and M. Gasperini [42] conducted the first phenomenological verification of the above hypothesis for the interior of hadrons via the use of conventional gauge theories, by obtaining maximal causal speeds up to $c = 75 \times c_o$.

More recently, various astrophysical measurements [43-46] have established the validity of the hypothesis submitted in Ref. [41] (without its quotation), by detecting masses expelled in astrophysical explosions (thus under contact interactions) at speeds $c \gg c_o$.

An additional verification of the validity of the Minkowski-Santilli isospace for the geometrization of media inside hadrons was provided in 1992 by H. B. Nielsen and I. Picek [47] [of the Niels Bohr Institute in Copenhagen, Denmark, who conducted extensive phenomenological calculations via conventional gauge

theories in the Higgs sector, and derived the following isometrics for the interior of pions and kaons,

$$\hat{\eta} = Diag.[(1-\alpha/3),(1-\alpha/3),(1-\alpha/3),-c_o\times(1-\alpha)] \equiv$$

$$\equiv\equiv Diag.(b_1^2,b_2^2,b_3^2,b_3^2,-c_o\times b_4^2) = Diag.(1/n_1^2,1/n_2^2,n_3^2,-c_o^2/n_4^2), \quad (6.1.51)$$

with numerical values for *pions*

$$b_1^2 = b_2^2 = b_3^2 = 1 + 1.2\times 10^{-3}, \quad b_4^2 = 1 - 3.79\times 10^{-3}, \quad (6.1.52)$$

and for *kaons*

$$b_1^2 = b_2^2 = b_3^2 = 1 - 2\times 10^{-4}, \quad b_4^2 = 1 + 6.1\times 10^{-4}. \quad (6.1.53)$$

As one can see, the phenomenological studies by Nielsen and Picek [47] provide a direct verification of isorelativity and relativistic hadronic mechanics, including the hypothesis [41] of speeds $c > c_o$.[20]

In fact, for pions we have $b_4 < 1$ and, consequently, speeds $c < c_o$, whereas for kaons we have $b_4 > 1$ and, therefore, $c > c_o$. Since the *charge radius* of all hadron is approximately the same, $1fm$, *the density of hadrons increases with mass.* Consequently, speeds $c > c_o$ are expected to persist for all heavier hadrons, as confirmed by subsequent data reviewed in the next sections.

The inapplicability of the conventional notions of spacetime for metrics (6.1.52)-(6.1.53), with consequential inapplicability of special relativity, are evident. The direct universality of the Minkowski-Santilli isospace and related isorelativity should equally be noted.

Intriguingly, the Minkowski-Santilli isospace requires that in the interior of hadrons we have an alteration of both space and time. Recall that the characteristic quantities characterize the isounit of the theory, Eq. (6.1.5b). Hence, from data (6.1.52), we have for pions

$$\hat{I}_{pions} = Diag(1/1.0012, 1/1.0012, 1/1.0012, 1/0.9963) =$$

$$= Diag(0.9988, 0.9988, 0.9988, 1.0037), \quad (6.1.54)$$

namely, the space isounit is smaller than 1 and the time isounit is bigger than 1. Consequently, *pions are iso-minkowskian media of Group II, Type5* (Figure 6.3).

[20]The author attempted a number of times to contact H. B. Nielsen and I. Picek at the Niels Bohr Institute in Copenhagen, to discuss the implications of their paper [47] with no replay, expectedly because such implications are in manifest conflict with organized interests on Einsteinian doctrines. The author subsequently received information that H. B. Nielsen and I. Picek had been under pressure by orthodox interests to renounce or dismiss the results of paper [47]. The Niels Bohr Institute is suggested to implement corrective measures and conduct indeed systematic studies on the inapplicability of orthodox doctrines within hadronic media so as to avoid problems of scientific ethics and accountability particularly for use of public funds.

For kaons we have the isounit

$$\hat{I}_{kaons} = Diag.(1/0.9998, 1/0.9998, 1/0.0008, 1/1.0004) =$$

$$= Diag.(1.0002, 1.0002, 1.0002, 0.9996), \tag{6.1.55}$$

namely, the space isounit is bigger than 1 and the time isounit is now smaller than 1. Consequently, *pions are iso-Minkowskian media of Group III, Type 9* (Figure 6.3).

The fundamental invariant is given by

$$x^2 = [length]^2 \times [unit]^2. \tag{6.1.56}$$

Consequently, data (6.1.52), (6.1.53) indicate that *in the interior of pion we have an isodilation of length of the order of*

$$\hat{\ell}^2 \approx .1.0012 \times \ell^2 \tag{6.1.57}$$

and an isocontraction of time of the order of

$$\hat{t}^2 \approx 0.9963 \times t^2 \tag{6.1.58}$$

while in the interior of pions we have an isocontraction of length of the order of

$$\hat{\ell} \approx 0.9998 \times \ell \tag{6.1.59}$$

and an isodilation of time of the order of

$$\hat{t} \approx 1.0004 \times t \tag{6.1.60}$$

This is a fundamental novel implication of Santilli isorelativity with vast implications at the epistemological, theoretical and experimental levels, where the novelty is given by the prediction that space and time are altered by matter as a physical medium without a direct gravitational consideration.[21]

Note that the above isodilations and isocontractions imply corresponding versions for the remaining isoactions. For instance, Isoaction V, Eq. (6.1.15) we have

$$E_{pions} = m \times V_{max} = m \times c_o \frac{b_4^2}{b_3^2} = m \times \frac{1.0037}{0.9998} =$$

$$= 1.0004 \times m \times c_o^2, \tag{6.1.61a}$$

[21]The reader should remember that the characteristic quantities do have a connection with gravitation since departures from the Minkowski metric can be interpreted as being of Riemannian character n (Section 6.1.2). However, even under such an interpretation, the prediction of alteration of space and time by isorelativity remains new, in the sense of being beyond general relativity.

$$m_{pions} = 0.9961 \times \frac{E_{pions}}{c_o^2}, \tag{6.1.61b}$$

and for kaons we have

$$E_{kaons} = m \times V_{max} = m \times c_o \frac{b_4^2}{b_3^2} = m \times \frac{0.9998}{1.0002} =$$

$$= 0.9996 \; m \times c_o^2, \tag{6.12.62a}$$

$$m_{kaons} = 1.0012 \times \frac{E_{pions}}{c_o^2} \tag{6.1.62b}$$

namely, *isorelativity predicts that the inertial mass of pions is smaller than that predicted by special relativity, while the inertial mass of kaons is bigger.* This prediction too has far reaching implications, such as the possibility of eliminating the need for the conjecture of *dark matter*, as we shall see later on in this section. The reader is encouraged to work out the remaining isoaxioms for data (6.1.61), (6.1.62).

Note that *features (6.1.61) are a consequenbce of the medium being of Group II, Type 5, and features (6.1.62) are a consequence of the medium being of Group III, Type 9.* This illustrate the profound dynamical implications of physicval media when deviating from the homogeneity and isotropy of the Minkowskian spacetime.

It should be indicated that *particles traveling in interior conditions faster than the local speed of light are not tachyons,*, or *isotachyons*, but ordinary *tardyons* or *isotardyons*. In fact, electrons traveling in water faster than the local speed of light are ordinary particles and cannot possibly be tachyons just because the speed of light is decreased. Similarly, particles traveling in the interior of kaons faster than the speed of light in vacuum, but slower than the internal maximal causal speed, are isotardyons and not tachyons or isotachyons..

In order to have true tachyons, a particle must be an isotachyon, namely, it should travel at speeds bigger than the maximal causal speed V_{max}. To the author's best knowledge, at this writing there is large experimental evidence of massive particles traveling at speeds bigger than the local speed of light, but there is no experimental evidence of true tachyons, namely, particles traveling faster than the local maximal causal speed.

6.1.9 Experimental Verifications with the Behavior of the Meanlives of Unstable Hadrons with Speed

The hyperdense character of the medium inside hadrons has been known since the discovery of protons and neutrons, and the measurement of their mass and size. In turn, dynamics within hyperdense media lead to the historical open

legacy that strong interactions have a nonlocal component due to deep wave-overlappings, namely, a condition that renders special relativity inapplicable beginning from its topology, let alone the inability to represent zero-range contact interactions extended over a volume.

Strong interactions have a range of $1lllfm$ that is essentially the size of all hadrons. It then follows that, unlike electromagnetic interactions, *a necessary condition to activate strong interactions is that hadrons enter into conditions of deep mutual overlappings* [14]. The nonlocal-integral condition of strong interactions is then beyond scientific doubt and so is the inapplicability of special relativity.

Also, to be physical, the hadronic constituents must have wavepackets of the order of the entire hadrons. This implies that, unlike the atomic constituents, *the hadronic constituents are in condition of total mutual penetration of their wavepackets, each one completely inside all others,* thus resulting, again, in a nonlocal-integral structure beyond any credible representationa capability by special relativity.

The above view *is not* in contrast with the experimental evidence that hadrons in a particle accelerator do indeed follow the laws of special relativity, because, in the high vacuum of a particle accelerator, hadrons are well approximated as being point-like particles under action-at-a-distance electromagnetic interactions, as necessary for the applicability of special relativity.

Hence, we have a dichotomy given by the exact applicability of special relativity for the center of mass behavior of hadrons in vacuum, and deviations from special relativity expected in the interior of hadrons, which dichotomy requires an experimental resolution.

Hence, the issue here addressed deals with *experimental means to detect from the outside deviations from special relativity expected in the interior of hadrons.* The answer to this question is known and it is given by *expected deviations from the prediction of special relativity on the behavior of the meanlives of unstable hadrons with speed* (or energy), i.e., deviations from the well known Einsteinian decay law

$$t = t_o \times (1 - \frac{v_k \times v_k}{c_o \times c_o})^{-1/2}. \tag{6.1.63}$$

To the authors' best knowledge, the first studies on deviations from special relativity caused by nonlocal internal effects in the structure of hadrons were conducted in 1964 by D. L. Blokhintsev and his group [48] of the JINR in Dubna, Russia. The studies were continued by L. B. Redei [49] in Italy, D. Y. Kim [50] in Canada, and others.

A rather unsettling feature of these studies was that they proposed different generalizations of the Einsteinian law (6.1.63), thus creating the problem of which law to test.

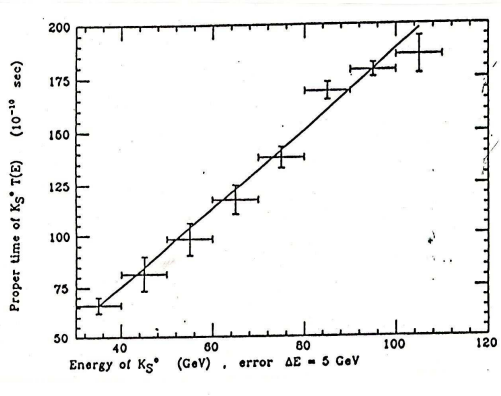

Figure 6.6. A first evidence of deviation from Einstein decay law in the meanlives of unstable hadrons is given by the linear fit of the experimental data on the K_s^o lifetime via law (6.1.63) conducted by Cardone et al [55]. The fit resulted in the value of the lifetime at rest $\tau = (0.9375 \pm 0.0021) \times 10^{-10}$ s compared to the experimental value also at rest $\tau_o = (0.8922 \pm 0.0020) \times 10^{-10}$ s with a confidence level 0.39 giving a probability of 61 % that the constant value at rest τ_o is *greater* then the actual value, namely, nonlocal internal effects are expected to *decrease* the value of the meanlife with speed. As we shall see, this behavior is connected to the *increase* of the proper time of the hadron considered compared to the proper time of an external observer. Not computed in Ref. [55] are corresponding deviations of the size of hadrons that is equally expected to deviate from Einsteinian contraction law. The reader should keep in mind that these mutations of space and time are the experimental foundation of the *isogeometric locomotion* of Chapter 13, namely, locomotion based on the control of distances via isogeometric mutations of space and time, without any Newtonian action and reaction.

In 1983 R. M. Santilli [3] proposed the iso-Minkowskian spaces $\hat{M}(\hat{x}, \hat{\eta}, \hat{R})$ with *isotime dilation* as in Isoaxiom III, Eqs. (6.1.13a),

$$t = t_o \times (1 - \frac{v_k \times b_k^2 \times v_k}{c_o \times b_4^2 \times c_o})^{-1/2} = t_o \times (1 - \frac{(v_k \times v_k / n_k^2)}{(c_o \times c_o / n_4^2)})^{-1/2} \tag{6.1.64}$$

A. K. Aringazin [51] from Kazakhstan proved that the Santilli's decay isolaw is *directly universal* for all possible (signature preserving) modifications of the Minkowskian law (6.1.63) (as expected from the direct universality of isorelativity), since all generalized decay laws can be obtained as particular cases of isolaw (6.1.64) via different expansions in terms of different coefficients subjected to different truncations. Aringazin's important result is that, rather than testing a variety of seemingly different laws, the experiments can be solely conducted for isolaw (6.1.64).

The first direct experimental measurement of the behavior of the meanlife of the unstable K_os with energy was conducted in 1983 by S. H. Aronson et al. [52]

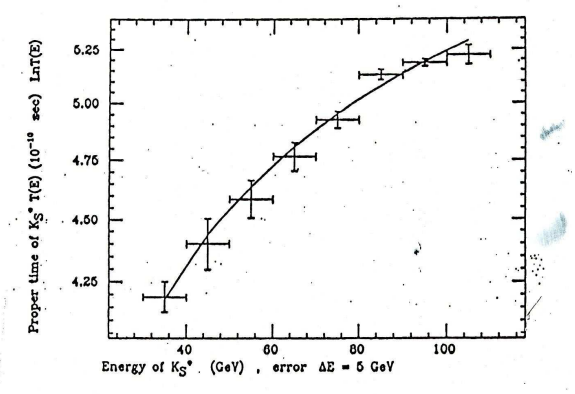

Figure 6.7. The exact fit of Santilli's iso-Minkowskian law (6.1.64) [3] provided by Cardone et al. [55] on the data of Fermilab experiment [52] from 30 to 100 GeV providing a second experimental confirmation of deviations from the Einsteinian decay law.

at Fermilab suggesting *clear deviations from the Einsteinian decat law (6.1.63) in the different energy range from* 30 *GeV to* 100 *GeV.*

Following the appearance of results [52], additional direct experimental measurements were conducted in 1987 by N. Grossman et al. [53] also at Fermilab, which tests showed *apparent verification* of the Einsteinian law (6.1.45), although in the *different* energy range from 100 to 400 GeV.

Additionally, a test of the decay law at short decay times was made by G. Alexander et al. at LEP [54], in which the events $Z^o \to \tau^+ + \tau^-$ show a clear *deviation* from the conventional law of the order of 1.1 %.

In paper [55] of 1992, F. Cardone (then of the First University in Rome, Italy) et al. proved that the Minkowski-Santilli isospace permits an exact fit of experimental data [52] (see Figure 6.6).

In the subsequent paper [56], F. Cardone et al. proved that the same Minkowski-Santilli isorepresentation unifies the seemingly discordant results of tests [52] and [53] (Figure 6.7).

In this way, Cardone et al. achieved the following numerical values of the characteristic quantities for the K^os

$$b_1^2 = b_2^2 = b_3^2 = 0.989080 \pm 0.0004, b_4^2 = 1.002 \pm 0.0007. \tag{6.1.65a}$$

$$\Delta b_k^2 = 0.007, \quad \Delta b_4^2 = 0.001. \tag{6.1.65b}$$

It is evident that the above fits constitute another experimental verification on the validity within kaons of Santilli isorelativity [3], the underlying Minkowski-Santilli isogeometry [10], and relativistic hadronic mechanics [16].

A most important feature of experimental data (6.1.65) is that theu provide an *independent confirmation f the iso-Minkowskian character of the medium within*

kaons reached in the preceding section with different procedures as being of Group III, Type 9 (Figure 6.3). Due to the general dominance of geometry over dynamics, the above independent confirmation of the iso-Minkowskian character of the medium inside kaons is the most important result of this section.

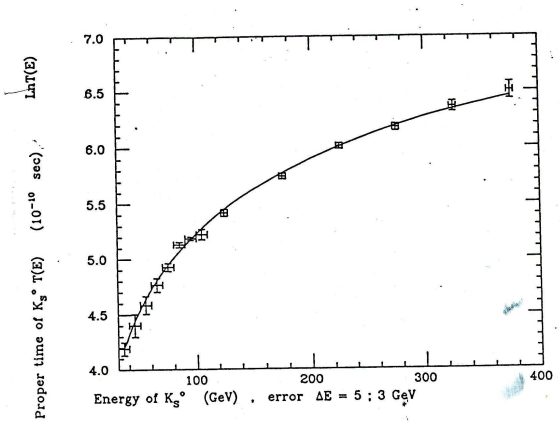

Figure 6.8. The exact fit of Santilli's iso-Minkowskian law (6.1.64) [3] provided by Cardone et al. [56] on the data of Fermilab experiment [52,53] from 30 to 400 GeV providing a third experimental confirmation of deviations from the Einsteinian decay law.

Somne of the consequences of Refs. [55,56] are the following:

1) The fits of Figure 6.6 confirm in an independent way that the maximal causal speeds in the interior of kaons is bigger than that in vacuum. In fact, values (6.1.65a) are very close to values (6.1.54) even though derived in different ways (the former via direct measurements and the latter via phenomenological calculations).

2) Results (6.1.65) confirm that the quantity $b_4 = 1/n_4$ provides a geometrization of the density of the hadron considered (again, normalized to the value $b_4 = 1/n_4 = 1$ for the vacuum), while the dependence of the characteristic quantities on the speed (or energy) is essentially in the space components $b_k = 1/n_k,\ ]\ k = 1, 2, 3$ (also normalized to the values $b_k 1/.n_k = 1.k = 1, 2, 3$ for the vacuum).

3) Results (6.1.65) void the measurements by Grossman et al. [53] of any conclusive value, evidently because we have experimental deviations from the Minkowskian geometry even under the assumption that tests [53] are valid.

4) Results (6.1.65) establish that the rest energy of the constituents of hadrons is not given by the familiar expression $E = m \times c_o^2$, but rather by the isorenormalized Eq. (6.1.15), i.e.

$$E = m \times V_{max}^2 = m \times c_o^2 \times \frac{b_4^2}{b_3^2} = m \times c_o^2 \times \frac{n_3^2}{n_4^2}. \tag{6.1.66}$$

Since the rest energies of the particles are well known, the above isoaxiom implies that *the masses (or inertia) of the kaons are smaller than what generally assumed until now.*.

5) Results (6.1.65) establish that the frequency $\hat{\nu}$ of photons (or gluons ?) emitted in the interior of hadrons is not characterized by the traditional law $\nu = E/h$, but instead by the isorenormalized law

$$\hat{\nu} = \nu \times \frac{b_4^2}{b_3^2} = \nu \times \frac{n_3^2}{n_4^2}, \tag{6.1.67}$$

with *isoredshift* (tendency toward the red) within the physical media inside pions and *isoblueshift* (tendency toward the blue) for kaons and all other hadrons.

6) Said results establish that light emitted in the interior of hadrons is also isoredshifted or isoblueshifted, that is, it reaches the outside at a frequency smaller or bigger than that originally emitted in the interior because of mechanisms of the isospecial relativity studied later on in astrophysical verifications (essentially due to release or absorption of energy from the medium).

7) Said results establish that in the interior of kaons and all other heavier hadrons, space is contracted in the geometric sense that the Euyclidean distance becomes smaller and time flows faster than the corresppponmding quantities in the exterior. In fact, the basic units of space and time are characterized by experimental fits (6.1.65) and are given by

$$\hat{I} = (\hat{I}_{space}, \hat{I}_{times}), \tag{6.1.68a}$$

$$\hat{I}_{space} = Diag.(1.001.1.001.1.001), \quad \hat{I}_{time} = 0.9980. \tag{6.1.68b}$$

Since spacetime invariants have the structure (Sections I.3.5)

$$Invariant = (Length)^2 \times (Unit)^2 \tag{6.1.69}$$

it is evident that the increase (decrease) of a unit causes the decrease (increase) of the related length.

As an incidental note, the above features have stimulated the formulation of the so-called geometrical propulsion studied in CChapter 13, in which objects can move following a local directional change of the geometry without the application of any force visible to the outside, thus permitting, on mathematical grounds, arbitrary speeds for an outside observer.

Remarkably, features 1) to 7) are verified by all subsequent experiments, as we shall see.

A few comments are now in order. We should first indicate that the measurements by Grossman et al. [53] have been the subject of rather severe criticisms. First of all, the experimenters have made the theoretical assumption in the data elaboration of a frame in which there is no CP violation, in which case it is known

that there cannot be Minkowskian anomalies, as shown by D. Y. Kim [50] and others. Moreover, the statistics of tests [53] are insufficient for any conclusion whether in favor or against orthodox doctrines. Additional flaws of tests [53] have been identified by Yu. Arestov et al. [57]/ mThese limitatioons are discussed in detail in Appendixc 6.D.

I would like also to stress that the deviations from the Minkowskian geometry do not constitute a violation of the fundamental Lorentz symmetry. This is due to the fact that the isotopies reconstruct the Lorentz symmetry as being exact in iso-Minkowskian space, as studied in Volume I. This feature is important to disprove claims, such as that by H. B. Nielsen and I. Picek that their parameter characterizes a "violation of the Lorentz symmetry" [47]. Such a statmenmt is a mere consequence of the use for the intgerior of hadrons mathematics solely applicxable for the exterior problem in vacuum because, when the appropriate mathematics is adop[ted, the Lorentz symmetry remains fuil;lyu valid for deformation of the spacetime of type (6.1.51).

Note, however, that the Lorentz symmetry is preserved exactly at the abstract, realization free level for the nonlocal internal effects here considered. However, this is not the fate of special relativity since experimental evidence requires structural departures, such as the impossibility of assuming the speed of lighty in vacuum or inside hadrons as the maximnal causal speed in the interior of the hyperdense hadrons and other deviations represented by the Isoaxioms I-V.

The reader should be aware that the exact fits of Figures 2 and 3 were simply unavoidable, due to the direct universality of Santilli's iso-Minkowskian geometry for the representation of all infinitely possible, signature preserving deviations from the Minkowskian form. [22]

6.1.10 Experimental Verifications via the Bose-Einstein Correlation

6.1.10.A The Unavoidable Nonlocal and Non-Hamiltonian character of the Correlation

The fundamental assumption of hadronic mechanics is that strong interactions have a nonlocal component of contact, thus nonpotential type due to deep wave-overlappings at mutual distances of 1 Fermi, which component has to be represented with anything except the Hamiltonian (to prevent granting potential energy to interactions that have none, a rather common trend in the physics of the 20-th century).

[22] We should indicate the existence in the literature of several other "deformations" of the Minkowski spacetime stimulated by the isotopies [3], such as those of Refs. [58] and papers quoted therein. These deformations are formulated over conventional fields, rather than on isofields, and, as such, they verify the Theorems of catastrophic Inconsistencies of Section 6.6.

The most fundamental experimental verifications of hadronic mechanics are, therefore, those testing directly the expected nonlocality of the strong interactions. Among them, the most important tests are those on the Bose-Einstein correlation (see, e.g., Refs. [59-62]) in which:

(i) Protons and antiprotons are made to collide at very big or very small energies;

(ii) In so doing, protons and antiprotons annihilate each other in a region called the *fireball;* and

(iii) The annihilation produces various unstable hadrons whose final states are given by correlated mesons (i.e., very loosely speaking, mesons which are "in phase" with each other despite large mutual distances compared to the size of the fireball).

It is well-known in the literature that the Bose-Einstein correlation cannot be admitted by purely local theories, that is, theories dealing with a finite set of isolated point-like particles. Hence, by conception and technical realization, *the Bose-Einstein correlation is a nonlocal event.*

At this point, numerous "nonlocal theories" have been constructed for the pre-set intent of adapting physical reality to Einsteinian theories. These theories are essentially based on the attempt of reducing a nonlocal event (distributed over the finite volume of the fireball) to a finite number of isolated points, said reduction being mandatory for the applicability of the mathematics underlying Einsteinian theories, let alone their physical laws.

Since the reduction of a finite volume to a set of isolated points is a figment of academic imagination dramatically disjoint from physical reality, these "nonlocal theories" are hereon ignored.

Equally known by experts (as the author can testify), and as shown in detail below, is the fact that *the Bose-Einstein correlation is incompatible with the axiom of expectation values of quantum mechanics, thus mandating the use of a covering theory, irrespective of whether nonlocal interactions can be manipulated to verify quantum laws.*

The first exact and invariant formulation of the Bose-Einstein correlation via relativistic hadronic mechanics was done by R. M. Santilli in memoir [63] of 1962. The first of the experimental data was done by F. Cardone and R. Mignani (then at the University La Sapienza, in Rome, Italy) and provided to Santilli as a private communication. Subsequently, F. Cardone and R. Mignani provided their version of the isorelativistic treatment in paper [64] of 1996. A number of additional papers were subsequently published (such as Ref. [65]) although without structural advances.[23]

[23]It should be noted that Ref. [64] was properly written with the quotation of all originating papers and the identification of the full paternity of the various theories by Santilli. It was unfortunate that the authors subsequently elected to write a series of papers (such as those accepted by Cornell University

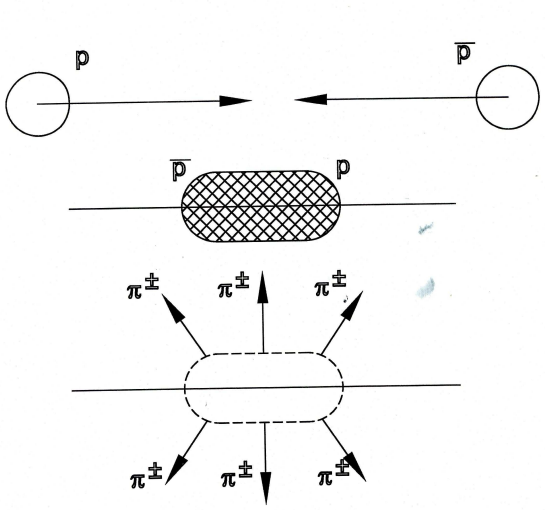

Figure 6.9. A conceptual view of the Bose-Einstein correlation in which: protons and antiprotons collide at extremely high energies; coalesce one into the other resulting into the so-called ireball (that is one of the densest media measured by mankind in laboratory until now); annihilate each other; and then result in the production of unstable particles whose final result is a large number of mesons that remain correlated at distances very large compared to the size of the fireball. Without doubt, the Bose Einstein correlation has seen the biggest scientific obscurantism in the 20-th century physics because treated under the claim that Einstein special relativity and relativistic quantum mechanics are exactly valid, while it has been known for decades that the arbitrary parameters needed for the fit of the experimental data (called "chaoticity parameters") are prohibited by the basic axioms of relativistic quantum mechanics, such as that for the vacuum expectation values (see the text). By comparison, relativistic hadronic mechanics allows an exact representation of the experimental data of the Bose-Einstein correlation while restoring the exact validity of the Lorentz and Poincaré symmetries under nonlocal and non-Hamiltonian internal effects. This episode raises the questions to be answered by the individual reader: Why do, a decreasing minority of seemingly qualified scientists continue to prefer the manipulations of the former treatment against the exact and invariant treatment of the covering theory?

In this section we shall follow the original derivation of memoir [63] due to departures from the rigorous use of relativistic hadronic mechanics of paper [64] identified below. The reader should be aware that, to avoid an excessive length, a study of the original memoir [63] is necessary for a technical knowledge of the field.

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arxiv) without any quotation whatever of Santillis originating papers. The lack of any corrective measures by both the authors and Cornell University then mandated the filing of legal action at the U./ S. federal Court one can inspect in the mirror web site http://www.scientificethics.org

6.1.10.B Conventional treatment of the Bose-Einstein correlation

We now outline the conventional treatment of the Bose-Einstein correlation via relativistic quantum mechanics by following review [59].

Consider a quantum system in 2-dimensions represented on a Hilbert space $\mathcal{H}$ with initial and final states $|a_k>$, $|b_k>$, $k = 1, 2$. The *vacuum expectation values* of an observable A are given

$$< A >=< a_k| \times A \times |b_k >= \Sigma_{k=1,2} a_k \times A_{kk} \times b_k, \tag{6.1.70}$$

which is *necessarily diagonal,* trivially, because a necessary condition for a quantity to be observable is that of being Hermitean.

The *two-points correlation function* of the Bose-Einstein correlation is defined by

$$C_2 = \frac{P(p_1, p_2)}{P(p_1) \times P(p_2)} \tag{6.1.71}$$

where $P(p_1, p_2)$ is the *two particles probability density* subjected to Bose-Einstein symmetrization, and $P(p_k)$, $k = 1, 2$, is the corresponding quantity for the k particle with 4-momentum p_k.

The two-particles density is routinely computed via the vacuum expectation value

$$P(p_1, p_2) =$$

$$= \int \psi^{\dagger}_{12}(x_1, x_2; r_1, r_2) \times \times \psi_{12}(x_1, x_2; r_1, r_2) \times F(r_1) \times F(r_2) \times d^4 r_1 \times d^4 r_2, \tag{6.1.72}$$

where ψ_{12} is the *probability amplitude* to produce two bosons at r_1 and r_2 that are detected at x_1 and x_2,

$$\psi_{12} = \frac{1}{\sqrt{2}} \times$$

$$\times (e^{i \times p_1 \times (x_1 - r_1)} \times e^{i \times p_2 \times (x_2 - r_2)} + e^{i \times p_1 \times (x_1 - p_2)} \times e^{i \times p_2 \times (x_2 - r_1)}). \tag{6.1.73}$$

Various steps (we suggest the reader to inspect in Ref. [59]) then lead to the the Gaussian form of the densities

$$F_k = \frac{1}{4 \times \pi^2 \times R^4} \times exp(-\frac{r^2}{2 \times R^2}),\ k = 1, 2, \tag{6.1.74}$$

where R is the Gaussian width and r is generally assumed to be the radius of the fireball.

Via the use of standard procedures, one reach in this way the final expression for the two-point correlation function

$$C_2 = 1 + e^{-Q^2_{12} \times R^2}, \tag{6.1.75}$$

where $Q_{12} = p_1 - p_2$ is the *momentum transfer.*

6.1.10.C Incompatibility of the Bose-Einstein correlation with Relativistic Quantum Mechanics

It is well known that the above treatment of the Bose-Einstein correlation deviates substantially from experimental data. This lead to the introduction of a first, completely unknown parameter λ, called "chaoticity parameter" and the *ad hoc* modification of law (6.1.75)

$$C_2 = 1 + \lambda \times e^{-Q_{12}^2 \times R^2}. \tag{6.1.76}$$

Note that it is impossible to derive the above parameter from any axiom of relativistic quantum mechanics. Hence, *on serious scientific grounds, the chaoticity parameter λ is the first direct evidence of the incompatibility of the Bose-Einstein correlation with quantum axioms.*

It soon turned out that adulterated expression (6.1.76) too deviates dramatically from experimental data. The problem was quickly "solved" in the conventional fashion of the 20-th century physics, via the introduction of an increasing number of completely unknown and arbitrary parameters until the desired fit of the experimental. data was achieved and then declare quantum mechanics to be exactly valid in the field.

This "solution" lead to the necessary introduction of *four completely arbitrary chaoticity parameters* and adulterated expressions of the type

$$C_2 = $$
$$= 1 + \lambda_1 \times e^{-Q_{12}^2 \times R^2} + \lambda_2 \times e^{-Q_{12}^2 \times R^2} + \lambda_3 \times e^{-Q_{12}^2 \times R^2} + \lambda_4 \times e^{-Q_{12}^2 \times R^2}, \tag{6.1.77}$$

that did eventually reach some compatibility with experimental data [59].

However, *the only scientific (that is, rigorous) way of achieving the additional terms in Eq. (6.1.77) is that via a nondiagonal formulation of the expectation values. The latter are prohibited by relativistic quantum mechanics for observable quantities as in Eq. (6.1.70).*

This establishes beyond scientific or otherwise credible doubt that *the chaoticity parameters are a direct measure of the deviation of the Bose-Einstein correlation from experimental evidence.*

Independently from that, relativistic quantum mechanics has the following insufficiencies for a serious study of the Bose-Einstein correlation:

(1) The theory can only represent the proton and the antiprotons as dimensionless points. The very existence of the fireball, let alone of the ensuring correlation, is then in question.

(ii) The above point-like abstraction of particles has a number of technical consequences, such as the factorization of the densities in Eq. (6.1.72) that, *per se,* is sufficient to prohibit correlation, as shown below;

(iii) Relativistic quantum mechanics must assume the fireball to be necessarily spherical, so as to prevent the loss of one of its central pillars, the rotational

symmetry, which feature alone is sufficient to warrant a covering theory irrespective of all other aspects, due to the dominance of spacetime symmetries over calculations.

6.1.10.D Representation of the Bose-Einstein correlation via relativistic hadronic mechanics

By falloring the first original derivation [63], we first recall that, unlike expression (6.1.70), the axiom of *isoexpectation value* for relativistic hadronic mechanics is given by

$$< \hat{A} >< \hat{a}_k| \times \hat{T} \times \hat{A} \times \hat{T} \times |\hat{b}_k >= \Sigma_{ijk=1,2}\, \hat{a}_i \times \hat{T}_i^j \times \hat{A}_{jj} \times \hat{T}_j^k \times \hat{b}_k, \quad (6.1.78)$$

where $\hat{T}$ is the isotopic element, and the "hat" denotes quantities defined on isospaces over isofields.

The main new feature is that the operator $\hat{A}$ must be Hermitean, thus diagonal, to be observable,[24] but the isotopic element does not need to be diagonal.

Santilli main contributions in memoir [63] are the proof that:

(i) *The Bose-Einstein correlation is incompatible with the axisms of relativistic quantum mechanics because of the impossibility to admit off-diagonal terms in the two-poingt correlation function from unadulterated first principles, and otehr reasons;* and

ii *The Bose-Einstein correlation is directly compatible with the axioms of the covering relativistic hadronic mechanics because of the admission of nonlocal non-Hamiltonian interactions and the appearence of off-diagonal terms from first principles.*

The rest is given by a mere application of relativistic hadronic mechanics. We assume at the foundation of the treatment Santilli isorelativity with Minkowski-Santilli isospace $\hat{M}(\hat{x}, \hat{\eta}, \hat{R})$, isoinvariant, isometric, isotopic elementand isounit given respectively by [3]

$$\hat{x}^{\hat{2}} = (\hat{x}^\mu \hat{\times} \hat{\eta}_{\mu\nu} \hat{\times} \hat{x}^\nu) \times \hat{I} = [x^\mu \times (\hat{T}_\mu^\nu \times \eta_{\nu\rho}) \times x^\rho] \times \hat{I} \ \in \ \hat{R}, \quad (6.1.79a)$$

$$\hat{\eta} = Diag.(b_1^2, b_2^2, b_3^2, -b_4^2) \times \Gamma = Diag.(1/n_1^2, 1/n_2^2, 1/n_3^2, -1/n_4^2) \times \Gamma, \quad (6,1,79b]$$

$$\hat{T} = Diag.(b_1^2, b_2^2, b_3^2, b_4^2) \times \Gamma = Diag.(1/n_1^2, 1/n_2^2, 1/n_3^2, 1/n_4^2) \times \Gamma, \quad (6.1.79c)$$

$$\hat{I} = Diag.(1/b_1^2, 1/b_2^2, 1/b_3^2, 1/b_4^2) \times \Gamma^{-1} = Diag.(n_1^2, n_2^2, n_3^2, n_4^2) \times \Gamma^{-1}, \quad (6.1.79d)$$

$$b_\mu = b_\mu(t, x, p, E, ...) > 0, n_\mu = n_\mu(t, x, p, E, ...) > 0, \quad (6.1.79e)$$

$$\hat{T} = \hat{T}(t, x, p, E, ...), \ \ \hat{I} = \hat{I}(t, x, p, E, ... = 1/\hat{T}), \quad (6.1.79f)$$

[24] Recall from Chapter I.3 that *iso-Hermiticity coincides with conventional Hermiticity.* Hence, all quantities that are observable for quantum mechanics remain observable for hadronic mechanics.

where: isoinvariant (6.1.79a)must be an element of the isofield $\hat{R}$ and, consequently, must have the structure of $\hat{x}^{\hat{2}} = n \times \hat{I}$, where n is a real number; the spacetime isocoordinatescoordinates must also be elements of the isofield, thus have the form $\hat{x} = x \times \hat{I},\ x = (x^\mu), \mu = 1, 2, 3, 4$; isoproducts of the isocoordinates with a generic quantity Q can be reduced for simplicity to ordinary products, $\hat{x}\hat{\times}Q = (x \times \hat{I})\hat{T} \times Q = x \times Q$ as done in isoinvariant (6.1.79a); we continue to use both notations for the characteristic quantities, $b_\mu = 1/n_\mu$ following their original formulation in [3,63] because handy in various applications; the quantity Γ is a $2x2$-matrix to be identified shortly; and one should keep in mind the explicit dependence of the characteristic quantities in time t, coordinates x, momenta p, energy E and any need additional quantity.[25]

It should be stressed that *the characteristic quantities must represent physically measurable quantities, namely,* $1/b_k^2 = n_k^2,\ k = 1, 2, 3,$ *must characterize the semiaxes of the Bose-Einstein fireball according to a proper normalization (see below), and* $1/b_4^2 = n_4^2$ *must characterize the density of the fireball in a way compatible with other experiments.*

To state this crucial point explicitly, the chaoticity parameters $\lambda_\mu,\ \mu = 1, 2, 3, 4$ are completely arbitrary and without any possible physical meaning. By constrast, the characteristic quantities $1/b_\mu^2 = n_\mu^2$ must represent concrete physical features that with experimentally verifiable numerical values as a condition for the isorepresentation to be consistent.

As a concrete illustration, in the event the fit of the experimental data yields values of the type $b_1^2 = b_2^2 = b_3^2$, the emerging isorepresentation would be inconsistent because the Bose-Ein stein fireball cannot possibly be a sphere due to the extreme energies of the collision. As a result, said fireball must be a very elongated sheroidalellipsoid, for instance, of the type $b_3^2 \gg b_1^2 = b_2^2$.

As an additional and independent condition for consistency, the numerical value of the density $b_4^2 = 1/n_4^2$ must be compatible with numerical values from different experiments on comparable densities, such as those for protons and neutrons.[26]

By continuing to follow the original derivation [63], we now represent the correlation on an iso-Hilbert space $\hat{\mathcal{H}}$ with initial and final isostates $|\hat{a}_k >,\ |\hat{b}_k >$

[25]It is known since the original proposal of 1978 [14] that the isotopies restrict the topological character of the isounit but otherwise leave its functional dependence completely unrestricted. This feature is at the foundation of the representation by hadronic mechanics of features such as density, extended shape, their deformation in time,etc., that are unthinkable with quantum mechanics.

[26]As we shall see in the next section, the value of the density of the Bose-Einstein fireball allows a numerically exact representation of all characteristics of the neutron as a hadronic bound state of an (iso)proton and an (iso)electron, including the numerical value of the anomalous magnetic moment, size, meanlife and other features that cannot even be treated with quantum mechanics.

, $k = 1, 2$, and the non-diagonal isotopic element (6.1.79c) in the explicit form

$$\hat{T} = Diag.(b_1^2, b_2^2, b_3^2, b_4^2) \times \Gamma = Diag.(1/n_1^2, 1/n_2^2, 1/n_3^2, 1/n_4^2) \times \Gamma, \quad (6.1.80a)$$

$$\Gamma =$$

$$= \begin{pmatrix} A & B \times |1 - \exp(\int dx^4 \times \psi_{b2}^{\dagger} \times \psi_{a1})| \\ C \times |1 - \exp(\int dx^4 \times \psi_{a2}^{\dagger} \times \psi_{b1})| & D \end{pmatrix} \quad (6.1.80b)$$

and the quantities $A, B, C.D$, are restricted by the condition[27]

$$Det\ \Gamma = 1. \quad (6.1.81)$$

As one can see, when used in the isoexpectation value (6.1.79), isotopic element (6.1.80):

(a) Allows indeed off-diagonal terms in the isoexpectation values;

(b) Represents the overlapping of the wavepackets of particles via the integrals in the exponents of Γ;

c) Eliminates all correlations when said overlapping is null, i.e., for the limit under condition (6.1.81)

$$Lim_{\int dx^4 \times \psi_{ij}^{\dagger} \times \psi_{jk} = 0} \Gamma = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}. \quad (6.1.82)$$

Next, the isorepresentation is given by a trivial isotopy of the conventional treatment [59], with the use now of the nontrivial isoexpectation values (6,1,78). We then have the *two-points isocorrelation function*

$$\hat{C}_2 = \frac{\hat{P}(p_1, p_2)}{\hat{P}(p_1) \times \hat{P}(p_2)} \quad (6.1.83)$$

where: $\hat{P}(p_1, p_2)$ is the *two-particle isoprobability density* subjected to proper symmetrization; $\hat{P}(p_k),\ k = 1, 2$, is the corresponding quantity for the k particle with 4-momentum p_k; and we ignore hereon the "hat" on variables for simplicity of notation.[28]

The two-particles isoprobability density is noa given by the isoeigenvalue expression

$$\hat{P}(p_1, p_2) =$$

[27] Values of determinant (6.1.81) different than 1 would merely im-ly a different renormalization of the characteristic quantities.

[28] On rigorous grounds, it should be noted that isocorrelkation function (6.1.83) is an isoscalar as it is the acse for the isoliune ele,ment (6.1.79a). This property is automatically guaranteed by the isue of an isoquotient. Fpor these mathe,matical aspects, we recommend the noninitiated reader to study Chapter I.2.

$$= \int \hat{\psi}_{12}^{\dagger}(x_1, x_2; r_1, r_2) \times \hat{T} \times \hat{\psi}_{12}(x_1, x_2; r_1, r_2) \times \hat{F}(r_1, r_2) \times d^4 r_1 \times d^4 r_2, \quad (6.1.84)$$

where: $\hat{\psi}_{12}$ is the *isoamplitude* for the production, as in the conventional treatment, two bosons at r_1 and r_2 that are detect ed x_1 and x_2; and the *isowavefunction* $\hat{\psi}_{ij}$ is given by a trivial isotopy of the conventional expression.

Note the crucial difference between Eq. (6.1.84) and (6.1.72) given by the isotopic lifting of all quantities and their operations and the appearance in the former of the isotopic element allowing the mixing of nondiagonal terms.

Another major difference between conventional and isotopic treatments is that *the probability densities for particles* 1 *and* 2 *are factorized in the conventional treatment (6.1.72), while they cannot be factorized in the isotopic treatment.* This is due to the fact that protons, antiprotons, and all produced mesons are point-like for relativistic quantum mechanics (as a necessary condition for a credible use of the underlying mathematics), while they are extended for the covering treatment. Hence, the separation of the densities would be equivalent to annulling all correlations.

The isotopy of the conventional treatment referred to isoexpectation values (6.1.78), including the symmetrization of the isotopic element and isowavefunctions for all possible directions, plus the assumed normalizations then leads to isodensity (9.11) of Ref. [63], i.e.,

$$\hat{F}(r_1, r_2) = \Sigma_\mu \hat{\eta}_{\mu\mu} \times \frac{b_m u^2}{4 \times \pi^2} \times e^{-\frac{1}{2} \times r^2 \times b_\mu^2} \quad (6.1.85)$$

where $r$can be interpreted as the radius of the sphere in which the correlated mesons are detected.

The continuation of calculations via a simple isotopy of the conventional treatment leads to the following expression of the two-points isocorrelation function derived for the first time in Eq. (9.12), p. 112, Ref. [63],

$$\hat{C}_2 = 1 + \Sigma_\mu \, b_\mu^2 \times e^{-\frac{\hat{Q}_{12}^{\hat{2}}}{b_\mu^2}} =$$

$$= 1 + b_1^2 \times e^{-\frac{\hat{Q}_{12}^{\hat{2}}}{b_1^2}} + b_2^2 \times e^{-\frac{\hat{Q}_{12}^{\hat{2}}}{b_2^2}} + b_3^2 \times e^{-\frac{\hat{Q}_{12}^{\hat{2}}}{b_3^2}} - b_4^2 \times e^{-\frac{\hat{Q}_{12}^{\hat{2}}}{b_4^2}}, \quad (6.1.86)$$

where, again, $Q_{12} = p_1 - p_2$.

The case of the three-points and higher isocorrelation functions is treated in Ref. [63], and it is here ignored for simplicity.

The attentive reader will have noted that, to prevent a catastrophic mixing of conventional and isotopic treatments, the *isosquare* of Eq. (6.1.86) is explicitly given by

$$\hat{Q}_{12}^{\hat{2}} = \hat{Q}_{12}^{\mu} \hat{\times} \hat{\eta}_{\mu\mu} \hat{\times} \hat{Q}_{12}^{\mu} = Q_{12}^{\mu} \times \hat{\eta}_{\mu\mu} \times Q_{12}^{\mu}, \quad (6.87)$$

multiplied by the isounit that is hereon ignored for simplicity.

At this point, the exponent of expression (6.1.86) ,must be reduced to quantities actually measured in the tests, the momentum transfer q_t and the characteristics values of the fireball. This reduction was also done in Ref. [63] and resulted in the following expression

$$\frac{\hat{Q_{12}^2}}{b_\mu^2} = \frac{q_t^2}{b'^2_\mu} \tag{6.1.88}$$

where $b'\mu^2$ represents renormalized expressions of the characteristic quantities. Howewer, their numerical value is unknown prior to fits of the experimental data. Hence, we assume $b'\mu^2 \equiv b_\mu^2$.

The final expression of the two-points isocorrelation function, derived for the first time in Eq. (9.25), page 119, Ref. [63] is given by one of the following equivalent expressions first achieved in Ref. [63], Eqs. (10.7), (10.8), (10.9), pages 121,122

$$\hat{C}_2 = 1 + \frac{1}{3} \times \Sigma_\mu \, b_\mu^2 \times e^{-\frac{q_t^2 \times K^2}{b_\mu^2}} =$$

$$= 1 + \frac{1}{3} \times b_1^2 \times e^{-\frac{q_t^2 \times K^2}{b_1^2}} + \frac{1}{3} \times b_2^2 \times e^{-\frac{q_t^2 \times K^2}{b_2^2}} + \frac{1}{3} \times b_3^2 \times e^{-\frac{q_t^2 \times K^2}{b_3^2}} - \frac{1}{3} \times b_4^2 \times e^{-\frac{q_t^2 \times K^2}{b_4^2}}, \tag{6.1.89a}$$

$$K^2 = b_1^2 + b_2^2 + b_3^2. \tag{6.1.89b}$$

By absorbing the k^2 term into the characteristic quantities, we have the equivalent form

$$\hat{C}_2 = 1 + \frac{K^2}{3} \times \Sigma_\mu \, b_\mu^2 \times e^{-\frac{q_t^2}{b'^2_\mu}}, \tag{6.1.90a}$$

$$b'_\mu = b_\mu / K^2. \tag{6.1.90b}$$

Another isorepresentation is given by (page 129, ref. [63])

$$\hat{C}_2 = 1 + \times \Sigma_\mu \, b_\mu^2 \times e^{-\frac{q_t^2 \times K^2}{b_\mu^2}}, \tag{6.1.91a}$$

$$K^2 = b_1^2 + b_2^2 + b_3^2 = 3. \tag{6.1.91b}$$

In the above isorepresentations, all operations are now conventional. Hence, the above expressions are the *projections* in our spacetime of the isocorrelation functions on isospace.

6.1.10.E Reconstruction of the Exact Poincaré Symmetry under Nonlocal and Non-Hamiltonian interactions of the Bose-Einstein Correlation

As indicated earlier, a crucial insufficiency of the conventional treatment of the Bose-Einstein correlation, is the inability to provide an invariant representation of

the fireball, due to its prolate character under which the conventional rotational symmetry no longer applies.

As studied in detail in Volume I, a central objective of hadronic mechanics is to restore the exact character of basic spacetime and other symmetries when popularly believed to be "broken" due to the use of excessively elementary or insufficient mathematics. It is important to show the reconstruction of the exact rotational and other spacetime symmetries for the isorelativistic treatment of the Bose-Einstein correlation as done in memoir [63]. In fact, the most important predictions of the isorepresentation characterize structural deviations from s[special relativity whose understanding, let alone rigorous derivation, can only be done at the level of isosymmetries.

With respect to Fig. 6.9, recall that the Bose-Einstein correlation creates a fireball characterized by a spheroid prolated in the direction of the proton-antiproton flight. Following its creation, the fireball expands rapidly, resulting in the correlated mesons. Consequently, the original characteristic quantities, here denoted $b'^2_k = 1/n^2_k$, have an explicit dependence on time.

By assuming that the prolateness is along the third axis, we have

$$K^2(t) = b'^2_1(t) + b'^2_2(t) + b'^2_3(t) \neq const, \;\; b'^2_3(t) \gg b'^2_1(t) = b'^2_2(t), \tag{6.1.92}$$

However, the fireball must preserve its shape during its expansion when considered as isolated from the rest of the universe. This implies that all characteristic quantities have the same factorizable time dependence, and we shall write

$$K^2(t) = k^2 \times f(t), \;\; b'^2_k(t) = f(t) \times b^2_k, \;\; k, b_k = const. \tag{6.1.93}$$

This implies the following important property

$$\frac{b'^2_k(t)}{b'^2_1(t) + b'^2_2(t) + b'^2_3(t)} = b^2_k = const. \tag{6.1.94}$$

that has been used for isorepresentation (6.1.89).

In conclusion, the fireball can be studied at the time of its formation with constant characteristic quantities $b^2_k = 1/n^2_k$ and the following isoinvariant formulated on the Euclide-Santilli isospace with isounit

$$\hat{R}^{\hat{2}} = (x^2_1 \times b^2_1 + x^2_2 \times b^2_2 + x^2_3 \times b^2_3) \times \hat{I} = (\frac{x^2_1}{n^2_1} + \frac{x^2_2}{n^2_2} + \frac{x^2_3}{n^2_3}) \times \hat{I}, \tag{6.1.95a}$$

$$\hat{I} = Diag.(1/b^2_1, 1/b^2_2, 1/b^2_3) = Diag.(n^2_1, n^2_2, n^2_3). \tag{6.1.95b}$$

As studied in Chapter 1.3, *isoinvariant (6.1.94) characterizes the perfect sphere on isosp[ace over the isofield, caleld the isosphere, and characterizes an ellipsoid only in its projection in our space.* This is due to the mechanism of the isotopies

that, in this case, must be applied to the conventional sphere in conventional space, assumed for simplicity to have radius $r = 1$. In this case the semiaxes $r_k^2 = 1$ are indeed lifted into those of the ellipsoid, $r_k^2 \to b_k^2$, but the corresponding units are lifted by the *inverse* amount, thus preserving the perfect spheridicity on isospace over isofields,

$$r_k^2 \to b_k^2, \;\; 1_k^2 \to 1/b_2^2, \tag{6.1.96}$$

Once the perfect sherical character of the fireball on isospace is understood, the reconstruction of the exact rotational symmetry for ellipsoids is trivial. In fact, we have the *Lie-Santilli isoalgebra* $\hat{O}(3)$(Ref. (63], page 115)

$$J_k = \epsilon_{ijk} \, r_i \times p_j, \tag{6.1.97a}$$

$$[J_i\hat{,}J_j] = J_i \times \hat{T} \times J_j - J_j \times \hat{T} \times J_i = b_k^2 \times J_k, \tag{6.1.97b}$$

$$J^{\hat{2}} = J \times \hat{T} \times J, \tag{6.1.97c}$$

where we have ignored for simplicity factorization of the isounit.

It is trivial to prove that the above isorotational algebra is isomorphic to the conventional algebra (due to the positive-definite character of the characteristic quantities b_k^2), $\hat{O}(3) \approx O(3)$, and this proves the reconstruction by hadronic mechanics of the exact rotational symmetry when popularly believed to be broken, a feature proved since the original proposal [14] of 1978.[29]

The reconstruction of the *exact Lorentz symmetry* $\hat{O}(3.1)$ for the Bose-Einstein correlation follows the same lines. Since the speed of light is assumed to be locally varying, we have *mutated light cones* of the type, e.g., in the (3.4)-plae

$$n\hat{2} = (x_3^2 \times b_3^2 - x_4^2 \times b_4^2) \times \hat{I} = \frac{x_3^2}{n_3^2} - \frac{x_4^2}{n_4^2} \times \hat{I}, \tag{6.1.98a}$$

$$\hat{I} = Diag.(1/b_3^2, 1/b_4^2) = Diag.(n_3^2, n_4^2). \tag{6.1.98b}$$

It is again easy to see that *the mutated light cone in our spacetime is the perfect light cone in isospace, called light isocone,* because, again, the mutation of each axis is complemented by the inverse mutation of the corresponding unit. The preservation of the original numerical values is then assumed by the structure of the isoinvariant, Eq. (6.1.69).

Once the light cone is exactly reconstructed on isospace for locally variable speeds of light, the reconstruction of the exact Lorentz symmetry became a trivial calculations (see Vol. I for brevity) and it is here left as an important exercise for the interested reader.

[29]See EHM Vol. II for realizations of the isorotational symmetry with conventional structure constants.

The same situation occurs for translations, resulting in the reconstruction of the exact Poincaré symmetry $\hat{P}(3.1)$ for all possible nonlocal and non-Hamiltonian realizations of the Bose-Einstein correlation, as first proved in Refs. [3.4].

Recall that isorelativity and special relativity coincide at the abstract, realization-free level, as confirmed by the speed of light *in vacuum* to be the constant maximal causal speed in *isospace.* Consequently, *the understanding of the isorepresentation of the Bose-Einstein correlation requires the knowledge that, rather than "violating" special relativity as at times perceived, in reality allows the maximal possible enlargement of the arena of applicability of Einsteinian axioms.*

6.1.10.F Theoretical Predictions

It is important now to identify the theoretical prediction of isorepresentation (6.1.89) so that we can compared them below with experimental data.

Prediction 1: The minimum value of the two-points isocorrelation function, first identified in Ref. [63],

$$\hat{C}_2^{Min} = 1, \tag{6.1.99}$$

evidently holding for infinite momentum transfer.

Prediction 2: The maximal value is predicted to be

$$\hat{C}_2^{Min} = 1 + \frac{1}{3} + \frac{1}{3} + \frac{1}{3} = 1.67. \tag{6.1.100}$$

evidently holding for null momentum transfer. Prior to any fit, we can say that, for the isorepresentation to be valid, all data must remain between the above minimum and maximum values.

Prediction 3: Isorepresentation (6.1.89) also predicts the *maximum value of the isodensity,* occurring for $\hat{C}_2^{Max}$ (Eq. (10.27, page 127, Ref. [63]]. In fact, for $q_t = 0$ we have no correlations, in which case we have

$$b_k^2 = 1,\ k = 1, 2, 3,\ K^2 = b_1^2 + b_2^2 + b_3^2 = 3, \tag{6.1.101a}$$

$$\hat{C}_2^{Max} = 1 + \frac{K^4}{3} - \frac{K^2 \times b_4^2}{3} = 1.67, \tag{6.1.101b}$$

$$b_4^2 = 2.33,\ \ n_4^2 = 0.429,\ \ b_4 = 1.526,\ \ n_4 = 0.654. \tag{6.1.101c}$$

Prediction 4: By assuming that $K^2 = 3$ and that the fireball is very prolate, e.g., with $b_3^2 = 30 \times b_1^2 = 30 \times b_2^2$, we obtain the following prediction on the remaining characteristic quantities

$$b_1^2 = b_2^2 = 0.043,\ \ b_3^2 = 2.816,$$

$$b_1^2 = n_1^2 = n_2^2 = 10.666,\ \ n_3^2 = 0.355 \tag{6.1.102}$$

Needless to say, the above prediction is mainly referred to the *type* of isospacetime inside the fireball, rather than the numerical values per se, due to the lack of knowledge at this point of the prolateness of the fireball.

From the above predictions we then derive the following expected values[30]

$$\hat{\beta}^2 = \frac{b_3^2}{b_4^2} \times \beta > \beta^2, \tag{6.1.103a}$$

$$\hat{\gamma} = \frac{1}{(1 - \hat{\beta}^2)^{1/2}} < \gamma. \tag{6.1.103b}$$

From the isoaxioms of Section 6.3, we then have the following additional predictions:

Prediction 5: The maximal causal speed within the fireball is *bigger* than that in vacuum,

$$V_{max} = c_o \times \frac{b_4}{b_3} > c_o; \tag{6.1.104}$$

Prediction 6: Time t within the fireball flows faster than time predicted by special relativity),

$$t = \hat{\gamma} \times t_o > \gamma \times t_o; \tag{6.1.105}$$

Prediction 7: Lengths ℓ inside the fireball are smaller than lengths predicted by special relativity,

$$\ell = \hat{\gamma}^{-1} \times \ell_o < \gamma \times \ell_o; \tag{6.1.106}$$

Prediction 8: Mass behavior with speed is bigger than that predicted by special relativity,

$$m = \hat{\gamma} \times m_o > \gamma \times m_o; \tag{6.1.107}$$

Prediction 9: The energy equivalence of the fireball is bigger than that predicted by special relativity or, equivalently, for a given energy, the mass is smaller),

$$E = m \times V_{max} > E_o = m \times c_o^2; \tag{6.1.108}$$

Prediction 10: Frequencies of light emitted inside the fireball, exist the same *isoblueshifted,* namely, with an increase of frequency as compared to the corresponding behavior p[predicted by special relativity

$$\omega = \hat{\gamma} \times \omega_o. \tag{6.1.109}$$

[30]The reader may note the use of the absolute value for the definition of the $\hat{\gamma}$ in footnote 42, page 123, Ref. [63]. This was due to the lack, at the time of that memoir (1992), of experimental data on the maximal causal speed within physical media, especially those opaque to light. This information was reached subsequently with the identification of Isoaxiom I. Eq. (6.1.11), with $V_{max} = c_o \times b_4/b_3$, in which case the speed v is always smaller than or equal to V_{max}, $\hat{\beta} \leq 1$, $\hat{\gamma}$ can only assume real values, and the absolute value is no longer necessary.

Prediction 11: The speed of light within the fireball is bigger than that in vacuum,

$$c = c_o > b_4 > c_4, \tag{6.1.110}$$

by smaller than the maximal causal speed

$$c = c_o \times b_4 < V_{max} = c_o \frac{b_4}{b_3}. \tag{6.1.111}$$

As one may recall from Volume I, the isoblueshift of light is nothing mysterious because it is a mere manifestation of the high energy density of the medium in which light propagates. Isoblueshift, as the increase of frequencies as predicted by special relativity in vacuum, is then a mere consequence of the medium transfer energy to light. A similar situation occurs for all other predictions.

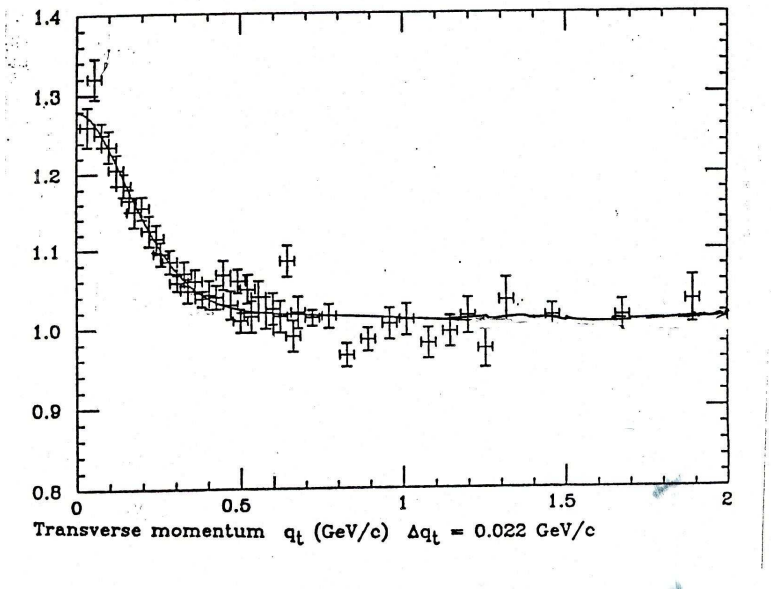

Figure 6.10. The exact fit of Santilli's two-point isocorrelation function (6.1.89) of the Bose-Einstein correlation at high energy made via the use of the experimental data from the UA1 tests at CERN [66]. The fit was done by F. Cardone and R. Mignani via a private communication to the author of 1992.

6.1.10.G Experimental verifications

It is rewarding for the author to report that *the fit of the experimental data on the Bose-Einstein correlation at high energy with the data of the UA1 experiments at CERN [66] have confirmed all the above predictions beyond the most optimistic expectations.*

The fit of Eq. (6.1.89) presented in Figure 5, page 129, Ref. [63] was conducted by F. Cardone and R. Mignani in 1992 and reported to the author as a private communication. The fit provided the following numerical values of the characteristic quantities for the fireball

$$b_1^2 = 0.092, \;\; b_2^2 = 0.097, \;\; b_3^2 = 3.463, \;\; b_4^2 = 3.616 \tag{6.1.12a}$$

$$b_1 = 0.303, \;\; b_2 = 0.3311, \;\; b_3 = 1.860, \;\; b_4 = 0.901, \tag{6.1.112b}$$

$$n_1^2 = 10.801, \;\; n_2 = 10.309, \;\; n_3^2 = 0.288, \;\; n_4^2 = 0.276, \tag{6.1.112c}$$

$$n_1 = 3.286, \;\; n_2 = 3.210, \;\; n_3 = 0.536, \;\; n_4 = 0.525 \tag{112d}$$

$$k^2 = b_1^2 + b_2^2 + b_3^2 = 3.653 \tag{6.1.112e}$$

A most important feature of the above data is that they *characterize the medium inside the fireball as being iso-Minkowskian of Group III, Type 9, thus confirming that all hadrons heavier than kaons have the same iso-Minkowskian features.* As we shall see, these geometric characterizations have primary relevance for further advances.

The fit of Figure 6.10 and the above values provide the following experimental verifications:

(1) The experimental data do indeed lie between the theoretically minimum (6.1.99) and maximal value (6.1.100);

(2) The experimental data confirm all eleven theoretical predictions (6.1.101) to (6.1.111);

(3) The experimental confirm the reconstruction of the exact character of the Poincaré symmetry for the Bose-Einstein correlation.

77).

In summary, *the fit of Figure 6.10 provides the fourth direct experimental verification of Santilli isorelativity and relativistic hadronic mechanics, this time, in their most fundamental assumption, the historical legacy of the nonlocality of strong interactions. In particular, this additional experimental verification is fully compatible with all preceding ones.*[31]

[31]The reader should be aware that the fit of the UAI data done in Ref. [64], page 441, is unacceptable for the following reasons:

1) The fit is done for *eight* parameters, the b_μ, $\mu = 1, 2, 3, 4$ of the original derivation [63], plus four new parameters a_μ. This assumption turns the analysis equivalent to the conventional one, in the sense that four out of the eight parameters are equivalent to the chaoticity parameters of Eq. (6.1,77) because the Bose-Einstein correlation can only characterize *four* physical quantities, the three semiaxes of the fireball and its density. By contrast, main efforts were devoted in Ref. [63] to show that the four characteristic quantities b_μ alone are sufficient for the fit, as in Eqs. (6.1.89)-(6.1.91).

2) The redundancy of the parameters is confirmed by the same data of Ref. [64], e.g.,

$$b_1 = 0.267, \;\; b_2 = 0.0437, \;\; b_3 = 1.661, \tag{a}$$

$$a_1 = 0.053 \times 10^{-13}, \;\; a_2 = 0.086 \times 10^{-13}, \;\; a_3 = 0.328 \times 10^{-13} \tag{b}$$

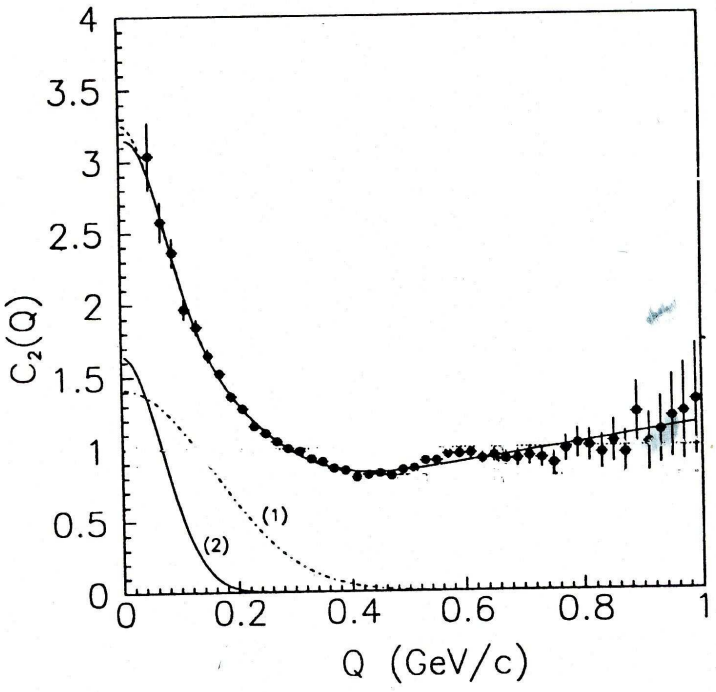

Figure 6.11. An illustration of another exact fit of the Bose-Einstein correlation from first axiomatic principles, this time of the proton-antiproton annihilation at very low energies, which can be obtained via the methods of this section. Its explicit study is ;left as an instructive exercise for the interested reader.

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that are manifestly proportional to each other because

$$\frac{b_1}{a_1} = 5.037 \times 10^{13}, \quad \frac{b_2}{a_2} = 5.081 \times 10^{13}. \quad \frac{b_3}{a_3} = 5.064 \times 10^{13}, \tag{c}$$

the very small differences of the above ratios being well within the error.

The above proportionality eliminates the need for one of the two sets of parameters because, as stressed in Ref. [63], *the characteristic quantities are always defined up to an arbitrary factor in view of the isotopic invariance* (6.1.69), that can be explicitly written for an arbitrary (non-null) constant C (see also Eq. (6.1.79))

$$\hat{x}^{\hat{2}} = [x^\mu \times (\hat{T}^\nu_\mu \times \eta_{\nu\rho}) \times x^\rho] \times \hat{I} = [x^\mu \times (C \times \hat{T}^\nu_\mu \times \eta_{\nu\rho}) \times x^\rho] \times (C^{-1} \times \hat{I} = \hat{x}^{\hat{2}}. \tag{d}$$

This the reason that the characteristic quantities are normalized to the value of the vacuum, $b_\mu = 1$. The fit for the fourth component in Ref. [64] is unacceptable for the independent reason that the forth component can only represent the *density* Energy / Volume or Mass / Volume, and cannot represent the meanlife as in Ref. [64] because the vacuum is permanently stable and b_4 is applicable first and above all for the stable proton, as we shall see in the next section. needless to say, the calculations of the meanlife of the fireball is significant and possible, but not at the expense of adding a second arbitrary parameter.

The repetition of the above analysis and related verification with the experimental data of the Bose-Einstein correlation at low energies (Figure 6.11) is left as an instructive exercise for the interested reader.

Another instructive exercise for readers interested in learning hadronic mechanics is to re-derive the entire results of this section via the simple method of a nonunitary transform of the conventional treatment according to Eqs. (6.1.22) (see Section 1.3.5 for more details).

In closing, the author would like to express his sadness for the excessive abuses of the name "Einstein" through the 20-th century and continuing to this day. There is no doubt that Albert Einstein is the biggest scientist of the 20-th century, with historical contributions to mankind deserving the highest respect by all.

However, it is equally true that Albert Einstein is the scientist most abused in the history of science because mediocre academicians improperly used and abused his name for personal gains in money, prestige and power.

The use of the name "Einstein" in the "Bose-Einstein correlation" has been one of several cases of abuses of Einstein's memory because Einsteinian theories are *inapplicable* (rather than "violated") in the field, since Einstein never studied dynamical problems in the interior of hyperdense media, such as the fireball, that were inconceivable at his time.

The difference in stature between Einstein and his followers is established by the writings. Einstein has a justly deserved, towering place in the history of science because he clearly identified in his limpid writings the arena of applicability of his theories, point particles and electromagnetic waves propagating in vacuum. The comparatively lilliputian dimension of physicists abusing his name is set in history by the absence, for evident political reasons, of identification of limitations that are inherent in any physical theory.

6.1.11 Experimental Verifications in Astrophysics

One of the unsolved mysteries of contemporary astrophysics is the experimental confirmation (see Ref. [67]) of the hypothesis (see Refs. [68,69]) that certain *quasars* are physically connected to associated *galaxies,* even though they have dramatic differences in their *cosmological redshifts* (see Figure 6.12).

The Einsteinian treatment of cosmological redshift requires its interpretation via *motion in vacuum away from us,* resulting in the well known *expansion of the univ erse.* However, the evidence that quasars and galaxies with dramatically

3) All formulations of Ref. [64] are based on spaces defined over conventional fields, i.e., they deal with conventional "deformations," thus dealing with conventionally nonunitary time evolutions. As a result, Ref. [64] activates the *Theorems of catastrophic Mathematical and Physical Inconsistencies* studied in detail in Section 1.5, and briefly outlined in Section 6.6.

For the above and other reasons, the author prefers fit (6.1.112) conducted under the strict requirements of relativistic hadronic mechanics.

different redshifts are physically connected, thus move with the same speed, prevents any serious or otherwise scientific representation via Einsteinian theories, whether in Minkowski or Riemannian spaces.

Numerous interpretations of the above anomalous occurrence have been attempted, such as the hypothesis that the difference in cosmological redshift is due to *creation of matter* within the quasars [69]. However, none of these interpretations have acquired the necessary numerical representation for scientific credibility.

In 1991, Santilli [6] proposed the simplest possible explanation according to which the indicated difference in cosmological redshifts is merely due to *the slow-down of the speed of light in the huge quasar chromospheres* (that can be as large as entire galaxies), similar to the slow-down of the speed of light in our atmosphere (Section 6.1.7). As a result, light exits the quasar chromospheres already redshifted. A similar phenomena does not exist in the same magnitudes for a galaxy because their stars are isolated in space, and have dramatically smaller chromospheres. In this way, light from physically connected quasars and galaxies having the same expansion speed, can reach us with dramatically different redshifts.

The effect can first be read off in the expansion of the Minkowskian redshift (here presented for simplicity for the case of null aberration)

$$\omega = \omega_o \times (1 - v/c_o) \times \gamma \approx \omega_o \times [1 - v/c_o + \frac{1}{2} \times (v/c_o)^2 + ...] \tag{6.1.113}$$

Since $v \ll c_o$, it is evident that a decrease of c_o will imply an increase of the redshift.

It was shown in Ref. [6], Vol. II, that the above equation is insufficient to represent astrophysical evidence, e.g., because chromospheres are anisotropic (due to their rotation) and inhomogeneous (due to the decrease of the density with the increase of the radial distance from the center), while the geometry underlying law (6.1.113) is purely isotropic and homogeneous.

By using Isopostulate IV, Eq. (6.1.14), Santilli [*loc. cit.*] suggested the following *isodoppler law* for the cosmological redshift

$$\omega = \omega_o \times [1 - (v \times b_3/c_o \times b_4) \times \hat{\gamma} \approx$$

$$\approx \omega_o \times [1 - \beta \times (b_s/b_4) + \frac{1}{2} \times \beta^2 \times (b_s/b_4)^2 + ...] \tag{6.1.114}$$

where n_s is the space characteristic quantity in the direction of emission of light, assuming the source to be spherical for simplicity. As one can see, the above isolaw predicts an additional contribution in the redshift due to the anisotropy and inhomogeneity of quasar chromospheres.

In 1992, R. Mignani [70] provided a direct experimental verification of Santilli's Isopostulate IV and related isodoppler law for all the most important pairs of

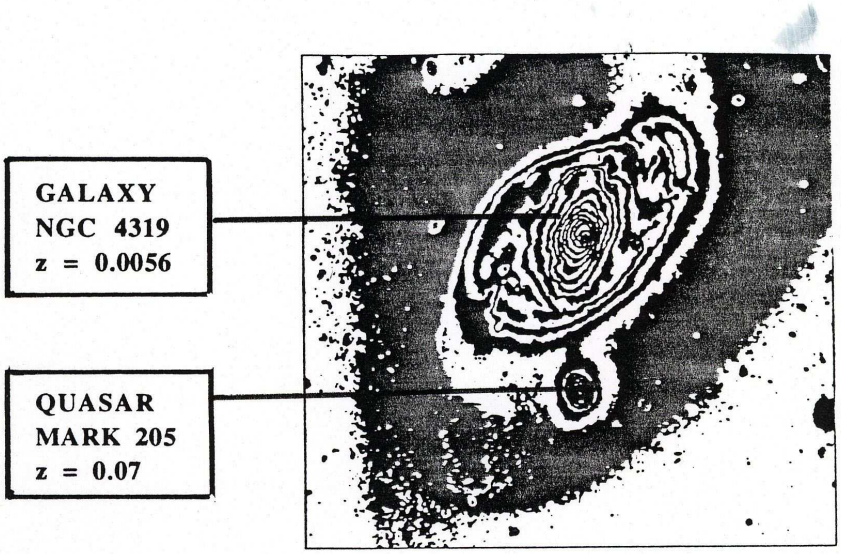

Figure 6.12. An example of clear evidence of astrophysical conditions beyond the capabilities of Einsteins special and general relativities or, equivalently, beyond the Minkowskian and Riemannian geometries: the experimentally verified (Ref. [67]) physical connection between the galaxy NGC 4319 and the quasar Mark 205, via the superposition of several gamma spectroscopic plates. By contrast, the quasar Mark 205 has a redshift with $z = 0.07$, while the associated galaxy NCG 4316 has a redshift of only $z = 0.0056$. The interpretation of this difference requires necessary departures from the Minkowskian and Riemannian geometries, because such a large difference would require that the quasar has at least 104 times the speed of the galaxy, under which conditions the quasar and its associated galaxy would have separated completely billions of years ago. Santilli's iso-Minkowskian geometry permits an exact, numerical, and invariant representation of the indicated large difference in cosmological redshifts, while restoring the abstract Minkowski and Poincaré axioms on isospaces over isofields.

quasars and associated galazies. The verification was done via the parameter

$$B = \frac{b_s}{b_4} = \frac{(\delta\omega + 1)^2}{(\delta\omega + 1)^2 + 1} \times \frac{\delta\hat{\omega} + 1)^2 - 1}{\delta\hat{\omega} + 1)^2 + 1}, \tag{6.1.115}$$

where $\delta\omega$ represents the measured Einsteinian redshift for galaxies, and $\delta\hat{\omega}$ represents the isotopic redshift for quasars according to Santilli's law (6.1.114).

A most important consequence of the data of Figure 6.14 is that *quasars chromospheres are iso-Minkowskian media of Group II, Type 5* (Figure 6.3). In this way, the anomalous redshift behavior here considered is reduced to the axiamatic geometric characterization of the inhomogeneity and anisotropy of astrophisical

GAL.	ω'_1	QUASAR	B	$\hat{\omega}_2$
NGC	0.018	UB1	31.91	0.91
		BSOI	20.25	1.46
NGC 470	0.009	68	87.98	1.88
		68D	67.21	1.53
NGC 1073	0.004	BSO1	198.94	1.94
		BSO2	109.98	0.60
		RSO	176.73	1.40
NGC 3842	0.020	QSO1	14.51	0.34
		QSO2	29.75	0.95
		QSO3	41.85	2.20
NGC 4319	0.0056	MARK205	12.14	0.07
NGC 3067	0.0049	3C232	82.17	0.53

Figure 6.13. A summary of Mignani's data [70] verifying Santilli's isorelativity for all major quasars that are physically associates to galaxies according to clear spectroscopic or other evidence, while having dramatically different cosmological redshifts.

chromospheres. As we shall see, this geometric characterization will allow numerical predictions for the isoredshift expected by Sun light at sunset.

It is evident that the data of Figure 6.13 provide another experimental verification of the the very central assumption of Santilli isorelativity, the *novel modification (called mutation) of spacetime caused by physics media,* where "novelty" is intended to clarify that said modification *is not* of gravitational or any previously known nature, but intrinsic in the anisotropy and/or inhomogeneity of the media.[32]

Yet another experimental verification of Santilli isorelativity is given by the exact, numerical, and invariant representation [71] of the*internal red-, and blueshift of quasars.* We are here referring to the unexpected behavior whereby, for a given cosmological redshift, there can be relatively smaller shifts toward the read or toward the blue. This is a phenomenon that clearly confirmed Santilli's isorelativity because it is known since Newton times, although not admitetd for

[32]Again, we use the word "mutation" suggested since the original proposal of hadronic mechanics, Re. [14]. referring to formulation defined on isospaces over isofield, so as to distinguish them from "deformations," namely, formulations defined on conventional spaces over conventional fields, because the catastrophic inconsistencies of the latter (Sections 1.3.5 and 6.1.6) were already known in 1978.

personal gains, that the index of refraction of lighgt has an explicit dependence on the frequency, resulting in thne beautiful separation of light into its various colors via a crystal. But the index of refraction is the characteristic quantity $1/b_4 = n_4$. Hence, thje quasars blueshifts and redshifts can be explained in a trivial way via Santilli's isorelativity, via a simple functional dependence of the characteristic quantities on the frequency, $b_\mu = b_\mu(\omega, ...)$ (Figure 6.14). See Ref. [71] for details and fits due to their simplicity.

Note *the absolute impossibility for special and general relativities to represent the astrophysical data of this subsection.* Hence, the covering relativity that is applicable for interior astrophysical problems is open to scientific debates, but the denial of its need is outside scientific or credible doubt

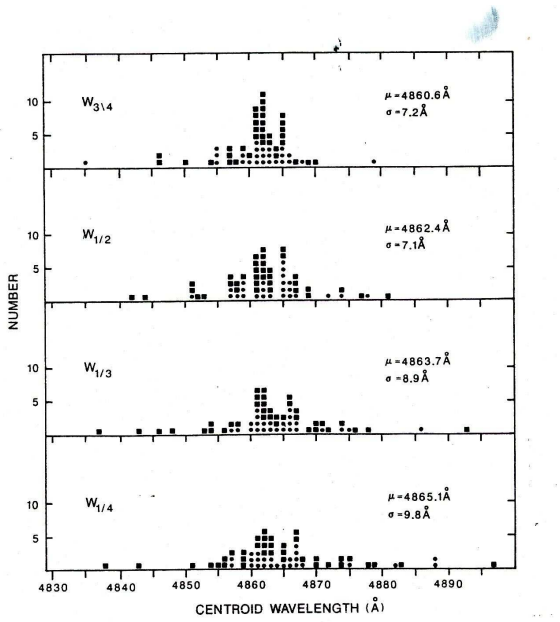

Figure 6.14. A schematic view of Sulentic's [67] discovery of the internal red- and blue-shift of quasars, that is, the decrease or increase of the cosmological redshift of quasars with corresponding variations of the light frequency. The latter occurrence is a further experimental confirmation of the validity of Santilli's iso-Minkowskian geometry for quantitative representations of cosmological redshifts. In fact, the evidence establishes a dependence of the redshift with the frequency, which is evidence of propagation of light within physical media fully known, although not admitted as of lately, since Newton's times. The iso-Minkowskian geometry then applies, e.g. because of its direct universality for interior conditions.

6.1.12 Verification via the Absence of Dark Matter and Energy

Recent astrophysical observations have established that matter in the visible universe, when computed with conventional theories, is substantially insufficient for a quantitative explanation of numerous astrophysical events, including galaxy evolutions, lensing effects, temperature distribution of hot gases, cosmic microwave background, and other events. Specific calculations indicate that, at this writing (October, 2007) matter (or energy) in the universe as above defined can only account for 3 % of the needed mass (or energy). Consequently, 93 % of the needed mass (or energy) is missing.

The above data lead to the proposal and widespread propagation of the conjecture of *dark matter (or energy),* (see Ref. [72] for a readable account and main references) according to which the missing 93 % is carried by an unknown state of matter capable of experiencing and causing gravitation (as an evident necessary condition for a credible explanation of gravitational anomalies), yet it is "dark" in the sense of not being visible, thus not emitting or absorbing radiations, and having additional quite implausible peculiarities identified below.

It is known by well informed scientist that *the conjecture of dark matter was suggested for the specific intent of salvaging the validity of Einstein special relativity in the interior of stars, quasars and black holes.* In particular, the conjecture was voiced at the time of mounting theoretical and experimental evidence of the *inapplicability* (rather than "violation") of Einsteinian doctrines in the indicated conditions for numerous reasons, such as the emerging locally varying character of the speed of light within physical media (see Section 6.1.8 and review paper [40]). [33]

In fact, the conjecture of "dark matter" is a direct consequence of the use in astrophysical calculations of the Einsteinian energy equivalence

$$E = m \times c_o^2, \tag{6.1.116}$$

where c_o is the speed of light *in vacuum.*

Said conjecture remains implausible for several reasons indicated below, the most damaging one being the lack of a "dark matter wind" during the motion of stars. In fact, the assumption that the visible mass is only 3 % of that existing in the universe, implies that stars must move within a "dark matter sea." Under

[33]Rather unreassuringly, the U. S. Department of Energy has recently advertised, rather widely, the availability of public funds specifically earmarked for the study of "dark energy," thus with a ‚mirror condition existing at the U. S. national Science Foundation, thus fueling rumors that U. S. Federal Agencies are controlled by organized interests on Einsteinian doctrines without a serious commitment to much needed basic advances. It is assumed that even the most unscrupulous reader will not dare to deny that strict verification of Einsteinian doctrines is a mandatory condition for securing *contemporary* federal research contracts. Documentation to the contrary would be gratefully appreciated by the author.

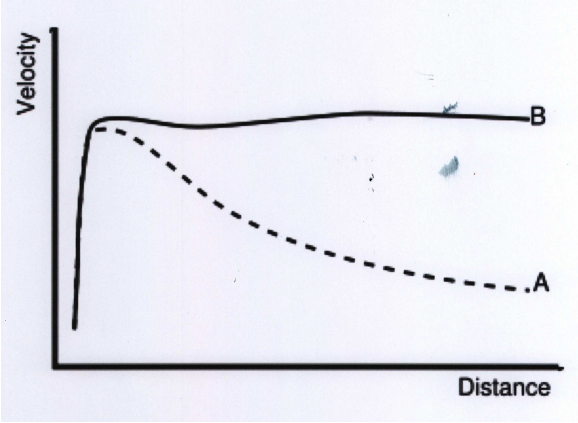

Figure 6.15. A typical illustration of the claimed need for "dark matter" [72] in a very large amount: the predicted rotation of stars in a spiral galaxy (A) and the observed behavior (B). As one can see, the observed behavior is *bigger* than that predicted by orthodox calculations. The aspect that turns the conjecture of "dark matter" into a theology is that "dark matter" should it decrease, rather than increase, the rotational motion of stars, evidently because, when assumed to constitute 93 % of the mass in the universe, "dark matter" becomes a physical medium with consequential "dark matter wind," namely, the necessary creation of a *resistance* that stars should experience while moving in the "dark matter sea." In reality, it is known by experts in the field that the conjecture of "dark matter" was submitted for the pre-meditated scope of maintaining the dominance of Einsteinian theories in conditions for which they are inapplicable. In fact, as soon as necessary deviations from Einsteinian theories are admitted in the interior of stars, quasars and black holes, there is no need at all for theological conjectures to explain the dynamics of the universe.

such a condition, the dynamics of stars is expected to be the *opposite* of what ventured, namely, "dark matter" should *decrease* the rotation of stars in galaxies, rather than increase them as, per primary scope of the conjecture.

The alternative is to assume that 93 % of the mass in the universe is in a state of "evanescence" so as not to cause the "dark matter wind" during the motion of stars, yet it causes gravitational effects. Such an unverifiable conjecture to support an unverifiable conjecture would cause exiting the boundaries of serious science.

As typical for all directly unverifiable conjectures ventured for the intent of salvaging Einsteinian theories, the conjecture of "dark matter" is now being complemented by additional unverifiable conjectures, such as that *"dark matter" is composed by the hypothetical neutrinos* (see next section for the basically unsettled character of the neutrino conjecture). The clear (but unspoken) intent here is to abuse academic credibility on the "evidence" for the existence of the hypothetical neutrinos as "evidence" in support of the conjecture of "dark matter," all for the pre-meditated intent of preserving Einsteinian doctrines, while studiously avoid-

ing a mention of their possible inapplicability under extreme conditions simply unthinkable during Einstein's times.

Needless to say, studies along the above theological lines should certainly be allowed to continue.[34] However, the field would be turned into an illusory science in the event said theological studies are not complemented with research based on *deviations* from Einsteinian doctrines within the hyperdense media inside stars, quasars and black holes.

It is hereon assumed the reader is aware of the fact that *gravitation originates from the energy of given bodies and not from their mass, the latter merely representing their inertia.* The popular misconception of assuming mass as the source of gravitation originates from Newton's equation

$$m \times \frac{dv}{dt} = F, \tag{6.1.117}$$

that was automatically extended for centuries to Newtonian gravitational attraction

$$F = G \times \frac{m_1 \times m_2}{r^2} \tag{6.1.118}$$

However, the force F in Newton's equation (6.1.117) is identically null for bodies at a constant mutual distance for which $dv/dt = 0$, while the force F in Eq. (6.1.18) is not null for the same conditions. Hence, recent studies (see EHM II and references quoted therein) have indicated that the more appropriate version of the gravitational attraction is that in terms of the energy content of the bodies,

$$F = S \times \frac{E_1 \times E_2}{r^2}, \tag{6.1.119a}$$

$$S = \frac{g}{c_o^2}. \tag{6.1.119b}$$

Needless to say, it is popularly known that formulations (6.1.18) and (6.1.19) are equivalent, since the passage from one to the other is given by a mere numerical proportionality. Such an equivalence is unquestionable for the conditions of exact applicability of Einstein's energy equivalence, namely, for *point particles moving in vacuum.*

What does not appear to be popularly known is that the equivalence between Eqs. (6.1.18) and (6.1.19) is lost when referred to *extended bodies with hyperdense interior media,* because the speed of light is no longer the maximal causal speed, assuming that light can propagate in the medium considered.

[34]Provided that papers written and published under public U. S. financial support explicitly quote the tentative nature of the research and the expected inapplicability of Einsteinian doctrines in the field, so as to avoid violations of U. S. Laws suitable for legal prosecution.

Hence, from now on, the physically important issue is the *missing energy,* in the universe, and not the missing mass.. Again, the latter merely represents the inertia as traditionally conceived through centuries, namely, as the matter tendency to oppose changes of speed. As such, inertia cannot possibly be the source of gravitation, thus leaving the energy as the only source available at this writing.

The reader accustomed to throw judgment via a quick glancing at topics in which he/she has no technical knowledge,[35] should be warned that the need to use energy as the true gravitational source requires a serious technical knowledge of isomathematics (EHM Vol. I and Section 3.2) including the geometric unification of the Minkowskian and Riemannian geometries and a serious resolution of the *Nine Theorems of Catastrophic Inconsistency of Einstein's Gravitation* studied in Section 1.4 [73]..

At any rate, *the use of energy as the source of gravitation, rather than mass, is mandated by experimental evidence that light has no mass, yet it experiences gravitation, such as in the case of the bending of light when passing near astrophysical bodies.* In this case we evidently have the gravitational attraction

$$F = S \times \frac{E_{mass} \times E_{light}}{r^2}. \tag{6.1.120}$$

Hence, the restriction of gravitational sources to mass would solely admit *some* gravitational events in the universe, while the use of energy would admit them *all.*

As an obvious comment, the above reformulation of gravity fully represents the data of our Solar system, because the currently assumed gravitational fields of the Sun and planets are identically reformulated from mass to their isoequivalent energies. However, the reformulation is, by far, non trivial, e.g., because it may provide new insights in interior ghravitational problems, such as the speed of lighjt and maxiumal causal speed inside the Sun.

Under the above clarifications, we can quote Santilli's view [74] according to which *isorelativity eliminates the need for dark matter and energy either in full or in part.* In fact, Isoaxiom V, Eq. (6.1.15), predicts that the energy equivalence of a given mass is given by

$$\hat{E} = m \times c_o^2 \times \frac{b_4^2}{b_s^2} = m \times c_o^2 \times \frac{n_s^2}{n_4^2}, \tag{6.1.121}$$

where we have assumed for simplicity a perfect sphericity of astrophysical bodies resulting in the single value $b_s = 1/n_s$.

[35]The author remembers "distinguished" colleagues, including a Nobel Laureate in Physics, refereeing papers during the duration of time for the elevator to reach the physics department second floor. For the intended "review," this time is amply sufficient to identity the affiliation of the author and the compatibility of the content with Einsteinian theories.

Santilli then pointed out that the "missing energy" ΔE can be accounted for via the value [*loc. cit.*]

$$\Delta E = m \times c_o^2 \times (\frac{b_4^2}{b_s^2} - 1) = m \times c_o^2 \times (\frac{n_s^2}{n_4^2} - 1). \tag{6.1.122}$$

Under the assumption that the mass of the universe, when computed via Einsteinian theories, is only 3 % of the needed mass, the behavior of stars and other objects in the universe can be explained via the following *average isotopic characteristics of trhe universe* applicable for the hyperdense medium inside stars, quasars and black holes

$$\frac{b_4^2}{b_s^2} = \frac{n_s^2}{n_4^2} = 94, \tag{6.1.123}$$

As an example, by using ordinary gauge theories, Ref. [42] computed the average value of the speed of light within hyperdense hadronic media to be 75-times that in vacuum, in which case we have

$$c = 75 \times c_o, \;\; b_4^2 = 75, \;\; b_s^2 = 0.079 \tag{6.1.124}$$

Needless to say, calculations [42] are merely approximate. Yet, the view that the conventional mass equivalent necessarily holds in the interior of black holes, has no scientific credibility.

Needless to say, value (6.122) and (6.1.123) are an *average* for the entire universe, under the understanding that they are based on current estimate of 93 % missing energy. Also, the values are expected to vary dramatically from stars to black holes, the latter being arguably the origin of the biggest contributions.

It should also be noted that isorelativity provides a *partial* elimination of the missing energy, because every point in space is traversed by light coming from the entire universe, thus characterizing a clear energy. Additional energy everywhere in space is provided by ordinary massive particles, such as cosmic rays, hydrogen, etc. Clearly, the latter component characterized by ordinary electromagnetic waves, particles and hydrogen has to be computed before finalizing the value of the average isotopic characteristic of the universe. Note that the latter conventional component is dramatically insufficient to account for all missing energy.

In summary, recent theological trends in astrophysics, for the pre-meditated scope of adapting nature to Einsteinian theories, have conjectured the existence of a mysterious substance existing in our spacetime, capable of experiencing and causing gravity, but unable to absorb or emit electromagnetic waves, not causing a "dark matter wind" in the motion of stars, being uniformly distributed at times to explain star rotations in Galaxies (Figure 6.15) while being entirely concentrated in a point to explain lensing effects Figure 6.16) and having other manifest basic flaws.

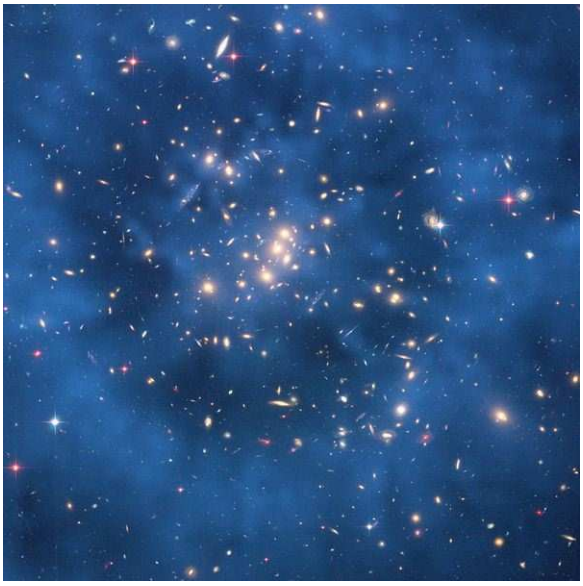

Figure 6.16. Another illustration of the widespread political preservation of Einsteinian theories under conditions for which they are inapplicable: the use of lensing effects in the universe as "evidence" in support of the conjectural "dark matter." The posturing is political because the indicated lensing effect is well known to be solely due to a highly concentrated mass in one of the foci, while the conjectural "dark matter" must be uniformly distributed in space to "interpret" the behavior of Figure 6.15. This is reminiscent of the case about one century ago of using the bending of light near an astrophysical body as "evidence" of the curvature of space, while in reality that bending is entirely due to Newtonian attraction, and, in the event curvature does indeed cause the bending of light, the prediction of Einstein's gravitation is double that measures [73]. The fact that curvature cannot possibly explain the free fall of bodies along a straight radial line, even though known to high school students, was suppressed, at times studiously, to serve a political purpose in science.

In this section, we have shown that the dynamics of the universe can be interpreted quantitatively by adapting the theories to the evidence, in this case, by honoring the *exact* validity of Einsteinian theories for the physical conditions limpidly expressed by Einstein ("point-particles and electromagnetic waves propagating in vacuum"), and by halting the abuse of Einstein's name and memory in pushing said validity beyond the arena of their original conception and experimental verifications, to the contemporary extremes of manipulation of scientific evidence that can only be euphemistically qualified as theological at best.[36]

[36]The author would like to:

1) Set a record for having received today, October 11, 2007, a visit from the Italian-British scientist, industrialist and philanthropist from London, **Dr. Francesco Fucilla**;

6.1.13 Experimental Verifications via Supernova Explosions

There is little doubt that contemporary astrophysics is one of the most theological fields of contemporary science due to the assumption of numerous fundamental aspects without serious theoretical and/or experimental evidence, and/or serious scrutiny, such as:

1) The most fundamental event in astrophysics, the *synthesis of the neutron from protons and electrons,*,

$$p^+ + e^- \to n + \nu, \tag{6.1.125}$$

is basically unknown at this writing on both theoretical and experimental grounds. On theoretical grounds the synthesis is basically unsettled because the rest energy of the neutron is 0.78 MeV *bigger* than the sum of the rest energies of the proton and the electron. Under these conditions quantum mechanics is fundamentally inapplicable due to the lack of physical meaning of Schrödinger's equations under the necessary *positive* binding energy of 0.78 MeV (in which case there is no energy available for the hypothetical neutrino). Yet, quantum mechanics is routinely applied for all calculations known to the author. On experimental grounds, the insufficiency is even greater due to the rejection by laboratories around the world of the author proposal over decades of testing synthesis (6.1.125), evidently due to its incompatibility with established doctrines (see next chapter for details). lacking fully established theoretical and experimental knowledge on the first and most fundamental synthesis (6.1.125) in a star, the rest of "astrophysics" (that is, the physics of stars") is evidently unsettle on serious scientific grounds.

2) Contemporary astrophysics is additionally based on the belief that neutrinos are physical particles in our spacetime. However, the only available quantitative representation of synthesis (6.1.125), that provided by hadronic mechanics, does not need the neutrino at all, as shown in the next section; as limpidly stated by Enrico Fermi, neutrinos cannot be experimentally detected; the indirect detections believed to be caused by neutrinos have alternative interpretations; and the neutrino conjecture remains afflicted by a number of unsettled aspects that multiply in time, rather than decrease, because unspoken. Under these conditions, any astrophysical model depending on neutrino conjectures is evidently unsettled on serious scientific grounds.

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2) Indicate that, if properly supported by scientists, educators, politicians, economists, industrialists and historians who care about human knowledge, Dr. Fucilla can be the coordinator of a much needed *new scientific renaissance* comparable to that originated by Lorenzo de' Medici (called "Il Magnifico") in the the 1500's, not only because of Lorenzo's superior vision, but also because of the support he received by luminaries such as Andrea del Verrocchio, Leonardo da Vinci, Sandro Botticelli, Domenico Ghirlandaio, Filippino Lippi, Michelangelo Buonarroti and so many others.

3) Note with pride that Dr. Fucilla is Italian.

3) Astrophysical observations are interpreted via spectral analysis established on earthly experiments, namely, on the spectral emissions of essentially unperturbed atoms, while it is known that atoms subjected to extreme conditions have spectral emissions *different* than those from ideal conditions. In more explicit terms, the spectral emission, for instance, iron under the extreme densities and pressures in the core of a star is expected to be dramatically different than the spectral emission of iron as measured on in our laboratories.
[37]

At any rate, after one century of studies, the spectral emission of our Sun is still basically unknown to the authors best knowledge, e.g., because of spectral lines that should originate from orbits *smaller* than the ground state of the hydrogen, and similar unresolved anomalies. Under these conditions, the theoretical interpretation of spectral lines from a far away star, quasar or supernova via quantum mechanics can only be qualified as being unsettled at best.

For the receptive young mind of any age interested in knowledge (rather than an academic career), the author suggest, as a pre-requisite for endless, fundamental new discoveries, to keep an open mind and study as a matter of principle *all* possibilities permitting quantitative interpretations, irrespective of wether via the use of quantum or hadronic mechanics.

Along these lines, the author suggest the conduction of quantitative studies on the *origin of the energy in supernova explosions.* As it is well known (se, e.g., Ref. [75] and large references therein), the sequence of a supernova is currently expected to be due to the exhaustion of the "nuclear fuel" in a star resulting in an expected iron core that, when reaching the Chandrasekar mass, collapses all atoms into into a neutron star, at which point contraction stops with the initiation of the explosion.

This produces one of the most violent explosions in the universe that are visible to the naked human eye on Earth as far away as tens of thousands of light years away estimated to require about 10^{50} joules of energy, namely., an amount of energy hardy comprehensible by mankind.

The issue in which the author would like to attract the attention of young mind of any age outside academic political and theological rings is that this huge energy is quickly "interpreted" as being provided by the the energy conversion of about

[37]It is appropriate to recall here that quantum mechanics has achieved an exact representation of the spectral emission solely of the hydrogen atom and solely when in essentially unperturbed conditions, since deviations between theoretical predictions and exponential evidence begin to be significant for the helium and become embarrassing for heavy atoms such as the zirconium because of a basic reason for the proposal to construct hadronic mechanics, the emergence of nonlocal, nonpotential and non-Hamiltonian effects between atom,ic electrons that begin precisely with the helium. When all atoms, including the hydrogen, are exposed to extreme conditions of pressures as occurring in stars,m these nonlocal, nonpotential and non-Hamiltonian effects are dramatically increased, resulting in dramatic deviations between the theoretical predictions based on quantum mechanics and the experimental evidence.

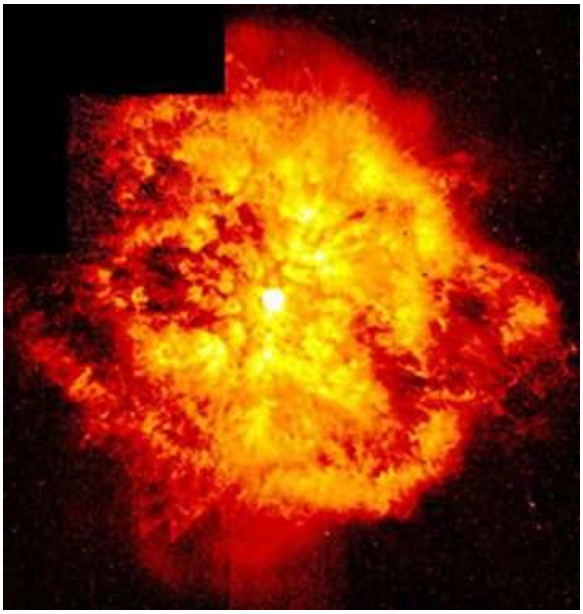

Figure 6.17. A NASA image of the nebula WR124 located 21,000 light years away showing the remnants of a supernova.

10 % of the original star mass. However, the *mechanism* of energy production is ignored, evidently because it is based on the synthesis of the neutron that, notoriously, cannot be treated via quantum mechanics, thus resulting in vague indications or theological feelings.

In fact, *at the time of reaching the state of a neutron star, there are no appreciable nuclear syntheses that can possibly account for the production of such un-imaginable amount of energy.* Hence, one [possibility that should be investigated, of cpourse, jointly with others, is that *the energy in a supernova may originate prior to the explosion, namely, during the formation of the neutron star.*

If the above arguments are admitted as part of others, potentially momentous advances are possible. In fact, we have recalled above that *the synthesis of the neutron does not release any energy and actually requires* 0.78 *millions electronVolts.*

Hence, the issue is addressed is: *where is the enormous amount of energy required to reach a neutron star originating from?* The issue brought to the attention of young minds of any age is the following:

SUPERNOVA HYPOTHESIS: The energy needed for a supernova explosion originates at least in part from space conceived as a universal medium of very high energy density (Section 6.1.2).

In the next section we shall study the synthesis of the neutron inside stars as solely permitted by hadronic mechanics in a quantitative, numerical. and in variant way. It is evident that, as a first possibility, the missing 0.79 MeV originates from the thermal and other energies available inside a star, are acquired by the proton and the electron during 'Rutherford's compression" of the hydrogen atom, and result in the synthesis of the neutron.

However, a scientific process cannot be claimed unless the studies include the alternative possibility that *the synthesis of the neutron inside a star is a mechanism of transfer of energy from space to matter, namely, a mechanism for continuous creation of matter in the universe.*

To conduct science as traditionally conceived, that via a quantitative and invariant ;process verifiable in laboratory, we have to halt at this point our study of supernova and defer interested reader to a study of the next section.

6.1.14 Verifications via the Bose-Einstein Condensation

The *Bose-Einstein condensation* (see, e.g., Refs. [76-78]) is one of the most mysterious events in nature that could stimulate major advances in scientific knowledge, under the condition that the memory of Satyendra Nath Bose and of Albert Einstein is indeed duly honored, but the limitations of their view is admitted as the premise the same advances, the belief in final theories being solely motivated by money, prestige and power.

There is no doubt that the initial experimental realization of the Bose-Einstein condensation can be fully treated with special relativity and quantum mechanics. However, there should be no doubt by serious scientists that its extreme realization includes *contact, zero-range, nonlocal and non-Hamiltonian interactions extended over the volume of deep wave-overlappings of the atomic electrons at short distances.*

The *approximate* character of special relativity and quantum mechanics for these novel interactions is beyond scientific doubt. By contrast, isorelativity and hadronic mechanics are the only theories known to the author that:

1) Provide an axiomatically correct representation on nonlocal;l interactions extended over a volume, beginning with the basic TSSFN isotopology specifically constructed for the interactions considered (Section 3.2.7);

2) Is "directly universal" for nonlocal and non-Hamiltonian interactions in the sense of admitting all infinitely possible interactions of the class admitted ("universality") directly in the frame of the experimenter, thus without the transformation to hypothetical frames ("direct universality"); and

3) It enjoys the same invariance of quantum mechanics, namely, admitting the same numerical predictions under the same conditions but at different times.

The conditions of applicability of relativistic hadronic mechanics to the Bose-Einstein condensation are those in which, under a sufficiently strong external

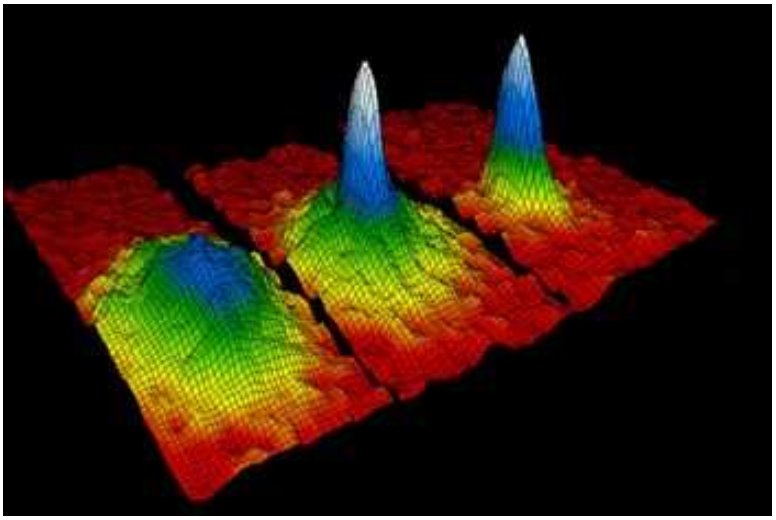

Figure 6.18. A typical illustration of the Bose-Einstein condensation from Ref. [76] showing the velocity distribution of gases: just before the appearance of the BoseEinstein condensate (left); just after the appearance of the condensate (center); and a representative sample of nearly pure condensate (right). The most intriguing event is the subsequent one with a "supernova-type behavior" that could activate an interplay between matter and space as a universal substratum of extremely high energy (Section 6.2).

magnetic field, the condensate enters into the attractive phase , shrinks beyond detection, and then explodes, by blowing off part of its atoms, the remaining parts essentially disappearing from detection.

It is known that this characteristic of BoseEinstein condensate cannot be explained with special relativity and quantum mechanics because of the evident impossibility to account for the *strongly attractive force between neutral atoms* that is needed for an implosions such to allow the condensate to disappear from measurements. Secondly, there is no possibility of explaining via quantum mechanics the *super-nova type behavior* of the condensate following the impletion.

Relativistic hadronic mechanics offers the possibility for a quantitative study of the above anomalous behavior. In fact, we shall study in detail in the next section that *nonlocal interactions due to wave overlappings at short distances in singlet couplings generate a strongly attractive force* that can be responsible for the synthesis of hadrons.

Additionally, relativistic hadronic mechanics offers means for quantitative studies as to whether the excessive energy needed for the super-nova phase of the condensation originates from space conceived as a universal medium of very high energy density. As we shall also see in the next section, iso-Hilbert spaces have

been also conceived for a quantitative representation of the interplay between matter and the ether as a universal medium.

Stated in different terms, once the limitations of orthodox doctrines are admitted as the very premise for basic advances, the Bose-Einstein condensation could have such far reaching implications of allowing experimental means for ascertaining whether the same mechanism occurs for supernova explosions or, more generally, whether or not there is indeed continuous creation of matter in the universe./

6.1.15 Verification in Cosmology

In preceding chapters, we have studied the various branches of hadronic mechanics consisting of methods for the representation of matter in conditions of progressively increasing complexity, such as

QUANTUM MECHANICS, representing isolated, reversible and single-valued systems of point particles under solely Hamiltonian interactions;

ISOMECHANICS, representing isolated, reversible and single-valued systems of extended, nonspherical and deformable particles under Hamiltonian and non-Hamiltonian interactions;

GENOMECHANICS, representing open, irreversible and single-valued systems of extended, nonspherical and deformable particles under Hamiltonian and non-Hamiltonian interactions;

HYPERMECHANICS, representing open, irreversible and multi-valued systems of extended, nonspherical and deformable particles under Hamiltonian and non-Hamiltonian interactions.

We have then studies the isodual images of all preceding four methods for the treatment of antimatter in conditions of corresponding, progressively increasing complexity.

These studies include the geometric unification of special and general relativity into isorelativity, their basic Poincaré-Santilli iso-, geno-, and hyper-symmetries, and the axiomatically consistent classical and operator gravity embedded in the basic unit.

For the purpose of this section we note that all distinctions between matter and antimatter are lost at the hyperstructural level, thus permitting a unification of *all* branches of hadronic mechanics into one single formulation, hypermechanics, admitting all other as particular cases. In fact, the hyperunit can be characterized by an ordered set of genounits and their isoduals,

$$\{\hat{I}\} = \{\hat{I}_1^>, \hat{I}_1^{>d}, ^<\hat{I}_1, ^<\hat{I}_1^d, I_2^>, ^<I_2^{>d}, ^<\hat{I}_2, ^<\hat{I}_2^d, ...\}, \tag{6.1.126}$$

under which the hyperproduct of two generic quantities a and b yields a corresponding ordered set of values

$$a\{\times\}b = \{c_1^>, c_1^{>d}, ^<c_1, ^<c_1^d, c_2, c_2^d, ^<c_2, ^<c_2^d, ...\} \tag{6.1.127}$$

Consequently, at this highest possible level of formulation, we have one single hyperrelativity, one single Poincaré-Santilli hypersymmetry

$$\{\hat{P}\}(3.1) = \hat{P}^{>}_{matter}(3.1) \times \hat{P}^{>d}_{antimatter}(3.1) \times^{<} \hat{P}(3.1) \times^{<} \hat{P}^{d}(3.1). \quad (6.1.128)$$

and one single hypergravity encompassing all particular cases of exterior and interior, classical and operator gravitation for both matter and antimatter.

The above defined hypermechanics have permitted the formulation of a *new cosmology*, first proposed by Santilli in Ref. [79], and now known as *hypercosmology* characterized by the following three basic assumptions:

HYPERAXIOM I: The universe is (3+1)-dimensional and multi-valued.

HYPERAXIOM II: All events in the universe verify the Poincaré-Santilli hypersymmetry.

HYPERAXIOM III: All total physical characteristics of the universe are identically null.

A few explanatory comments are in order to assist the non-initiated reader. As studied throughout Volume I, the sole possibility known to the author of achieving a consistent *classical* treatment of antimatter that verifies all experimental data and admits charge conjugate operator images, is given by the isodual theory. This theory implies that *the universe is (3.1)-dimensional but two-valued.* In fact, antimatter does indeed exist in a (3.1)-dimensional space, but the isodual conventional, iso-, geno, or hyper-Minkowski space is *different* than the conventional space of matter. This leads to a two-valued structure of the universe, namely, a structure consisting of two coexisting worlds, in which each of the (3.1) components has two values, one for matter with unit $+1$ and one for antimatter with unit -1.

The extension from the two-valued matter-antimatter spacetime to a multivalued universe is dictated by numerous aspects, not only in astrophysics, but also in biology where multi-valuedness is necessary to attempt any minimally credible study of biological structures such as the DNA code whose complexity is beyond human imagination at this time (Chapter 5)

Note in covering structures (6.1.126)-(6.1.128) the presence of *all* possible formulations, namely: formulations for the description of matter systems moving forward and backwards in time and their isoduals for antimatter. This all encompassing generality is dictated, certainly not by elementary systems familiar to physicists, but by the complexity of the biological world that is beyond the imagination of the most educated biologist.

We have indicated in Chapter 1.5 that a credible representation of a truly elementary biological event, such as the bifurcation achieved by seashells during their growth in time, requires *all four directions of time, that is: motion forward*

in future time; motion forward from past time; motion backward from future time; and motion backward in past times. Then, the most skeptic of a reader cannot deny the necessity of our isodual theories without risking a credibility collapse due to ignorance, for the evident reason that *time reversal can only achieve two out of four time directions, while the remaining two can be only achieved only via isoduality in a way compatible with classical and operator experimental evidence.* Alternative conjugations are encouraged, provided that they are not merely epistemological, but quantitative and published in refereed journals, and with the understanding that they will remain redundant over isoduality [83].

The reader should be aware of the *dramatic differences between multi-dimensional and multi-valued theories.*. Multidimensional theories are herein defined as being characterized by a number of spacetime dimensions bigger than (3.1), such as (4.1, (3.3), etc. These theories, even though at time mathematically elegant, are herein strictly rejected on physical grounds because directly incompatible with our sensory perception that, as well known, is based on our three Eustachian lobes solely permitting a three-dimensional perception of space, and our one-dimensional perception of time.

By contrast, our multi-valued theories have been conceived and developed to achieve full compatibility with our sensory perception, while admitting a complexity of the universe beyond our imagination. As an example, when we observe a seashell in our hand, we perceive its shape in three-dimension and its evolution along our one-dimensional time. However, the same seashell can overlap a large number of spaces and their isoduals, resulting in multi-fold formulations including the four different directions of time indicated above. To state it differently, the assumption that the internal time of a seashell is necessarily the same as our time can only originate from arrogance of planetary proportions. The sole scientific statement we can venture at this writing is that the intrinsic time of a seashell is of such a complexity to be beyond our rather limited mental capabilities.

In Section 1.4., the author has shown that general theory of relativity is catastrophically inconsistent on mathematical and physical grounds for numerous diversified reasons, some of which are nowadays vexing because untreated (let alone unresolved) for about one century, while other reasons have emerged from these studies (see the *Nine Theorems of Catastrophic Inconsistencies of General Relativity* of Ref. [73]).

In the author's view, the biggest damage caused to science by general relativity has been in turning cosmology into a theology (see Appendix 6.D). One, among numerous reasons, is the structuring of gravitation on on *covariance* that leads to the impossibility of preserving the same numerical predictions under the same conditions at different times, the violation of causality, and other catastrophic inconsistencies. This is a reason for the author spending decades of his time in reformulating gravitation on a *universal symmetry* [5] as the only known way

to avoid these catastrophic inconsistencies, as per historical teaching of special relativity.

The foundation of our hypercosmology on the universal hypersymmetry (6.1.128) is the single most important result of the author's lifetime of research because it governs the totality of the events in the universe, from large scale cosmological dynamics, down to the most elementary component of the universe. The clear understanding is that we are here merely referring to a *model* that, as such, has numerous limitations, some of which are identified below, for science will never admit a "final theory."

One illustration of the theological aspect of the cosmological studies of the 20-th century is the large effort devoted to the *age of the universe* without a serious scrutiny of the limitations in the very formulation of the problem. The origin of these problems remains always the widespread studious tendency of adapting nature to Einsteinian theories.

But, as established in Chapters 1.1 and 1.2, Einsteinian theories have no *classical* mean at all to differentiate neutral matter and antimatter stars; the only differentiations available in the 20-th century being that at the level of *second quantization;* and general relativity admitting no consistent formulation at the level of *first* quantization, let alone the second. As a result of this vast scientific imbalance, in order to adapt nature to Einsteinian theories, antimatter has been intentionally ignored in the gravitational and cosmological studies of the 20-th century and the "age of the universe" has been studiously referred to matter alone, "studiously" because the antimatter component of the universe is generally *not* mentioned.

The reader who has studied seriously the content of Volume I before a quick glance at this section knows well that *the the total time of the universe is identically null for an equal distribution of matter and antimatter,* that is implicit in hyperaxiom III, of course, as a limit case.

Even by restricting the study to *the age of the matter component of the universe and, separately, the antimatter component,* there are insufficiencies in the very formulation of the "age of the universe," let alone on a possible answer, because such a question is tacitly based on the assumption of Einsteinian theories as being universally valid everywhere in the universe.

If, instead, broader vistas are admitted as possible, the problem of the age of the matter component of the universe, or its antimatter component becomes rather complex because of the *strictly local character of each of the four different times,* where the locally varying character *not* referred to gravitation, but to *the local variation of the four different time units* that include indeed gravitation, but in its *interior* formulation.

Once the initiated reader has technically understood that the total time of the universe under an equal distribution of matter and antimatter can only be

identically null, then the reader can easily see that: *the total energy, the total momentum, the total angular momentum and all other characteristics of the universe are identically null* (see Volume I and Ref. [83] for technical details).

Yet another reason for the theological character of the cosmological studies of the 20-th century is the belief that the universe initiated with an *immense singularity* in the fabric of spacetime, called the "big bang" without a serious scrutiny of its foundation. To begin, the primordial explosion is tacitly referred to solely to matter. Antimatter is studiously ignored because not treatable with Einstein's gravitation and, consequently, it is tacitly assumed not to exist.. By contrast, *the mere inclusion of antimatter would eliminate the singularity in the act of creation, evidently because the total characteristics of the universe were identically null prior to creation and so remain after creation.*

But the problem of the origin of the universe is of such a complexity to be immensely beyond our comprehension, thus demanding the only statement for true science, we do not know, and no certain answer is foreseable at this writing. To illustrate the need for serious scientific caution, we have touched in the preceding sections the possibility of *continuous creation* of matter, hence of antimatter, in the universe, and we shall enter into its quantitative studies beginning from the next section on.

It is evident that a possible continuous creation of matter in the universe renders arrogant any questions such as that on the "the age of the universe." At any rate, the author is a religious person, because the complexity of the universe is simply too enormous to be the outcome of random occurrences. The addressing of issues such as "age of the universe," the "creation of the universe," etc., indicate lilliputian intellect, because tacitly based on the unspoken, yet evident assumption of a capability to understand God's will. This is a reason for presenting our cosmological views more for the identification of the insufficiencies of existing views, rather than because actually true.

Other unreassuring cosmological studies are those on the apparent *expansion of the universe.* To begin, the views are essentially based on the Einsteinian interpretation of cosmological redshift as being due to motions away from us. However, we have shown in preceding sections that, subject to final experimental verification strongly requested in the next section,. *light can indeed slow down in the huge astrophysical chromospheres, thus being emitted already redshifted even for the case of astrophysical bodies at rest with us.* Hence, the current measurements on cosmological redshifts are indeed "actual," but their interpretation down to expansion speed are merely conjectural, again, because based on Einsteinian beliefs.

The author's view is that the "notion of expansion" of the universe appears to be supported by a number of direct or indirect astrophysical evidence, although the "numerical rate of expansion" is at this writing a mere personal belief due to

the lack of experimental verifications of the Doppler-Santilli isoredshift rejected by astrophysical laboratories for decades, evidently not to question Einsteinian theories.

Additional unreassuring aspects are related to the origin of the expansion because antigravity would be a natural origin, but, according to a widespread view, "antigravity does not exist because not admitted by Einsteinian theories." Such a view must be denounced as sheer scientific corruption for personal gains in money, prestige and power, because Einsteinian theories do not even represent antimatter, as a consequence of which any study of antigravity via Einsteinian theories is entirely vacuous. In reality, *the most plausible understanding of the expansion of the universe known to the author is that the universe is constituted by a generally homogeneous distribution of matter and antimatter galaxies experiencing mutual gravitational repulsion as studied in detail in Chapter 13.*

To be plausible, the interpretation should not only explain the *expansion per se,* but also the apparent *increase of the expansion in time.* These two occurrences cannot possibly be explained with the "big bang" since the expansion should decrease, rather than increase in time due to the "dark matter wind" that is inherent in orthodox theological beliefs). The increase of the rate of expansion can be *solely* explained via the existence of a *continuous, action-at-a-distance, repulsive force between galaxies.* In turn, the only conceivable possibility verifying these conditions is *antigravity,* and, in turn, the only known source of gravitational repulsion is *antimatter.*

We reach in this way the expectation of the existence of antimatter stars, galaxies and quasars, this time derived as the only plausible interpretation of the gravitational expansion *and* its increase in time. Unreassuringly, the author has been informed that numerous astrophysical events can only be interpreted quantitatively via antigravity, but such an interpretation cannot be voiced (or published) because antigravity is not predicted by Einsteinian doctrines.

As indicated in Volume I, the isodual theory of antimatter has been worked out because it provides, for the first time to the author's knowledge, quantitative mathematical, theoretical and experimental possibilities of ascertaining whether a far away galaxy or quasar is made up of matter or of antimatter, not only via unbiased astrophysical observations requiring antigravity, but also via unbiased interferometric studies of the light originating from galaxies and quasars to ascertain whether they it is composed by *ordinary photons,* or by *isodual photons,* The former is *attracted* by Earth's gravitational field, while the latter is *repelled,* thus rendering current interferometric techniques suitable for the detection or the denial of antimatter in the universe [83].

We should not forget that, according to unbiased reports, Earth appears to be bombarded by cosmic rays of both matter and antimatter nature, as indicated by flashes of light visible from spaceships while traversing the dark side of Earth.

These flashes can be best interpreted as being due to *antimatter cosmic rays* annihilating in our atmosphere, and certainly not by *matter cosmic rays* since the latter are known to penetrate deeply into our atmosphere and definitely not to annihilate in it.

To avoid adapting nature to preferred theologies, we should not forget that the *Tunguska explosion* in Siberia in June 30, 1908, can be most plausibly explained via an *antimatter meteorite* penetrating deep into the Earth's atmosphere and then exploding due to annihilation. This interpretation is suggested by the lack of a crater in the Tunguska event, despite a huge flattening of the local forest for over hundreds of square miles. By comparison, the hypothesis of a *matter meteorite* has no credibility since the lack of a crater would require its believed "evaporation" (sic) in atmosphere, namely, an occurrence firstly denied by all other craters caused by matter meteorites and, secondly, because the "evaporation" would have not even part of the energy needed for a scientific, that is, numerical explanation of the event.

Hence, antimatter is a most fundamental aspect of cosmology that has been forgotten during the physics of the 20-th century, to the evident detriment of researchers in the field, since their study cannot possibly pass the test of time without a full scientific democracy between matter and antimatter. It is hoped that this unreassuring trend is corrected in the 21-st century because true science cannot be done with theological beliefs or the adaptation of nature to preferred theories, but solely via the unbiased mathematical, theoretical and experimental study of *all* plausible theories, irrespective of whether compatible or not with Einsteinian doctrines

To fully understand this statement, the reader should know that, as we shall see in the final Chapter 14, all grand unification theories done throughout the 20-th century, beginning with the failed attempts by Einstein, can be proved rather easily to be catastrophically inconsistent on the sole ground that they do not include antimatter.

In closing, to keep a kilometric distance from orthodox trends, the author would like to stress that his hypercosmology has been presented as a sheer exercise of scientific curiosity without any claim of "scientific truth, and for the sole intent of showing the limitations of pre-existing cosmologies.

The author solely claims (and will defend, see the Legal Notice at the beginning of this volume) paternity of the first "cosmology" in the Greek meaning of the word, that is, including all structures in the universe, and thus *include life,* for that inclusion alone mandates all studies reported in these volumes.

6.2 HADRONIC STRUCTURE MODELS WITHOUT QUARKS AND NEUTRINOS

6.2.1 Introduction

Hadronic mechanics (hm) was proposed in memoirs [14] of 1978 for the primary purpose of achieving an exact and invariant representation of the neutron as a bound state of one proton and one electron, of course, in a generalized form (hereinafter denoted with a "hat")

$$n = (\hat{p}^+, \hat{e}^-)_{hm}. \tag{6.2.1}$$

The first rational basis for the proposal is that the proton and the electron are the only massive stable particles existing in nature. Hence, during the synthesis of the neutron in the core of stars from the hydrogen atom, the proton and the electron simply cannot "disappear" to please academicians. Consequently, the most rational assumption is that they are actual physical constituents of the neutron.

The second rational basis of the proposal is that the proton and the electron are reproduced in the *spontaneous* decay of the neutron and, as such, they simply cannot "reappear" to comply with preferred theories. Since the creation of the only known massive stable particles at the time of the neutron spontaneous decay is extremely implausible, the most rational assumption is that, again, the proton and the electron are actual physical constituents of the neutron.[38]

It is evident to undergraduate students that structure model (6.2.1) is impossible for quantum mechanics. Rather then adapting nature to preferred theories, memoirs [14] suggested adapting the theories to nature via the construction of a generalization of quantum mechanics permitting models (6.2.1).

The proposal was based on a *nonunitary transformation* of quantum mechanics (qm), as a necessary condition to exit the classes of equivalence of quantum mechanics under *unitary transforms.* The nonunitary structure was also proposed in view of the fact that, in the transition from the hydrogen atom to the neutron in the core of stars, we have the transition of the electron from the state of a point particle moving in vacuum with sole action-at-a-distance interactions, to the state of an extended wavepacket in condition of total penetration within the hyperdense medium inside the proton. The latter conditions characterize new, contact, nonlinear, nonlocal and nonpotential interactions dramatically beyond the representational capability of a Hamiltonian. The inability of representing

[38]The author experiences great difficulties in reading the particle physics literature of the 20-th century because of the presentation of particle reactions in which new particles are created without any explanation whatsoever. This posture is generally intentional to claim the validity of quantum mechanics in particle physics, since its insufficiency becomes crushing when the mechanisms creating new particles are addressed quantitatively.

the neutron synthesis with the sole knowledge of the Hamiltonian, then confirmed the need for a nonunitary theory.

Hence, memoirs [14] proposed the construction of a nonunitary image of quantum mechanics permitting a consistent map of the hydrogen atom H into the neutron exactly as occurring in the core of stars,

$$H = (p^+, e^-)_{qm} \ ;\rightarrow \ \ n = (\hat{p}^+, \hat{e}^-)_{hm} = U_n \times (p^+, e^-)_{qm} \times U_n^\dagger, \qquad (6.2.2a)$$

$$U_n \times U_n^\dagger \neq I. \qquad (6.2.2b)$$

The neutron was proposed as essentially being a new state of the hydrogen atom solely occurring at mutual distances of the order of $10^{-13} cm = 1$ fm, the hydrogen atom obeying quantum mechanics and the neutron obeying the covering hadronic mechanics. Requirement (6.2.2) then imposed *ab initio* that hadronic mechanics is solely valid at mutual distances of particles of the order of one fm, namely, for the range of strong interactions. Equivalently, map (6.2.2) requires that the excited states of the neutrons are the quantized states of the hydrogen atom, or, alternatively, that

$$Lim_{r>1fm}(U_n \times U_n^\dagger) = I. \qquad (6.2.3)$$

It was stressed in memoirs [14] that quantized orbits do exist for point particles moving in vacuum, as in the hydrogen atom, but the belief of the existence of tiny quantized orbits within the hyperdense medium inside the neutron would be pure nonscientific nonsense. This prevented in refs. [14] for ethical reasons the use of the word "quantum" for the new discipline. The name "hadronic mechanics" was selected to stress the primary intent of the new mechanics, the study of the hadronic structure or, more generally, of strong interactions.

Since quantized orbits are represented by the *basic unit of quantum mechanics,* Planck's constant $I = \hbar$, the absence of quantized orbits inside the neutron mandated a generalization, called *lifting,* of the Planck's constant into a Hermitean and positive-definite, but otherwise arbitrary, integro-differential operator $\hat{I}$. In the same way as the synthesis of the neutron is the most fundamental event in nature, its mathematical representation required the lifting of the most fundamental mathematical quantity, the basic unit, namely, synthesis (6.2.2) requires the following lifting of Planck's constant

$$U \times U^\dagger = U^\dagger \times U = I = \hbar \rightarrow U_n \times U_n^\dagger = \hat{I}_n = \hat{I}_n^\dagger = \hat{I}_n(r, p, \psi, \partial_r \psi, ...) > 0, \quad (6.2.4)$$

with the subsidiary condition following from Eq. (6.2.3)

$$Lim_{r>1fm} \hat{I}_n = I = \hbar, \qquad (6.2.5)$$

Since a mathematics based on an arbitrary (nonsingular) unit simply did not exist in 1978, all branches of mathematics had to be rewritten in such a form

admitting $\hat{I}$, rather than I, as the left and right unit at all levels. This mandated the lifting of: numbers; fields; functional analysis; topology; differential calculus; enveloping associative algebras; Lie algebras; Lie groups; Lie symmetries; Lie representation theory; Euclidean, Minkowskian, symplectic, Riemannian and other geometries; etc. These liftings illustrate the need for decades of research in pure mathematics prior to being in a position of doing serious quantitative studies on the synthesis of the neutron. The occurrence also illustrates the dimension of the resulting works (consisting of over 20,000 pages of published research by hundreds of authors outlined in the General Bibliography) of which we can regrettably touch in this section only the most salient lines.

This huge effort was motivated not only by scientific curiosity, but also by the alarming environmental problems afflicting our planet, which problems were already clear in 1978, even though irrationally dismissed. As already well known in 1978, the resolution of our environmental problems requires new clean energies and fuels. As equally known in 1978, all possible energies and fuels conceivable with quantum mechanics and special relativity had been fully discovered by that time, and all turned out to be environmentally unacceptable. The only hope for society was then the construction of suitable *generalizations* of quantum mechanics and special relativity that would at least permit the conception of new clean energies and fuels. This need provided the author the necessary strength to trash out academic putrescence and its organized opposition against the construction of hadronic mechanics denounced in the footnotes of these volumes.

In fact, if (and only if) the electron is an actual physical constituent of the neutron, then (and only then) the neutron could be stimulated to decay via resonance and/or other mechanisms, thus initiating a it new class of energies called *hadronic energies,* because different than nuclear, atomic and molecular energies and originating from mechanisms in the structure of individual hadrons, rather than in their collection. Unlike nuclear energies, the latter are expected to exist for *light nuclei,* thus being "clean" in the sense of not having sufficient energy to release harmful radiations and/or leave harmful waste, as we shall see in Chapter 11.

The extension of model (6.2.2) to some of the other baryons is elementary, e.g.,

$$\Lambda = (\hat{p}^+, \hat{\pi}^-)_{hm} \equiv (\hat{n}, \hat{\pi}^o)_{hm}, \tag{6.2.6}$$

where the reader should keep in mind the equivalence on iso-Hilbert spaces of particles that are distinct on conventional Hilbert spaces, due to internal non-Lagrangian / non-Hamiltonian exchanges and renormalizations we shall indicate in this section.

Additionally, memoirs [14] worked out in details (see Ref. [14b], Section 5) the representation of *all* characteristics of the π^o meson as a hadronic bound state of

an electron and a positron, although in their isotopic form

$$\pi^o = (\hat{e}^+, \hat{e}^-)_{hm}. \tag{6.2.7}$$

Much along lines (6.2.2) for the neutron, the above model was proposed as a nonunitary image of the positronium P

$$P = (e^+, e^-)_{qm} \ ; \rightarrow \ \pi^o = (\hat{e}^+, \hat{e}^-)_{hm} = U_{\pi^o} \times (e^+, e^-)_{qm} \times U^\dagger_{\pi^o}, \tag{6.2.8a}$$

$$U_{\pi^o} \times U^\dagger_{\pi^o} = \hat{I}_{\pi^o} > 0 \tag{6.2.8b}$$

where the reader should note from these introductory lines that quantum mechanics admits one and only one unit, Planck's constant. while hadronic mechanics admits *different isounits for different particles,* trivially, because the isounit represents contact non-Hamiltonian effects that are different for different particles.

Recall that the positronium is entirely described by one single equation, Schrödinger equation. Similarly, the nonunitary map (6.2.8) yielded *one single hadronic structure equations representing "all" features of the π^o,* including rest energy, charge radius, meanlife, charge, spin, magnetic moments, parity and spontaneous decay, the latter identifying the actual physical constituents.

Memoirs [14] then worked out the model for other mesons, resulting in "bootstrap" models of the type

$$\pi^\pm = (\hat{e}^+, e^\pm, \hat{e}^-)_{hm} \equiv (\hat{\pi}^o, \hat{e}^\pm)_{hm}, \tag{6.2.9}$$

whose spontaneous decay identifies, again, the actual physical constituents, This decay is called *hadronic tunnel effect,* in the sense that the tunneling occurs through Hamiltonian and non-Hamiltonian barriers.

The radical departures from orthodox trends of the above structure models of unstable hadrons should be noted upfront, such as:

1) The new structure models are absolutely impossible if attempted via the use of quantum mechanics for countless reasons, some of which will be identified in this section;

2) The new structure models have no need whatsoever of quark and neutrino conjectures as also shown in detail in this section;[39] and

[39]In 1979, when at the Lyman Laboratory of Physics of Harvard University, the author made 200 copies of the preprint of paper [88] indicating various impossibilities for quarks in being physical particles in our spacetime, and deposited them in person, one by one, in the mailboxes of all members of the physics departments of Harvard University, the Massachusetts Institute of Technology, Boston University, Brandeis University, Tufts University and Northeaster University. In so doing, the author (then still naive) was hoping for some technical exchanges with colleagues. However, by that time, public money was already granted by the Department of Energy and the National Science Foundation on the belief that quarks are physical particles in our spacetime. Consequently, none of the 200 or so colleagues who received the paper had any interest in discussing the issue. The research on quark conjectures as physical

3) Eliminate for the structural problem the widespread tendency of looking for the "mass spectrum," a feature allowed only for classification, a point emphatically stressed in memoir [14]. In fact, nonunitary maps (6.2.2) and (6.2.8) were identified under the condition of being *spectrum suppressing,* namely, the generalized Schrödinger equation for a hadron had to characterize one state and one state only, the hadron considered, trivially, because all exited states are conventional quantum, thus atomic states, under limits (6.2.5).

The above radical departures from rather universal trends of the time (1978) require the following comments. In essence, hadron physics of the 20-th century was dominated by the belief that the mechanics exactly valid for the description of point-like electrons moving in vacuum around atomic nuclei was also exactly valid for the description of the same particles moving within the hyperdense media inside hadrons.

Such a belief lead to scientific imbalances of historical proportions studied in Volume I and in the preceding section. The conjecture that quarks and neutrinos are physical particles in our spacetime was a mere consequence of adapting the hadronic structure to a preferred theory. The outcome was a plethora of fundamental problems that remained unresolved, because un-dressed due to the widespread illusion of achieving credibility via the academic power of the affiliations and physical societies, rather than serious scientific evidence.

To minimize misrepresentations of the intent of this section, it should be stated upfront that *we fully accepts the validity of the standard model and of the theory of weak interactions.* However, we restrict their validity to an *external,* Mendeleev-type treatments of hadrons; we deny their additional role as providing a joint representation of both, the classification and the structure of hadrons; and, by following the historical teaching for nuclei, atoms and molecules, *we seek basically new models of the hadronic structure with ordinary massive physical constituents under the condition of achieving compatibility with the established, external, Mendeleev-type theories.*[40]

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particles continued in a totally unperturbed way, of course, without any quotation of dissident view [88]. This is another reason the author believes that contemporary societies are in a condition similar to that of the Roman empire prior to the setting of the Roman Code of Laws, because of the current lack of any meaningful Scientific Code of Law. It is unfortunate for mankind that responsible authorities do not (or appear not to) understand that manipulations of scientific knowledge for personal gains in money, prestige and power causes damage to society much bigger than ordinary crimes.

[40]When the author was visiting in the mid 1970s the Institute for Theoretical Physics of the Massachusetts Institute of technology (thanks to a kind invitation by the director of the time, Francis Low, that it is here acknowledge with appreciation), the author used to participate to rather pleasant lunch meetings that were perhaps more interested than formal MIT seminars because informal, thus allowing participants a somewhat limited freedom of scientific expression. During one of these lunch meetings, the author asked a leading colleagues on quark conjectures, MIT bags, and all that, whether he would accept a graduate student for a Ph. D. thesis in the joint use of the Mendeleev model for both the classification and structure of atoms. The horrified colleague blasted the author with strong words for posing such a nonsensical question. The author then noted "But that's exactly what you do for hadrons by using

It should be noted that the new structure model of unstable hadrons did not require the addressing of the neutrino conjecture for the case of mesons and, consequently, could be worked out in its entirety already in the original memoirs [14] under the sole denial of quarks as physical particles in our spacetime. In this section, we shall review *ad litteram* the new structure model for mesons as originally conceived in 1978 by leaving additional advances to interested readers.

The explicit construction of the corresponding new structure model of unstable baryons with ordinary massive physical constituents was delayed for decades because of technical and political reasons. On technical grounds, the use of hadronic mechanics for baryons required the isotopic lifting of the $SU(2)$-spin symmetry that was unavailable at the time of the original proposal [14] (that, however, did contain the isotopies of the $O(3)$-symmetry). The first nonrelativistic structure model of the neutron as a bound state of a proton and an electron appeared in ref. [95] of 1990 following the isotopies of the spin symmetries (see Refs. [5]). Its relativistic extension appeared in papers [5f,96] only following the achievement of the the isotopies of the spinorial covering of the Poincaré symmetry in ref. [5f].

The political difficulties were caused by the fact that the belief in neutrinos as physical particles was, and remains to this day, much more entrenched in the mind of physicists than the corresponding belief for quarks. Consequently,all papers on the new structure model of the neutron and with the additional denial that neutrino as physical particles caused incredible oppositions, at times even hysterical. These oppositions delayed considerably the scientific process and caused a somewhat unusual scientific situation in which, on one side, editors and reviewers mandated the maintaining of the neutrino conjecture while, on the other side, hadronic structure models did not required such a conjecture at all. This explains the presence of the neutrino conjecture in paper [95,96].[41]

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the $SU(3)$ model for both the classification and the structure of hadrons," at which point the horror in the colleague's face turned into a silent anguish. This and other episodes reviewed in book [89] and documented in volumes [90] indicated that the author did not (wanted to) belong to the Massachusetts Institute of Technology. In fact, the author soon moved to Harvard University thanks to a referral by Francis Low to Steven Weinberg, referral that is recorded here for appreciation.

[41]Papers [95,96] on the neutron as a hadronic bound state of a proton and an electron were submitted to the journals of the American, British, Italian, Swedish and other physical societies, to receive the most violent and offensive, yet scientifically vacuous rejections in the author's fifty years of research experience.

The case of the "review" by the (British) Royal Society deserves a special mention, in the event British colleagues are interested in containing the rapidly decay of scientific ethics in their country. It is traditional in science that advances following a historical publication are submitted to the journal of origin.

The *Proceedings of the Royal Society* published in 1920 Lord Rutherford's conjecture of the neutron as a "compressed hydrogen atom," a conjecture that, at that time, was very farfetched, yet it was published because, in 1920, England enjoyed a real scientific democracy.

Immediately following the achievement of the spin isotopies, the author submitted paper [95] to the *Proceedings of the Royal Society* with a special dedication to the memory of Lord Rutherford and a

cover letter essentially explaining, in respectful academic parlance, the societal implications for new clean energies.

The repetitiously repeated rejections by the Proc. Roy. Soc. were so un-British, because using scientifically offensive language with total lack of technical content, to exclude any hope of serious science at the British Royal Society in the field at that time.

This occurrence should be complemented with rather vast documentation (currently deposited in Europe for the safety of the author's office and house) that the British Physical Society, known as the Institute of Physics (IOP), following routine publications by the author and his associates up to 1983, rejected (and continues to reject to this day) the totality of papers on hadronic mechanics by the author and all his associates.

The rejections have been so systematic to crease serious legal issues pertaining to the Statutes of Plagiarisms, Tort, Fraud and other charges that should perhaps be addressed by British subjects who care about the dignity of their country.

As an example, following about one thousand publications by the IOP on q-deformations without any quotation of their origination in Ref. [97] of 1967, the author contacted the editor in chief with a respectful letter and a copy of paper [97] requesting its quotation in subsequent papers in the field.

The editor rejected the request on grounds that, in the 1967 paper, "the equation $\lambda ab - \mu ba$ is written for nonassociative algebras with product ab while the q-deformations are formulated in terms of an associative product ab." The author then respectfully brought o the attention of the IOP editor that: 1) associative algebras are a trivial particular case of non associative ones as kown by all educated physicists; 2) the particular associative case was indicated in paper [97]; and 3) The use of nonassociative algebras such as $ab = m \times a \times b - n \times b \times a$ implies their trivial reformulations in terms of an associative product $\times$

$$(m \times a \times b - n \times b \times a) - (m \times b \times a - n \times a \times b) = p \times a \times b - q \times b \times a,$$
$$p = m - n, \quad q = n + m.$$

The IOP editor continued in the denial of paternity, hence creating clear legal problems that were brought to the attention of the highest levels of the IOP to no avail, and the paternity fraud of q-deformation continues to this day in a completely unperturbed way, thus offering in a silver plate beautiful grounds for legal prosecutions (in which the secretaries, usually writing letters in lieu of IOP editors believing to remain anonymous, should be spared action because innocent victims).

Needless to say, among the hundreds of rejections for over two decades, the IOP equally rejected with scientifically offensive, yet technically vacuous "motivations" all papers on the structure of the neutron as a bound state of one proton and one electron, despite petitions by various colleagues for the implications pertaining to "new" clean energies and the duty by the British physics community to participate in their search.

To understand the gravity of the condition of physical research existing nowadays in England, British colleagues should know that a main scientist (we cannot identify here to prevent his personal and scientific life from being disrupted) appealed to the head of the IOP and other British authorities for participation in the search for "new" clean energies on grounds that the Gulf Stream is down by about 30 % according to a report by the Pentagon published in the Economist, and that, when the Gulf Stream stops, England will become like Iceland in winter and like Uganda in summer.

The IOP head dismissed the appeal under the illusion that his parlance was credible, and all publications on hadronic mechanics by the IOP continued in being suppressed, particularly those dealing with new clean energies so much needed by mankind. The current situation is that the author considers offensive the very idea of additional submission to the British Institute of Physics and, in any case, publications in its journal are basically un-necessary. In the final analysis, the author has written several times in his works that *lack of participation in basic advances is a gift of scientific priorities to others.*

Needless to say, as it was the case for Italy (see Footnote 32 of Chapter 3), the above harsh judgment is *a priori* wrong if extended to the entire British physics community. Among the numerous British scientists openly opposing the current decay of scientific ethics in England I mention here Jeremy Dunning Davies of the University of Hull, who is the author of the courageous denounciation [110] as well as of truly pioneering research beyond organized financial interests in physics for which he received a Gold Medal for Scientific Merits.

The controversies on the nature of the neutrino delayed this volume for at least ten years since it was repugnant for us to complete a lifelong research with political postures. A determining event occurred at the 2006 meeting of the *International Association for Relativistic Dynamics* (IARD) held at the University of Connecticut, in Storrs. During this meeting the participants allowed the author to express his doubts on the existence of the neutrinos as physical particles. The author has no words to express his appreciation and gratitude to all IARD members for their tolerance of dissident views, as well as his sincere respect for their commitment to true scientific democracy for qualified inquiries. Said tolerance by IARD's colleagues gave the author sufficient motivation to initiate the completion of this second volume.

The final decision to initiate the release of this volume was permitted by M. van der Merwe, Editor of Foundations of Physics for the first publication by the author [97], following four independent reviewers, with systematic doubts on the existence of the neutrinos as physical particles in our spacetime. This paper also contains considerable references of similar publications by dissident colleagues. Because of this publication, as well as numerous others by the author (such as the first paper with systematic doubts on the existence of quarks as physical particles, Ref. [88] of 1981), and numerous other pioneering works by other authors, M. van der Merwe was recently granted a Gold Medal for Scientific Merits to be granted in 2008.

As historical notes, we should recall that quantum mechanics was called "atomic mechanics" in Ref. [14], namely, a mechanics conceived and constructed for the atomic structure, in order to distinguish it from "hadronic mechanics," namely, the mechanics conceived and constructed for the hadronic structure. This terminology has been lost with the passing of time. but remains still valid as of today.

Also, electrons were said to be *mutated* when within the hyperdense medium inside hadrons, to reflect a corresponding mutation in Ref. [100] of Lie algebras into covering Lie-isotopic or Lie-admissible algebras. This dual particle and algebra meaning of the word "mutation" has remained in use and will be adopted in this section under the assumption that covering algebras are treated with new mathematics to bypass the Theorems of Catastrophic Inconsistencies of Nonunitary Theories (Section 6.1.6).

Finally, mutated electrons and positrons were called in Ref. [14] "eletons" and "antieletons," respectively. These terms have been replaced with the corre-

The relativistic representation of model (6.2.1), Ref. [96], was eventually published in an *electronic* journal in China. The author then made a pilgrimage to Beijing in 1995 to personally express his appreciation to the Editor Kexi Liu, an appreciation that is recorded here as a sense of scientific duty. In this way, the new emerging China published a basic paper for possible new energies that the entire, decaying Western "civilization" suppressed.

sponding terms used in this section, namely,. "isoelectrons" and "isopositrons", or "isodual isoelectrons" to denote the fundamental symmetry for the characterization of their mutations, the Poincaré-Santilli isosymmetry and its isodual [5].

Needless to say, due to the extreme complexity of the problem, this section includes the use of the *totality* of the preceding studies on hadronic mechanics as per classification of Figure 1.22. Readers with a vast knowledge of quantum mechanics but insufficient knowledge of the covering hadronic mechanics are discouraged from glancing at this section to prevent the illusion of its understanding.

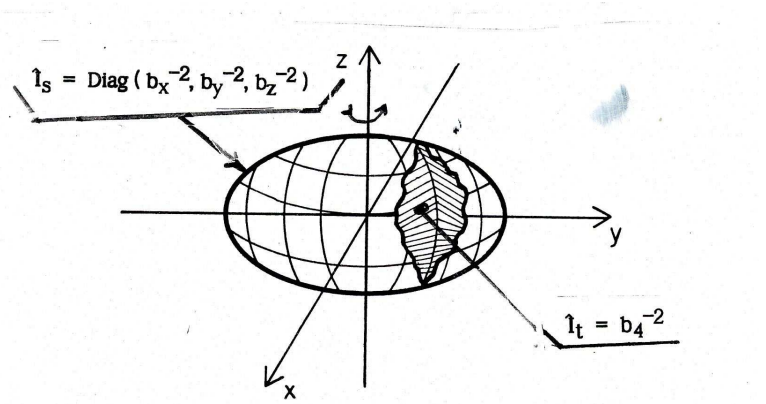

Figure 6.19. A schematic view of one of the various physical meanings of the characteristic quantities defined by isorelativity and hadronic mechanics, the representation of the actual *share* of the particle considered via the space components $b_k^2 = 1/n_k^2$, $k = x, y, z$, here depicting a spheroidal ellipsoid for simplicity (see EHM-II for other shapes represented via nondiagonal isounits), and the representation of the *density* via the fourth component $b_4^2 = 1/n_4^2$, all normalized to the values 1 for the vacuum. Note that these representations do not exist in the mathematics and physics of the 20-th century, trivially, because structurally beyond any hope of representation via a Hamiltonian. Orthodox interests claim that the characteristic quantities are "free parameters." The political nature of such a claim is unmasked by noting that its acceptance requires the belief that the size and ,mass of hadrons are also free parameters. As we shall see in the next chapter from neutron interferometric measurements, the nonspherical and deformable shape of hadrons is *measured* quite accurately and so is the density, trivially given by the ratio between the rest energy and the volume. The confirmation that the characteristic quantities are not "free parameters" will be given in this volume by showing that their numerical values for a given particle are compatible with other tests dealing with the same particle, in the same way that, after it has been measured, the mass of the neutron cannot be changed in going from one test to another.

6.2.2 Inapplicability of Quantum Mechanics for the Hadronic Structure

Rutherford [91] submitted in 1920 the hypothesis that hydrogen atoms in the core of stars are compressed into new neutral particles having the size of the proton that he called *neutrons,* according to the synthesis

$$p^+ + e^- \to n. \tag{6.2.10}$$

The existence of the neutron was confirmed in 1932 by Chadwick [92]. However, Pauli [93] noted that the spin 1/2 of the neutron cannot be represented via a quantum state of two particles each having spin 1/2. Fermi [94] adopted Pauli's objection and, for its resolution, conjectured the emission of a neutral and massless particle he called *neutrino* (meaning in Italian "little neutron") with symbol ν for the particle and $\bar{\nu}$ for the antiparticle. Fermi then developed the theory of *weak interactions* according to which the synthesis of the neutron is characterized by the reaction

$$p^+ + e^- \to n + \nu, \tag{6.2.11}$$

with or complementary reaction

$$p^+ + \bar{\nu} + e^- \to n, \tag{6.2.12}$$

and inverse reaction, the spontaneous decay of an isolated neutron,

$$n \to p^+ + e^- + \bar{\nu}. \tag{6.2.13}$$

Hence, **following Pauli's objection [93], Fermi [94] introduced the neutrino hypothesis for the specific purpose of salvaging the validity of quantum mechanics for the neutron synthesis. However, Santilli proved in 1978 [14] that quantum mechanics remains basically inapplicable (rather than violated) for the neutron synthesis for various reasons,** such as:

INAPPLICABILITY 1. Schrödinger equation does not admit physical solutions for the total energy and other physical quantities for synthesis (6.2.10) because the sum of the rest energies of the proton and of the electron,

$$m_p + m_e = 938.272\,\text{MeV} + 0.511\,\text{MeV} = 938.783\,\text{MeV}, \tag{6.2.14}$$

is *smaller* than the rest energy of the neutron,

$$m_n = 939.565\ MeV, \tag{6.2.15}$$

with "positive" energy difference

$$m_n - (m_p + m_e) = 939.565 - (938.272 + 0.511)\,\text{MeV} = 0.782\,\text{MeV}. \tag{6.2.16}$$

The above data would require a *positive binding energy,* under which Schrödinger equation becomes physically inconsistent because its indicial equation no longer admits real solutions (see Santilli [14], Shiff et al [98] and literature quoted therein). In fact, all consistent quantum bound states (such as those for nuclei, atoms and molecules) have a *negative binding energy* that results in the well known *mass defect* with familiar eigenvalue equation for the Coulomb bound state of two particles with the same mass in relative coordinates

$$(\frac{-\hbar^2}{m} \times \Delta - \frac{e^2}{r}) \times \} psi >= E \times |\psi >, \quad E \in R, \quad E < 0. \tag{6.2.17}$$

where m is the reduced mass. From data (6.2.14)-(6.2.16), the synthesis of the neutron would requires an equation with a positive binding energy of the type

$$(\frac{-\hbar^2}{m} \times \Delta + |V(r)|) \times |\psi >= E \times |\psi >, \tag{6.2.18}$$

that is physically inconsistent, as the skeptic reader is encouraged to verify.

INAPPLICABILITY 2: I n view of numerical values (6.2.14)-(6.2.16), *as written in all particle physics books of the 20-th century, synthesis (6.2.11) violates the principle of conservation of the energy* because without any specification that the l.h.s. should have the minimal kinetic energy of 0.78 MeV, in which case there is no energy left for the neutrino.

INAPPLICABILITY 3. Assuming that the proton and the electron have a relative kinetic energy of (at least) 0.78 MeV, synthesis (6.2.11) remains impossible according to quantum mechanics ,because, at that value of the kinetic energy, the proton-electron cross section is excessively small (about 10^{-20} barns).

INAPPLICABILITY 4. Assuming that the above problems are somewhat resolved via a manipulation of Schrödinger equation, it is impossible for quantum mechanics to achieve a meaningful representation of:

4.1: The meanlife of the neutron of

$$\tau_n = 15m, \tag{6.2.19}$$

, since quantum mechanics would predict a meanlife of the order of $10^{-19}s$;

4.2. The anomalous magnetic moment of the neutron

$$\mu_n = -1.913\mu_N \tag{6.2.20}$$

because, when computed from the magnetic moments of the proton

$$\mu_p = 2.792\mu_N \tag{6.2.21}$$

and of the electron

$$\mu_e = 1.001\mu_B, \tag{6.2.22}$$

would be wrong even in the sign; and of

4.3. The neutron charge radius

$$R = 10^{-13}cm, \tag{6.2.23}$$

since Bohr's radius $R = 10^{-8}cm$ is the smallest radius permitted by quantum mechanics for a "stable" bound state of a proton and an electron.

INAPPLICABILITY 5. The impossibility for quantum mechanics to reach a meaningful representation of the synthesis of the neutron is multiplied, rather than resolved, by complementary synthesis (6.2.12) because, being an antiparticle, the antineutrino carries a *negative* energy, rather than the needed positive energy and, in any case, the cross section of antineutrinos on protons and/or electrons must be assumed as being null for any serious study.

It should be noted that the above insufficiencies of quantum mechanics generally apply for the synthesis of all hadrons at large, beginning with that for the neutral pion

$$e^+ + e^- \to \pi^o, \tag{6.2.24}$$

where the "positive binding energy" is now of 133.95 MeV.

The above occurrences, presented in Ref. [14b] (see page 829, in particular) signaled the birth of hadronic mechanics. In fact, the author attempted for years to achieve a consistent solution of synthesis (6.2.11) via quantum mechanics. The confirmation by Cantabridgean colleagues that a consistent solution for Eq. (6.2.18) does not exist within the class of unitary equivalence of quantum mechanics, left no other choice than that of subjecting the conventional Schrödinger equation to a *nonunitary transform,* thus abandoning quantum mechanics for a covering theory.

6.2.3 Insufficiencies of Neutrino Conjectures

As it is well known, the neutrino hypothesis was more recently incorporated into the so-called *standard model*[42] in which the original neutrino was extended to three different particles, the *electron, muon and tau neutrinos* and their antiparticles. Neutrinos were then assumed to have masses, then to have different masses derived from the fit of experimental data, then to "oscillate" (namely, to change "flavor" or transform one type into the other), with the expectation of additional conjectures intended to bypass preceding unverifiable conjectures.

[42]The literature in the field is so vast to discourage discriminatory listings.

Despite historical advances, the neutrino hypothesis has remained afflicted by a number of basic, although generally unspoken insufficiencies addressed in Section 1.1.2.8, and outlined as follows for the self-sufficiency of this volume:

INSUFFICIENCY 1: According to the standard model, a neutral particle carrying mass and energy in our spacetime is predicted to cross very large hyperdense media, such as those inside stars, without any collision. Such a view is outside scientific reason because already questionable when the neutrinos were assumed in being massless. The recent use of massive neutrinos has rendered the view beyond the limit of plausibility because a massive particle carrying energy in our spacetime simply cannot propagate within hyperdense media inside large collections of hadrons without any collision. The general belief that this is due to the very low value of the cross section between neutrinos and other particles casts shadows on the theory, rather than resolving the inconsistency here considered.

INSUFFICIENCY 2. The fundamental reaction for the production of the (electron) neutrino, Eq. (6.2.11), generally lacks sufficient energy for the synthesis of the neutron itself, let alone the additional energy needed to characterize the hypothetical neutrino.

INSUFFICIENCY 3. As reported in nuclear physics textbooks (see Figure 1.7), the energy measured as being carried by the electron in beta decays follows a bell-shaped curve with a maximum value of the order of 0.782 MeV (depending on nuclear data). The "missing energy" (as the difference between $0.78 MeV$ and the electron energy) has been assumed throughout the 20-th century as being carried by the hypothetical neutrino. However, in view of the strongly attractive Coulomb interactions between the nucleus and the electron, the energy carried by the electron is depends on the direction of emission, with maximal value for radial emission and minimal value for tangential emission (Figure 1.8). Despite a laborious search, the author has been unable to identify in the literature much needed calculations of this aspect because if the "missing energy" is entirely absorbed by the nucleus, then, again, there is no energy left for the neutrino.

INSUFFICIENCY 4. The claims of "experimental detection" of neutrinos are perhaps more controversial than the theoretical aspects because of numerous reasons, such as:

4.1 Enrico Fermi clearly stated in his writings that "the neutrino cannot be directly detected in laboratory;"

4.2. All claims of "neutrino detections" are based on a scattering theory that is basically inapplicable for deep inelastic scatterings (Figure 1.2;

4.3. The elaboration of the data via a theory centrally dependent on the neutrino hypotheses clearly implies "experimental results" compatible with the theoretical assumptions

4.4. The claims of "neutrino detections" via the selection of extremely few events over an extremely large number of events;

4.5. The presence in recent "neutrino detectors" of radioactive sources could themselves account for the extremely few events over an enormous number of total events;

4.5. The lack of clear, physically verifiable differentiations of the various neutrinos;

4.7. The lack of uniqueness of the neutrino interpretation for the interpretation of the experimental data due to the existence of alternative interpretations without the neutrino hypothesis (see Ref. [99] and references quoted therein); and other insufficiencies.

INSUFFICIENCY 5. Numerous additional insufficiencies exist, such as the theory contains an excessive number of parameters essentially capable to achiever any desired fit, and other problems [99]. In fact, the six different "neutrino masses" are *derived* from fit of the data and, as such, could merely be arbitrary *ad hoc* parameters.

For additional studies on the insufficiencies of the neutrino hypothesis, one may consult Bagge [101] and Franklin [102] for an alternative theories without the neutrino hypothesis; Wilhelm [103] for additional problematic aspects; Mössbauer [104] for problems in neutrino oscillations; Fanchi [105] for apparent serious biases in "neutrino experiments"; and literature quoted therein.

The author would like to express his deepest appreciation to Horst E. Wilhelm because his vast physical knowledge, combined with a serious commitment to scientific inquiries, and his independence of thought were instrumental for the author to release his view on the lack of existence of neutrinos as physical particles.

6.2.4 Insufficiencies of Quark Conjectures

The view expressed by the author since the birth of quark theories (see memoir [88] of 1981) is that:

I) SU(3) color theories and more recently the standard model have provided the final Mendeleev-type, classification of particles into families;

II) Quarks are necessary for the elaboration of the theory, however,

III) On ground of strict scientific rigor, quarks should be solely defined what they are technically, purely mathematical representations of a purely mathematical internal symmetry solely definable on a purely mathematical, complex-valued unitary space.

Whenever quarks are assumed to be physiocal particles in our spacetime, numerous unresolved (and generally unspoken) insufficiencies emerge, as treated in Section 1.2.7. and outlined below for the self-sufficiency of this volume:

INSUFFICIENCY 1. According to the standard model, at the time of the synthesis of the neutron, the proton and the electron literally "disappear" from the universe to be replaced by hypothetical quarks as neutron constituents. Moreover, at the time of the neutron spontaneous decay, the proton and the electron literally "reappear" again into our spacetime. This view is beyond scientific reason, because, as pointed out in Section 6.2.1, the proton and the electron are the only *permanently stable* massive particles identified so far and, as such, they simply cannot "disappear" and then "reappear" in our spacetime just because so desired by quark supporters. The *only* plausible hypothesis is that the proton and the electron are actual physical constituents of the neutron as originally conjectured by Rutherford, although the latter view requires the adaptation of our theories to physical reality.

INSUFFICIENCY 2. When interpreted as physical particles in our spacetime, irrespective of whether we refer to mass or energy, *quarks cannot experience any gravity.* As clearly stated by Albert Einstein in his writings, gravity can only be defined in spacetime, while quarks can only be defined in the mathematical, internal, complex-valued unitary space with no known connection to our spacetime. In particular, O'Rafearthaigh's theorem prohibits quarks to be defined via our spacetime symmetries. Consequently, physicists who support the hypothesis that quarks are the physical constituents of protons and neutrons, thus of all nuclei, should see their bodies levitate due to the absence of gravity.

INSUFFICIENCY 3. When, again, interpreted as physical particles in our spacetime, *quarks cannot have any inertia.* In fact, inertia can only be rigorously admitted for the eigenvalues of the second order Casimir invariant of the Poincaré symmetry, while quarks cannot be defined via such a basic spacetime symmetry, as expected to be known by experts to qualify as such. Consequently, "quark masses" are purely mathematical parameters deprived of technical characterization as masses in our spacetime. Hence, "quark masses" are mere *ad hoc* parameters identified by pre-selected fits of data.

INSUFFICIENCY 4. Even assuming that, with unknown scientific manipulations, the above insufficiencies are resolved, it is known by experts that quark theories at the level of first quantization have failed to achieve a representation of *all* characteristics of hadrons, with catastrophic insufficiencies in the representation of spin, magnetic moment, mean lives, charge radii and other basic features of hadrons. Of course Quantum Chromodynamics (QCD) and gauge theories have provided deeper insights, but not a resolution of the controversies due to the inability to reach exact solutions of nonlinear partial differential equations.

INSUFFICIENCY 5. It is also known by experts that the application of quark conjectures to the structure of nuclei has multiplied the controversies, while re-

solving none of them. As an example, the assumption that quarks are the physical constituents of protons and neutrons in nuclei has failed to achieve a representation of the main characteristics of the simplest possible nucleus, the deuteron because:

5.1. Quark conjectures are unable to represent the spin 1 of the deuteron, since they predict spin zero in the ground state of two particles each having spin 1/2, while the deuteron has spin 1;

5.2. Quark conjectures are unable to represent the anomalous magnetic moment of the deuteron despite all possible relativistic corrections attempted for decades, because the presumed "quark orbits" are too small to fit data following polarizations or deformations;

5.3. Quark conjectures are unable to represent the stability of the neutron when a deuteron constituent;

5.4. Quark conjectures are unable to represent the charge radius of the deuteron, and

5.5. When passing to larger nuclei, such as the zirconium, the catastrophic inconsistencies of quark conjectures can only be defined as being embarrassing.

For additional references, one may consult Ref. [88] on historical reasons preventing quarks to be physical particles in our spacetime; Ref. [106] on a technical treatment of the impossibility for quarks to have gravity or inertia; Ref. [97,107] on a more detailed presentation on the topic of this section; and Wilhelm [103] for an in-depth treatment of the lack of rational priorities in quark theories.

The implications of the above insufficiencies are rather serious. In fact, they imply that *the identification of the hadronic constituents with physical particles truly existing in our spacetime is more open than ever and carries ever increasing societal implications since the assumption that quarks are physical constituents of hadrons prevents due scientific process on alternative models admitting new clean energies so much needed by mankind, as illustrated later on.*

Alternatively, we can say that *the insufficiencies of quark conjectures as physical particles in our spacetime render the current status of hadron physics essentially equivalent to our knowledge of atoms at the beginning of the 20-th century, namely, prior to the discovery of their structure. We did have at that time the Mendeleev-classification of atoms into families, but we had yet to initiate the study of the structure of individual atoms. Similarly, at this writing SU(3) color theories and the standard model have indeed provided the final classification of hadrons into family. However, on serious scientific ground the structure of individual hadrons of a given SU(3)-multiplet must be indicated as being unknown.*

As stressed in Section 6.2.1, *all alternative structure models, including those without neutrino and quark conjectures, must achieve full compatibility with the unitary models of classification, in essentially the same way according to which*

quantum structures of atoms achieved full compatibility with their Mendeleev classification.

On historical grounds, the classification of nuclei, atoms and molecules required *two different models,* one for the classification into families and a separate model for the structure of the individual elements of a given family. Quark theories depart from this historical teaching because of their original conception of attempting to represent with one single theory both, the classification and the structure of hadrons. Admittedly, in recent times quarks are differentiated whether characterizing classification and structure, but the problematic aspect persists because of the belief that one single theory can represent the totality of the phenomenology of particles. Hence, current quark theories are basically flawed in their conception. .

The view advocated by Santilli since 1978 [14] (see paper [88] of 1981 and paper [106] of 2006, all completely ignored by organized financial interests on quark conjectures to this date - November 11, 2007) is that, quite likely, history will repeat itself. The transition from the Mendeleev classification of atoms to the atomic structure required a basically new theory, quantum mechanics, due to the large differences existing in the classification and structure of atoms. Similarly, the transition from the Mendeleev-type classification of hadrons to the structure of individual hadrons will require a broadening of the basic theory, this time a generalization of quantum mechanics and special relativity due to the truly dramatic differences of the dynamics of point-particles moving in vacuum, as in the atomic structure, to the dynamics of extended wavepackets moving within hyperdense media, as in the hadronic structure.

6.2.5 Hadronic Two-Body Bound State

The *hadronic two-body bound state* was proposed and solved in the original proposal [14] (see Ref. [14b] Section 5), then used to illustrate, not only the capabilities of hadronic mechanics, but also the achievement of feature unthinkable with quantum mechanics.

The main result of the study was the achievement of a *quantitative representation of the charge independence of strong interactions,* namely, the feature known since Fermi's times that strong interactions are generally attractive irrespective of the relative signs of the charge. In turn, this is the very feature that justified the use of the name "hadronic mechanics" in the original proposal.

The above important achievement was reached by showing that **the mutual penetration of particles in singlet coupling at mutual distances of the order of the range of strong interactions (1 fm) causes a strongly attractive force independent from the sign of their charges.** There is no word to stress emphatically that this basic feature is impossible for quantum mechanics.

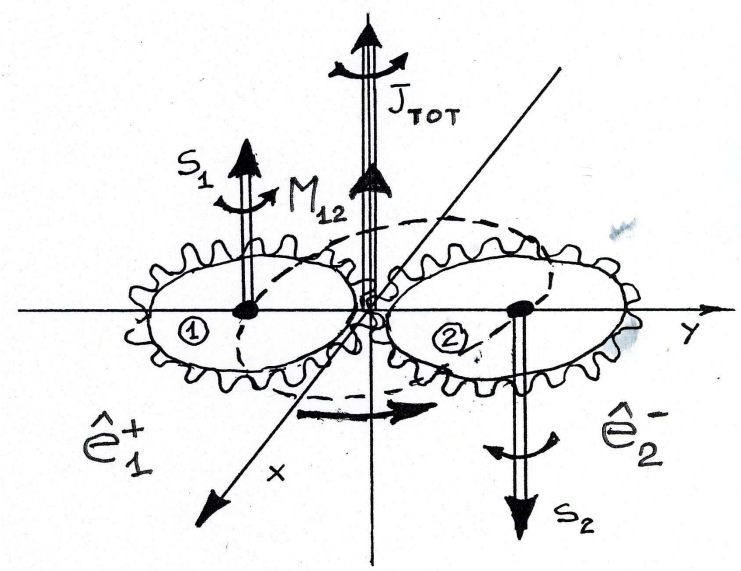

Figure 6.20. A schematic view of the *gear model* for the singlet coupling of two particles at mutual distances of the order of the range of the strong interactions pro[posed in Ref. [14b], page 852, to illustrate that stable bound states at the mutual distance here considered can only occur for singlet couplings, while triplet couplings cause strong repulsive forces, as it occurs for the coupling of ordinary gears.

This is, by far, one of the most important advances permitted by hadronic mechanics with deep implications for all structural problems, including mesons, baryons, nuclei, molecules, stars, quasars, etc. It is expected as being admitted by the mind most resilient to advances that the achievement of the first quantitative understanding of the mechanism of attraction under strong interactions is the necessary pre-requisite for basically new clean energies and fuels, thus mandating its study.

In this section we review the above features as proposed in Ref. [14b], plus the very few additional details emerged since 1978. The rest of this volume is essentially dedicated to an *application* of the content of this section. It is unfortunate that, despite the above features, proposal [14] remained ignored for decades by organized interests in quantum mechanics and special relativity, despite our bringing it to the attention of "leading" (?) physicists via letters, explanations, petitions and the like. Yet, as stressed several times, their lack of response was appreciated because a gift of scientific priority to our group. Let us begin with the following:

HADRONIC POSTULATE 1: All particles at mutual distances of the order of the strong interactions experience a strongly "attractive" force in "singlet" coupling and a "repulsive" force in "triplet" coupling.

This postulate was introduced and illustrated in proposal [14b] via the following (see Figure 6.22):

GEAR MODEL: Gears can only be coupled in singlet.

In essence, when particle wavepackets penetrate one inside the other, as in Figure 6.2, their intrinsic rotation remains allowed if and only if the coupling is with anti[parallel spin, while in the event of a coupling with parallel spins it is easy to see the emergence of a strongly *repulsive* force, exactly as it occurs for ordinary gears, trivially, because intrinsic rotations should occur for one wavepacket (one gear) moving against the other.

We assume the reader knows that this is a fundamental feature of nature. In fact, *valence electrons correlate/bond in molecular structures only in singlet pairs,* whose lack of quantitative treatment is one of the biggest century old failure of quantum chemistry. We expect the educated reader to know that a similar feature occurs in nuclear structures. It is our task to show in this section that a similar feature occurs also in the hadronic structure. Hence, from now on, unless otherwise stated, all couplings of particles pairs will be in singlet.

INSUFFICIENCY OF THE QUANTUM SCATTERING THEORY: The author has indicated for decades, to no avail, that the quantum scattering theory is fundamentally inapplicable for deep inelastic scatterings, because quantum mechanics can only represent particles as dimensionless points. Consequently, quantum mechanics has no mean to differentiate singlet and triplet couplings. Lacking such a differentiations, all "experimental results" in deep inelastic scatterings based on the conventional "quantum, scattering theory, are certainly suitable to secure large public funds, academic chairs and prizes, but they are mere "experimental beliefs" on strict scientific grounds, and they will remain so until vast theoretical and experimental studies are conducted via a covering scattering theory with a credible differentiation between singlet and triplet couplings.

A further notion needed for the understanding of this section is that of the *trigger.* In essence, experimental evidence studied later on indicates that spinning particles, such as the electrons, do not achieve a state of deep mutual penetration of their wavepackets in singlet coupling, unless there is an external intervention called "trigger." Alternatively, we can say that spinning particles have a *hadronic horizon,* given by a sphere of radius 1 fm separating the validity of quantum mechanics in the outside and that of hadronic mechanics in the inside. The "trigger" is then the external action need to cross the hadronic horizon.

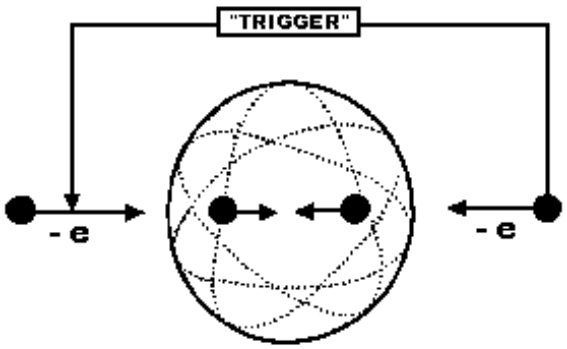

Figure 6.21. A schematic view of the *trigger,* namely, an action generally needed for two particles to cross the *hadronic horizon* and activate strong interactions. This notion will emerge better later on when we study the laboratory synthesis of the neutron from protons and electrons, and related new clean energies. At this moment we assume simple realizations of the "trigger," e.g. those merely caused by sufficient kinetic energy to achieve the deep penetration of the wavepackets needed to activate hadronic mechanics.

In nature, the best known realization of the "trigger" is the pressure in the core of stars "compressing," in Rutherford's words, the electron inside the proton to synthesize the neutron. However, we shall see in Chapter 8 that the Cooper pair in superconductivity is created thanks to a "trigger" caused by cuprates. Similarly, we shall see in Chapter 9 that electron valence bonds are triggered by nuclei.

To put it differently, isolated electrons *repel* each other due to their identical charge, and certainly cannot form any bond. An external intervention is then needed to create electron pairs in valence couplings, Cooper pairs and other structures, namely, to cross the hadronic horizon as a necessary condition to activate the charge independent, strongly attractive forces identified below.

After these background lines, we pass to a review of the two-body hadronic model proposed in Ref. [14b], Section 5. As indicated since the introductory Section 6.2.1, Eq. (6.1.2), the objective is the study of the lifting of a conventional quantum bound state under a nonunitary transform. The lifting of the center-of-mass motion is trivial and i is left to the interested reader.

Additionally, the isoeigenvalues of the *isotopic rotational symmetry* for the angular momentum component are conventional [5a,5b] and they are hereon ignored because inessential for the content of this section.Hence, we consider the important part, the nonunitary lifting of a conventional, two-body, Schrödinger's

equation in relative coordinates

$$\left(\frac{p\times p}{m}-\frac{z\times e^2}{r}\right)\times\psi(r)=E_0\times\psi(r),\ \ E_0\in R,\ \ E_0<0. \tag{6.2.25a}$$

$$p\times\psi(r)=-i\times\partial_r\psi(r), \tag{6.2.25b}$$

where r is the relative distance, m is the reduced mass and we have assumed $\hbar=1$.

As familiar to the reader who has studied the preceding parts. the desired lifting is characterized by *the same nonunitary transform applied to the totality of the quantum mechanics formalism, including the totality of their operations,* with no exception to avoid the Theorems of Catastrophic Inconsistencies of Section 6.1.6, and we shall write

$$U\times U^\dagger\neq I,\ \ U\times U^\dagger>0, \tag{6.2.26a}$$

$$I\to\hat{I}=U\times I\times U^\dagger=1/\hat{T}>0, \tag{6.2.26b}$$

$$A\to\hat{A}=U\times A\times U^\dagger,\ \ A=p,H,\ldots, \tag{6.2.26c}$$

$$U\times(A\times B)\times U^\dagger=\hat{A}\hat{\times}\hat{B}=\hat{A}\times\hat{T}\times\hat{B},\hat{\psi}=U\times\psi\times U^\dagger, \tag{6.2.26d}$$

The fundamental invariance (intended as the preservation of the same numerical predictions under the same conditions at different times despite the nonunitary structure) is assured by the Santilli isomathematics based on the reconstruction of the totality of the conventional mathematics of quantum mechanics into a form admitting $\hat{I}$, rather than I, as the correct left and right generalized unit at all levels.

This requires the reformulation of the *nonunitary* transform (evidently expressed on a conventional Hilbert space $\mathcal{H}$ over the field of complex numbers $\mathcal{C}$) as the *isounitary transform* on a iso-Hilbert space $\hat{\mathcal{H}}$ over the isofield of isocomplex numbers $\hat{\mathcal{C}}$, i.e.,

$$U=\hat{U}\times\hat{T}^{1/2},\ \ U\times U^\dagger=\hat{U}\hat{\times}\hat{U}^\dagger=\hat{U}^\dagger\times\hat{U}=\hat{I}, \tag{6.2.27}$$

under which we have the basic invariances

$$\hat{I}\to\hat{I}'=\hat{U}\hat{\times}\hat{I}\hat{\times}\hat{U}^\dagger\equiv\hat{I}, \tag{6.2.28a}$$

$$\hat{A}\hat{\times}\hat{B}\to\hat{U}\hat{\times}(\hat{A}\hat{\times}\hat{B})\hat{\times}\hat{U}^\dagger=\hat{A}'\hat{\times}\hat{B}', \tag{6.2.28b}$$

where one should note the preservation of the numerical value of the isounit essential for measurements, from which all other invariances follow.

At this point *readers still intent in using conventional mathematics are discouraged from continuing the glancing of this section,* because it would be like

elaborating "quantum" equations with "isomathematics," resulting in a complete nonscientific nonsense. This implies the reader abandoning the use of sinus, cosinus, exponential, differential and *all* mathematics so familiar for protracted use, and the replacement with isotopic covering forms.

Under the above assumptions, the isounitary lifting of Schrödinger equations yields the Schrödinger-Santilli isoequations

$$U \times \left(\frac{p \times p}{m} - \frac{z \times e^2}{r} \right) \times \psi(r) \times U^\dagger =$$

$$= \left(\frac{1}{m} \hat{p} \times \hat{T} \times \hat{p} \times \hat{T} - \frac{z \times e^2}{r} \right) \times \hat{\psi}(r) =$$

$$= U \times [E_0 \times \psi(r)] \times U^\dagger = \hat{E} \hat{t} imes \hat{\psi} = E \times hat \psi, \tag{6.2.29a}$$

$$U \times [p \times \psi(r)] \times U^\dagger = \hat{p} \hat{\times} \hat{\psi}(r) =$$

$$= -U \times [i \times \partial_r \psi(r)] \times U^\dagger = -\hat{i} \hat{\times} \hat{\partial}_r \hat{\psi} = -i \times \hat{T} \times \partial_r \hat{\psi}(r), \tag{6.2.29b}$$

where one should note the *lifting of the numerical value of the binding energy* from E_o to E, trivially, due to the lifting of the operator from H to $H \times T$,[43] with consequential lifting of the wavefunction. One should also note that there is no isotopic element in the r.h.s of the Coulomb term because of the lifting of the fraction for which we can symbolically write

$$U \times [(/) \times \psi] \times U^\dagger = (\hat{/}) \hat{\times} \hat{\psi} = (/) \times U \times \psi \times U^\dagger = (/) \times \hat{\psi}. \tag{6.2.30}$$

Alternatively, the isounitary lifting solely generalizes operators and eigenfunctions and cannot lift scalars.

As it will soon be evident, Eqs. (6.2.29) are insufficient for the hadronic bound state because they miss the "trigger" that, being external, has to be added. The trigger here assumed is of Coulomb nature, it is represented by the addition in Eq. (6.2.29a) of the term $(e^2/r) \times \hat{T}$, and we shall write[44]

$$\left(\frac{1}{m} \hat{p} \times \hat{T} \times \hat{p} \times \hat{T} - \frac{z \times e^2}{r} + \frac{e^2}{r} \times \hat{T} \right) \times \hat{\psi}(r) = E \times \hat{\psi}(r). \tag{6.2.31a}$$

$$\hat{p} \times \hat{T} \times \hat{\psi}(r) = -i \times \hat{T} \times \partial_r \hat{\psi}(r), \tag{6.2.31b}$$

To proceed, we now assume the isounit

$$\hat{I} = Diag.(n_1^2(1), n_2^2(1), n_3^2(1), n_4^2(1)) \times Diag.(n_1^2(2), n_2^2(2), n_3^2(2), n_4^2(2)) \times$$

[43] Note that $\hat{H}$ and $\hat{T}$ do not generally commute. As a consequence, $\hat{H} \times \hat{T} \times \hat{\psi} \neq \hat{T} \times \hat{H} \times \hat{\psi}$.

[44] The sign of the trigegr will soon result to be inessential.

$$\times e^{(\psi/\hat{\psi})\times\int dr^3\hat{\psi}^\dagger(r)_{1\downarrow}\times\hat{\psi}(r)_{2\uparrow}} \tag{6.2.32}$$

where the two diagonal matrices represent the shapes (assumed to be spheroids) and the densities of the particle considered, while the last term represents the non-Hamiltonian interactions. As now familiar, the above isounit represents:

1) The nonlocality of the strong interactions expressed by the volume integral of waveoverlapping, as per historical legacy;

2) The nonlinearity of the strong interactions expressed by an explicit dependence of the isounit on the wavefunctions, also as epr historical legacy; and

3) The non-Hamiltonian character of the strong interactions, also per open historical legacy, here referred to the inability for their complete representation with a Hamiltonian and the need for a second operator, the isounit.[45]

The above isounit is excessively general for the limited scope of this section. We shall then use the approximate expression characterized by:

1) The assumption that the particles have a point-like *charge,* such as the electrons, in which case the characteristic quantities can be approximated to 1 and the two diagonal matrices in (6.2.31) be ignored in first approximation;

2) The evaluation of the volume integral into a constant; and

3) The expansion of the isoexponent terminated to the second term.

The above approximations yield the expressions

$$\hat{I} \approx e^{N\times\psi/\hat{\psi}} \approx 1 + N \times \psi/\hat{\psi}, \tag{6.2.33a}$$

$$\hat{T} \approx e^{-N\times\psi/\hat{\psi}} \approx 1 - N \times \psi/\hat{\psi}, \tag{6.2.33b}$$

$$N = \int dr^3\, \hat{\psi}^\dagger(r)_{1\downarrow} \times \hat{\psi}(r)_{2\uparrow}, \tag{6.2.32c}$$

$$|\hat{I}| \gg 1, \;\; |\hat{T}| \ll 1, \tag{6.2.33d}$$

$$Lim_{r\gg 1fm}\hat{I} = 1. \tag{6.2.33e}$$

Note that the explicit form of ψ is of the familiar Coulomb type, thus behaving like

$$\psi \approx P \times \exp(-b \times r), \tag{6.2.34}$$

[45]As we shall see in the next chapter, one of the biggest failure of the nuclear physics of the 20-th century has been the inability to understand nuclear forces, despite recent representations with a very large number of terms researchers keep adding to the Hamiltonian in the dream of finding an accurate representation. The origin of the failure is precisely the belief that the strong nuclear forces are entirely representable with a Hamiltonian while the physical reality is dramatically more complex than that. The main point here raised is that, of course, strong interactions have a Hamiltonian component, but they also have a "contact" component dramatically beyond the representational capabilities of a Hamiltonian. Such a "contact" component *cannot* be represented with a potential to prevent major physical distortions equivalent to granting a potential to resistive forces. Hadronic mechanics was built to represent such a contact, non-=Hamiltonian component in an axiomatically consistent and invariant way.

with P (approximately) constant and hadronic horizon

$$r_h = \frac{1}{b}, \tag{6.2.35}$$

while $\hat{\psi}$ behaves like (see also below)

$$\hat{\psi} \approx Q \times \left(1 - \frac{e^{-b\times r}}{r}\right), \tag{6.2.36}$$

with Q also (approximately) constant.

By introducing the *Hulthen potential*

$$V_{Hulthen} = W \frac{e^{-b\times r}}{1 - e^{-b\times r}}, \tag{6.2.37}$$

where W is Hulthen's constant, the isotopic element can be written

$$\hat{T} \approx 1 - N \times \psi/\hat{\psi} = 1 - V_0 \frac{e^{-b\times r}}{(1 - e^{-b\times r})/r}, \tag{6.2.38}$$

where we have a new Hlthen constant because it has absorbed the constant N in Eq. (6.2.38) for the Hulthen potential.

Recall that *the Hulthen potential behaves at small distances like the Coulomb potential,*

$$V_{Hulthen} \approx \frac{V_0}{b} \times \frac{1}{r}. \tag{6.2.39}$$

An understanding of the strength of the Hulthen potential is then given by the fact that the quantity b in the denominator is of the order of 10^{-13} cm, thus resulting the a multiplicative factor of the order of 10^{13}.

As a result, *inside the hadronic horizon, the Coulomb potential is absorbed by the Hulthen potential,* and we can write

$$+\frac{e^2}{r}\times\hat{T} - \frac{z\times e^2}{r} \approx +\frac{e^2}{r}\times\left(1 - \frac{V_{\text{Hulthen}}}{r}\right) - \frac{z\times e^2}{r} = -V\times\frac{e^{-b\times r}}{1 - e^{-b\times r}}, \tag{6.2.40}$$

therefore resulting in the desired overall attractive force inside the hadronic horizon.

By assuming in first approximation

$$|\hat{T}| \approx \rho < 1, \tag{6.2.41}$$

and by reinstating $\hbar$ for clarity, the radial isoequation can be written

$$\left[\frac{1}{r^2}\left(\frac{d}{dr}r^2\frac{d}{dr}\right) + \frac{m}{\rho^2\times\hbar^2}\left(E_{hb} + V\times\frac{e^{-b\times r}}{1-e^{-b\times r}}\right)\right]\times\hat{\psi}(r) = 0, \tag{6.2.42}$$

where E_{hb} is the hadronic binding energy and,, again, we have ignored the Coulomb term because absorbed in the Hulthen potential (see Ref. [14b] for the inclusion of the Coulomb term).

The exact solution and related boundary conditions were first computed in detail in Ref. [14b], Section 5, page 837, and remain fully applicable today. By assuming the change of variable

$$x = 1 - e^{-b\times r} \tag{6.2.43}$$

Eq. (6.2.42) can be written

$$\left[x \times (1-x) \times \frac{d^2}{dx^2} - (2 \times |A|^{1/2} + 1) \times \frac{d}{dx} + \beta^2\right] \times S(x) = 0, \tag{6.2.44a}$$

$$A = \frac{m}{\hbar^2 \times \rho^2 \times b^2} \times E_{ib} < 0, \;\; \beta^2 = \frac{m \times V_0}{\hbar^2 \times \rho^2 \times b^2}, \tag{6.2.44b}$$

with boundary conditions

$$S(0) = 0, \;\; Lim_{r\to\infty} e^{-|A|^{1/2}\times b\times r} \times S(r) = 0, \tag{6.2.x45}$$

The solution of Eq. (6.2.44a) is then given by (Ref. [14b], Eq. (5.1.19), page 837)

$$G_n(x) = \Sigma_{k=1}^{k=n} \left(\begin{array}{c} n-1 \\ k-1 \end{array} \right) \times \left(\begin{array}{c} n+k+2\times|A|^{1/2}-1 \\ k \end{array} \right) \times x^k, \tag{6.2.46}$$

and can be rewritten

$$\hat{\psi}(r) =_2 F_1(2\times\gamma+1+n, 2\times\gamma, e^{-b\times r}) \times \frac{1-e^{-b\times r}}{r} \times e^{-b\times r}, \tag{6.2.47a}$$

where

$$\gamma = \frac{\beta^2 - n^2}{2\times n}, \tag{6.2.48}$$

with isorenormalized isoeigenfunctions (Ref. []14b] Eq. (5.1.29), page 839)

$$\hat{\psi}(r) = \left[\frac{\Gamma(2\times|A|^{1/2}+3)}{\Gamma(3)\times\Gamma(2\times A|^{1/2})}\right]^{1/2} \times \frac{1-e^{-b\times r}}{r} \times e^{-|A|^{1/2}\times b\times r} \tag{6.2.49}$$

The *hadronic binding energy* is then given by (Ref. [14b], Eq. (5.1.20, page 847)

$$E_{hb} = -\frac{\hbar^2\times\rho^2\times b^2}{4\times m} \times \left(\frac{m\times V_0}{\hbar^2\times\rho^2\times b^2\times n} - n\right)^2 =$$

$$= -\frac{V_0}{4 \times \beta^2} \times \left(\frac{\beta^2}{n} - n \right)^2 . \tag{6.2.50}$$

The boundary conditions now demand that

$$\beta^2 = \frac{m \times V_0}{\hbar^2 \times \rho^2 \times b^2} \; > \; n^2. \tag{6.2.51}$$

The above results recovers the well known property that *the Hulthen potential has a finite spectrum of eigenvalues.* This feature begins to illustrate the hadronic bound state because the corresponding quantum state has an infinite spectrum of energy. However, as we shall see in the next section, *to be fully hadronic, the bound state must suppress the Hulthen spectrum down to only one value, the particle considered,* because, as indicated earlier, excited states would exit the hadronic horizon and be quantum mechanical.

The original derivation [14b] then proceeds to reduce the above solution to a form usable for hadronic structure models. For an isoparticle to be bounded inside the hadronic horizon b^{-1}, its isowavelength must be proportional to the horizon itself, and we shall write

$$\lambda = (k_1 \times b)^{-1}/2 \times \pi, \tag{6.2.52}$$

where k_1 is a positive quantity that must be constant for a stationary state.

Next, the *hadronic kinetic energy* E_{hk} of one constituent can be written

$$E_{hk} = \frac{\hat{p}^2}{2m} \approx \frac{\hbar^2 \times \rho^2 \times b^2}{2 \times m}, \tag{6.2.53}$$

[46]

Next, Ref. [14b] introduces the following second constant

$$k_2 = \beta^2 = \frac{m \times V_0}{\hbar^2 \times \rho^2 \times b^2} = 1 + \epsilon, \tag{6.2.54}$$

from which we have the expression

$$V_0 = k_2 \times \frac{\hbar^2 \times \rho^2 \times b^2}{m} = 2 \times k_2 \times E_{hk} \tag{6.2.55}$$

Hence, the *hadrolnic total energy* of the hadronic bound state is given by (Ref. [14b] Eq. (5.1.28), i.e.,

$$E_{ht} = 2 \times E_{hr} + 2 \times E_{hk} - E_{hb} \approx 2 \times k_1 \times [1 - (k_2 - 1)^2] \times \hbar \times b \times c_o =$$

[46]Ref. [14b], page 838, stresses the need to use the "physical" momentum $p = m \times v$, and not the "canonical" linear momentum, because, under nonpotential forces, the latter, in general, has no connection to the physical quantity.

$$= 2 \times k_1(1-\epsilon^2) \times \hbar \times b \times c_o. \tag{6.2.56}$$

where c_o is the speed of light in vacuum, and one should remember that the last approximation holds for hadronic bound states where the rest energy is ignorable with respect to the kinetic energy, as we shall see to be the case for isoelectrons.

At this point Ref. [14b] had reached an expression for the total energy of the two-body hadronic bound state that, however, depends on two unknowns, k_1, k_2. To achieve a numerical solution, Ref. [14b] introduces, as a second expression, the *meanlife* of the hadron considered, since *we solely consider unstable hadrons.* The expression selected for the meanlife is the familiar one

$$\tau^{-1} = \lambda^2 \times |\hat{\psi}(0)|^2 \times \frac{\alpha^2 \times E_{hk}}{\pi \times \hbar}. \tag{6.2.57}$$

where α is the fine structure constant, and the reader should keep in mind that the meanlife τ^{-1} is isotopic, that is, derived via isotopic methdos, like all other measurable quantities.. By using the above expressions, we can write

$$\hat{\psi}(0) \left[\frac{\frac{1}{2} \times (k_2-1) \times \Gamma[\frac{1}{2} \times (k_2-1)+2]}{3! \times \Gamma[\frac{1}{2} \times (k_2-1)]} \right]^{1/2} \times b =$$

$$= \left[\frac{\frac{1}{4} \times (k_2-1)^2 \times \Gamma[\frac{1}{2} \times (k_2--1)+1]}{6 \times \Gamma[\frac{1}{2} \times (k_2-1)]} \right]^{1/2} \times b = \frac{(k_2-1)^{3/2}}{48^{1/2}} \times b. \tag{6.2.58}$$

The meanlife of the hadronic bound state then becomes

$$\tau^{-1} = \frac{4 \times \pi}{k_1^2 \times b^2} \times \frac{(k_2-1)^3}{48} \times \frac{K_1 \times \hbar \times b \times c_o}{(137)^2 \times \hbar} =$$

$$= \frac{4 \times \pi}{48 \times (137)^2} \times \frac{(k_2-1)^3}{k_1} \times b \times c_o. \tag{6.2.59}$$

In this way, Ref. [14b], Eqs. (5.1.32), page 840, reached a *system of two equations with two unknown quantities,* k_1, k_2 expressed in terms of the total rest energy E_{tot}, the meanlife τ and the charge radius R_c of the two-body hadronic bound state, that it is reproduced identically below

$$k_1 \times [1-(k_2-1)^2] = \frac{E_{ht}}{2 \times \hbar \times b \times c_o}. \tag{6.2.60a}$$

$$\frac{(k_2-1)^3}{k_1} = \frac{48 \times (137)^2}{4 \times \pi \times b \times c_o} \times \tau^{-1} \tag{6.2.60b}$$

The most important results can be summarized as follow:

CHARGE INDEPENDENCE OF STRONG INTERACTIONS. To the best of our knowledge, hadronic mechanivs achieves the first and only known quantitative representation of the charge independence of strong interactions. As clear from the preceding analysis, this important result is achieved via the use of a force that is strongly attractive inside the hadronic horizon and such to behave like the Coulomb force, thus absorbing the latter irrespective of whether attractive or repulsive.

Alternatively, the same result can be achieved with an attractive force other than the Hulthem one not necessarily behaving like the Coulomb force inside the hadronic horizon, but sufficiently stronger than the latter as an evident condition to reach charge independence.

To fully understand the mechanism, the reader should keep ion mind that the actual representation occurs on iso-Hilbert spaces over isofields, and that the treatment presented in this section has been the *projection* of the isotopic treatment in our Euclidean space for clarity.

MASS-ENERGY ISORENORMALIZATIONS. Ref. [14b] achieved the first and only known renormalization originating from contact, non- Lagrangian / non-Hamiltonian interactions, called *isorenormalizations,* given the following liftings of quantum rest (qr) and quantum kinetic (qk) energies into the corresponding hadronic rest (hr) and hadronic kinetic (hk) energies

$$E_{qr} = m_{qr} \times c_o^2 \ \rightarrow \ \hat{E}_{hr} = m_{hr} \times c_o^2 = \frac{m_{qr}}{\rho^2} \times c_o^2, \tag{6.2.61a}$$

$$E_{qk} = \frac{1}{2 \times m_{qr}} \times p^2 \ \rightarrow \hat{E}_{hk} = \frac{1}{m_{hr}} \times p^2 = \frac{\rho^2}{m_{qr}} \times p^2, \tag{6.2.61b}$$

which are *necessary* to resolve the inconsistency of quantum mechanics under "positive" binding energies (Section 6.2.2), as we shall see in the next sections.

In fact, the resolution permitted by hadronic mechanics is that, when a quantum solution is impossible because the value of the rest energy is such to require inconsistent positive binding energies, the isorenormalized total energ becomes so large to admit a *negative* binding energy, as it is the case for the above model.

Note that *isorenormalizations are fully predicted by Santilli isorelativity.* Those considefred herein are characterized by the variation of the speed of light and maximal causal speeds within hyperdense media already established by preceding experimental verifications,

$$c = \frac{c_o}{\rho^2} = \frac{c_o}{n_4} = c_o \times b_4, \tag{6.2.62a}$$

$$V_{ma} = c_o \times \frac{n_3^2}{n_4^2} = c_o \times b_4^2$$

$\mathrm{n}\frac{\frac{2}{4}}{n_3^2=\frac{b_3^2}{b_4}=\rho^2,(6.2.62b)}namely,\rho^2$ is a numerical value of the geometrization of the departure of the interior of hadrons from our spacetime.

The reader with a technical knowledge of Santilli's isorelativity knows that the above isorenormalizations can be best derived from the Poincaré-Santilli isosymmetry, that causes, in general, a mutation of *all* intrinsic physical characteristics of particles.

Hence, the most insidious misrepresentation of the content of this section is the theological belief that, when immersed within the hyperdense medium inside hadrons, an ordinary particle such as the electron is the same as that in vacuum. In reality, the electron is characterized by an irreducible representation of the (spinorial covering of) the Poincaré group, while the isoelectron is characterized by a corresponding irreducible representation of the covering Poincaré-Santilli isogroup, with consequential mutations, in general, of all physical characteristics as a result of the distortions in the electron wavepacket and other features caused by the hyperdense medium.

We can say that electromagnetic interactions can only change the *kinematic* characteristics of particles while leaving their *intrinsic* characteristics (spin, parity, etc.) unchanged. By comparison, strong interactions are predicted to cause mutations of *all* characteristics, whether kinematical or intrinsic. Still alternatively, the belief that the electron has spin 1/2 when in the core of a collapsing star is pure theology proffered for personal gains without scientific credibility.

SPECTRUM SUPPRESSION. A basic assumption of hadronic mechanics is that *the excited hadronic states are quantum mechanical* [14b]. Hence, the hadronic bound state studied in this section is consistent if and only if the finite Hulthen spectrum is reduced to one, and only one energy level, that of the hadron considered. Any excitation brings the isoconstituents outside the hadronic horizon, in which the Hulthen potential is null and the state recovers the quantum form. As we shall see, the above crucial condition is indeed verified for our hadronic structure models with conventional massive particles as physical constituents.

It should be indicated that this is expected as being the case for "simple" unstable hadrons, such as light mesons and the first baryons. The possibility of exited states is not excluded for some of the baryonic resonances. Their study is rather complex since it implies the joint use of quantum and hadronic mechanics and will be left to the interested reader.

On historical notes, the most important study of the hadronic bound state following that of Ref. [14b] was done by A. O. E. Animalu [108] who applied the model for the first and only known representation of the structure of the Cooper pair and developed his isosuperconductivity theory reported in Chapter 8. An additional study was done by Animalu and Santilli [109] that set the basis for

chemical applications studied in Chapter 9. No additional study, conducted via the true use of hadronic mechanics, has occurred during the three decades since the original proposal [14b], to our best knwoeldge.

6.2.6 The π^o Meson as a Compressed Positronium

Following the detailed solution of the two-body hadronic bound state outlined in the preceding section, Ref. [14b] presented its consistent application for the *representation of all characteristics of the π^o meson as hadronic bound state of one isoelectron and one isopositron,* or as a "compressed positronium" in Rutherford's language, according to models (6.2.7), (6.2.8), Figure 6.20,

$$\pi^o = (\hat{e}^+, \hat{e}^-)_{hm}. \tag{6.2.63a}$$

$$P = (e^+, e^-)_{qm} \ \rightarrow \ \pi^o = (\hat{e}^+, \hat{e}^-)_{hm} = U_{\pi^o} \times (e^+, e^-)_{qm} \times U^\dagger_{\pi^o}, \tag{6.2.63b}$$

$$U \times U^\dagger = \hat{I}_{\pi^o} \neq I, > 0. \tag{6.2.63c}$$

The model permitted the exact and invariant representation of: rest energy E_{π^o}, meanlife τ_{π^o}, charge radius R_c, charge q, spin J, electric and magnetic moments $\epsilon,\ \mu$, space and charge parities I^G

$$E_{\pi^o} = 134.97 MeV,\ \tau_{\pi^o} = 0.84 \times 10^{-16} s,\ R_c = 10^{-13} cm, \tag{6.2.64a}$$

$$q = 0,\ J = 0,\ I^G = 1^-,\ \epsilon = 0,\ \mu = 0, \tag{6.2.64b}$$

and the spontaneous decay

$$\pi^o = (\hat{e}^+, \hat{e}^-)_{hm} \ \rightarrow \ \gamma + \gamma, \quad (98.7798 \pm 0.032)\%, \tag{6.2.65}$$

representing the evident annihilation of the physical constituents, the decay

$$\pi^o = (\hat{e}^+, \hat{e}^-)_{hm} \rightarrow e^+ + e^-, \quad (7.5 \pm 2.0 \times 10^{-8})\% \tag{6.2.66}$$

representing the hadronic tunneling of the physical constituents, the remaining decays, such as

$$\pi^o = (\hat{e}^+, \hat{e}^-)_{hm} \rightarrow e^+ + e^- + \gamma \quad (1.198 \pm 0.032)\% \tag{6.2.67a}$$

$$\pi^o = (\hat{e}^+, \hat{e}^-)_{hm} \rightarrow \ (e^+, e^-)_{qm} + \gamma \quad (1.82 \pm 0.29 \times 10^8)\% \tag{6.2.67b}$$

being secondary effects.

The model is merely given by structural isoequation (9.6.42) combined with the meanlife (6.2.57) and charge radious as subsidiary constraints, merely reformulated for the π^o meson,

$$\left[\frac{1}{r^2} \left(\frac{d}{dr} r^2 \frac{d}{dr} \right) + \frac{m}{\rho^2 \times \hbar^2} \left(E^{\pi^o}_{hb} + V \times \frac{e^{-b \times r}}{1 - e^{-b \times r}} \right) \right] \times \hat{\psi}(r) = 0, \tag{6.2.68a}$$

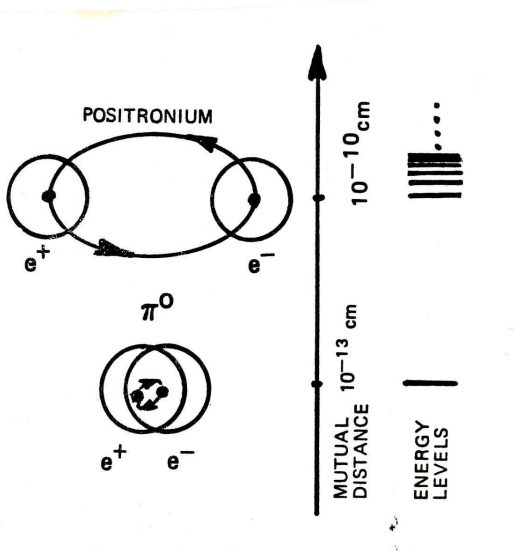

Figure 6.22. Quantum mechanics solely permits the representation of the structure of the π^o meson as a hypothetical bound state of one hypothetical quark and one hypothetical antiquark that, by conception (but not in quantitative realization) are believed as being permanently confined inside the meson, despite the extreme energies achieved in recent particles accelerators. Despite all these conjectures and shortcomings, the model can only represent *some* and definitely not all the characteristics of the particle. Hadronic mechanics allows a quantitative representation of the π^o meson as a bound state of one isoelectron and one isopositron at mutual distances of the order of the strong interactions (1 fm), as depicted in Figure 6.20. Alternatively, hadronic mechanics permits the representation of the π^o meson as a new bound state of the positronium at short distances, or, in Rutherford's words, as a "compressed positronium." Contrary to quark theologies, our hadronic model permits the exact and invariant representation of *all* characteristics of the meson, including the spontaneous decays. The model was worked out in all details in Section 5 of memoir [14b] of 1978, and has remained unchanged since that time, although ignored by organized interests in quark theologies.

$$\tau^{-1} = \lambda^2 \times |\hat{\psi}(0)|^2 \times \frac{\alpha^2 \times E_{hk}}{\pi \times \hbar}.$$

$$b^{-1} = R_c, \tag{6.2.68c}$$

with ensuing system (6.2.60 in the two unknown quantities $k_1 and k_2$

$$k_1 \times [1 - (k_2 - 1)^2] = \frac{135}{2 \times \hbar \times 10^{-13} \times c_o}. \tag{6.2.69a}$$

$$\frac{(k_2 - 1)^3}{k_1} = \frac{48 \times (137)^2}{4 \times \pi \times b \times c_o} \times 10^{-17}. \tag{6.2.69b}$$

By using values (6.2.65), the numerical solution is given by Eqs. (5.1.33), Ref. [14b] page 840, i.e.,

$$k_1 = 0.34. \tag{6.2.70a}$$

$$k_2 = 1 + 4.27x10^{-2}. \tag{6.2.70b}$$

The original proposal; []14b] then continued with the following results. Note that $\beta^2 \approx 1$. Hence, we have

$$\frac{\beta^2}{n} - n \approx 0, \quad \beta^2 = 1 + \epsilon, \quad \epsilon > 0, \quad \epsilon \approx 0, \quad n = 1. \tag{6.2.71}$$

Consequently, the hadronic binding binding energy, Eq. (6.2.49), is ignorable in nonrelativistic approximation,

$$E_{hb} = -\frac{V_0}{4 \times \beta^2} \times \left(\frac{\beta^2}{n} - n \right) \approx 0. \tag{6.2.72}$$

By recalling that the rest energy of electrons and positrons, $m_e = -0.511\ MeV$, is much smaller than the total rest energy, $E_{\pi^o} = 135$ MeV, the hadronic total energy, Eq. (6,2,56), reduces to the *mutated* (or *isorenormalized*) rest and kinetic energies of the isoelectron and the isoproton (Ref. [14b], Eq. (5.1.34) page 841),

$$E_{\pi^o} \approx 2 \times E_{hr,\hat{e}} + 2 \times E_{hk,\hat{e}} = 135\ MeV. \tag{6.2.73}$$

Altrernatively, we have the following mutation (see Isoaxiom I, Section 6.1.4)

$$E_{qr,e} = m_e \times c_o^2 \ \rightarrow \ E_{hr,\hat{e}} = m_e \times \frac{c_o^2}{\rho^2} = m_e \times c_o^2 \times \frac{n_3^2}{n_4^2} = m_e \times c_o^2 \times \frac{b_4^2}{b_3^2}, \tag{6.2.74}$$

where

$$\rho^2 = |\hat{T}|^2 = \frac{n_4^2}{n_3^2} = \frac{b_3^2}{b_4^2}. \tag{6.2.75}$$

The hadronic total energy can the n be written

$$E_{\pi^o} = 2 \times m_e \times c_o^2 \times \frac{b_4^2}{b_3^2} + \frac{p^2}{m_e} \times \frac{b_3^2}{b_4^2} = 135\ MeV. \tag{6.2.76}$$

By assuming spherical symmetry of the isoparticles and phenomenological values (6.1.52) (the only available for pions), we have[47]

$$\frac{b_4^2}{b_3^2} = \frac{0.998}{1.0037} = 0.9943, \quad \frac{b_3^2}{b_4^2} = 1.004, \tag{6.2.77}$$

[47]Remember that the data for pions characterize a maximal causal speed in π^o interior *smaller* than that in vacuum, $V_{max} = c_o \times 0.9943$.

from which we have the equation in only one unknown quantity, the hadronic kinetic energy

$$E_{\pi^o} = 2 \times m_e \times \frac{b_4^2}{b_3^2} + 2 \times E_{hk,\hat{e}} \times \frac{b_4^2}{b_3^2} =$$

$$= 2 \times 0.511 \times 0.9943 + 2 \times E_{hk,\hat{e}} \times 1.004 = 135 \ MeV \tag{6.2.78a}$$

$$E_{\hat{e})=0.508 \ MeV,(6.2.78b)}$$

$$E_{hk,\hat{e}} \approx 66.61 \ MeV. \tag{6.2.78c}$$

The following comments are in order:

AXIOMATIC CONSISTENCY. The above model confirms the mechanism provided by hadronic mechanics to avoid the inconsistency of quantum mechanics. Recall that a quantum treatment of model (6.2.63) would be catastrophically inconsistent since it would require a "positive" binding energy of about 134 MeV. Hadronic mechanics avoids this inconsistency via the mutation - isorenormalization of the energy, namely, of the maximal causal speed inside the π^o such that *the sum of the isorenormalized energies of the constituents is bigger than the total energy of the π^o, as a result of which the hadronic model admits a "negative" binding energy as necessary for consistency.*

Needless to say, the "negative" binding energy is that caused by the Coulomb interactions between electron and positron that has been ignored in first approximation since the latter is considerably smaller than 135 MeV.

REPRESENTATION OF ALL CHARACTERISTICS OF THE PARTICLE: Remember that quantum mechanics allows the representation of *all* characteristics of the positronium with one single equation, Schrödinger's equation. As a consequence, said equation is indeed of structural character. As stressed in Ref. [14b], Section 5, hadronic mechanics allows the same feature, this time for the π^o meson. In fact, the Schrödinger-Santilli isoequation represents all characteristics (6.2.64) of the π^o, as one can verify.

Primary decay (6.2.65) is directly represented and it is in actuality the best confirmation that the physical constituents are indeed one electron and one positron in a mutated form. Decay (6.2.66) is the hadronic tunnelling of the physical constituents and it is an additional direct confirmation that said constituents are indeed an electron and a positron. The remaining secondary decays require isorelativistic treatment that is not studied at this time. For additional comments, one may inspect Ref. [14b], pages 843, 844, with particular reference to the warning on the inability to compute these secondary decays with the conventional scattering theory due to its unitary character.

By comparison, quark conjectures *do not* represent *all* characteristics (6.2.64), but only *some* of them; they do not admit one single structural equation, but represent different characteristics with generally different procedures; and the

spontaneous decays are represented via abuse of academic power, such as the claim that a quark-antiquark system can decay 98 % of the time into two photons, or the claim that the electron and the positron of decay (6.2.66) are "created" at the time of the "disappearance" of the quark-antiquark pair, all this without any explanation and without any quotation of the dissident, refereed publications such as Refs. [88, 101-105].

SUPPRESSION OF THE ATOMIC SPECTRUM. In view of subsidiary condition (6.2.51), characteristic value (6.2.70b) causes the *suppression of the atomic spectrum of energy levels down to only one state, the* π^o. In fact, the value $k_2 > 1,\ k_2 \approx 1$ implies the values $n = 1 < \beta^2 < n = 2$, by therefore suppressing in Eq. (6.2.49) all energy levels from $n = 2$ on, the only allowed level being that for $n = 1$ (see Figure 6.22)

The above atomic spectrum suppression is a most important confirmation of the validity of hadronic mechanics fully identified and emphasized in the original proposal [14b]. In fact, the π^o meson has no known excited state. Consequently, the admission of even one additional energy levels, besides that for the π^o, would be inconsistent with experimental evidence.

Besides a confirmation of validity, the suppression of the atomic spectrum has deep implications. *Model (6.2.63a) does indeed admit an infinite number of excited states, but they are those of the positronium.* Alternatively, any excitation of the energy level of the physical constituents of the π^o causes them to exit the hadronic horizon $R_c = \ 1\ $ fm, after which the Hulthen potential is null, and the hadronic model recovers the conventional Schrödinger equation of the positronium uniquely and identically.

Note that the suppression of the atomic spectrum is considered of paramount important t to avoid the illusion of studying the structure, while in reality one solely deals with the classification. Different views would require that the Schrödinger equation for the hydrogen atom must include the related Mendeleev family, which is notoriously not the case. The inability to separate the classification from the structural problems, while at the foundations of historical studies on nuclei, atoms and molecules, has remained entranced in the minds of researchers in hadron physics due to the political condition of the field.

As we shall soon see, another basic implication of the atomic spectrum suppression is that the transition from the structure of the π^o to that of the $\pi^\pm$ requires the *increase* of the number of constituents in order to comply with physical evidence. By comparison, the classification of mesons does not require such an increase, as well known, because we have a classification via mathematical representation of a mathematical symmetry defined on a mathematical complex-valued space without any known connection to our spacetime.

IGNORABLE HADRONIC BINDING ENERGY. Another aspect, that is fundamental for the proper understanding of hadronic mechanics, but also departs dramatically from quantum settings, is that *the hadronic binding energy is so small as being ignorable in first approximation.* It is known from undergraduate studies that contact resistive forces have no potential energy. The main physical origin of structure model (6.2.63) is the *contact, zero-range, interaction* due to the complete immersion of one wavepacket within the other. Hence, any grant-

ing of energy to contact interactions responsible for structure (6.2.63) would be outside the boundary pf physics.[48]

[48]When NASA initiated space missions, it became clear that classical Hamiltonian mechanics permits extreme accuracy for the orbits of satellites *in vacuum.* However, NASA engineers soon discovered that the computation of *the satellite trajectory during re-entry in atmosphere* was afflicted by serious theoretical difficulties, as well as safety concerns due to lack of accurate predictions.

When this insufficiency propagated throughout physics departments in the U.S.A., a physicist from a "leading" college visited NASA to "help" in computing re-entry trajectories. The physicist was allowed to deliver his talk as scheduled, but the affair resulted in great embarrassment because that physicist has insufficiently knowledge of the field, yet was coming from a U. S. institution crucial for NASA obtaining governmental funds.

The embarrassment by NASA engineers was due to the fact that the "physicist" from a "leading" institution had the "illusion" of treating re-entry trajectories with the only theory he knew, tcnventional Hamiltonian mechanics, that based on the truncated Hamilton equations without external terms (see Volume I). In plain language, the "physicist" was dreaming to represent re-entry trajectories with a Hamiltonian! The embarrassment by the engineers was due to the fact that, at that time, to improve the approximation of the trajectory, they had been forced to use nonpotential forces that had reached the 9-th power of the speed, e.g.,

$$F = -N_o - N_1 \times v - N_2 \times v^2 - N_3 \times v^3 - N_4 \times v^4 -$$
$$-N_5 \times v^5 - N_6 \times v^6 - N_7 \times v^7 - N_8 \times v^8 - N_9 \times v^9$$

where the Ns are positive constants. Evidently, they were dealing with a force in three dimensions immensely beyond any dream of representation with a Hamiltonian. With considerable embarrassment, NASA engineers presented great praises to the "learned" academician and gently had him return to his "leading" institution.

The episode circulated in the physics community and partially inspired the author to write two monographs on re-entry trajectories and similar non-Hamiltonian problems, under the title of *Foundations of Theoretical Mechanics,* published by Springer-Verlag, Heidelberg, Germany. Volume I, *The Inverse Problem in Newtonian Mechanics* (1978), directly relevant to the above case, presenetd a systematic study of the necessary and sufficient conditions for the existence of a potential or a Hamiltonian (the conditions of variational selfadjointness),. Volume I then proved the impossibility for the Hamiltonian to represent nonpotential interactions in the frame of the experimenter from two dimensions on. Volume II, entitled *Birkhoffian Generalization of Hamiltonian Mechanics* (1981), to provide NASA engineers a universal variational principle (evidently necessary for optimization) applicable to all possible, sufficiently smooth re-entry trajectories with unrestricted, variationally nonselfadjoint forces much more complex than the one above.

Unfortunately, to the author's best knowledge (evidence to the contrary would be greatly appreciated for due corrections) NASA engineers were never allowed (or interested) to use the two volumes published by Springer-Verlag, because they were constrained for political reasons to continue their contacts with "leading" physicists at "leading" institutions as a condition for funding.

In turn, the absence of such a of the intended primary use of the two Springer-Verlag monographs provided additional motivation for the author being dubbed "the most plagiarized physicists of the 20-th century," because numerous other researchers subsequently published various papers in "leading" journals without any reference to the author' s two volumes in the field, publication occurred with the generally studious intent by the editors of avoiding the consultation of the author as a referee.

As a last act, the author filed in 1994 at the Massachusetts Institute of technology a request of investigations by its ethics committee to receive prophetic phone calls that the author was wasting his time, as it did turn out indeed to be the case, since academic behavior has no control whatsoever by society. As a result of all this, the huge efforts in writing the two volumes with Springer-Verlag (each volume written and rewritten several times to reach referee's acceptance, one full year being spent solely in historical search in various libraries) went into oblivion.

ISOSELFDUALITY PREDICTION. In Chapter 2, we have stressed that *isoselfduality* (invariance under the isodual map as enjoyed by the imaginary unit i) is a new invariance of nature so fundamental that it is verified by the conventional Dirac's equation (thus leading to a basically new interpretation that escaped the physics of the 20-th century), and be assumed at the basis of our cosmology (Section 6.1.15).

Quark supporters have ignored for over a decade this new invariance, and so has been the case by the Particle Data Group who write spontaneous decay (6.2.65) without being aware that it violates this new invariance. It is easy to see that *the proposed structure model of the π^o is isoselfdual,* being constituted by a particle-antiparticle system

$$\pi^o \ = \ (\hat{e}^+, \hat{e}^-)_{hm} \ \equiv \ [(\hat{e}^+, \hat{e}^-)_{hm}]^d. \tag{6.2.79}$$

Note that the same invariance is verified by quark-antiquark systems. By contrast, the r.h.s. of decay (6.2.65) is not isoselfdual,

$$\gamma + \gamma \ \rightarrow \ (\gamma + \gamma)^d \neq \gamma + \gamma. \tag{6.2.80}$$

A serious knowledge of hadronic mechanics requires the awareness of the complete democracy requested between the treatments of matter and antimatter. In turn, this leads to the prediction that *one of the two photons of decay (6.2.65) is the isodual photon γd* (Chapter 2), that is physically distinct from the conventional; photon. Contrary to what released in the Particle Data, the correct form of writing decay (6.2.65) is that verifying isoselfdual invariance

$$\pi^o \ = \ (\hat{e}^+, \hat{e}^-)_{hm} \equiv [(\hat{e}^+, \hat{e}^-)_{hm}]^d \ \rightarrow \ \gamma + \gamma^d \equiv \gamma + \gamma^d. \tag{6.2.81}$$

By recalling the need for mankind to initiate quantitative studies as to whether a far away galaxy or quasar is made up of matter or of antimatter (chapters 1 and 2), it is hoped that researchers in particle physics will eventually acknowledge basically new invariances, such as isoselfduality, particularly when they have been available for over a decade.

What is at stake, particularly for large laboratories, such as CERN, FERMILAB, DESY, RUTHERFORD, IJNR, etc. is to avoid the possible waste of truly large public sums in the laboratory fabrication of anti-hydrogen atoms for the purpose of studying their light, because the light emitted by antimatter is available in the elementary decay of the most elementary meson, the π^o.

Note that we have ignored the neutrino decays, such as

$$\pi^o = (\hat{e}^+, \hat{e}^-)_{hm} \ \rightarrow \ \nu + \bar{\nu} \ \ (8.3 \times 10^{-7}\% \ \ 90\% CL, \tag{6.2.82}$$

because purely theoretical and without any direct *experimental* evidence since neutrinos and antineutrinos cannot be directly detected like the physical particles in the preceding decay. Neutrinos are conjectured based on the production of

particles. However, the latter production admits alternative interpretation without the conjecture of the neutrinos and antineutrinos as physical particles. hence, to regain credibility, and prevent shadows of affiliations of the financial interests around the neutrino conjectures, *the Particle Data Group should restrict the data to actual physical particles directly detected in our laboratory, and remove any mention of neutrinos (or quarks) in their data, some of which listed with* 90 % *Confidence Level!.*

On historical comments, the only difference of the above presentation and the original one is the information gained during the three decades that passed in regard to the fact that the maximal causal speed within hadronic matter is given by $V_{max} = c_o \times) b_4/b_3) and not by c = c_o \times b_4$.

6.2.7 Nonrelativistic Structure Model of the Neutron as a Compressed Hydrogen Atom

IN PREPARATION, see
R. M. Santilli, Hadronic J. **13**, 513 (1990).

6.2.8 Relativistyic Structure Model of the Neutron as a Compressed Hydrogen Atom

In prepatation
see
R. M. Santilli, Chinese J. Syst. Eng. and Electr. & Electr. **6,** 177 (1996) [5f];

6.2.9 Hadronic Structure Model of Mesons with Physical Constituents

In preparation

6.2.10 Hadronic Structure Model of Baryons with Physical Constituents

In preparation

6.2.11 Compatibility of the Hadronic Structure Models with SU(3)-Color Classifications

In preparation

Appendix 6.A
Ethical Problems in Particle Experiments

Only the most corrupt of a scientist can deny the existence of serious ethical problems in contemporary physics. The situation is so serious and the consequences are so grave, that *our contemporary society can be compared to the condition of the Roman empire prior to setting of Roman laws, because of basic insufficiencies of existing laws to address scientific crimes.*

Recall the Roman original definition of "crime" as damage to society. it is then evident that the manipulation by a physicist of scientific knowledge for personal gains causes damage to society dramatically bigger than ordinary crimes, such as a gun point stealing of money at a grocery store. The insufficiencies of current laws are then clearly established by the fact that the latter crime can indeed be punished with jail sentences, while the former is fully permitted despite its much more serious character.

The above view is not capricious, but based on personal experience. In fact, during the various personal attempts by the author to contain scientific corruptions, plagiarisms, frauds and other scientific crimes, judges and attorneys alike could not even understand the author's claims, let alone properly act on them in the protection of society (see http://www.scientificethics.org).

Exactly as it was the case for the Roman society over two millennia ago, our contemporary society will not enter into an era of great discoveries, capable of unthinkable advances, all the way to bring mankind to the stars (Section 6.1.3), until scientists, educators, economists, industrialists and politicians understand the need for, and implement *a new code of laws* encompassing also the control of scientific crimes.

In the Preface of this volume we indicated that the easiest manipulations of scientific knowledge occur in contemporary experiments because:

1) Manipulations of data to verify a preset theory are quite easy due to the complexity of the elaborations themselves;

2) The experimental data are generally elaborated via the very theory intended for verification, as a consequence of which, the "experimental results" must be compatible with the pre-set assumptions;

3) Very few events are often selected out of hundred of millions of events (as it is the case for the claimed "neutrino detection"), and then use of academic power to claim a pre-set result.

A dark shadow in the science history of the U. S. A. is the claim in 1995 by FERMILAB of the "discovery of the top quark" via its CDF and CO experiments with the additional claim to have "measured its mass" (174.2 GeV corresponding to the mass of a nucleus) [84]. In fact, the scientifically correct statement should have been the "detection of physical particles predicted by the unobservable top quark." At any rate, the same experimental results are admitted by other theories not assuming quarks as physical particles in our spacetime (see next chapter),

The claim to have "measured the top quark mass" passes all boundaries of serious science because quarks cannot have gravity, as well known to qualified experts (see Chapter 1 and next section), thus rendering "quark masses" mere ad hoc parameters introduced to fit a preferred theory. In any case, the unplausible high value of the "top quark mass" is a mere result of using an excessively elementary mathematics in excessively complex physical conditions because the use of isomathematics would dramatically reduce such an unreasonably high value the "quark mass" while keeping the same experimental data on physical, that is, actually observed particles.[49]

Similar dark shadows in the European history of science exist for the various claims at CERN, GRAN e and other laboratories to have "detected neutrinos" to the point of sending them across Europe from one laboratory to another, with the equal claim to have "measured neutrino masses" [85]. As limpidly stated by Enrico Fermi, "neutrinos cannot be directly detected" for the obvious reason that they are neutral./ hence, the scientifically correct statement should be the "detection of physical particles predicted by the neutrino hypothesis." Similar vast issues of scientific ethics occur in the very claim that neutrino have masses, l;et alone that they have been measured (see next chapter).

It is obvious to the educated observer in good faith that these far reaching and so objectionable claims are purely political motivations to secure money, prestige and power via the abuse of the credibility of the releasing institutions, for real science requires a dramatically more cautious language.

To illustrate the unreassuring condition of particle physics, in this appendix we show how easy is to manipulate experimental data for the pre-set objective of fitting the desired theory. The illustration is done by re-elaborating the data of Grossman's tests [53] and showing that they can be turned, from their claim of verifying Einsteinian doctrines, into a form showing deviations and full verification of Aronson's results [52].

To minimize additional scientific manipulations expected from this presentation, the author stresses that *no position is here assumed as to whether or not experiments [53[had indeed been manipulated to serve political interests, because*

[49]The reduction of current experimental beliefs on quark masses is a direct consequence of the strong convergence of divergent quantum perturbation series under isotopy (see EHM II and Chapter 3).

that position would be itself political, the only [possible scientific statement being lack of final experimental resolution at this writing one way or another.

The main objective of this section is to show the need for the conduction of contemporary particle experiments under the supervision of external Committee on Scientific Ethics and Accountability. Following fifty years of research experience, the author is forced to state again that *no basic advancement in scientific knowledge is possible without the joint consideration of scientific ethic s and accountability.*

To begin, the author wants to be on record to testify that, immediately following the appearance of Grossman's claims [53], all papers submitted to journals of the *American Physical Society* (APS) on possible deviations from the Einsteinian decay law were rejected by APS editors with written statements to the effect that "the verification of the Einsteinian decay law has been confirmed by Grossman's tests" [53].

This editorial posture must be denounced since a serious statement should have been "the validity of the Einsteinian decay law has been confirmed by tests [53] in the range from 100 to 400 GeV, but deviations have been reported by Aronson et al [52]," rather than the absolute confirmation ventured by APS editors for all values of the energy, a posture that is evidently implicit in the releases statement.

In any case, tests [53] were and remain to this day very controversial because of a number of equivocal assumptions in the data elaboration, some of which are identified below. This nonscientific posturing by APS editors confirmed (or perhaps initiated) rumors that Grossman's tests [53] had been "commissioned" by organized interests on Einsteinian doctrines following the claim of departures in Ref. [52]. Consequently, so the rumors say, the experimental data had been manipulated to meet pre-established political objectives.

As studied in the preceding and in this volume, all available conceptual, epistemological, theoretical, phenomenological and experimental evidence suggest deviations from the Minkowskian spacetime inside hadrons, with the sole exception of the Grossman tests [53]. the sole evidence that photons cannot propagate within the hyperdense medium inside hadrons is sufficient to cast serious shadows.

A re-elaboration of tests [53] was conducted in in 1998 by Yu. Arestov et al. [57] of the Institute for High Energy Physics of Protvino, Russia, by focusing the attention on the range-energy selection rule which can be applied to re-elaborate the initial data on K_s decays. In this section we shall use re-elaboration [57] and develop it further alone the lines above indicated.

Arestov et al. first obtained the raw data of tests [53] and initiated their re-elaboration via a new Monte Carlo simulation of the main features of the experiment and made new fits for K_s^o. To begin, the parameters in the full formula dN/dt for the proper time evolution are strongly correlated. This may cause a generally non-relevant regular dependence of the parameters on entities

which are not present in the formula, such as number of runs, energy, etc., apart from systematic uncertainties. Therefore, the above dependence may shadow the weak energy dependence, as can be seen from the large values of the correlation elements.[50]

Ref. [53] solved the problem of non-correlated fits by selecting the K_S^o momenta greater than $100GeV/c$, an assumption that prevents the use of the results below $100GeV/c$. By means of that energy cut, Ref. [53] obtained the data sample in which the CP violating terms contribute up to 1.6%.

A first apparent manipulation of Grossman's tests [53] occurred in looking for deviations from the Einsteinian decay law of the order of a few percentages. This is manipulatory because known by experts to be unrealistic, since all expectations are to look for deviations from the Einsteinian law of the order of 10^{-3}, as suggested by studies [48-52].

The confirmation of a possible manipulation is given by the fact that the assumption in Ref. [53] of 1.6% contribution from PC violation in the data elaboration implies looking for the energy dependence of τ_s at the level $k \times 10^{-2}$, thus rendering meaningless *ab initio* to look for more realistic deviations of the order of 10^{-3} or smaller.

Ref. [53] significantly suppressed the CP violating terms by using selection rule for the ratio R/E, where R and E represent the K_s^o range and energy. In experiment [53], R/E ranges from 2.3 to 36.1 cm/GeV. The R/E interval should be selected to make the contribution of the CP violating terms less than a desirable value, say $k \times 10^{-3}$. An effective (R, E) plot can then be calculated via Monte Carlo methods applied to the real decay volume.

Note that the above assumption caused in Ref. [57] to *lower statistics,* thus increasing the credibility of the data re-elaboration of Ref. [57] over that of the original paper [53]. In fact, under the above new assumptions, $60 - 70\%$ of the events are rejected, i.e., only $63K - 84K$ events of the total $220K$ events were used in Ref. [57]. Apart from the loss of a major part of the data, 1/3 of the decay volume in the experiment turns out to be also useless.

The large inefficiency of experiment [53] occurred because it had not been optimized for the problem. Basically, the experimental design and data selection

[50]The author jointly submitted paper [57] to *four* editors of *Physics Letters B* specifically selected because belonging to CERN, the paper essentially suggesting in due scientific language that CERN should repeat experiments [52,53] and finalize such a fundamental aspect of particle physics BEFORE spending additional public funds in the field. All four editors rejected the paper with a single signed letter stating that the paper was "excessively speculative," the same editors routinely accepting papers on neutrino and quark conjectures, evidently, as non-speculative. Following a long personal experience, it is the author's opinion that, in view of the billions of euros involved, the abuse of the laboratory credibility, the academic power of its leaders, and other factors, *no truly basic advance of physical knowledge can possibly occur at CERN without judicial injunctions for misuse of public funds and other charges initiated by European taxpayers,* the expectation that physicists at CERN may listen to scientific arguments being very naive or proffered by accomplices.

rules followed that of conventional K_s, K_l studies. A comparison of the statistics selected in re-elaboration [57] with the elaborations [53] then adds additional credibility to the rumors that Grossman's tests were commissioned.

Ref. [57] then illustrated the above arguments with two fits shown in the figure below, illustrating K_S decays at six energy values (from 125 to $375GeV$) that were generated in the decay volume with the ranges from $9.3m$ to $25.3m$. The energy dependence of the lifetime was assumed in the form

$$\tau(E) = \tau_S(1 + \epsilon E), \quad \tau_S \ = \ 0.8927, \quad \epsilon \ = \ 4 \cdot 10^{-5}. \tag{6.D.1}$$

After applying the range-energy selection rule, a sample of $64K$ events was chosen in Ref. [57] for which the contribution of the CP violating terms was less then 0.008. Namely Ref. [57] dealt with the following distribution for the proper lifetime:

$$\frac{dN}{dx} = N\{\exp(-x) \ + \ \text{CPV}\}, \tag{6.D.2}$$

where N is a normalization constant, $x = t/\tau(E)$ and CP violating terms are equal to

$$\text{CPV} \ = \ \mid \eta_{+-} \mid^2 \exp(-xy) \ + \ 2D \mid \eta_{+-}, \tag{6.D.3}$$

$$\mid \ \cos(\Delta m \ t - \phi_{+-})\exp(-x(1+y)/2) \tag{6.D.4}$$

where y stands for $\tau_s(E)/\tau_\ell$.

The values of other parameters are taken as the world average values. They are

$$\mid \eta_{+-} \mid \ = \ 2.284 \cdot 10^{-3}, \tag{6.D.5}$$

The magnitude of the CP-nonconservation parameter in the expression

$$K^o_\ell \to \pi^+\pi^-, \quad \phi_{+-} \ = \ 43.7^o, \quad \Delta m \ = \ 0.5333 \cdot 10^{10}\hbar sec^{-1} \tag{6.D.6}$$

is given by the mass difference of K^o_ℓ and K^o_s. The dilution factor D is defined as the ratio

$$\frac{N - \bar{N}}{N + \bar{N}}, \tag{6.D.7}$$

where N ($\bar{N}$) is the number of K^o ($\bar{K}^o$) produced by the proton beam on the target.

Note that Ref. [57] accepted the value $D = 0.75$ of Ref. [53]. The sequence of the mean proper lifetimes is plotted in the figure below versus E, the K^o_s laboratory energies. The dependence was obtained by simulations of K^o_s decays in the experimental volume under the conditions described above.

The figure presents two fits obtained by Arestov et al [57] with the energy-dependent formula of the type

$$\tau(E) \ = \ 0.8927(1 \ + \ p_1 E), \tag{6.D.8}$$

and the values

$$\tau(E) \ = \ c, c = 0.90 \pm 0.01, \chi^2/ndf \ = \ 0.7/5, \qquad (6.D.9)$$

represented by the dashed line at top left of the figure, and

$$p_1 \ = \ (4 \ \pm \ 5), cdot10^{-5}, chi^2/ndf \ = \ 0.38/, \qquad (6.D.10)$$

represented by the solid line top left.

For comparison, Ref. [57] performed also the two-parameter fit to the formula of Ref [53],

$$\tau(E) \ = \ p_2(1 \ + \ p_1 E) \qquad (6.D.11a)$$

$$p_1 = (4 \ \pm \ 23) \cdot 10^{-5}, \qquad (6.D.11b)$$

with $\chi^2/ndf \ = \ 0.38/4$.

There is a difference in interpretation of parameters in the two fitting formulae with the energy dependence. The parameter p_2 in the fit from paper [53] was interpreted as the zero-energy mean value of the proper lifetime. It is difficult to extrapolate the fitting formulae from the energy interval $100 - 400GeV$ to zero. Instead, Ref. [57] used the energy dependence in a limited energy interval by fit starting from a definite point. This difference in interpretation is important because, in general, various approaches in fitting procedures may lead to crucially different numerical results, thus confirming beyond credible doubt the possibility of manipulating the data elaboration to verify any pre-set beloved doctrine.

Thus, in the amount of the events selected in Ref. [57], both fits dig up well the mean value of the hidden parameter ϵ determining the energy dependence in the simulated K_S^o decays, but the error bars differ strongly. Though both results for fitting the values of p_1 are still insignificant statistically, even in the selected sample of events, the 100% error bar in fit [57] being rather promising. a pre-set goal.

An additional possibility, we note here that no firm spacetime verification of the Einsteinian decay law can be established via elaboration [53] for PC violating contributions of the order of 1.6% because possible anomalies are within the errorbars due to insufficient statistics of tests [53] and other reasons.

Arestov et al concluded their analysis in paper [57 with the statement: *The analysis of this paper establishes the insufficiencies of the tests by Grossman et al. and the need for final, more accurate measurements as the only way to resolve the now vexing fundamental problem of the spacetime geometry and physical laws holding in the interior of the hyperdense hadrons. After all, as indicated earlier, the isominkowskian fit of experiments [55-56] establishes the existence of space-time anomalies with superluminal speeds in the interior of hadrons even in the event that measurements [53] result to be correct.*

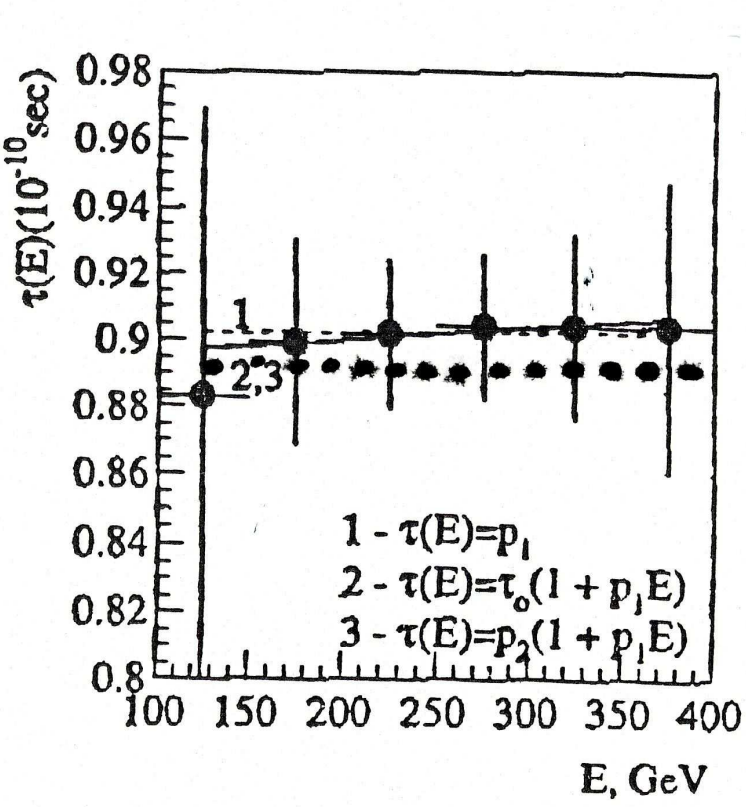

Figure 6.A.1. Re-elaboration of the experimental data of the experiments by Grossman et al [53] for the lifetime $\tau(E)$ dependence on energy. The dashed line (top left) and the continuous line (middle left) are the re-elaboration of said data as published by Arestov et al [57] to illustrate the lack of final character of the claims contained in paper [53]. The dotted line (left bottom) presents re-elaboration by the author via different fitting functions and other minor changes to illustrate how easy it is to manipulate contemporary experiments for the pre-determined intent of fitting Einsteinian doctrines. This establishes the need for the conduction of any and all particle physics experiments under the strict control of an external Committee on Scientific Ethics and Accountability. The occurrence also established the need for an in depth apolitical review of ALL recent particle experiments based on Einsteinian doctrines for conditions different then those of its original conception. Finally, the re-elaboration confirm the new for a *a new code of laws* addressing scientific manipulations, as suggested in the text

The author has re-examined the above analysis under profiles pertaining to scientific ethic s and accountability. It is evident that the "experimental verification" claimed by Grossman et al [53] could have been intentionally achieved via virtually endless manipulations of the data elaboration, all presented under

a patina of seemingly technical calculations, although solely capable of fouling readers without sufficient technical knowledge.

To mention only one among numerous possible adulterations, statistical and other conditions can be selected in such a way that the deviations from Einsteinian doctrines are of the order of magnitude of the error, and then claim verification of said doctrines. In any case, the rumors persist that this was indeed done by Grossman et al [53] and by the editors of the APS with*their* publication of the paper.

Such a visible absence of serious editorial processing is systematically implemented by APS editors for papers claiming experimental verification of Einsteinian doctrines and quantum mechanics. By contrast, the more important papers claiming experimental deviation from said doctrines are subjected by ASPS editors to brutal "reviews" intended to discourage the continued submission via a never ending sequence of criticisms on manifestly tangential issues, without issuing, in general, a formal rejection.

It is equally evident that there exist a large number of possibilities to manipulate the data to reach pre-set departures from the Einsteinian decay law. As a matter of fact, the alternatives are so many to be embarrassing. In the figure we report deviations from the Einsteinian decay law (dotted line at bottom left) obtained via a 5% change of the PC violating parameter, a different value of the fitting function and other small "adjustments."

Note that the deviations from the preceding two curves is intentionally small because it could have been as large ad desired. In particular, simple "adjustments" in the selection of the statistics, reduction of the PC parameter, suitable selection of the fitting function and others things can easily produce deviations 3-4 timers bigger than the error. Their study is left as an instructive exercise for the ethically sound scholar.

It is hoped that educators, administrators and editors seriously committed to serious science see the necessity of *a new code of laws* encompassing scientific crimes, as well as the necessity that all contemporary experiments, whether in favor or against Einsteinian doctrines, be subjected to controls by an external Committee on Scientific Ethics and Accountability prior to publication. Educators, administrators and editors should never forget that what is at stake is the ability or inability to solve increasingly alarming environmental problems in our planet. In plain language, leaving the status quo in the current conduction of basic science is not only unethical, and irresponsible but actually suicidal.

Appendix 6.B
Ethical Problems in String Theories

In preparation as of October 1, 2007.

See the catastrophic inconsistencies of string theories published in a refereed journal of which the author is not an editor

R. M. Santilli, "New problematic aspects of current string theories and their apparent isotopic resolution,"
Foundation of Physics **32**, 1111(2002)

Serious ethical probles emerge because these catastrophic inconsistencies havce remained totally ignored by organoized interests in the field.

Until physicists were playing personal games of purely mathematical in curiosity in string theories, they were tolerated. Now that laboratories are raising large public funds for experiemts on a theory proved to be catastrophically inconsistent on physical grounds, without first disproving such inconsistencies in equally refereed piublications, judicial action is necessary to prevent this unethical condition and conduction of basic scientific knowledge.

Appendix 6.C
Ethical Problems in Black Holes

In preparation as of October 1, 2007. See

Jeremy Dunning Davies, *Exploding a Myth*
Harwood, England (2007
ISBN 978-1-904275-30-5

In Santilli's view, Black holes constitute one of the most sinister episodes in the history of science because of an excessively long list of excessive ethical problems, all ignored because of the illusion of achieving credibility via the abuse of academic authority, complemented by the illusion that all physicists are naive or gullible.

As one indication, current studies of black holes, in the form appearing in publications, dishonor the memory of Schwartzchild who wrote *two* historical papers, one on the *exterior* solution and one on the *interior* problem. Even though black holes constitute the ultimate interior gravitational problem in the universe as known these days to high school students these, they are treated with the exterior solution, while being completely silent on the interior character due final incompatibility with Einsteinian doctrines, the only possible bypassing of ethical problems being an admission of scientific illiteracy.

Additional ethical problems are caused by the complete ignorance of the catastrophic mathematical and physical inconsistencies of Einstein's gravitation under the illusion that they disappear via silence, complemented by the illusion that abuses of academic authority produce certain mental slavery, while in reality setting up the illusionists for probable legal prosecution by contemporary colleagues and certain condemnation by posterity, for serious science can be solely based on a collegian addressing, rather than suppressing, of fundamental unresolved problems.

Appendix 6.D
Requested Experiments

Following a lifelong experience, the author regrets to state that physics used to be a science with an absolute standard of value, the experimental verification. Experiments themselves used to have their own standard of value, in the sense that experiments on fundamental unresolved aspects had priority over those of peripheral; relevance.

Nowadays, the standard of value is primarily set by academic power; the more fundamental a proposed experiment is, the bigger the opposition for its conduction; and, when undesired basic tests somehow manage to escape current restrictions, manipulated counter-experiments are soon commissioned to protect organized interests on Einsteinian doctrines (se Appendices 6.1.A, 6.1.B, 6.1.C).

These are the reasons for the view, repeatedly expressed by the author, that *nowadays, no basic aspects in physics can be seriously addressed without a joint consideration of issues pertaining to scientific ethics and accountability.* Hence, the author has long suggested the need for external Ethics Committees supervising basic research similar to those existing in other branches of science, particularly when the research is conducted under public financial support.

More recent events have shown that organized obstructions against undesired advances have increased with the increase of the evidence of the limitations of Einsteinian doctrines. Since the power and capillary organization of orthodox interests is beyond the imagination by outsiders, the author predicts that *no experiment on truly basic open issues is possible nowadays without legal proceedings against physics laboratories and their directors for misuse of public funds, discriminatory conduct, and other violation of federal laws.*

In this section we present n numerous basic experiments submitted by the author over three decades (see Refs. [81,6] and EHM II) to all major laboratories around the world whose list and related documentation will be disclosed at the appropriate future time in the appropriate conduit. Even the "consideration" of the experiments herein proposed by flatly rejected, let alone their "conduction."

To appraise the gravity of the situation, the "consideration" of the basic experiments reviewed below was rejected even though their costs was at times quite moderate with very large scientific implications whatever the outcome, while other experiments were preferred of immensely bigger costs to the taxpayer, without any major relevance, and often intended to test sheer theological beliefs. The

reason for this disparity documented beyond credible doubt, and continuing to this day in any case at all major physica laboratories around the world, is that the later experiments were aligned with Einsteinian doctrines while the former were not.

In view of such a deplorable condition of physics, and the expectation of its resolution via judicial proceedings, in his capacity as a U. S. taxpayer, the author has changed the original titles of "Suggested Experiments" into "Requested Experiments." Readers who interprets the content of this section as aimed at "proving Einstein wrong" and the like, are disqualified as being outside serious science because, as shown by scientific history, serious science is solely conducted via serious experiments *irrespective of whether in favor or against a preferred theory.* The endless distortions, deviations, peripherals, and the like the author has been exposed too over decades are mere schemes aimed at personal gains in money, prestige and power.

REQUESTED EXPERIMENT 1: Measure the possible isoredshift of light from a quasar before and after passing through a planetary atmosphere (such as that of Jupiter) or an astrophysical chromosphere (such as that of the Sun).

The above test was first proposed by Santilli the early 1980s when at Harvard University, and then reviewed in a number of publications such as Ref. [81] of 1988 and subsequent works (see monograph [6] in particular) and papers quoted therein.

The reason for the impossibility of astrophysical laboratories to even consider the experiment, let alone conduct it, is that, at the time of the proposals, the author was still naive, in the sense of still believing in the above quoted absolute standards of values on which the preceding history of physics was based upon. In fact, the respectful "suggestions" to consider Experiment 1 included a detailed identification of its fundamental implications. The suppression of the consideration was due to such an identification. In different terms, had the experiment been disguised by misinformation on title ands content, perhaps there would have been a chance at least for its consideration.

Had, in the United States of America, any astrophysics laboratory formally "considered" Experiment 1, that laboratory would have seen the termination of research funding by the Department of Energy, the National Science Foundation, and other governmental agencies or private foundations. Under these conditions in the U.S.A., foreign astrophysical laboratories had no other choice than align themselves with organized interests in the U.S.A. [51] It is important to identify

[51]Documentary evidence of ONE research contract existing at this writing (October 23, 2007) by the D.O.E. or the N.S.F. funding experiments that could invalidate Einsteinian doctrines would be greatly appreciated for due corrections.

the political problems that have prevented the consideration of the test so far, because useful for serious scholars seriously interested in serious science.

POLITICAL PROBLEM 1: As recalled earlier, the "universal constancy of the speed of light" is maintained within physical media via the belief that photons scatter through atoms, thus causing a believed *increase of the travel time* through the medium that appears to us as a decrease of the light speed. The important political point is that, in this way, photons continues to travel in vacuum at the "universal value" c_o. By comparison, if successful, Experiment 1 would detect a *slowdown of the speed of light itself* because it is the sole capable of causing a redshift. Admitting the possibility of detecting the local variation of the speed of light would mean terminating the dominance of Einsteinian doctrines throughtout all media in the universe, with consequential expected termination of funding perhaps in excess of one billion dollars, thus mandating the commissioning of counter-experiments, and similar scientific misconduct nowadays a routine in physics due to the total absence of any control by society.

POLITICAL PROBLEM 2: As shown below, the sole decrease of the speed of light is insufficient for serious science because the considered media are inhomogeneous and anisotropic. Experiment 1 is additionally intended to measure possible deviations from the homogeneity and isotropy of empty space, namely, something more damaging to organized interests on Einsteinian doctrines than the mere change of the speed of light, with consequential, expected, increased reactions, obstructions, schemes, manipulations, and the like.

POLITICAL PROBLEM 3: If successful, Experiment 1 would establish the exact validity within physical media of Santilli's isotopic covering of Einsteinian doctrines, including the exact validity of the iso-Minkowskian spacetime, the iso-Lorentz symmetry and related iso-axioms, namely, the proposed test would establish something expected to have truly large organized oppositions, obstructions and disruptions.

Following these necessary preliminary for outsiders to have a glimpse of the real experimental world in physic s these days, we can now pass to an outline of the scientific case to the best of our capability. To keep a kilometric distance from orthodox interests, the presentation below is submitted as tentative and conjectural, for which very reason there is the need for an experimental verification, by keeping in mind that *the orthodox interpretation is equally tentative and conjectural, again, due to the lack of direct experimental verifications.*

As well known, the conventional *Doppler's law,* for the simpler case of null angle of aberration, is given by

$$\omega = \omega_o \times \frac{1-\beta}{\sqrt{1-\beta^2}},\ \beta = \frac{v}{c_o}, \tag{6.1.129}$$

where c_o is the speed of light in vacuum, and can be written via a power series expansion

$$\omega = \omega_o[1 - \frac{v}{c_o} + \frac{1}{2} \times (\frac{v}{c_o})^2 + ...]. \tag{6.1.130}$$

As also well known, $v \ll c_o$, $v/c_o]ggv^2/c_o^2$ and, consequently, the term v/c_o dominates the expansion. We can then write

$$\omega \approx \omega_o \times (1 - \frac{v}{c_o}). \tag{6.1.131}$$

Also, $v/c_o \ll 1$. Consequently, Eq. (6.1.131) represents a *decrease* of the original frequency ω_o. Then, for $v \neq 0$, we have a *redshift* that can be defined as[52]

$$\Delta_\omega = \omega_o - \omega > 0. \tag{6.1.132}$$

It is equally evident in Eq. (6.1.131) that, in the event, for a given value of v, there is a decrease of the speed of light within the selected planetary atmosphere or astrophysical chromosphere, namely,

$$c_o \rightarrow = c = c_o \times b_4 = \frac{c_o}{n_4}, \;\; b_4 < 1, \;\; n_4 > 1, \;\; c < c_o, \tag{6.1.133}$$

Eq. (6.1.131) becomes

$$\omega \approx \omega_o \times (1 - \frac{v}{c_o} \times \frac{1}{b_4}) = \omega_o \times (1 - \frac{v}{c_o} \times n_4). \tag{6.1.134}.$$

As one can seen, *in the event, for a given v, we have a decrease of the speed of light within the medium considered, the redshift is bigger,* exactly along the Section 6.1.11.

It is equally easy to see that Eq. (6.1.134) is geometrically unbalanced and incomplete because inhomogeneity can be represented with a dependence of the index of refraction on the local coordinates, $n_4 = n_4(r, ...)$ (since n_4 represents the local density), but we lack a representation of the anisotropy of the medium considered caused by its its rotation with consequential preferred direction in space. The latter requirement leads uniquely and unambiguously to Isoaxiom IV with isotopic law

$$\omega = \omega_o \times \frac{1 - \hat{\beta}}{\sqrt{1 - \hat{\beta}^2}}, \tag{6.1.135a}$$

$$\hat{\beta} = \frac{v}{c_o} \times \frac{b_s}{b_4} = \frac{v}{c_o} \times \frac{n_4}{n_s}, \tag{6.1.135b}$$

[52]We should caution the reader that there are numerous different definitions of redshifts in astrophysics.

and final approximate expression

$$\omega \approx \omega_o(1 - \frac{v}{c_o} \times B, \qquad (6.1.136a).$$

$$B = \frac{b_s}{b_4} = \frac{n_4}{n_s} \qquad (6.1.136b)$$

where we have assumed, again, spherical symmetry for simplicity.

The following estimates of isoredshift for quasars light passing through Jupiter's atmosphere was reached in Ref. [6b], Section VII.4 and VII.5. The average value of the characteristic quantity B in the data of Fig. 6.1.13 is

$$B_{aver} = 72.58 \qquad (6.1.137)$$

from which we have the average redshift of quasars

$$\Delta^q_\omega = 1.15, \qquad (6.1.138)$$

with corresponding average redshift ofd the associated galaxies

$$\Delta^g_{aver} = 0.001. \qquad (6.1.139)$$

From astrophysical and planetary data we can assume, in first approximation, that quasar chromospheres ("q") are about 10^5 denser than Jupiter's atmosphere ("j"), and by recalling that $n_4 = 1/b_4$ represents the density d of the medium considered, we have the proportionality

$$\frac{B^q_{aver}}{B^j} \approx \frac{d^q_{aver}}{d^j}, \qquad (6.1.140)$$

with the estimate value of B for Jupiter [6b]

$$B^j_{est} = 7.3 \times 10^{-4}, \qquad (6.1.141)$$

and the corresponding estimate of the isotopic redshift for quasar light passing through Jupiter's atmosphere predicted by isorelativity

$$\Delta^q_{est} = 1.14 \times 10^{-5}. \qquad (6.1.142)$$

Individual values for b_s and b_4 can then be obtained from comparative measurements of the predicted decrease of the speed of light within Earth's atmosphere presented below, since such value would provide a good approximation of the corresponding value of b_4 for Jupiter. The value of b_s would then follow from the value of B.

"Requested" Experiment 1 suggests first to measure the quasar redshift in empty space via available instruments and techniques and then measure it again

when the same light passes through Jupiter's atmosphere. The experiment is readily feasible because it requires no new equipment, but merely the *extension* of conventionally conducted measurements only under new conditions. Also, estimate (6.1.141) is fully within current experimental feasibility.

To understand the gravity of contemporary experimental physics, noninitiated readers should know that the consideration, let alone conduction of Experiment 1 was rejected also by astrophysical laboratories that were conducting measurements of quasars redshifts, hence requiring no additional funds.

Said gravity is further illustrated by the fact that Experiment 1 requires, in reality, only a *confirmation,* since NASA planetary missions have provided apparent data showing exactly the isodoppler effect of Experiment 1 for the case of electromagnetic communications with satellites when passing though planetary atmospheres or the Sun's chromosphere. Regrettably, the author was unable to collect these data or possible references thereof, and their indication by interested colleagues would be greatly appreciated for due revisions.

The following alternative of Experiment 1 was submitted in Refs. [81,6b] but equally ignored by astrophysical laboratories:

REQUESTED EXPERIMENT 2: Measure from a satellite the possible isoredshift of light originating from a far away star or quasar when passing through Earth's atmosphere.

It is evident that possible comparative measurements of isoredshift in Jupiter's and Earth's atmospheres would yield invaluable scientific information on the geometries of physical media, particularly useful for new energies depending on spacetime anomalies, as we shall see.

The following third experiment is partially responsible for the view often expressed by the author that *the most ascientific process of contemporary physics is the scientific process.* The view is caused by a widespread dismissal of plausible dissident views, this time dealing with the *origin of the tendency toward the red of Sun light at sunset.*

REQUESTED EXPERIMENT 3: Measure at the equator the expected isoredshift of sunlight in the transition from the zenith to the horizon.

It is popularly believed that the "redness of sunsets" is caused by the absorption by our atmosphere of blue and other light resulting in the dominance of red visible by all of us. This view is not reason for debates. The problems originate when said view is assumed as the origin of the *entire* tendency toward the red at sunset, since there are *three* additional plausible contributions, all deserving experimental verification.

Conventional Doppler's effect. Earth's rotates. Hence, an observer at the equator is moved *toward* the Sun. It then follows that, at least one contribution of the "redness of sunsets," is a bona-fine, conventional redshift. In fact, said observer has the following tangential speed toward the Sun

$$v = 0.46Kw/s \tag{6.1.143}$$

resulting in the value

$$\beta = \frac{v}{c_i} = 1.57 \times 10^{-8}. \tag{6.1.144}$$

Despite its smallness, the latter value causes a conventional Doppler's shift visible by the naked eye and given by half of the visible difference of the tendency toward the read between sunset and sunrise. In fact, the observer is moving it away from the Sun at sunrise, thus causing a *blueshift* (because in this case the negative sign in Eq. (6.1.134) is turned into a positive sign). Clearly this contribution "requires" an experimental verification or denial.

Decrease of the light speed. Light decreases in speed about 33 % in water.[53] Since the ratio of the densities of water and atmosphere is of about 10^3, in Earth's atmosphere, Sun light speed is expected to decrease in the approximate value

$$c = c_o \times b_4 = \frac{1}{3} \times c_o \times 10^{-3}. \tag{6.1.145}$$

Since effect (6.1.144) is visible to the naked eye, effect (6.1.145) "requires" an experimental verification or denial because 10^5 times bigger than the former.

Full isotopic effect. Again, law (6.1.135) for value (6.1.145) is geometrically inadequate, requiring the full isotopic law (6.1.135). The latter effect also deserves experimental verification or denial because Earth's atmosphere is expected to be a medium of Group II, Type 5, for which b_s is *smaller* than b_4, as a result of which *the anisotropy of Earth's atmosphere is expected to decrease the redshift predicted by the decrease of light speed.*.

Experiment 3 can be conducted quite easily via currently available spectrometers, by first selecting one or more spectral lines at the zenith and then following them to the horizon. Possible errors in following the Sun can be compensated with a broader selection of spectral spectral lines, with the understanding that current astrophysical equipment can follow the micrometric motion of far away stars, thus being amply sufficient for the simpler motion herein considered.

Note that Experiments 1 and 2 are intended to ascertain whether or not an *already redshifted* light can experience an additional redshift when passing through a

[53]Despite this large decrease, readers should not expect a redshift in a glass of water due to the need for a large water volume to reach a measurable effect.

medium. Experiment 3 is intended to ascertain whether or not light not originally redshifted can be redshifted by passing through a medium. Hence, Experiments 1 and 2 could be successful even in the event Experiment 3 is not.

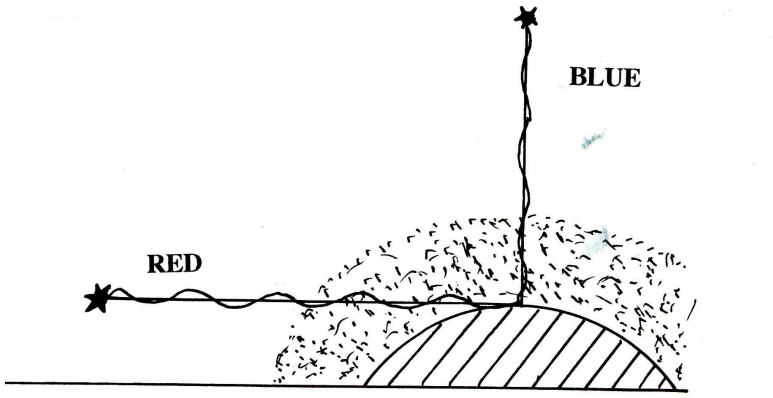

Figure 6.D.1. A schematic view of the Experiment 3 intended to ascertain whether or not,an observer at the equator following the transition from the zenith to the horizon, sunlight experiences three different contributions to the redness at sunset: 1) A conventional Doppler's redshift due to motion of the observer toward the Sun; 2) An isotopic redshift due to the predicted decrease of the speed of light within Earth's atmosphere; and 3) A blueshift reduction of the preceding redshift due to the anisotropy of the medium caused by Earth's rotation. As illustrated in the text, it should be stressed that isotopic contributions *cannot* turn blue light at the zenith into red light at the horizon. Hence, the proposed tests refer to *contributions* to the redness at sunset while keeping the conventional interpretation valid in first approximation (that Earth's atmosphere at the horizon absorbs the blue leaving the red as dominant). Despite its secondary numerical value, if confirmed, said contributions would have far reaching physical, astrophysical and cosmological implications.

We have indicated in the preceding section the current "experimental beliefs" on the expansion of the universe because redshifts measurements (that are not questioned here) are interpreted with the unverified assumption that light propagates through the immense astrophysical chromospheres at the same speed as that in vacuum. This results in an "experimental belief" because actual measurements are used to proffer personal unverified theoretical views, a rather widespread practice in contemporary physics, as we shall see.

To turn this theological condition of astrophysics into serious science, the author proposed in Ref. [6b], Sect. VII.5 the following additional test:

REQUESTED EXPERIMENT 4: Measure at one of the poles the possible isoredshift of sunlight from the zenith to the horizon.

The evident main difference between Experiments 3 and 4 is that, in the former case, we do have motion of the observer toward the Sun while, in the second case, the observer can be approximately considered to be at rest with respect to the Sun. Hence, Experiment 4 has a fundamental character for astrophysics, for which reason the author "requests" its conduction as a U. S. taxpayer. In fact, the test would permit the study:

1) Whether or not far away astrophysical bodies may exhibit a redshift while being at rest with respect to Earth;

2) Whether or not the currently believed expansion of far away astrophysical bodies should be decreased because of isotopic contributions from the slow down of the speed of light in their chromospheres; and'

3) Whether or not astrophysical bodies currently believed to be expanding from Earth are in reality moving toward Earth, trivially, because the isotopic redshift due to the chromosphere could be bigger than the blueshift due to motion.

The theology underlying the above open issue is essentially similar to that on antigravity, namely, "Einsteinian theories predict spectral shifts only under relative motion and, therefore, when there is no shift, the bodies are at rest with respect to each other." However, physical reality is definitely much more complex than this theological posturing.

The preceding experimental verifications of isorelativity have established that $n_4 = 1/b_s$ represents the local density d thus depending on the local coordinate r, $n_4(r, d, ...) = 1/b_4(r, d, ...)$. In the preceding calculations, $n_4 = 1/b_4$ has been averaged to a constant for simplicity. By contrast, the space component $n_s = 1/b_s$ depends on the speed and, trivially, from the energy E [81], $n_s(v, E, ... = i/b_s(v, E, ...)$. Hence, the isotopic law can be explicitly written

$$\omega \approx \omega_o \times [1 - \frac{v \times b_s(v, ...)}{c_o \times b_4(r, ...)}]. \tag{6.1.146}$$

Since the functional dependence of the characteristic quantity b_s on the speed is unknown at this writing, we cannot apriory assume that $\Delta_\omega = 0$ for $v = 0$ in Eq. (6.1.146). The only possible serious pursue of scientific knowledge is that via unbiased experiments, to be sure, conducted under an external Ethics Committee.

In summary the above possibilities 1), 2) and 3) may originate, not only from, a possible slowdown of the speed of light in astrophysical chromospheres, but also and independently, from, the anisotropy of the medium considered.

An illustration of one of the numerous scientific manipulations used to oppose the above proposed experiments is necessary to inform the serious scholar. The dismissal of the (at that time) "suggested" experiments was once voiced

by a seemingly senior "scientist" belonging to seemingly "leading" university on grounds that "Santilli believes that blue light at the zenith can be turned into read at the horizon via his mathematics." The following comments are then in order in the hope of at least preventing the repetition of the same "objection" against basic experiments.

The mid-blue ("b") at the zenith is characterized by the following frequency

$$\omega^b = 6.34 \times 10^1 4 Hz, \tag{6.1.147}$$

while the mid red ("r") at the horizon is characterized by

$$\omega^r = 4.38 \times 10^1 4 Hz, \tag{6.1.148}$$

with ratio

$$\frac{\omega^r}{\omega^b} = 0.69. \tag{6.1.149}$$

The hypothetical "redshift" from blue to red would then require

$$\omega^r = \omega^b \times [1 - \frac{v}{c_o} \times b], \tag{6.1.150a}$$

$$1 - \frac{v}{c_o} \times B = 0.69 \tag{6.1.150b}$$

$$B = 1.4 \times 10^7 \tag{6.1.150c}$$

where we have used value (6.1.143).

It is evident that *value (6.1.150c) is impossible in Earth's atmosphere.* Since it was proffered by a seemingly qualified senior "scientist" belonging to a qualified University, the statement "Santilli believes that blue light at the zenith is turned into read at the horizon via his mathematics" was an act of sheer scientific corruption intended to oppose, jeopardize or prevent undesired basic experiments for personal gains in money, power and prestige. Very unfortunately for society, physics is nowadays done via academic power. Since the abused institution was credible, the dismissal was accepted rather widely by naive followers, and the suppression of the pre-meditated experiment was fully successful.[54]

[54]Since they lack technical arguments, corrupt academicians retort to all sort of nonscientific and tangential "arguments" to prevent the conduction of undesired basic experiments. Another objection was that "the tests are not warranted because Santilli did not work then out in all the necessary experimental details." The corrupt character of the "objection" is soon identified by recalling, for instance, that the discovery of the Ω^- was done by *experiments worked out in their technological details by experimentalists* following the *purely theoretical* prediction via $SU(3)$ symmetries. The evident reason for this evident disparity is that the latter test was fuly aligned with Einsteinian theories while the former are not. Another "objection" voiced by another "physicist" is that "the experiments have no sense because Santilli believes that quasars have atmospheres." The "objection" originated from a mistake by the author in Ref. [6a] of using, in one passage, the word "atmosphere" in lieu of "chromosphere," and this was reason for the successful suppression of the tests. The author spares the reader the report of additional "objections" because their very reading is demeaning for what is supposed to be a serious scientific process.

We close this section with the following fifth fundamental tests that are mandatory for any basic advance in hadron physics, while additional tests will be reviewed and "requested" in the remaining parts of this volume.

REQUESTED EXPERIMENT 5: Achieve final experimental resolution of the behavior of the meanlives of unstable hadrons with speed.

The need to conduct this fifth experiment, and the necessity of its conduction under an external Ethics Committee, are presented and documented in Appendix 6.1.A.

It is hoped that physics laboratories will conduct the much needed *basic* tests under the strict supervision of external Ethics Committees so as to prevent their otherwise inevitable conduction under judicial injunctions due to misuse of public funds, discriminatory practices, and other violations of Federal Laws that are inherent in the current use of public funds for generally very expensive experiments based on essentially unsettled foundations.

TO BE COMPLETED WITH ADDITIONAL TRESTS

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Chapter 7

EXPERIMENTAL VERIFICATIONS AND APPLICATIONS IN NUCLEAR PHYSICS

7.1 IN PREPARATION - NOVEMBER 1, 2005

For a summary of the content of this chapter, consult

The Physics of New Clean Energies and Fuels According to Hadronic Mechanics, R. M. Santilli, Special issue of the Journal of New Energy, 318 pages (1998).

Foundations of Hadronic Chemistry with Applications to New Clean Energies and Fuels, R. M. santilli, Kluwer Academic Publishers, Boston-Dordrecht-London (2001).

Isodual Theory of Antimatter with Applications to Antigravity, Grand Unification and Cosmology, R. M. Santilli, Sprionger (in press)

Chapter 8

EXPERIMENTAL VERIFICATIONS AND APPLICATIONS IN SUPERCONDUCTIVITY

8.1 Introduction

An understanding of hadronic mechanics requires the knowledge that the new discipline and its underlying new mathematics are applicable in fields beyond particle physics, nuclear physics, and astrophysics. Another field of applicability of hadronic mechanics is superconductivity.

There is no doubt that quantum mechanics provides a good description of an *ensembles* of *Cooper (or electron) pairs* in superconductivity (see, e.g., Ref. [1]), when necessarily represented as points in oder to prevent major conflicts with the basic axioms of the theory. However, there is equally no scientific doubt that quantum mechanics cannot possibly represent the *structure of one isolated Cooper pair.*

The Cooper pair is a physical system requiring an *attractive* interaction among two *identical* electrons via the intermediate action of Cuprate ions, and the bond-correlation of the two electron is so "strong" that cooper pairs can even tunnel as a single particle according to clear experimental evidence.

But electrons repel each other according to quantum mechanics. therefore, to achieve an understanding of the bond-correlation, a conjecture was submitted according to which there is a new interaction between the two electrons mediated by a hypothetical particle called "phonon."

However, phonons represent elementary heat excitations-oscillations in a *crystal.* Consequently, it is difficult to understand how phonons can be propagated in vacuum from atom to atom in the fixed lattice of a crystal. Even assuming that this is possible, it is difficult to understand how phonons can create an *attraction* between pairs of identical electrons.

In any case, considered *ad litteram,* phonons are sound waves or at best, vibrations of the superconducting medium, in which case, again, it is evidently

difficult to understand how such vibrations could propagate in vacuum and, in case this can be explained, how could they produce a real attraction between identical electrons.

Also, the 20-th century physics has identified all possible particles. Yet, this branch of physics has no evidence of phonons, as well as of the interactions electron-phonon.

The Cooper pair (CP) is an excellent physical system to test the effectiveness of isotopic methods at large. Comprehensive studies along these lines have been conducted by A. O. E. Animalu [2] who has introduced a nonlinear, nonlocal, and non-Hamiltonian realization of hadronic mechanics for the Cooper pair known as *Animalu's isosuperconductivity* that is in remarkable agreement with experimental data, and possesses intriguing and novel predictive capacities.

8.2 Animalu's Hadronic Superconductivity and its Experimental Verification

The birth of Animalu's Hadronic Superconductivity, or *isosuperconductivity* for short can be traced back to the structure model of the π^o meson submitted by Santilli in the original proposal to build hadronic mechanics (Ref. [3], Sect. 5)

$$\pi^0 = (\hat{e}^+_\uparrow, \hat{e}^-_\downarrow)_{\rm HM}, \tag{8.1}$$

where HM stands for hadronic mechanics, and $\hat{e}^-$ represents the *isoelectron*, that is, the ordinary electron when described via the isomechanics and related Galilei-Santilli isosymmetry for nonrelativistic description or the Poincaré-santilli isosymmetry for relativistic treatments. For brevity, in this chapter we study only the nonrelativistic profile, and refer to the quoted literature for the relativistic extension.

As familiar from Chapter 6, model (8.1) is based on the property that the nonlocal-nonpotential interactions due to deep wave-overlapping results in being strongly attractive for singlet coupling (only) irrespective of whether the Coulomb interaction is attractive or repulsive.

Isosuperconductivity is based on the *isoelectron pairs* (IEP) proposed by Animalu [2] and studied in details by Animalu and Santilli [3] at the 1995 Sanibel Symposium held in Florida that can represented with the symbol

$$\text{IEP} = (\hat{e}^-_\uparrow, \hat{e}^-_\downarrow)_{\rm HM}, \tag{8.2}$$

A main property of model (8.2) is that *the attractive force caused by deep waveoverlapping of isoelectrons in singlet coupling is so strong to overcome the Coulomb interactions even when repulsive,* thus permitting the extension from model (8.1) to (8.2).

The quantitative representation of the above property can be outline as follows. Consider one electron with charge $-e$, spin up $\uparrow$ and wavefunction $\psi_\uparrow$ in

the field of another electron with the same charge, spin down $\downarrow$ and wavefunction $\psi_\downarrow$ considered as *external*. Its Schrödinger equation is given by the familiar expression

$$H_{\text{Coul.}} \times \psi(t,r) = \left(\frac{1}{2m} p_k p^k + \frac{e^2}{r}\right) \times \psi_\uparrow(t,r) = E_0 \times \psi_\uparrow(t,r), \tag{8.3a}$$

$$p_k \times \psi_\uparrow(t,r) = -i \times \partial_k \psi_\uparrow(t,r), \tag{8.3b}$$

where m is the electron rest mass. The above equation and related wavefunction $\psi_\uparrow(t,r)$ represent *repulsion*, as well known. We are interested in the physical reality in which there is *attraction* represented by a new wavefunction here denoted $\hat{\psi}_\uparrow(t,r)$.

By recalling that quantum mechanical Coulomb interactions are invariant under unitary transforms, the map $\psi_\uparrow \to \hat{\psi}_\uparrow$ is representable by a transform $\hat{\psi} = U\psi$ which is *nonunitary*, $U \times U^\dagger = U^\dagger U = \mathcal{I} \neq I$, where $\mathcal{I}$ has to be determined (see below). This activates *ab initio* the applicability of hadronic mechanics as per Sect. 1.8. The first step of the proposed model is, therefore, that of transforming system (1.28) in $\psi_\uparrow$ into a new system in $\hat{\psi}_\uparrow = U \times \psi_\uparrow$ where U is nonunitary,

$$\begin{aligned} U \times H_{\text{Coulomb}} \times U^\dagger \times (U \times U^\dagger)^{-1} \times U \times \psi_\uparrow(t,r) = \\ = \hat{H}_{\text{Coulomb}} \times T \times \hat{\psi}_\uparrow(t,r) = \\ = \left(\tfrac{1}{2m} \hat{p}_k \times T \times \hat{p}^k + \tfrac{e^2}{r}\mathcal{I}\right) \times T \times \hat{\psi}_\uparrow(t,r) = E \times \hat{\psi}_\uparrow(t,r), \end{aligned} \tag{8.4a}$$

$$\hat{p}_k \times T \times \hat{\psi}_\uparrow(t,r) = -i \times T_k^i \times \partial_i \hat{\psi}_\uparrow(t,r). \tag{8.4b}$$

System (8.4) is incomplete because it misses the interaction with the Cu^{z+} ion represented by the familiar term $-ze^2/r$ [10]. The latter are not transformed (i.e., they are conventionally quantum mechanical) and, therefore, they should be merely added to the transformed equations (1.29). The formal equations of the proposed model $\text{CP} = (e_\uparrow^-, e_\downarrow^-)_{HM}$ are therefore given by

$$\begin{aligned} \left(\frac{1}{2m} \hat{p}_k \times T \times \hat{p}^k + \frac{e^2}{r} \times \mathcal{I} - z\frac{e^2}{r}\right) \times T \times \hat{\psi}_\uparrow(t,r) = \\ = \frac{1}{2m} \hat{p}_k \times T \times \hat{p}^k \times T \times \hat{\psi}_\uparrow + \frac{e^2}{r}\hat{\psi}_\uparrow - z\frac{e^2}{r} \times T \times \hat{\psi}_\uparrow(t,r) = \\ = E \times \hat{\psi}_\uparrow(t,r), \quad \hat{p}_k \times T \times \hat{\psi}_\uparrow(t,r) = -i \times T_k^i \times \partial_i \hat{\psi}_\uparrow(t,r). \end{aligned} \tag{8.5}$$

In order to achieve a form of the model confrontable with experimental data, we need an explicit expression of the isounit $\mathcal{I}$. Among various possibilities, Animalu [10] selected the simplest possible isounit for the problem at hand, which we write

$$\begin{aligned} \mathcal{I} &= e^{-\langle \hat{\psi}_\uparrow | \hat{\psi}_\downarrow \rangle \psi_\uparrow / \hat{\psi}_\uparrow} \approx 1 - \langle \hat{\psi}_\uparrow | \hat{\psi}_\downarrow \rangle \psi_\uparrow / \hat{\psi}_\uparrow + \ldots, \\ \mathcal{T} &= e^{+\langle \hat{\psi}_\uparrow | \hat{\psi}_\downarrow \rangle \psi_\uparrow / \hat{\psi}_\uparrow} \approx 1 + \langle \hat{\psi}_\uparrow | \hat{\psi}_\downarrow \rangle \psi_\uparrow / \hat{\psi}_\uparrow + \ldots, \end{aligned} \tag{8.6}$$

under which Eqs. (8.5) can be written

$$\frac{1}{2m}\hat{p}_k T \hat{p}^k T \hat{\psi}_\uparrow - (z-1)\frac{e^2}{r}\hat{\psi}_\uparrow - \tag{8.7}$$

$$-z\frac{e^2}{r}\langle\hat{\psi}_\uparrow|\hat{\psi}_\downarrow\rangle(\psi_\uparrow/\hat{\psi}_\uparrow)\hat{\psi}_\uparrow(t,r) = E\hat{\psi}_\uparrow.$$

Now, it is well known from quantum mechanics that the radial part of $\psi_\uparrow$ in the ground state ($L=0$) behaves as

$$\psi_\uparrow(r) \approx Ae^{-r/R}, \tag{8.8}$$

where A is (approximately) constant and R is the coherence length of the pair. The radial solution for $\hat{\psi}_\uparrow$ also in the ground state is known from Eqs. (5.1.21), p. 837, Ref. [3] to behave as

$$\hat{\psi}_\uparrow \approx B\frac{1-e^{-r/R}}{r}, \tag{8.9}$$

where B is also approximately a constant. The last term in the l.h.s. of Eq. (8.9) behaves like a *Hulten potential*

$$V_0 \times \frac{e^{-r/R}}{1-e^{-r/R}}, \quad V_0 = e^2\langle\hat{\psi}_\uparrow|\hat{\psi}_\downarrow\rangle. \tag{8.10}$$

After substituting the expression for the isomomentum, the radial isoschrödinger equation can be written

$$\left(-\frac{\mathcal{I}}{2\times\hat{m}}r^2\frac{d}{dr}r^2\frac{d}{dr} - (z-1)\frac{e^2}{r} - V_0\frac{e^{-r/R}}{1-e^{-r/R}}\right)\times\hat{\psi}_\uparrow(r) = E\times\hat{\psi}_\uparrow(r), \tag{8.11}$$

where $\hat{m}$ is the isorenormalized mass of the isoelectron.

The solution of the above equation is known from Ref. [5e], Sect. 5.1. The Hulten potential behaves at small distances like the Coulomb potential,

$$V_{\text{Hulten}} = V_0 \times \frac{e^{-r/R}}{1-e^{-r/R}} \approx V_0 \times \frac{R}{r}. \tag{1.37}$$

At distances smaller than the coherent length of the pair, Eq. (1.36) can therefore be effectively reduced to the form

$$\left(-\frac{1}{2\times\hat{m}}r^2\frac{d}{dr}r^2\frac{d}{dr} - V\frac{e^{-r/R}}{1-e^{-r/R}}\right)\times\hat{\psi}_\uparrow(r) = E\times\hat{\psi}_\uparrow(r), \tag{8.12a}$$

$$V = V_0 \times R + (z-1)\times e^2, \tag{1.38b}$$

with general solution, boundary condition and related spectrum (see Ref. [3], pp. 837-838)

$$\hat{\psi}_{\uparrow}(r) = {}_2F_1(2\times\alpha+1+n, 1-\alpha, 2\times\alpha+1, e^{-r/R})e^{-\alpha\times r/R}\frac{1-e^{-r/R}}{r}, \qquad (1.39a)$$

$$\alpha = (\beta^2 - n^2)/2n > 0, \quad \beta^2 = \hat{m}\times V\times R^2/\hbar^2 > n^2, \qquad (8.12b)$$

$$E = -\frac{\hbar^2}{4\times\hat{m}\times R^2}\left(\frac{\hat{m}\times V\times R^2}{\hbar^2}\frac{1}{n} - n\right)^2, \quad n = 1, 2, 3, \ldots \qquad (8.12c)$$

where we have reinstated $\hbar$ for clarity.

Santilli [3] identified the numerical solution of Eqs. (8.12) for the hadronic model $\pi^0 = (\hat{e}^+_{\uparrow}, \hat{e}^-_{\downarrow})_{\rm HM}$ (in which there is evidently no contribution from the Cuprate ions to the constant V), by introducing the parameters

$$k_1 = \hbar/2\times\hat{m}\times R\times c_0, \quad k_2 = \hat{m}\times V\times R^2/\hbar, \qquad (8.13)$$

where c_0 is the speed of light in vacuum. Then,

$$V = 2\times k_1\times k_2^2\times\hbar\times c_0/R, \qquad (8.14)$$

and the total energy of the state $\pi^0 = (e^+_{\uparrow}, e^-_{\downarrow})_{\rm HM}$ becomes in the ground state (which occurs for $n = 1$ for the Hulten potential)

$$\begin{aligned} E_{{\rm tot},\pi^0} &= 2\times k_1\times[1-(k_2-1)^2/4]\times\hbar\times c_0/R = \\ &= 2\times k_1(1-\varepsilon^2)\times\hbar\times c_0/R. \end{aligned} \qquad (8.15)$$

The use of the total energy of the π^0 (135 MeV), its charge radius ($R\approx 10^{-13}$ cm) and its meanlife ($\tau\approx 10^{-16}$ sec), then yields the values (Eqs. (5.1.33), p. 840, Ref. [3])

$$k_1 = 0.34, \quad \varepsilon = 4.27\times 10^{-2}, \qquad (8.16a)$$

$$k_2 = 1 + 8.54\times 10^{-2} > 1. \qquad (8.16b)$$

Animalu [10a] identified the solution of Eqs. (1.39) for the Cooper pair by introducing the parameters

$$k_1 = \varepsilon\times F\times R/\hbar\times c_0, \quad k_2 = KR/\varepsilon_{\rm F}, \qquad (8.17)$$

where $\varepsilon_{\rm F}$ is the iso-Fermi energy of the isoelectron (that for hadronic mechanics).

The total energy of the Cooper pair in the ground state is then given by

$$E_{\rm Tot,\ Cooper\ pair} = 2\times k_1\times[1-(k_2-1)^2/4]\times\hbar\times c_0/R \approx k_2\times T_c/\theta_{\rm D}, \qquad (8.18)$$

where $\theta_{\rm D}$ is the Debye temperature.

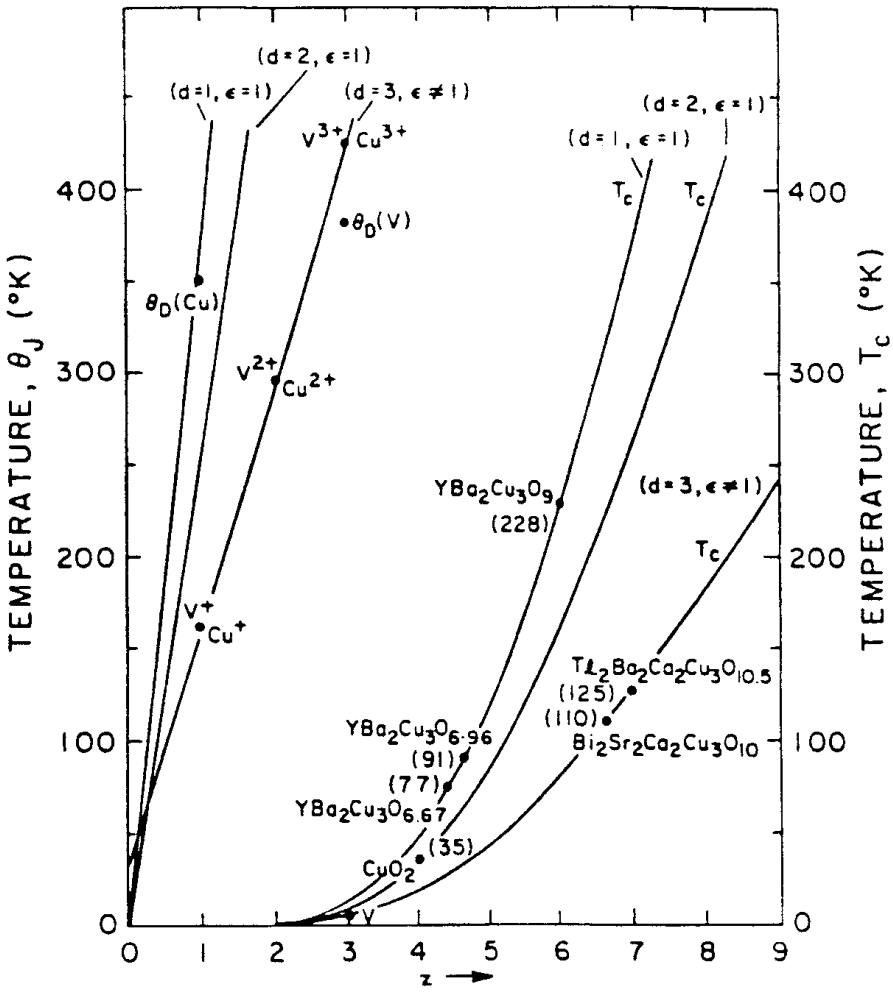

Figure 8.1. A reproduction of Fig. 10 of Ref. [10a] illustrating the remarkable agreement between the predicted dependence of T_c from the effective valence z of ions (continuous curve) and the experimental values on the "jellium temperature" for various compounds (solid dots).

Several numerical examples were considered in Refs. [2]. The use of experimental data for aluminum,

$$\theta_{\rm D} = 428^0 K, \quad \varepsilon_{\rm F} = 11.6{\rm C}, \quad T_c = 1.18^0 K, \tag{8.19}$$

yields the values

$$k_1 = 94, \quad k_2 = 1.6 \times 10^{-3} < 1. \tag{8.20}$$

For the case of $YBa_2Cu_3O_{6-\chi}$ the model yields [*loc. cit.*]

$$k_1 = 1.3z^{-1/2} \times 10^{-4}, \quad k_2 = 1.0 \times z^{1/2}, \tag{8.21}$$

where the effective valence $z = 2(7 - \chi)/3$ varies from a minimum of $z = 4.66$ for $YBa_2Cu_3O_{6.96}$ ($T_c = 91^0 K$) to a maximum of $z = 4.33$ for $YBa_2Cu_3O_{6.5}$ ($T_c = 20^0 K$). The general expression predicted by hadronic mechanics for $YBa_2Cu_3O_{6-\chi}$ is given by (Eq. (5.15), p. 373, Ref. [10a])

$$T_c = 367.3 \times z \times e^{-13.6/z}, \tag{8.22}$$

and it is in remarkable agreement with experimental data (see Figs. 1.21–1.23).

A few comments are now in order. The above Animalu-Santilli model of the Cooper pair is indeed nonlinear, nonlocal and nonpotential. In fact, the nonlinearity in $\hat{\psi}_\uparrow$ is expressed by the presence of such a quantity in Eqs. (1.31). The nonlocality is expressed by the term $\langle\hat{\psi}_\uparrow|\hat{\psi}_\downarrow\rangle$ representing the overlapping of the wavepackets of the electrons, and the nonpotentiality is expressed by the presence of interactions, those characterized by the isounit, which are outside the representational capabilities of the Hamiltonian H. This illustrates the necessity of using hadronic mechanics or other similar nonhamiltonian theories (provided that they are physically consistent), because of the strictly linear-local-potential character of quantum mechanics.

Note that, whenever the wave-overlapping is no longer appreciable, i.e., for $\langle\hat{\psi}_\uparrow|\hat{\psi}_\downarrow\rangle = 0$, $\mathcal{I} \equiv I$, quantum mechanics is recovered identically as a particular case, although without attraction.

The mechanism of the creation of the *attraction* among the *identical* electrons of the pair via the intermediate action of Cuprate ions is a general law of hadronic mechanics according to which *nonlinear-nonlocal-nonhamiltonian interactions due to wave-overlappings at short distances are always attractive in singlet couplings and such to absorb Coulomb interactions, resulting in total attractive interactions irrespective of whether the Coulomb contribution is attractive or repulsive*. As noted earlier, the Hulten potential is known to behave as the Coulomb one at small distances and, therefore, the former absorbs the latter.

Alternatively, we can say that within the coherent length of the Cooper pair, the Hulten interaction is stronger than the Coulomb force. This results in the overall attraction. Thus, the similarities between the model for the π^0 and that for the Cooper pair are remarkable. The applicability of the same model for other aspects should then be expected, such as for a deeper understanding of the valence, and will be studied in the next chapters.

Another main feature of the model is characterized also by a general law of hadronic mechanics, that *bound state of particles due to wave-overlappings at short distances in singlet states suppress the atomic spectrum of energy down to only one possible level*. The Hulten potential is known to admit a *finite* number

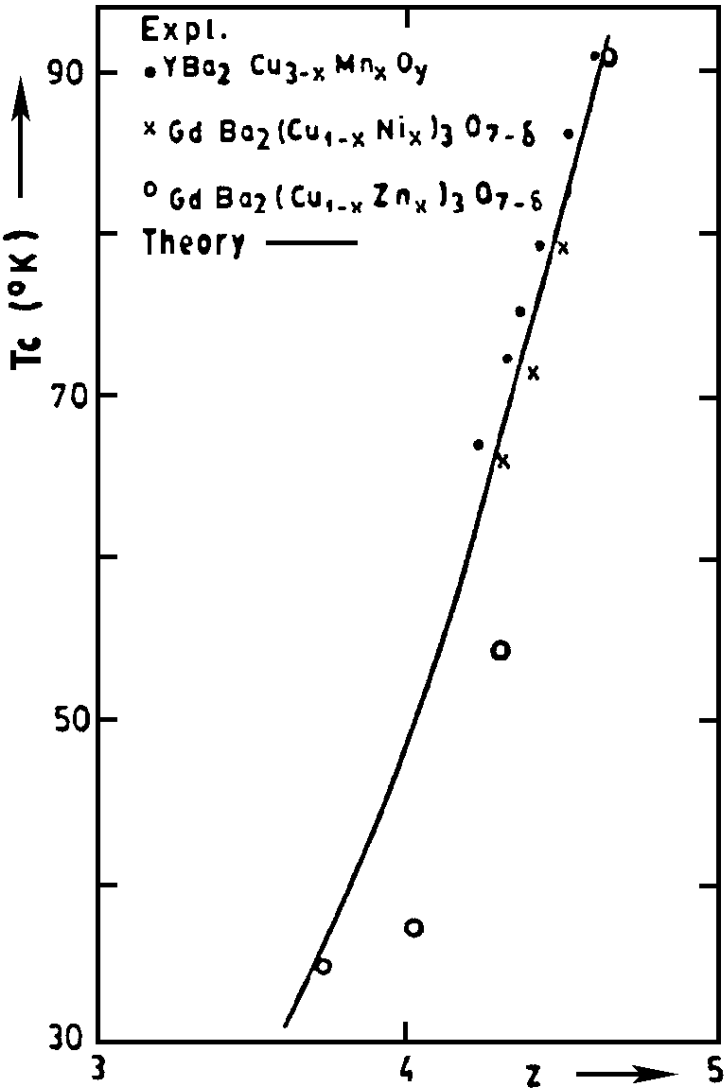

Figure 8.2. A reproduction of Fig. 5, p. 380 of Ref. [10a] showing the agreement between the prediction of isosuperconductivity for the doped 1:2:3 Cuprates and the experimental data.

of energy levels. Santilli's [5e] solution for the π^0 shows the suppression of the energy spectrum of the positronium down to only one energy level, 135 MeV of the π^0 for $k_2 > 1$. Similarly, the solutions for the Cooper pair [10] also reduce the same finite spectrum down to only one admissible level.

Table 1. $YBa_2Cu_{3-x}Mn_xO_y$
(After N.L. Saini *et al.*, Int. J. Mod. Phys. B6, 3515 (1992)

x	y	z	T_c (theory)	T_c (expt.)
0.00	6.92	4.613	88.9	91
0.03	6.88	4.541	83.5	86.6
0.09	6.87	4.447	76.7	79.0
0.15	6.91	4.387	72.6	75.0
0.21	6.92	4.312	67.6	72.0
0.30	6.95	4.212	61.3	67.0

Note: T_c (theory) $= 367.3z\exp(-13.6/z)$, where the effect of replacing Cu_3 by $Cu_{3-x}Mn_x$ is obtained by replacing 3 by $(3-x)+2x = 3+x$, which lowers the effective valence (z) on Cu^{2+} ions to $z = 2y/(3+x)$.

Table 2. $GdBa_2(Cu_{1-x}Ni_x)_3O_{7-\delta}$
(After, Chin Lin *et al.*, Phys. Rev. B42, 2554 (1990))

x	$y = 7-\delta$	z	T_c (theory)	T_c (expt.)
0.000	6.96	4.640	91.0	91
0.025	6.96	4.527	82.4	79
0.050	6.96	4.419	74.8	71
0.075	6.96	4.316	67.9	65

Note: T_c (theory) $= 367.3z\exp(-13.6/z)$, $z = 2y/3(1+x)$ as discussed in Table 1.

Table 3. $GdBa_2(Cu_{1-x}Zn_x)_3O_{7-\delta}$
(After, Chin Lin *et al.*, Phys. Rev. B42, 2554 (1990))

x	$y = 7-\delta$	z	T_c (theory)	T_c (expt.)
0.000	6.96	4.640	91.0	91
0.025	6.96	4.309	67.4	54
0.050	6.96	4.009	49.0	37
0.075	6.96	3.737	36.1	35

Figure 8.3. A reproduction of the tables of p. 379, Ref. [10a] illustrating the agreement between the predictions of the model with experimental data from other profiles.

Excited states are indeed admitted, but they imply large distances R for which nonlinear-nonlocal-nonhamiltonian interactions are ignorable. This implies that all excited states are conventionally quantum mechanical, that is, they *do not* represent the π^0 or the Cooper pair. Said excited states represent instead the discrete spectrum of the ordinary positronium, or the continuous spectrum of repulsive Coulomb interactions among the two identical electrons.

Alternatively, we can say that, in addition to the conventional, quantum mechanical, Coulomb interactions among two electrons, there is *only one additional system* of hadronic type with *only one energy level* per each couple of particles, one for $\pi^0 = (e^+_\uparrow, e^-_\downarrow)_{\rm HM}$ and the other for the Cooper pair, $\rm CP = (e^-_\uparrow, e^-_\downarrow)_{\rm HM}$.

The case of possible triplet couplings also follows a general law of hadronic mechanics. While singlets and triplets are equally admitted in quantum mechanics (read, coupling of particles at large mutual distances under their point-like approximation), this is no longer the case for hadronic mechanics (read, couplings

of particles when represented as being extended and at mutual distances smaller than their wavepackets/wavelengths). In fact, *all triplet couplings of particles under nonlinear-nonlocal-nonhamiltonian interactions are highly unstable, the only stable states being the singlets.*

This law was first derived in Ref. [5e] via the "gear model", i.e., the illustration via ordinary mechanical gears which experience a highly repulsive force in triplet couplings, while they can be coupled in a stable way only in singlets. The possibility of applying the model to a deeper understanding of Pauli's exclusion principle is then consequential, and will be studied in Chapters 4 and 5.

The connection between the proposed model and the conventional theory of the Cooper pair is intriguing. The constant in the Hulten potential can be written

$$V_0 = \hbar\omega, \tag{8.23}$$

where ω is precisely the (average) *phonon frequency.* The total energy can then be rewritten

$$E_{Tot} = 2 \times \varepsilon_{\rm F} - E \approx 2 \times k_1 \times k_2 \times \hbar \times c_0/R(e^{1/N\times V} - 1), \tag{8.24}$$

where $N \times V$ is the (dimensionless) *electron-phonon coupling constant.*

In summary, a main result of studies [2] is that *the conventional representation of the Cooper pair via a mysterious "phonon" can be reformulated without any need of such a hypothetical particle, resulting in a real, sufficiently strong attraction between the identical electrons, that is absent in the phonon theory.*

The above model of the Cooper pair see its true formulation at the relativistic level because it provides a *geometrization* of the Cooper pair, better possibilities for novel predictions and the best possible experiments tests. These profiles [10] will not be reviewed for brevity.

8.3 Novel Predictions of Animalu's Hadronic Superconductivity

As indicated in Section 1.2, besides the inability to achieve any understanding of the Cooper pair, anotehr major insufficiency of quantum mechanics is superconductivity is the well known exhaustion of all predictive capacities for the main objective of the theory, the achievement of superconductive capacity at ambient temperature.

Besides the achievement of a quantitative representation of the structure of the Cooper pair, one of the most important features of hadronic mechanics in superconductivity is precisely its capability of permitting *new* predictions.

One of them is a realistic possibility of achieving a form of superconductivity at ambient temperature that can be outlined as follows. Recall that the electric resistance originates from the interactions between the electric and magnetic fields of the electrons and those of atomic electron clouds (see Figure 8.4). Particular

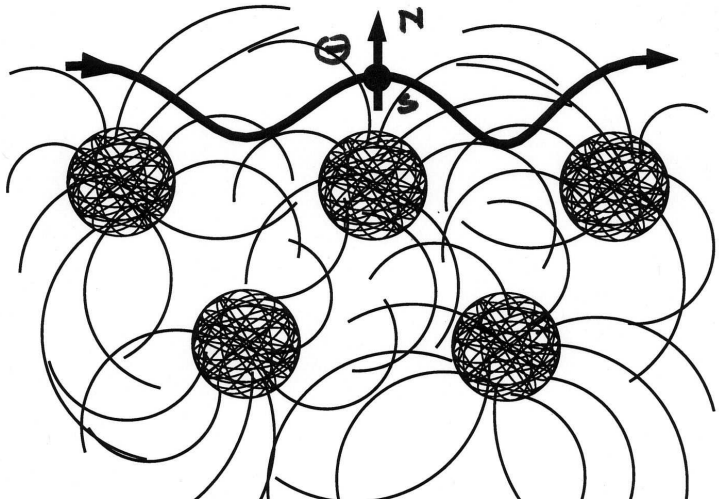

Figure 8.4. A schematic view of a conventional electric current, here represented with one electron (top view), moving in the surface of an ordinary conductor (lower view), illustrating the origin of the electric resistance due to interactions of both electric and magnetic type with the electromagnetic fields of the atoms of the conductor.

"obstructions" against the flow of electrons in conductors (thus causing resistance) originates from the interaction of the intrinsic magnetic field of electrons and the atomic electron cloud of the conductor.

The achievement of a quantitative understanding of the Cooper pair then permits the prediction and quantitative treatment of a *new electric current characterized by a flow through ordinary conductors of isoelectron pairs, rather than individual electrons,* as illustrated in Figure 8.4.

In fact, the total magnetic moment of the isoelectron pair can be considered as being null at interatomic distances, thus implying a dramatic decrease of the electric resistance, due to the reduction of the interactions between the current and the conductor to the sole Coulomb interactions.

Moreover, hadronic mechanics can assist in the creation of such a new current via the removal under sufficiently intense external electric fields of "valence pairs", rather individual electrons, from various substances (including plastic compounds and non-conducting materials), said substances being selected under the condition of having two unbonded valence electrons.

This is due to the fact that, as experimentally established in the helium, when not bonded into molecules, the electrons of a valence pair are not separated in an orbital but are generally coupled in singlet exactly along the structure of the isoelectron pair.

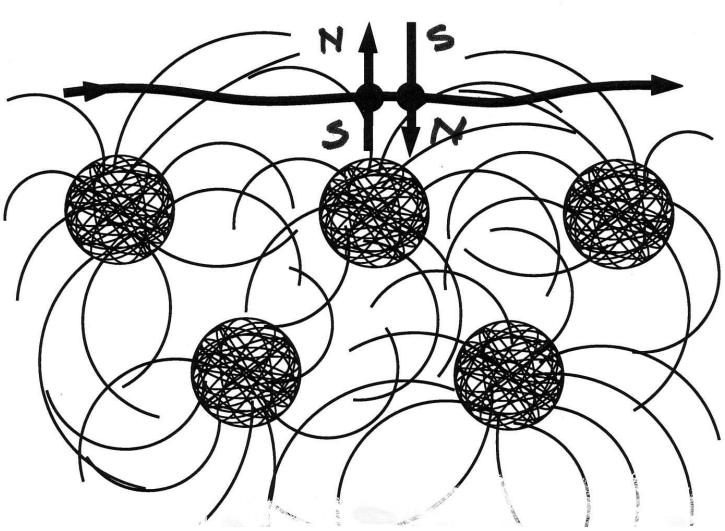

Figure 8.5. A schematic view of the new electric current predicted by hadronic superconductivity, consisting of the current of *electron pairs bonded in singlet,* in which case there is the absence of the magnetic field of the current constituents, with consequential reduction of the electric resistance.

A rather intense research to achieve superconductivity at ambient temperature is under way in corporate circles which research, unfortunately, is not generally available to academia due to its novelty, that is, the use of methods and theories generally opposed by organized interests in academia at this time. It is regrettably for scientific knowledge that this type of advanced corporate research cannot be reported in this monograph at this time.

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Chapter 9

EXPERIMENTAL VERIFICATIONS AND APPLICATIONS IN CHEMISTRY

9.1 ISOCHEMICAL MODEL OF THE HYDROGEN MOLECULE

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9.1.1 Introduction

Chemistry provides some of the most important experimental verifications and applications of hadronic mechanics in its version known as *hadronic chemistry* essentially consisting of the isotopic methods of Chapter 3 for chemical processes that are invariant under time reversal (*isochemistry*), the genotopic methods of Chapter 4 for irreversible processes (*genochemistry*), the multi-valued methods of Chapter 5 for biological structures (*hyperchemistry*), and their isoduals for the first known formulation of antimatter chemistry (*isodual iso-, geno- and hyperchemistry*). A comprehensive study of these formulations is presented in monograph [67]. This chapter is essentially dedicated to a review of the experimental verifications and scientific applications of isochemistry. Industrial applications of hadronic chemistry are presented in Chapters 11 and 12.

As an indication, in Sections 1.2 and 1.3 we showed that, following one century of failed attempts, quantum chemistry was unable to represent from unadulterated basic axioms a residual amount of 2% of molecular binding energies with electric and magnetic moments being wrong even in their signs, while the improvement of the representation via the so-called "screenings of the Coulomb law" causes the loss of the quantum of energy as well as other inconsistencies.

By comparison, in this chapter we show that *hadronic chemistry has permitted the first exact and invariant representation from first principles of molecular binding energies and other molecular data without adulteration of the basic ax-*

ioms, while admitting as particular cases conventional screenings of the Coulomb law.

The studies presented in this chapter are devoted to the representation of molecular structures assumed as isolated from the rest of the universe, thus being invariant under time reversal. Consequently, unless otherwise stated, all studies of this chapter are based on *isochemistry.* various experimental verifications and applications of the broader *genochemistry* and *hyperchemistry* and their isoduals are under way by various scholars and they will be reported in their works.

As it is well known, the primary structural characteristics of *quantum chemistry* (see, e.g., Refs. [1]) are those of being:

1) *linear*, in the sense that eigenvalue equations depend on wavefunctions only to the first power;

2) *local-differential*, in the sense of acting among a finite number of isolated points; and

3) *potential*, in the sense that all acting forces are derivable from a potential energy.

Therefore, quantum chemistry is a *Hamiltonian theory*, i.e., models are completely characterized by the *sole* knowledge of the Hamiltonian operator, with a *unitary structure*, i.e., the time evolution verifies the unitarity conditions

$$U = e^{iH\times t}, \quad U \times U^\dagger = U^\dagger \times U = I, \quad H = H^\dagger, \tag{9.1.1}$$

when formulated on conventional Hilbert spaces over the conventional fields of complex numbers.

Despite outstanding achievements throughout the 20-th century, quantum chemistry cannot be considered as "final" because of numerous insufficiencies identified in Chapter 1.

A most important insufficiency is *the inability to represent deep mutual penetrations of the wavepackets of valence electrons in molecular bonds.* The latter interactions are known to be:

$\hat{1}$) *nonlinear*, i.e., dependent on powers of the wavefunctions greater than one;

$\hat{2}$) *nonlocal-integral*, i.e., dependent on integrals over the volume of overlapping, which, as such, cannot be reduced to a finite set of isolated points; and

$\hat{3}$) *nonpotential*, i.e., consisting of "contact" interactions with consequential "zero range," for which the notion of potential energy has no mathematical or physical sense.

A representation of the latter features evidently requires a *nonhamiltonian theory*, i.e., a theory which cannot be solely characterized by the Hamiltonian, and requires additional terms. It then follows that the emerging theory is *nonunitary* i.e., its time evolution verifies the law,

$$U \times U^\dagger = U^\dagger \times U \neq I, \tag{9.1.2}$$

when formulated on conventional Hilbert spaces over conventional fields.

It is evident that the above features are beyond any hope of scientific-quantitative treatment via quantum mechanics and chemistry.

In the preceding Chapter 3 we have submitted the foundations of a generalization covering of quantum chemistry under the name of *hadronic chemistry*, first submitted by Santilli and Shillady in Ref. [2], which is capable of providing an invariant representation of the above-mentioned nonlinear, nonlocal, nonpotential, nonhamiltonian, and nonunitary interactions in deep correlations of valence electrons.

In Chapter 3, we have also shown that the conventional "screenings" of the Coulomb potential (which are necessary for a better representation of experimental data) are outside the axiomatic structure of "quantum" chemistry because such screenings can only be reached via nonunitary maps of the Coulomb law, thus resulting in being particular cases of the broader hadronic chemistry.

The main purpose of this chapter is the application of hadronic chemistry to the construction of a new model of molecular bonds and its verification in the representation of experimental data of the hydrogen molecule.

Since molecular structures are considered as isolated, thus being closed, conservative, and reversible, the applicable branch of hadronic chemistry is *isochemistry*, which is characterized by the identification of the nonunitary time evolution with the *generalized unit* of the theory, called *isounit*,

$$U \times U^\dagger = \hat{I}(r, p, \psi, \partial\psi, ...) \neq I, \tag{9.1.3}$$

assumed hereon not to depend explicitly on time, and the reconstruction of the *totality* of the formalism of quantum chemistry into a new form admitting of $\hat{I}$, rather than I, as the correct right and left new unit.

The capability by the isounit to represent nonlinear, nonlocal, and nonhamiltonian interactions is evident. Its selection over other possible choices is mandated by the condition of *invariance*, that is, the prediction of the same numerical values for the same quantities under the same conditions, but at different times. In fact, whether generalized or not, the unit of any theory is the basic invariant.

A central assumption of this chapter is that *quantum mechanics and chemistry are exactly valid at all distances of the order of the Bohr radius* ($\simeq 10^{-8}$ *cm*), *and the covering hadronic chemistry only holds at distance of the order of the size of the wavepackets of valence electrons* (1 fm $= 10^{-13}$ cm).

This condition is evidently necessary, on one side, to admit the conventional quantum structure of the hydrogen atom, and, on the other side, to admit quantitative studies of the nonhamiltonian interactions of short range valence bonds.

The above condition is readily achieved by imposing that all isounits used in this chapter recover the conventional unit at distances greater than 1 fm,

$$\lim_{r \gg 1 \text{ fm}} \hat{I}(r, p, \psi, \partial\psi, \dots) = I, \tag{9.1.4a}$$

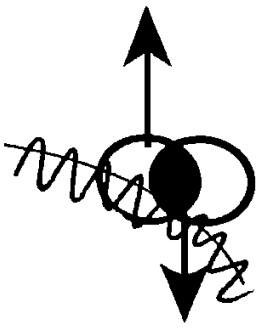

Figure 9.1. A schematic view of the central conditions studied in this chapter, the deep overlapping of the wavepackets of valence electrons in singlet coupling (to verify Pauli's exclusion principle). These conditions are known to be nonlinear, nonlocal, and nonpotential (due to the zero-range, contact character of the interactions), thus not being representable via a Hamiltonian, and, consequently, not being unitary. As a result, the ultimate nature of valence bonds is outside any credible representation via quantum chemistry. Hadronic chemistry (Chapter 3) has been built for the specific scope of representing the conditions herein considered of the bonding of valence electrons.

$$|\hat{I}| \ll 1, \quad |\hat{T}| \gg 1. \tag{9.1.4b}$$

In fact, under the above condition, hadronic chemistry recovers quantum chemistry everywhere identically. The reader should keep in mind the crucial implications of conditions (9.1.4b) which, as shown in Sect. 3.4, permit a dramatic increase of the convergence of chemical series, with corresponding decrease of computer time, as verified in the models of this chapter and of the following ones.

The reader should also note that, quite remarkably, rather than being imposed, both conditions (9.4a) and (9.4b) are naturally verified by actual chemical models.

It should be recalled that, under the assumption of representing closed-isolated systems, *isochemistry verifies all conventional laws and principles of quantum mechanics* (Chapter 3). Therefore, there is no *a priori* mean for rejecting the validity of hadronic chemistry within the small region of space of valence bonds.

It then follows that the selection of which theory is valid is referred to the capability to represent experimental data. Quantum mechanics has been capable of achieving an exact representation of all experimental data for the structure of *one individual* hydrogen atom. Therefore, quantum mechanics is here assumed as being exactly valid within such a well defined physical system, any possible improvement being redundant at best.

By comparison, quantum mechanics and chemistry have not been able to achieve an exact representation of the experimental data of the *different* conditions of molecular structures, as discussed in detail in Chapter 1. As a result,

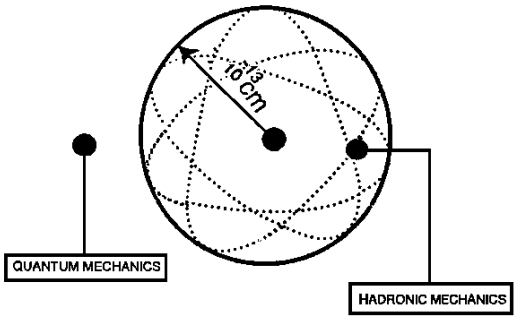

Figure 9.2. A schematic unit of the *hadronic horizon*, namely, of the sphere of radius 1 fm (= 10^{-13} cm) outside which quantum chemistry is assumed to be exactly valid, and inside which nonlinear, nonlocal, and nonpotential effects are no longer negligible, thus requesting the use of hadronic chemistry for their numerical and invariant treatment.

these theories are *not* considered as being exactly valid for the different conditions of molecular bonds (see Fig. 1.7).

As we shall see in this chapter, hadronic chemistry can indeed provide an exact representation of molecular characteristics, and, therefore, it is consider as being exactly valid for the indicated conditions of applicability.

A knowledge of *isomathematics* of Chapter 3 is essential for a technical understanding of the content of this chapter. A comprehemnsive presentation is available in monograph [67]

(see also representative papers [3, 4]).

For mathematically less inclined readers, we recall from Sect. 3.3.6 that specific applications of isochemistry can be constructed in their entirety via a simple nonunitary transform of conventional quantum chemical models. In fact such a transform adds precisely the desired short range, nonlinear, nonlocal, and nonhamiltonian effects.

9.1.2 Isochemical Model of Molecular Bonds

We now present the conceptual foundations of our *isochemical model of molecular bonds* for the simplest possible case of the H_2 molecule, which was first submitted by Santilli and Shillady in Ref. [5]. We shall then extend the model to the water and to other molecules in the subsequent chapter.

Since the nuclei of the two H-atoms remain at large mutual distances, the bond of the H_2 molecule is evidently due to the bond of the peripheral valence electrons, as generally acknowledged [1].

Our main assumption [5] is that *pairs of valence electrons from two different atoms can bond themselves at short distances into a singlet quasi-particle state*

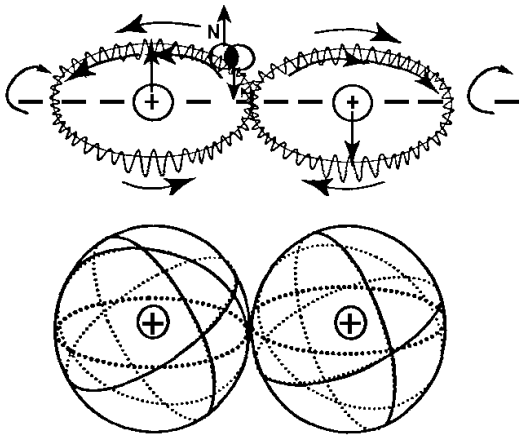

Figure 9.3. A schematic view of the proposed *isochemical model of the hydrogen molecule with fully stable isoelectronium*, where the top view refers to absolute zero degree temperature and in the absence of any motions, while the lower view includes rotations, thus recovering the conventional spherical distribution. The view is complementary to that of Fig. 9.7 for the unstable isoelectronium. The model is here depicted in terms of *orbits of the valence electrons*, rather than in terms of *orbitals, or density distributions*. The fundamental assumption is that the two valence electrons, one per each atom, correlate themselves into a bonded singlet state at short distance we have called *isoelectronium*, which is assumed in this figure to be stable. In this case the only orbit yielding a stable H-molecule is that in which the isoelectronium describes a *oo*-shaped orbit around the respective two nuclei, as it occurs for planets in certain systems of binary stars. The isoelectronium is then responsible for the *attractive force* between the two atoms. The *binding energy* is instead characterized by the *oo*-shaped orbit of the isoelectronium around the two nuclei, conceptually represented in this figure via a standing wave for a particle of spin 0, charge $-2e$, and null magnetic moment. As we shall see in this chapter, the model then permits a representation of: the reason why the H_2 and H_2O molecules have only two hydrogen atoms; the exact representation of the binding energy; the resolution of some of the inconsistencies of the conventional model; and other advances. Note finally that the model is easily extendable to dimers such as HO, HC, *etc.*, as studied in Chapter 3. The novelty in predictive character of the model can be seen from these preliminary lines. For instance, the model depicted in this figure predicts that *the hydrogen molecule becomes asymmetric, thus acquiring an infrared signature, under sufficient magnetic polarization, which removes its rotational motions.*

called "isoelectronium," which describes an oo-shaped orbit around the two nuclei similar to that of planets in binary star systems (Fig. 9.3).

It is important to note that recent studies in pure mathematics [39] have established that the *oo*-shaped orbit, called the *figure eight* solution, is one of the most stable solutions of the N-body problem.

The primary binding force of the isoelectronium is assumed to be of nonlinear, nonlocal, and nonpotential type due to contact effects in deep overlappings of the wavepackets of the valence electrons, as studied in Sect. 9.3.

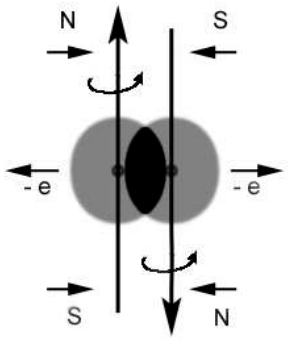

Figure 9.4. A schematic view of the conventional Coulomb forces of electrostatic and magnetostatic type in the structure of the isoelectronium. Since the charges are equal, they cause a *repulsion*. However, since the coupling is in singlet, the magnetic polarities are opposite, thus implying an *attraction*. Elementary calculations show that the magnetostatic attraction equals the electrostatic repulsion at a mutual distance of the order of 1 fm, while it becomes bigger at smaller distances, thus explaining the reason why the hadronic horizon has been set at 10^{-13} cm. This evidence establishes that the bonding force of the isoelectronium can also see its origin on purely Coulomb forces and, more particular, on the dominance of magnetic over electric effects at short distances, which is a rather general occurrence under the proper conditions (see the new chemical special of *magnecules* in Chapter 8). Despite this fully potential attractive total force, it should be stressed that the isoelectronium cannot be treated within a purely quantum mechanics context for various reasons. The first reason is that with the decrease of the distance, both electrostatic and magnetostatic effects diverge, thus preventing any serious scientific study. Hadronic mechanics and chemistry have been built precisely to remove these divergencies via the isotopies of generic products $A\hat{\times}B = A \times \hat{T} \times B$ with $|\hat{T}| \ll 1$ (Chapter 3). Therefore, the hadronic treatment of the isoelectronium permits convergent numerical predictions which would be otherwise impossible for quantum chemistry. Independently from that, the nonunitary lifting of quantum chemistry is mandated by the need to achieve an exact representation of experimental data on molecules which, as now established, requires screenings solely obtainable via nonunitary transforms of the Coulomb potential. Thus, any attempt to preserve old theories as exactly valid is doomed to failures. Despite that, the electrostatic and magnetostatic effects depicted in this figure illustrate that conventional potential effects should also be expected in the structure of the isoelectronium. In other words, rather than assuming either a purely quantum or a purely hadronic setting, we have *in media virtus*, i.e., the most plausible origin of the bonding force of the isoelectronium is that partially of potential and partially of nonpotential type. Still in turn, this implies the possibility of a significant (negative) binding energy for the isoelectronium, which is evidently that characterized by the potential component (Sect. 9.3).

However, the reader should be aware that the isoelectronium is expected to have a component of the binding force of purely potential type because, when the electrons are in singlet coupling, the magnetostatic *attraction* may be conceivably bigger than the electrostatic *repulsion* at distances of the order of one fermi or less (see Fig. 9.4 for details).

It should be stressed, however, that a purely potential origin of the isoelectronium is not expected to be exactly valid for various reasons, the most visible one being the fact that, at the very small mutual distances here considered, magnetostatic and electrostatic laws diverge, thus prohibiting reliable quantitative studies.

Hadronic chemistry has been built to resolve all divergences in the study of the isoelectronium thanks to the isomathematics with product $A\hat{\times}B = A \times \hat{T} \times B$, and the isotopic element $\hat{T}$ restricted to have absolute values much smaller than 1. In this way, the hadronic component of the isoelectronium binding force will "absorb" all divergent or otherwise repulsive effects, resulting in convergent numerical values.

The reader is also discouraged to reduce the isoelectronium to a purely quantum structure because, in this way, the theory would preserve all the insufficiencies of chemistry studied in Chapter 1, most importantly, the inability to reach an exact representation of molecular characteristics from the strict application of first quantum principles without *ad hoc* adulterations. In fact, as now well established, such an exact representation requires screenings of the Coulomb law, which can only be obtained via nonunitary transforms. The same nonunitary broadening of quantum chemistry is requested on numerous other counts independent from the isoelectronium.

Despite these limitations, the purely magnetostatic-electrostatic structure of the isoelectronium remains important *in first approximation*, because it recovers in a very simple way the hadronic horizon (Fig. 9.2), as well as the prediction by hadronic mechanics dating back to 1978 that triplet couplings are highly unstable. In fact, in the latter case, both electrostatic and magnetostatic forces would be *repulsive*, thus prohibiting any possible bound state, in beautiful agreement with Pauli's exclusion principle.

It is easy to predict that *the isoelectronium cannot be permanently stable when interpreted as a quasi-particle of about* 1 *fm charge diameter*. In fact, the mere presence of exchange forces, which remain fully admitted by isochemistry, prevents the achievement of a complete stability under the indicated small mutual distances of the electrons. As we shall see in more details in Chapter 6, there are additional technical reasons which prevent the complete stability at short distances, and actually render the isoelectronium a short lived quasi-particles when the valence electrons are assumed at mutual distances of 1 fm.

However, it is easy to see that *the isoelectronium must be fully stable when the mutual distance of the two valence electrons is permitted to be of the order of molecular size. In fact, any instability under the latter long range conditions would imply a necessary violation of the fundamental Pauli's exclusion principle.*

In different words, *the isoelectronium is one of the first known quantitative representations of Pauli's principle*, in the sense that:

1) When assumed to be of potential type, the interaction responsible for Pauli's principle implies catastrophic inconsistencies, such as shifts of experimentally established energy levels, deviations from all spectroscopic lines, etc. As a result, a quantitative representation of Pauli's principle is *impossible* for quantum mechanics, evidently due to its strictly potential character. For this reason, Pauli's principle is merely imposed in quantum mechanics without any explanations, as well known. By comparison, a quantitative representation is possible for hadronic mechanics precisely because of its admission of *nonpotential* interactions, that is, interactions which have no bearing on energy levels and spectroscopic lines.

2) Quantum mechanics admits, in general, both singlet and triplet couplings because particles are assumed to be point like as per the very topological structure of the theory. By comparison, hadronic mechanics represents particles as expended at mutual distances smaller than their wavepackets, and solely admits singlet couplings due to highly repulsive-unstable forces predicted for all triplet couplings. The latter repulsive forces originate from the drag experienced by one wavepackets when rotating within and against the rotation of the other wavepacket, as well as by the fact that in triplet couplings both magnetostatic and electrostatic effects are repulsive (Fig. 9.4); and

3) Quantum mechanics cannot provide an exact representation of an *attraction* between *identical* electrons at very short distances, as discussed earlier, in disagreement with the experimental evidence, e.g., that the two electrons of the helium are bonded most of the time, to such an extent that they are emitted in such a bonded form during photodisintegrations, and in other events. By comparison, hadronic mechanics has been built to represent precisely the *bonding* of identical electrons in *singlet* coupling under interactions *not* derivable from a potential.

The assumption of the isoelectronium as being unstable when its valence electrons are at mutual distances of molecular order, implies a violation of Pauli's principle, e.g., because of the automatic admission of triplet couplings for two electrons at the same energy level.

When assumed as being stable in the limit case of a quasi-particle of 1 fm charge radius, *the most stable trajectory of the isoelectronium is of oo-type, each o-branch occurring around each nucleus* (Fig. 9.3). As illustrated in Fig. 9.4 (see also Chapter 8), such a shape automatically prevents the inconsistent prediction of ferromagnetic character of all molecules.

When the correlation-bond is distributed over the entire molecular orbit, *the trajectory of the isoelectronium is also expected to be oo-shaped around the two nuclei with inverted direction of rotation from one o-branch to the other*. This is suggested by a variety of reasons, such as: the need of avoiding the inconsistent prediction of ferromagnetic character, the compatibility with the limit case of a

fully stable particle at short distance (which, as we shall see, can describe several *oo*-shaped orbits prior to separation), and others.

It should be indicated that the assumption of a finite lifetime of the isoelectronium irrespective of size implies the possibility of adding several H-atoms to the H_2 molecule for the duration of the unbound valence electrons, as well as other inconsistencies, such as the capability by hydrogen and water to be paramagnetic (Chapter 8).

In this chapter, we apply the above hypothesis to the construction of a new model of the hydrogen molecule and prove its capability to:

1) provide an essentially exact representation of the binding energy and other characteristics of the hydrogen molecules;

2) said representation occurs from first axiomatic principles without exiting from the underlying class of equivalence as occurring for Coulomb screenings;

3) explain for the first time to our knowledge the reason why the hydrogen molecule has only two atoms;

4) introduce an actual "strongly" attractive molecular bond;

5) achieve a much faster convergence of power series with consequential large reduction in computer times;

6) prevent inconsistencies such as the prediction that the hydrogen is ferromagnetic. In fact, whatever magnetic polarity can be acquired by the orbit around one nucleus, the corresponding polarity around the second nucleus will necessarily be opposite, due to the opposite direction of the rotations in the two *o*-branches, thus preventing the acquisition of a net total polarity North-South of the molecule.

By recalling from Chapter 3 that Gaussian screenings of the Coulomb law are a particular case of the general nonunitary structure of hadronic chemistry, one can see from these introductory lines that our first achievement on scientific records of an essentially exact representation of molecular characteristics is reduced to the proper selection of the basic nonunitary transform, because the latter will permit dramatically more restrictive screenings.

The derivability of the essentially exact representation from first axioms of hadronic chemistry without adulterations is evident.

Equally evident is the first introduction of an actual, "strongly" attractive interatomic force (where the word "strongly" does not evidently refer to strong interactions in hadron physics), which is absent in current models due to the notorious "weak" nature of exchange and other forces of current used in molecular structures (where the word "weak" does not evidently refer to the weak interactions among leptons).

The representation of the reason why the hydrogen (or water) molecule has only two H-atoms is inherent in the very conception of the isoelectronium. Once the two valence electrons of the H-atoms couple themselves into a singlet quasi-

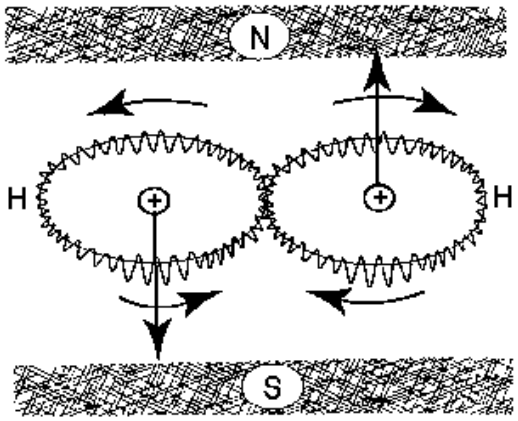

Figure 9.5. A schematic view of the impossibility for the isochemical model of the hydrogen molecule to acquire a net magnetic polarity, thus resolving a serious inconsistency of quantum chemistry. Recall from Chapter 1 that current molecular models are based on exchange, van der Waals, and other forces of nuclear origin, all implying the independence of the orbitals of the individual atoms. Under these assumptions, quantum electrodynamics demands that all molecules acquire a net total magnetic polarity North-South when exposed to an external magnetic field, in dramatic disagreement with reality. The isochemical model of molecular structure resolves this inconsistency because, as indicated in Fig. 4.3, the most stable trajectory for the isoelectronium is *oo*-shaped as it also occurs for the trajectory of planets in binary stars, with each *o*-branch around each nucleus. In this case, the rotation of the two *o*-branches are necessarily opposite to each other, thus resulting in *opposite* magnetic polarities, with the consequential impossibility to reach a *net* molecular magnetic polarity. As we shall see in Chapter 7, the above features have important industrial applications for new clean fuels and energies.

particle state, there is no possibility for a third valence electron to participate in the bound state, e.g., because we would have an impossible bound state between a fermion (the third electron) and a boson (the isoelectronium).

The achievement of a much faster convergence of the power series, or, equivalently, a dramatic reduction of computer times for the same calculations, is evident from the structure of hadronic chemistry as discussed in Chapter 3.

The avoidance of the prediction of ferromagnetic features (acquisition of a total North-South polarity under an external magnetic field) is due to the nature of the orbit of the isoelectronium, as discussed in details below and in Chapter 8.

In this chapter, we shall study two realizations of the proposed new model of the hydrogen molecule, the first model is a limiting case in which the isoelectronium is assumed to be *stable* (with an infinite lifetime) at ordinary conditions, and the second model in which the isoelectronium is assumed to be *unstable* (with a finite lifetime). The lifetime of the isoelectronium will then be computed in Chapter 6.

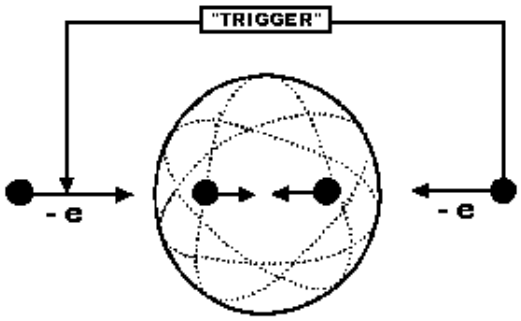

Figure 9.6. A schematic view of the *trigger*, namely, the external means suitable to force electrons with the same charge to penetrate the hadronic barrier (Fig. 9.2), in which attractive hadronic forces overcome the repulsive Coulomb barrier.

The hypothesis of the bonding of electrons at short distances was first introduced by Santilli [7a] for the structure of the π^0 meson as a hadronic bound state of one electron and one positron. Animalu [7b] and Animalu and Santilli [7c] extended the model to the Cooper pair in superconductivity as a hadronic bound state of two identical electrons.

A notion which is important for the very existence of the isoelectronium is that of a *trigger*, namely, *external (conventional) interactions, which cause the identical electrons to move one toward the other and to penetrate the hadronic horizon (Fig. 9.2) against their repulsive Coulomb interactions*. Once inside the above mentioned horizon, the attractive hadronic forces overcome the repulsive Coulomb interaction, resulting in a bound state.

In the case of the π^0 model as a bound state of an electron and a positron at short distances, there is no need for a trigger because the constituents naturally attract each other. On the contrary, the existence of the Cooper pair does indeed require a trigger, which was identified by Animalu [7b] and Animalu and Santilli [7c] as being provided by the Cuprate ions. For the case of an isolated hydrogen molecule, we conjecture that the trigger is constituted by the two H-nuclei, which do indeed attract the electrons. We essentially argue that the attraction of the electrons by the two nuclei is sufficient to cause the overlapping of the two wavepackets, thus triggering the electrons beyond the hadronic horizon.

It should be indicated that we cannot use the term "electronium" because it would imply a bound state of two identical electrons under *quantum* mechanics, which is known to be impossible. The term "electronium" would also be technically inappropriate because the constituents *are not* ordinary electrons, but rather "isoelectrons," i.e., the image of ordinary particles under *nonunitary* transforms

or, more technically, irreducible isounitary representations of the covering of the Poincarè symmetry known as the *Poincarè-Santilli isosymmetry* [3c, 3d, 4a].

We cannot close this conceptual section without a few comments regarding the possibility of treating the isoelectronium via *quantum electrodynamics* (QED), since the latter appears to be the natural discipline for a valence bond of two identical electrons at short distance. This issue is compounded by the general belief of the *unrestricted* exact validity of QED all the way to very small distances of the order of 10^{-24} cm.

It is easy to see that, as it is the case for quantum mechanics, a quantitative treatment of the isoelectronium is beyond the technical capabilities of QED for numerous conceptual and technical reasons. In fact, QED is purely linear, local and potential, while the interactions we are interested in representing are nonlinear, nonlocal and nonpotential.

In any case, it is easy to prove via the use of the Feynman diagrams that QED *cannot* represent any *attraction* between identical electrons in singlet coupling at short distance, as it occurs in the physical reality for the two electrons of the Helium, the Cooper pair, the valence electrons, and other systems. On the contrary, the *isotopies of quantum electrodynamics* (ISOQED) are expected to provide such a representation, but their study here would be vastly beyond the limited scope of this monograph.

The reconciliation between the current belief of the unrestricted exact validity of QED and the bonding of identical electrons is permitted by the fact that all experimental verifications of QED at shorter and shorter distances have been conducted via the use of *higher and higher energies*. On the contrary, the experimental verification of QED for the conditions of the isoelectronium require *smaller and smaller energies* which experimental verifications have been absent in the physics of the 20-th century due to the notorious emphasis on high energies.

As a final comment, it should be noted that the limitations of QED for the study of the isoelectronium are purely classical, and rest on *the inability of classical electrodynamics to represent the physical evidence of the attraction of identical spinning charges at sufficiently small distances, evidence which is even visible to the naked eyes, e.g., in ball lighting as created by nature, in microwave ovens or other means*.

As a matter of fact, no classical theory of electromagnetism can possibly be considered as "final" until it achieves the capability of representing the attraction of identical charges under suitable conditions. As a result, no quantum theory of electromagnetism, including QED, can be considered as "final" unless it is based on the preceding classical theory. One of the objectives of classical and operator isochemistry is precisely that of achieving such a missing representation.

9.1.3 The Limit Case of Stable Isoelectronium

We are now equipped to conduct a nonrelativistic study of the isoelectronium (Fig. 9.3) in the limit case of full stability under the assumption that the binding force is of purely hadronic type without potential contributions (Fig. 9.4). This approach is evidently done to test the effectiveness of hadronic chemistry for the numerical studies of the problem considered, since corrections due to potential effects can be easily added.

The reader should be aware upfront that *the above assumptions imply that the isoelectronium has no binding energy*, trivially, because nonpotential forces have no potential energy by conception.

The reader should be aware that the actual hadronic treatment should be conducted within the context of isomathematics, that is, on isoeuclidean and isohilbert spaces defined over isofields. To avoid excessive mathematical complexity, in this section we study the *projection* of this isotopic treatment on conventional spaces over conventional fields. However, it should be stressed that the only correct formulation remains the isotopic one.

As we shall see, the hadronic treatment of the isoelectronium yields an attraction of the type of the Hulten potential which is so strong to "absorb" at short distances all other forces, whether attractive or repulsive. However, the direct interpretation of the Hulten potential as an actual potential would be erroneous, since it solely occurs in the *projection* of the model on conventional spaces, while being completely absent in the technically appropriate treatment on isospaces over isofields. The direct interpretation of the Hulten potential as an actual potential well of quantum mechanical nature would also be in direct contradiction with the absence of binding energy.

Therefore, the assumption of the projected model as the correct one leads to insidious inconsistencies and misrepresentations, such as the possible interpretation of the isoelectronium via a potential well, which treatment is very familiar in quantum mechanics, but the same treatment has no physical meaning for the isoelectronium. This is due to the fact that, as stressed earlier, a necessary condition to avoid inconsistencies in the interpretation of Pauli's principle is that its interaction *does not* admit a potential energy, thus rendering meaningless, or at best contradictory, conventional potential wells.

Note that the emergence of a "strong" Hulten potential eliminates the issue whether the isoelectronium is due to the dominance of the attractive magnetostatic forces over the repulsive electric ones (Fig. 9.4). This is due to the fact that the Hulten potential, as we shall review shortly in detail, behaves at short distances as $constant/r$, thus absorbing all Coulomb forces, irrespective of whether attractive or not. Moreover, the unified treatment via the Hulten potential presented below eliminates the divergent character of these forces at short distances, thus permitting meaningful numerical results.

We should finally indicate, to avoid inconsistencies, that the study of this section deals with the *limit* case of *a perfectly stable isoelectronium interpreted as a quasi-particle of about 1 fm charge diameter*, while in reality such form of the isoelectronium is unstable. Moreover, in this section we shall not study the expectation that the isoelectronium persists beyond the 1 fm mutual distance of the valence electrons, as necessary to prevent violations of Pauli's principle.

We begin our quantitative analysis with the nonrelativistic quantum mechanical equation of two ordinary electrons in singlet couplings, $e^-_\downarrow$ and $e^-_\uparrow$ represented by the wavefunction $\psi_{\uparrow\downarrow}(r) = \psi(r)$,

$$\left(\frac{p \times p}{m} - \frac{e^2}{r}\right) \times \psi(r) = E \times \psi(r). \tag{9.1.5}$$

To transform this state into the isoelectronium representing the bonding of the H-electron with a valence electron of another atom of generic charge ze, we need first to submit Eq. (9.1.5) to a nonunitary transform characterizing the short range hadronic effects, and then we must add the *trigger*, namely, the Coulomb attraction by the nuclei.

This procedure yields the *isoschrödinger equation for the isoelectronium* (Chapter 1),

$$U \times U^\dagger = \hat{I} = 1/\hat{T} > 0, \tag{9.1.6a}$$

$$\hat{A} = U \times A \times U^\dagger, \quad A = p,\ H, \ldots, \tag{9.1.6b}$$

$$U \times (A \times B) \times U^\dagger = \hat{A}\hat{\times}\hat{B} = \hat{A} \times \hat{T} \times \hat{B}, \quad \hat{\psi} = U \times \psi, \tag{9.1.6c}$$

$$\left(\frac{1}{m}\hat{p} \times \hat{T} \times \hat{p} \times \hat{T} + \frac{e^2}{r} \times \hat{T} - \frac{z \times e^2}{r}\right) \times \hat{\psi}(r) = E_0 \times \hat{\psi}(r), \tag{9.1.6d}$$

$$\hat{p}\hat{\times}\hat{\psi}(r) = -i \times \hat{T} \times \nabla\hat{\psi}(r), \tag{9.1.6e}$$

where the factor $\hat{T}$ in the first Coulomb term originates from the nonunitary transform of model (9.1.5), while the same factor is absent in the second Coulomb term because the latter is long range, thus being conventional. As a result, in the model here considered the trigger is merely added to the equation.

The angular component of model (9.1.6) is conventional [3], and it is hereon ignored. For the radial component $r = |\mathbf{r}|$, we assume the isounit [7]

$$\hat{I} = e^{N \times \psi/\hat{\psi}} \approx 1 + N \times \psi/\hat{\psi}, \quad N = \int dr^3\, \hat{\psi}^\dagger(r)_{1\downarrow} \times \hat{\psi}(r)_{2\uparrow}, \tag{9.1.7a}$$

$$\hat{T} \approx 1 - N \times \psi/\hat{\psi}, \tag{9.1.7b}$$

$$|\hat{I}| \gg 1, \quad |\hat{T}| \ll 1, \tag{9.1.7c}$$

$$\lim_{r \gg 1\text{fm}} \hat{I} = 1, \tag{9.1.7d}$$

where one should note that Eqs. (9.1.7c) and (9.1.7d) are automatically verified by expressions (9.1.7a) and (9.1.7b).

Note that the explicit form of ψ is of Coulomb type, thus behaving like

$$\psi \approx N \times \exp(-b \times r), \tag{9.1.8}$$

with N approximately constant at distances near the hadronic horizon of radius

$$r_c = \frac{1}{b}, \tag{9.1.9}$$

while $\hat{\psi}$ behaves like

$$\hat{\psi} \approx M \times \left(1 - \frac{\exp(-b \times r)}{r}\right), \tag{9.1.10}$$

with M being also approximately constant under the same range [7a]. We then have

$$\hat{T} \approx 1 - \frac{V_{\text{Hulten}}}{r} = 1 - V_0 \frac{e^{-b \times r}}{(1 - e^{-b \times r})/r}, \tag{9.1.11}$$

namely, we see the appearance of a Hulten potential in this local approximation. But the Hulten potential behaves at short distances like the Coulomb one,

$$V_{\text{Hulten}} r \approx \frac{1}{b} \approx \frac{V_0}{b} \times \frac{1}{r}. \tag{9.1.12}$$

As a result, inside the hadronic horizon we can ignore the repulsive (or attractive) Coulomb forces altogether, and write

$$+\frac{e^2}{r} \times \hat{T} - \frac{e^2}{r} \approx +\frac{e^2}{r} \times \left(1 - \frac{V_{\text{Hulten}}}{r}\right) - \frac{z \times e^2}{r} = -V \times \frac{e^{-b \times r}}{1 - e^{-b \times r}}, \tag{9.1.13}$$

by therefore resulting in the desired overall *attractive* force among the identical electrons inside the hadronic horizon.

By assuming in first approximation $|\hat{T}| = \rho \approx 1$, the radial equation of model reduces to the model of π^0 meson [7a] or of the Cooper pair [7b, 7c], although with different values of V and b.

$$\left[\frac{1}{r^2}\left(\frac{d}{dr} r^2 \frac{d}{dr}\right) + \frac{m}{\rho^2 \times \hbar^2}\left(E_0 + V \times \frac{e^{-b \times r}}{1 - e^{-b \times r}}\right)\right] \times \hat{\psi}(r) = 0.. \tag{9.1.14}$$

The exact solution and related boundary conditions were first computed in Ref. [7a], Sect. 5, and remain fully applicable to the isoelectronium.

The resulting spectrum is the typical one of the Hulten potential,

$$|E_0| = \frac{\rho^2 \times \hbar^2 \times b^2}{4 \times m}\left(\frac{m \times V}{\rho^2 \times \hbar^2 \times b^2} \times \frac{1}{n} - n\right)^2, \tag{9.1.15}$$

which evidently possesses a *finite* spectrum, as well known.

To reach a numerical solution, we introduce the parametrization as in Ref. [7a],

$$k_1 = \frac{1}{\lambda \times b}, \tag{9.1.16a}$$

$$k_2 = \frac{m \times V}{\rho^2 \times \hbar^2 \times b^2}. \tag{9.1.16b}$$

We note again that, from boundary conditions, k_2 must be bigger than but close to one, $k_2 \approx 1$ [7].

We therefore assume in first nonrelativistic approximation that

$$\frac{m \times V}{\rho^2 \times \hbar^2 \times b^2} = 1. \tag{9.1.17}$$

By assuming that V is of the order of magnitude of the total energy of the isoelectrons at rest as in the preceding models [7],

$$V \approx 2 \times \hbar \times \omega \approx 2 \times 0.5\text{MeV} = 1\text{MeV}, \tag{9.1.18}$$

and by recalling that $\rho \approx 1$, we reach the following estimate for the *radius of the isoelectronium*

$$\begin{aligned} r_c = b^{-1} &\approx \left(\frac{\hbar^2}{m \times V}\right)^{1/2} = \left(\frac{\hbar}{m \times \omega_0}\right)^{1/2} = \\ &= \left(\frac{1.054 \times 10^{-27}\text{erg} \cdot \text{sec}}{1.82 \times 10^{-27}\ \text{g} \times 1.236 \times 10^{20}\ \text{Hz}}\right)^{1/2} = \\ &= 6.8432329 \times 10^{-11}\text{cm} = 0.015424288\ \text{bohrs} = 0.006843\ \text{Å}, \end{aligned} \tag{9.1.19}$$

It should be noted that: 1) the above values of r_c and V are only *upper boundary values* in the center-of-mass frame of the isoelectronium, i.e., the largest possible values under the assumptions of this section; 2) the values have been computed under the approximation of null relative kinetic energy of the isoelectrons with individual total energy equal to their rest energy; and 3) the values evidently *decrease* with the addition of the relative kinetic energy of the isoelectrons (because this implies the increase of m in the denominator).

The actual radius of the isoelectronium, when considered to be an quasiparticle as in this section, is also expected to vary with the trigger, that is, with the nuclear charges, as confirmed by the calculations presented in the next sections. This illustrates again the upper boundary character of value (9.1.19).

The value k_1 is then given by

$$k_1 = \frac{V}{2 \times k_2 \times b \times c_0} = 0.19, \quad k_2 \approx 1. \tag{9.1.20}$$

Intriguingly, the above two values for the isoelectronium are quite close to the corresponding values of the π^0 [7a] and of the Cooper pair [7b, 7c] (see also Sect. 1.9),

$$k_1 = 0.34, \quad k_2 = 1 + 8.54 \times 10^{-2}, \tag{9.1.21a}$$

$$k_1 = 1.3 \times \sqrt{z} \times 10^{-4}, \quad k_2 = 1.0 \times \sqrt{z}, \tag{9.1.21b}$$

It is important to see that, at this nonrelativistic approximation, *the binding energy of the isoelectronium is not only unique, but also identically null,*

$$|E_0| = \frac{\rho^2 \times \hbar^2 \times b^2}{4 \times m} \left(\frac{m \times V}{\rho^2 \times \hbar^2 \times b^2} - 1 \right)^2 = \frac{V}{4 \times k_2} \times (k_2 - 1)^2 = 0. \tag{9.1.22}$$

This result is crucial to prevent inconsistencies with Pauli's exclusion principle, which, as indicated earlier, *requires no potently energy between the two electrons for its interpretation in a way consistent with experimental data.*

The notion of *a bound state with only one allowed energy level* (called "hadronic suppression of the atomic spectrum" [7a]) is foreign to conventional quantum mechanics and chemistry, although it is of great importance for hadronic mechanics. In fact, any excitation of the constituents, whether the π^0, the Cooper pair or the isoelectronium, causes their exiting the hadronic horizon, by therefore re-acquiring the typical atomic spectrum. Each of the considered three hadronic states has, therefore, only one possible energy level.

The additional notion of *a bound state with null binding energy* is also foreign to quantum mechanics and chemistry, although it is another fundamental characteristic of hadronic mechanics and isochemistry. In fact, the hadronic interactions admit no potential energy, and as such, they cannot admit any appreciable binding energy, as typical for ordinary contact zero-range forces of our macroscopic Newtonian reality.

The null value of the binding energy can be confirmed from the expression of the meanlife of the isoelectronium, which can be written in this nonrelativistic approximation [7a]

$$\tau = \frac{\hbar}{4 \times \pi \times \hbar^2} |\hat{\psi}(0)| \times \alpha \times E_{\hat{e}}^{\rm Kin} = 7.16 \times 10^4 \times \frac{k_1}{(k_2 - 1)^3 \times b \times c_0}. \tag{9.1.23}$$

The full stability of the isoelectronium, $\tau = \infty$, therefore, requires the *exact* value $k_2 \equiv 1$, which, in turn, implies $E_0 \equiv 0$.

The above derivation characterizes the *limiting assumption of a fully stable isoelectronium in nonrelativistic approximation.* By comparison, the Cooper pair under the same derivation *is not* permanently stable because its binding energy is very small, yet finite [7b], thus implying a large yet finite meanlife. Also by comparison, the π^0 *cannot* be stable, and actually has a very small meanlife, evidently because the constituents are a particle-antiparticle pair and, as such, they annihilate each other when bound at short distances.

Another important information of this section is that *the isoelectronium is sufficiently small in size to be treated as a single quasi-particle*. This property will permit rather important simplifications in the isochemical structure of molecules studied in the next sections.

By comparison, the Cooper pair has a size much bigger than that of the isoelectronium [7b, 7c]. This property is fundamental to prevent that the Cooper pair takes the role of the isoelectronium in molecular bonds, i.e., even though possessing the same constituents and similar physical origins, the isoelectronium and the Cooper pair are different, non-interchangeable, hadronic bound states.

The lack of binding energy of the isoelectronium is perhaps the most important information of this section. In fact, it transfers the representation of the binding energy of molecular bonds to the motion of the isoelectronium in a molecular structure, as studied in the next sections.

A novelty of isochemistry over quantum chemistry is that the mutual distance (charge diameter) between the two isoelectrons in the isoelectronium could, as a limited case, also be identically null, that is, the two isoelectrons could be superimposed in a singlet state. Rather than being far fetched, this limit case is intriguing because it yields the value $-2e$ for the charge of the isoelectronium, the null value of the relative kinetic energy, and an identically null magnetic field. This is a perfectly diamagnetic state, which evidently allows a better stability of the isochemical bond as compared to a quasi-particle with non-null size.

Note that, if conventionally treated (i.e., represented on conventional spaces over conventional fields), the nonunitary image of model (9.1.5) would yield *non-invariant numerical results* which, as such, are unacceptable (Sect. 1.7). This occurrence mandates the use of the covering isochemistry and related isomathematics which assures the achievement of invariant results.

Note also that the main physical idea of isounit (9.1.7) is the *representation of the overlapping of the wavepackets of the two electrons under the condition of recovering conventional quantum chemistry identically whenever such overlapping is no longer appreciable*. In fact, for sufficiently large relative distances, the volume integral of isounit (9.1.7a) is null, the exponential reduces to I, Eq. (9.1.7d), the nonunitary transform becomes conventionally unitary, and quantum chemistry is recovered identically.

It is also important to see that, under transform (9.1.7a), model (9.1.5) is implemented with interactions which are: *nonlinear*, due to the factor $\psi/\hat{\psi}$ in the exponent; *nonlocal*, because of the volume integral in (9.1.7a); and *nonpotential*, because not represented by a Hamiltonian.

We finally note that the explicit form of the isotopic element $\hat{T}$, Eq. (9.1.7b), emerges in a rather natural way as being *smaller than one* in absolute value, Eq. (9.1.7c), i.e.,

$$|\hat{T}| = |1 - N \times \psi/\hat{\psi}| \ll 1. \tag{9.1.24}$$

As pointed out in Chapter 3, this property alone is sufficient to *guarantee* that all slowly convergent series of quantum chemistry converge faster for isochemistry.

9.1.4 Isochemical Model of the Hydrogen Molecule with Stable Isoelectronium

We are now sufficiently equipped to initiate the study of the *isochemical model of the hydrogen molecule*, first submitted by Santilli and Shillady in Ref. [5] (see Figs. 9.3, 9.4 an d 9.5). In this Section we shall begin the study by identifying the equation of structure of the H-molecule under the limit assumption that the isoelectronium is perfectly stable at short distances, namely, that the two valence electrons are permanently trapped inside the hadronic horizon, resulting in the main features derived in the preceding section

$$\begin{aligned} \text{mass} \approx 1\text{MeV}, \quad \text{spin} = 0, \\ \text{charge} = 2 \times e, \quad \text{magnetic moment} \approx 0, \end{aligned} \tag{9.1.25a}$$

$$\begin{aligned} \text{radius} = r_c = b^{-1} = 6.8432329 \times 10^{-11}\text{cm} = \\ = 0.015424288 \text{ bohrs} = 0.006843 \text{ Å}. \end{aligned} \tag{9.1.25b}$$

The more realistic case when the isoelectronium is unstable at such small distances is studied later on in this chapter, where we shall also reach an essentially exact representation of the characteristics of the hydrogen molecule.

The main reason for assuming the isoelectronium to be stable at short distances with characteristics (9.1.25) is that such an approximation permits rather major structural simplifications, most notably, the transition, from the conventional hydrogen molecule (which is a *four-body system*), to the isochemical model of this section (which is a *three-body system*, Fig. 9.3). By recalling that four-body systems do not admit an exact solution, while restricted three-body systems do admit an exact analytic solution, the implications of the approximate model of this section are sufficient to warrant an inspection.

Our foundation is the conventional quantum model of H_2 molecule [1],

$$\begin{aligned} \left(\frac{1}{2\mu_1} p_1 \times p_1 + \frac{1}{2\mu_2} p_2 \times p_2 + \right. \\ \left. + \frac{e^2}{r_{12}} - \frac{e^2}{r_{1a}} - \frac{e^2}{r_{2a}} - \frac{e^2}{r_{1b}} - \frac{e^2}{r_{2b}} + \frac{e^2}{R} \right) \times |\psi\rangle = E \times |\psi\rangle. \end{aligned} \tag{9.1.26}$$

Our task is that of subjecting the above model to a transform

$$U \times U^\dagger|_{r \approx r_c} = \hat{I} = 1/\hat{T} \neq I, \tag{9.1.27}$$

which is nonunitary only at the short mutual distances

$$r_c = b^{-1} = r_{12} \approx 6.8 \times 10^{-11}\text{cm}, \tag{9.1.28}$$

and becomes unitary at bigger distances,

$$U \times U^{\dagger}|_{r \leq 10^{-10}\mathrm{cm}} \neq I, \quad I_{r \gg 10^{-10}\mathrm{cm}} = I. \tag{9.1.29}$$

This guarantees that our isochemical model coincides with the conventional model everywhere except for small contributions at small distances.

Assumption (9.1.29) also guarantees that *the conventional energy level of the individual hydrogen atoms are not altered*. In other words, assumption (9.1.29) realizes the main conception of this monograph, the exact character of quantum mechanics for the structure of *one* hydrogen atom, and its insufficiency for *two* hydrogen atoms bounded into the hydrogen molecule (Chapter 1).

The Hilbert space of systems (9.1.26) can be factorized in the familiar form (in which each term is duly symmetrized or antisymmetrized) as in Refs. [1]

$$|\psi\rangle = |\psi_{12}\rangle \times |\psi_{1a}\rangle \times |\psi_{1b}\rangle \times |\psi_{2a}\rangle \times |\psi_{2b}\rangle \times |\psi_{R}\rangle, \tag{9.1.30a}$$

$$\mathcal{H}_{\mathrm{Tot}} = \mathcal{H}_{12} \times \mathcal{H}_{1a} \times \mathcal{H}_{1b} \times \mathcal{H}_{2a} \times \mathcal{H}_{2b} \times \mathcal{H}_{R}. \tag{9.1.30b}$$

The nonunitary transform we are looking for shall act only on the r_{12} variable while leaving all others unchanged. The simplest possible solution is given by

$$U(r_{12}) \times U^{\dagger}(r_{12}) = \hat{I} = \exp\left[\frac{\psi(r_{12})}{\hat{\psi}(r_{12})} \int dr_{12} \hat{\psi}^{\dagger}(r_{12})_{1\downarrow} \times \hat{\psi}(r_{12})_{2\uparrow}\right], \tag{9.1.31}$$

where the ψ's represent conventional wavefunctions and the $\hat{\psi}$'s represent isowavefunctions.

As an alternative yielding the same results, one can transform short-range terms (isochemistry), and add un-transformed long-range terms (quantum chemistry), resulting in the radial equation

$$\left(-\frac{\hbar^2}{2 \times \mu_1} \hat{T} \times \nabla_1 \times \hat{T} \times \nabla_1 - \frac{\hbar^2}{2 \times \mu_2} \hat{T} \times \nabla_2 \times \hat{T} \times \nabla_2 + \right.$$
$$\left. + \frac{e^2}{r_{12}} - \frac{e^2}{r_{1a}} - \frac{e^2}{r_{2a}} - \frac{e^2}{r_{1b}} - \frac{e^2}{r_{2b}} + \frac{e^2}{R}\right) \times |\hat{\psi}\rangle = E \times |\hat{\psi}\rangle. \tag{9.1.32}$$

By recalling that the Hulten potential behaves at small distances like the Coulomb one, Eq. (9.1.32) becomes

$$\left(-\frac{\hbar^2}{2 \times \mu_1} \times \nabla_1^2 - \frac{\hbar^2}{2 \times \mu_2} \times \nabla_2^2 - V \times \frac{e^{-r_{12} \times b}}{1 - e^{-r_{12} \times b}} - \right.$$
$$\left. - \frac{e^2}{r_{1a}} - \frac{e^2}{r_{2a}} - \frac{e^2}{r_{1b}} - \frac{e^2}{r_{2b}} + \frac{e^2}{R}\right) \times |\hat{\psi}\rangle = E \times |\hat{\psi}\rangle. \tag{9.1.33}$$

The above equation does indeed achieve our objectives. In fact, it exhibits a *new explicitly attractive force between the neutral atoms of the hydrogen molecule, which force is absent in conventional quantum chemistry.* The equation also explains the reasons why the H_2 molecule admits only *two* H-atoms. As we shall see in the remaining sections, Eq. (9.1.33) also permits essentially exact representations of the binding energy and other molecular characteristics, yields much faster convergence of series with much reduced computer times, and resolves other insufficiencies of conventional models.

9.1.5 Exactly Solvable, Three-Body, Isochemical Model of the Hydrogen Molecule

Our isochemical model of the hydrogen molecule, Eqs. (9.1.33), can be subjected to an additional simplification, which is impossible for quantum chemistry. In our isotopic model, the two isoelectrons are bonded together into a single state we have called isoelectronium. In particular, the charge radius of the latter is sufficiently small to permit the values (see Fig. 9.3)

$$r_{12} \leq r_{1a}, \text{ and } r_{1b}, \quad r_{12} \approx 0, \tag{9.1.34a}$$

$$r_{1a} \approx r_{2a} = r_a, \quad r_{1b} \approx r_{2b} = r_b. \tag{9.1.34b}$$

Moreover, the H-nuclei are about 2,000 times heavier than the isoelectronium. Therefore, our model (9.1.33) can be reduced to a *restricted three body problem* similar to that possible for the conventional H_2^+ *ion* [1], but *not* for the conventional H_2 molecule.

Such a restricted model essentially consists of two H-protons at rest at a fixed mutual distance plus the isoelectronium moving around them in the *oo*-shaped orbit of Fig. 9.4, according to the structural equation

$$\left(-\frac{\hbar^2}{2\mu_1}\times\nabla_1^2-\frac{\hbar^2}{2\mu_2}\times\nabla_1^2-V\times\frac{e^{-r_{12}b}}{1-e^{-r_{12}b}}-\right.$$

$$\left.-\frac{2e^2}{r_a}-\frac{2e^2}{r_b}+\frac{e^2}{R}\right)\times|\hat{\psi}\rangle=E\times|\hat{\psi}\rangle. \tag{9.1.35}$$

Under the latter approximation, the model permits, for the first time, the achievement of an *exacts solution for the structure of the H_2 molecule*, as it is the case for the H_2^+ ion or for all restricted three-body problems. This solution will be studied in Chapter 6 via variational methods. The exact analytic solution has not been studied at this writing, and its study is here solicited by interested colleagues. At this introductory level we only limit ourselves to a few comments.

Note that *the above exact solution of the hydrogen molecule is only possible for the case of the isoelectronium fully stable at short mutual distances.* In fact,

for the case of the mutual distance of the valence electrons no longer restricted to 1 fm, the model is a full *four-body structure*, which, as such, admits no exact solution.

Note also that model (9.1.35) is the isochemical model of the H_2 molecule inside the hadronic horizon. The matching representation *outside* the hadronic horizon is presented in the next section.

Note also that the above restricted three-body model can be used for the study of the bonding of an H-atom to another generic atom, such as HO, thus permitting, again for the first time, novel exact calculations on the water as HOH, namely, as two intersecting isotopic bonds HO and OH, each admitting an exact solution, with possible extension to molecular chains, and evident extensions to other molecules.

Readers interested in studying model (9.1.35) should keep in mind that *the rest energy of the isoelectronium is unknown at this writing, thus being a free parameter suitable for fitting experimental data*. More specifically, in Eq. (9.1.35) we have *assumed* from Sect. 9.3 that

$$m_{\text{isoelectronium}} = 2 \times m_{\text{electron}}. \tag{9.1.36}$$

However, the results of Sect. 9.3 are approximate. In particular, they hold under *the assumption that the isoelectronium has no internal binding energy*. Such an assumption was made for the specific purpose of proving that nonpotential forces represented with the isounit can indeed yield a bound state. In particular, the assumption was suggested by the need to represent Pauli's exclusion principle without the introduction of a potential.

However, such a view may be solely valid at molecular distances of valence electrons, and not necessarily at short distances. As a result, the isoelectronium may indeed have an internal binding energy, that is, it can have internal forces derivable from a potential in addition to the nonpotential forces without binding energy of hadronic chemistry, as outlined in Fig. 9.4.

This is due to the fact that the structure of the isoelectronium implies *three* acting forces: *one repulsive* Coulomb force due to the same changes, plus *two attractive* forces due to the two pairs of opposite magnetic polarities in singlet configuration. The latter two attractive forces may overcome the repulsion due to the change beginning at distances of the order of one Fermi, resulting in a conceivable net attractive force derivable from a potential.

Under the latter conditions, the isoelectronium would indeed have a *negative* binding energy, resulting in the unknown value

$$m_{\text{isoelectronium}} < 2 \times m_{\text{electron}}. \tag{9.1.37}$$

The understanding is that the case $m_{\text{isoelectronium}} > 2 \times m_{\text{electron}}$ is impossible.

The unknown character of the isoelectronium mass alters considerably the perspective of restricted model (9.1.35). As we shall see in Chapter 6, it is possible

to prove via variational and other methods that *model* (9.1.35) *under assumption* (9.1.36) *does not admit exact solutions accurately representing the binding energy of the hydrogen molecule.* However, under the use of the isoelectronium mass free for fitting experimental data, the situation may be different.

Another information which should not be assumed to be exact is the *size of the isoelectronium*, Eq. (9.1.19). In fact, as stressed in Sect. 9.3, such a value too must be assumed to be an *upper boundary value*. In model (9.1.35) the isoelectronium is assumed to be point-like. However, the model can be first extended via Eq. (9.1.35) for a stable isoelectronium with a *fixed* unknown radius

$$r_c = b^{-1} \leq 6.8 \times 10^{-11}\text{cm}. \tag{9.1.38}$$

A second extension of model (9.1.35) should also be taken into consideration, that in which

$$r_c = b^{-1} \geq 6.8 \times 10^{-11}\text{cm}, \tag{9.1.39}$$

because, as stressed in Sects. 9.2 and 9.3, any assumption that the isoelectronium ceases to exist at distances bigger than 10^{-11} cm would imply a violation of Pauli's exclusion principle.

As a matter of fact, the assumed mass (9.1.36) is more in line with assumption (9.1.39), than with assumption (9.1.38), again, to prevent the existence at large mutual distances of the valence electrons of attractive internal potential forces with a binding energy which would alter conventional atomic structures.

Even though, admittedly, *the size of the isoelectronium is variable in the physical reality*, its average into a constant value may have meaning, of course, as a first approximation.

A third quantity of model (9.1.35) deserving inspection is the experimental value of the bond length, which is generally referred to the distance between the two nuclei R. In principle, such a distance is expected to be altered by a fully stable isoelectronium. Therefore, a solution of model (9.1.35) in which R is fitted from the experimental data is indeed meaningful, of course, as a first approximation.

In conclusion, in both, the four-body model (9.1.33) and the restricted three-body model (9.1.35), we have *three quantities which, in principle, can be assumed to be unknown and, therefore, should be derived from the fit of experimental data: 1) the mass of the isoelectronium; 2) the size of the isoelectronium; and 3) the bond length.*

There is no doubt that an exact analytic solution of model (9.35) suitable to represent the binding energy of the hydrogen is permitted by the above three free fits with intriguing implications for all H-bonds whose study is left to interested researchers.

9.1.6 Isochemical Model of the Hydrogen Molecule with Unstable Isoelectronium

In this section we review the study of Ref. [5] on the solution of the restricted isochemical model of the hydrogen molecule, Eq. (9.1.35) and Fig. 9.3, via conventional variational methods used in chemistry, under the assumption that the isoelectronium has characteristics (9.3.21). As we shall see, these studies have achieved an essentially exact representation of experimental data on the hydrogen molecule, including its binding energy and bond length, for the first time from exact first principles without ad hoc adulterations.

For historical papers in chemistry connected to our model, see Refs. [6]. Representative, more recent papers with technical connections to our study as outlined below are given by Refs. [8 – 38].

The possibilities that the mass of the isoelectronium be smaller than $2\times$mass of electron and its radius be bigger than 6.8×10^{-11} cm will not be considered in this section.

For this purpose we first note that the solution of the full model with the Hulten potential $e^{-rb}/(1-e^{-rb})$ where $r_c = b^{-1}$ is the size of the isoelectronium, implies rather considerable technical difficulties. Therefore, we shall study model (9.1.35) under an *approximation* of the Hulten potential given by one Gaussian of the type

$$\frac{e^{-rb}}{1-e^{-rb}} \approx \frac{1-Ae^{-br}}{r}, \tag{9.1.40}$$

with A a constant identified below.

It is known that a linear combination of sufficient number of Gaussians can approximate any function. Therefore, the achievement of an essentially exact representation of molecular data via approximation (9.1.40) will evidently persist under the full use of the Hulten potential.

Recall from Sect. 9.3 that the *stable* character of the isoelectronium is crucially dependent on the use of the attractive Hulten potential, which "absorbs" repulsive Coulomb forces at short distances resulting in attraction. Therefore, the weakening of the Hulten potential into the above Gaussian form has the direct consequence of turning the isoelectronium into an *unstable* state.

In this and in the following sections, we shall therefore study an isochemical model of the hydrogen molecule which is somewhat intermediary between the conventional chemical model and the isochemical model with a fully stable isoelectronium.

It should be indicated that the terms "unstable isoelectronium" should be referred as the period of time in which the two valence electrons remain within the hadronic horizon of 6.8×10^{-11} cm. The same terms *should not* be interpreted to the fact that the isoelectronium does not exist outside the hadronic horizon, because the latter view implies a number of inconsistencies, such as possible

violation of Pauli's exclusion principle, acquisition by molecules of ferromagnetic character, *etc.*

The main objective of this section is to show the achievement of the exact representation of molecular characteristics even for the case of one Gaussian approximation (9.1.40). The question whether the isoelectronium is stable or unstable evidently depends on the amount of instability and its confrontation with experimental data, e.g., on magnetic susceptibility. As such, the issue will be addressed theoretically and experimentally in a future paper.

Under the above assumption, our first step is the study of model (9.1.35) in an exemplified Coulomb form characterized by the following equation, hereon expressed in atomic units (a.u.)

$$H \times \Psi = \left(-\frac{1}{2}\nabla^2 - \frac{2}{r_a} - \frac{2}{r_b} + \frac{1}{R} \right) \times \Psi, \tag{9.1.41}$$

where the differences from the corresponding equation for the H_2^+ ion [1] are the replacement of the reduced mass $\mu = 1$ with $\mu = 2$, and the increase in the electric charge from $e = 1$ to $e = 2$.

The standard method for solving the above equation is the following. The variational calculation is set up in matrix algebra form in a nonorthogonal basis set S which has been normalized to 1. The metric of this non-orthogonal system of equations S is used to set up the orthogonal eigenvalue problem and the eigenvalues are sorted to find the lowest value. H and S are Hermitean matrices. E is a diagonal matrix with the energy eigenvalues

$$HC = ESC; \;\; \text{define } C = S^{-\frac{1}{2}}C', \text{ then } HS^{-\frac{1}{2}}C' = ES^{-\frac{1}{2}}C', \tag{9.1.42a}$$

$$(S^{-\frac{1}{2}}HS^{+\frac{1}{2}}C') = H'C' = E(S^{-\frac{1}{2}}SS^{-\frac{1}{2}})C' = EC', \tag{9.1.42b}$$

where the last equation is obtained by multiplying the first equation from the left by $S^{-\frac{1}{2}}$, and use the unitary property that $S^{-\frac{1}{2}} = S^{+\frac{1}{2}}$ to form an orthogonal eigenvalue problem. Finally we solve for C' by diagonalizing H' and obtain $C = S^{-\frac{1}{2}}C'$.

Here the basis is formed from contracted basis sets Φ, which are fixed linear combinations of Gaussian spheres χ fitted to real shapes of spherical harmonic functions. The eigenvector column in C gives the basis coefficients of the molecular orbitals according to the expression

$$\Psi_i = \sum_{c_{i,j}} (j : \Psi_j = \sum_{a_{j,k}} \Psi_k; \; \chi = \left(\frac{2\alpha}{\pi} \right)^{3/4} \exp[-(\alpha - A)^2] = /\alpha, A). \tag{9.1.43}$$

The problem of how to form a sharp cusp on a 1s orbital is solved to a practical extent by using up to six Gaussians; here we use the very best "least-energy" 1s

orbital from Pople's group [18]. In this problem the s-, p-, d- and f-orbitals are polarization functions that merely serve to evaluate the effect of other angular components on the $1s$ orbitals which are the main terms of the $1s$-sigma bond in H_2.

Gaussian orbitals can easily be scaled to screened nuclear charge values by multiplying the Gaussian exponents by the square of the scaling factor (in effect, shrinking the space of the H-atom model) followed by renormalization of the linear combination of Gaussians. In this work the scaling constant of the $1s$ orbitals was optimized to 1.191 and the 2-, 3- and 4-shell orbitals optimized as scaled shells rather than optimizing each orbital individually.

As the orbitals were optimized using parabolic fitting to three energy values as a function of the scaling value, it became apparent that the bond length of the three-body model is much shorter than the usual value of 1.4011 Bohr (= 0.74143 Angströms). Thus, the bond length was re-optimized after optimization of the scaling for each principle shell. The scaling constants and the orbital contractions are Angströms at an energy of −7.61509174 Hartrees (= −207.2051232 eV) where the achievement of an exact representation of the binding energy is studied in detail.

Although a large basis set of $1s$, $2s$, $2p$, $3s$, $3p$, $3d$, $4s$, $4p$, and $4f$ orbitals was used, this variational energy is probably higher than the exact solution of the type used by Bates, Ledsham and Stewart [12]. However, the energy of the 6-gaussian ($6G$) Least-Energy $1s$ function [18] is −0.499946 Hartrees for the H atom so the energy quoted here should be within 0.001 Hartrees of the exact solution.

While it is expected that a collapsed isoelectronium pair would be even more unstable than a collapsed positronium quasi-particle due to the repulsive interaction of the electrons, this three-body model of H_2 predicts over 6 Hartrees added molecular stability and a substantial decrease in bond length. The $E(1)$ value of the electronium-pair of some −11.473164 Hartrees is lower than the total energy of the molecule due to the repulsion of the proton-nuclei from the $1/R$ term of the Hamiltonian.

9.1.7 Gaussian Approximation of the Isochemical Model of the Hydrogen Molecule as a Four-Body System

As indicated earlier, it is possible that the valence electrons bond themselves into the isoelectronium not in a permanent fashion, but rather in a statistical fashion, with only a percentage of their time in a bonded state, in which case the restricted three-body model is evidently insufficient. In this section we review the studies of Ref. [5] on the full four-body isochemical model of H_2, which model also permits the achievement of an exact representation of the binding energy from first principles without adulterations (see Fig. 9.7).

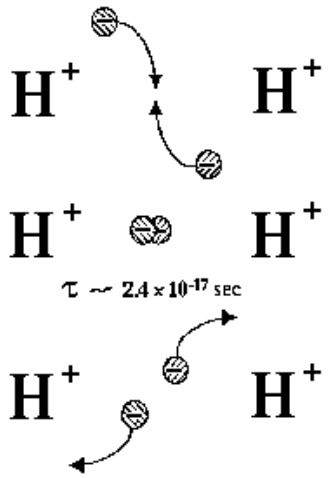

Figure 9.7. A schematic view of the *isochemical model of the hydrogen molecule with unstable isoelectronium* due to the weakening of the Hulten potential and consequential relaxation of the infinite lifetime, as a view complementary to that of Fig. 9.4 with stable isoelectronium. In this case the notion of isoelectronium essentially represents a tendency of pairs of valence electrons to correlate-bond in singlet states at short distances. The use of isochemistry, rather than conventional chemistry, is necessary because even this weaker form of the isoelectronium, as well as all screenings of the Coulomb potential at large, are nonunitary images of conventional Coulomb settings, as established in Chapter 1. Therefore, all these models require a representation on isospaces over isofields for their invariant formulation. In the text, we present the projection of such an invariant formulation on conventional spaces over conventional fields for simplicity.

A considerable effort has been made since the time of Hylleraas [20] in the 1930's to find a way to calculate the last 2% of the binding energy of molecules. Boys [22] derived a form of "configuration interaction" which offered exact variational solutions, but this proved to be very slowly convergent and only applicable to small molecules. Moller-Plesset perturbation developed by Pople *et. al.* [23] is popular today, but studies up to eighth order have been shown not to converge after huge expense in computer time. Linked-cluster diagrams by Bartlett *et. al.* [24]) multiconfiguration-self-consistent-field (MCSCF) calculations by Schaefer *et. al.* [25] and Goldstone-Bruekner-Feynman diagrammatic perturbation by Kelly [26] have all been shown to require very large computer resources, are limited to small molecules and sometimes fail to give even negative binding energies as shown by Goddard [27] for Cr_2.

All these slow and expensive methods seem to share one common feature, the use of high energy empty "virtual" orbitals from a ground state calculation, usually of Hartree-Fock-Roothaan type, to improve the representation of the ground state.

One might ask how it is possible to lower the energy by using higher energy wavefunctions. The fact that some energy lowering is found suggests electron dynamics is indeed complicated, and the rate of convergence of this method is quite slow.

The method adopted here is to use the usual Hartree-Fock-Roothaan self-consistent-field equations [1] (which also has some formal flaws such as the self-interaction terms [27]), and question the form of the Coulomb interaction of the electron.

Note that reducing the values of the Coulomb integrals will lower the energy by reducing the electron-electron repulsion while reducing the exchange terms will raise the energy, but the 1/2 factor reduces the effect of the exchange terms. Thus, a reduction of the value of the integrals will lower the energy. Note that Goddard [27] has already recommended reducing the atomic self-energy by subtracting 1.39 eV from Hartree-Fock exchange integrals in the cases of Cr_2 and Mo_2. In this way, we reach the expressions

$$FC = ESC; \quad F_{i,j} = H_{i,j} + \sum_{k,l} P_{k,l}[(i,j|k,l) - \frac{1}{2}(i,k|j,l)], \tag{9.1.44a}$$

$$(i,j|k,l) = \iint \chi_i(1)\chi_j(1)\frac{1}{r_{12}}\chi_k(2)\chi_l(2)\, d\tau_1 d\tau_2, \tag{9.1.44b}$$

$$P_{i,j} = 2\sum_n c_{n,i}c_{n,j} \quad (\text{sum } n \text{ only over occupied orbitals}). \tag{9.1.44c}$$

The 1995 paper on Cooper pairs by Santilli and Animalu [7c] invokes the non-local hadronic attractive force first identified in the π^0-meson [7a] as applied to singlet-paired electrons which form a boson particle. After using a non-local isotopic nonlinear transformation, the hadronic attraction was transformed back to real-space and modeled resulting into an attractive force which overcomes the repulsive Coulomb force. In turn, the latter occurrence constitutes the physical-chemical origin in the use of a suitably screened Coulomb potential for the binding energy.

Examination of the original 1978 paper on positronium collapse by Santilli [7a], reveals that the Hulten potential is not necessarily a unique representation of the hadronic force; since a linear combination of similar potentials could be used to represent the same hadronic bound state, provided that they characterize an attractive force among the electrons capable of overcoming their Coulomb repulsion.

This work assumes that until matrix elements of a two-Gaussian-screened-Coulomb potential can be used to approximate the real-space form of the hadronic attraction. This form has the important property that it can be merged with the general case of the four-center Coulomb or exchange integral derived by Shavitt

[16] using the famous Gaussian transform technique.

$$\frac{1}{r_{12}} = \sqrt{\frac{1}{\pi}} \int_0^\infty s^{-\frac{1}{2}} \exp[-s r_{12}^2] ds, \tag{9.1.45a}$$

$$1 + \frac{p+q}{pq} s = \frac{1}{1-t^2}. \tag{9.1.45b}$$

For future reference, note that this transform already has a pole at the lower limit where $s = 0$. This pole was removed at the last step by a change in variable, given as Eqs. (9.1.45). Shavitt was able (as a former graduate student of S.F. Boys) to show that the Gaussian transform technique reproduced the formula previously derived by Boys [6] in 1950 using electrostatic arguments. The Gaussian-lobe basis SCF programs by Shillady [8, 28] and others.

It is important to note that the formula is completely general in orientation of four Gaussian sphere lobe-orbitals as well as the distance between two electrons. As modified for description of correlation of two electrons, *such a general formula can describe angular correlation as well as distance interaction.* Thus, matrix Coulomb repulsion to model the real-space form of the hadronic attraction of two electrons.

Well-founded admiration for Shavitt's work in deriving the Coulomb interaction was rekindled as his derivation was checked. This work added the Gaussian screening as $\exp[-r^2]/r$ so that the special properties of Gaussians could be used, especially the property that polar coordinates readily separate into factorable x, y, z components. The goal is to evaluate the two-electron four-center matrix elements of the Gaussian-screened-Coulomb potential as shown below,

$$Y(r) = \frac{1 - 2\exp[-\alpha r^2]}{r}. \tag{9.1.46}$$

Intriguingly, the Gaussian exponent carried through the original derivation of the Coulomb interaction by resorting to a well known auxiliary function F_0 which has been studied by Shillady [8, 28] and others. Since both $s^{\frac{1}{2}}$ and $(s+\alpha)^{\frac{1}{2}}$ occur in the denominator of the screened-Coulomb form, two poles occur in the integral. A change of variable absorbs the term

$$1 + \frac{p+q}{pq}(s+\alpha) = \frac{1}{1-t^2}, \tag{9.1.47}$$

while the pole due to $(s+\alpha)^{-1/2}$ shifts the other pole at $s^{-\frac{1}{2}}$ to the lower limit of the integral. A smooth spike is evident at the lower value of the integration using a 70 point Simpson's Rule Integration (two ranges are used with 20 points more closely spaced near the pole and 50 points for the remaining range.)

The above work was carried out using 64 bit double precision arithmetic which provides 14 significant figures. A simple offset (δ) of 1.0×10^{-15} has provided useful results with this simple offset to avoid numerical overflow. While this pole is a problem in need of a continuous function to integrate, numerical integration seems to handle this well to 14 significant figures, particularly since the routines used for the Coulomb integrals are known to be accurate only to 12 significant figures [28].

The area under the pole-spike is estimated as a narrow triangle upon a rectangle 1.0×10^{-15} wide with the height of the triangle set at 1.79940×10^{13} times the height of the point set 1.0×10^{-15} into the range of integration (the first Simpson point).

The present code for this screened-Coulomb integral is presently slower than the corresponding function used for the Coulomb integrals due to the 70 point Simpson integration [28], but the integrand is nearly flat after the spike at $s = 0.0$ so that portion of the integrand can be evaluated more rapidly with fewer points. The simple offset of the lower limit by 1.0×10^{-15} is adequate for this monograph.

$$\left(aA(1), bB(1) \left| \frac{\exp(-\alpha(r_{12})^2)}{r_{12}} \right| cC(2), dD(2) \right) = \tag{9.1.48a}$$

$$= \frac{2\pi^{5/2}}{pq\sqrt{p+q}} e^{[ab/(a+b)]\overline{AB}^2 - [cd/(c+d)]\overline{CD}^2} \times$$

$$\times \int_{\rho}^{1} e^{-[pq/(p+q)]\overline{PQ}^2 t^2} \left(\frac{[pq/(p+q)]t^2}{[pq/(p+q)]t^2 + \alpha(t^2-1)} \right)^{1/2} dt, \tag{9.1.48b}$$

$$\rho = \delta + \frac{\alpha\sqrt{p+q}}{pq + (p+q)\alpha}, \quad p = (a+b), \quad q = c+d, \quad \delta = 1.0 \times 10^{-15}, \tag{9.1.48c}$$

$$\text{pole} = (1.79940 \times 10^{13}) e^{-[pq/(p+q)]\overline{PQ}^2 \rho^2}. \tag{9.1.48d}$$

The new integral was incorporated into the same routine used to evaluate the usual Hartree-Fock-Roothaan SCF scheme except F_0 was supplemented by the new auxiliary function (9.1.46). The H_2 molecule was treated using the same fixed-nuclei method with a bond distance of 1.4011 Bohrs. A simple basis set of just one Least-Energy $6G$-$1s$ orbital [18] centered on each H-nucleus was used to test the new program "Santilli-Animalu-Shillady-Lobe" (SASLOBE), which is set to handle up to 512 contracted orbitals.

It must be stated that the energies given are now parametrically dependent on the Gaussian-screening constant as $E(\alpha)$. The energy is variationally bound to be above the true energy in a narrow range around the optimum value. It is extremely important to note that the energy is lowered using the new attractive

hadronic term, but the optimum value is difficult to locate and "variational collapse" occurs when r_c is extended or reduced away from a shallow minimum in the energy.

In order to minimize the number of parameters in the model (only one, the Coulomb screening constant A) two equations were imposed on the Gaussian-function. First, the function was required to be equal to zero at some radial cutoff value r_c which is assumed to be the inverse of the b-variable of Sect. 9.1.5,

$$b = \frac{1}{r_c} = A\frac{\exp[-\alpha r_c^2]}{r_c}, \quad A = \exp[+\alpha r_c^2]. \tag{9.1.49}$$

Second, this radial cutoff value was used as sigma of the inverted Gaussian (radius at half-height),

$$A\exp\left[-\frac{\ln 2}{r_c^2}r_c^2\right] = \frac{A}{2}, \quad \alpha = \frac{\ln 2}{r_c}, \quad A = 2. \tag{9.1.50}$$

The upper boundary of the radius of the isoelectronium has been estimated in Sect. 9.3 to be about 0.6843×10^{-10} cm, which corresponds to 0.012931401 Bohrs. This radius does lower the Hartree-Fock-Roothaan energy noticeably for H_2, and further optimization of the pole-spike produced an SCF energy of -1.17446875 Hartrees with a cutoff radius of 0.0118447 Bohrs or 1.18447×10^{-10} cm using the minimum $1s$ basis. In conclusion, the fitted value of $b \equiv 1/r_c$ is reasonably close to the estimate value for the H_2 molecule. The minimum basis was later extended to $6G$-$1s$, $1G$-$2s$, $1G$-$2p$ for pole calibration.

Details of the exact representation of the binding energy via the above second method are presented in Appendix 9.B.

9.1.8 Summary of the Results

In order to demonstrate the advantage of the isochemical model using a Gaussian-screened-Coulomb attraction between electrons, a standard Boys-Reeves [22] calculation was carried out in Ref. [2]. This included all single- and double-excitations CISD from the ground state Hartree-Fock-Roothaan SCF orbitals for a 99×99 "codetor" [6] interaction. Only the 1s orbitals were optimized with a scaling of 1.191 for the Least-Energy $6G$-$1s$ orbitals, but the basis also included $1G$-$2s$, $2G$-$2p$, $1G$-$3s$, $1G$-$3p$, $3G$-$3d$, Thd $1G$-$4sp$ (tetrahedral array of four Gaussian spheres), and $4G$-$4f$ orbitals scaled to hydrogenic values as previously optimized [17].

The additional basis functions provide opportunity to excite electrons to higher orbitals as is the standard technique in configuration interaction, somewhat contrary to the main hypothesis of this work, which is that there is an attractive hadronic force between electron pairs inside the r_c critical radius. The results of the above calculations are summarized in Table 9.1.

Table 9.1. Summary of results for the hydrogen molecule.

Species	H_2	H_2 [a]	H_2
Basis screening			
$1s$	1.191	6.103	1.191
$2s$	0.50	24.35	0.50
$2p$	0.50	24.35	2.36
$3s$	0.34	16.23	*
$3p$	0.34	16.23	*
$3d$	0.34	-16.2[b]	*
$4sp$	0.25	12.18	*
$4f$	0.25	12.18	*
Variational energy (a.u.)	*	-7.61509174	*
SCF energy (a.u.)	-1.12822497	*	-1.13291228
CI energy (a.u.)	-1.14231305	*	*
CINO energy (a.u.)	-1.14241312	*	*
SAS energy (a.u.)	*	*	-1.174444
Exact energy (a.u.) [30]	-1.174474	*	-1.174474
Bond length (bohr)	1.4011	0.2592	1.4011
Isoelectronium radius (bohr)	*	*	0.01124995

[a] Three-body Hamiltonian (5.1).
[b] The negative $3d$ scaling indicates five equivalent three-sphere scaled to 16.20 rather than "canonical" $3d$ shapes.

The Boys-Reeves C.I. achieved an energy of -1.14241305 Hartrees based on an SCF energy of -1.12822497 Hartrees. This was followed by one additional iteration of "natural orbitals" (CINO), in which the first order density matrix is diagonalized to improve the electron pairing to first order [29]. The fact that this procedure lowered the energy only slightly to -1.14241312 Hartrees (i.e., -7.0×10^{-7} Hartrees), indicates the 99-configuration representation is close to the lower energy bound using this basis set while the isochemistry calculation produced the exact energy with a comparatively much smaller basis set.

Since SASLOBE has only a n^7 routine for the necessary integral transformation instead of the most efficient n^5 algorithm ($\simeq n$ is the number of basis functions), the SASLOBE C.I. runs are somewhat slow and required about 20 hours on a 300 MFLOPS Silicon Graphics computer.

With more efficient routines, this time can be reduced to about three hours. However, the screened-Coulomb attraction method used a smaller basis and achieved lower energies in a few seconds. It is also estimated that careful spacing of fewer quadrature points in the new integral routine can certainly reduce the SASLOBE run times by a factor of 2 at least.

Therefore it is clear that calculations in hadronic chemistry are, conservatively, at least 1,000 times faster than a C.I. calculation, an occurrence fully similar to the corresponding case in hadronic *vs.* quantum mechanics.

Another estimate is that, since the new integral corrections require a little more time than the usual Coulomb integrals (but do not take any additional storage space), the computer run-times for an isochemistry calculation should only be about three times the run-times for the corresponding Hartree-Fock-Roothaan calculation in any given basis set.

The extension of the isochemical model of the H_2 molecule to other molecules is conceptually straightforward. In particular, the notion of isoelectronium essentially restricts all possible bonds to the established ones, as it is the case for the water molecule (see next chapter).

In order to generalize the underlying quantitative treatment to molecules containing H–to–F, the pole-spike was re-optimized to obtain 100% of the correlation energy below the SCF energy in the given basis set since the SCF energy here was not quite at the Hartree-Fock limit.

Table 9.2. Isoelectronium results for selected molecules.

Species	H_2	H_2O	HF
SCF-energy (DH) (a.u.)	-1.132800^a	-76.051524	-100.057186
Hartree-Fock[d] (a.u.)			-100.07185^d
Iso-energy (a.u.)	-1.174441^c	-76.398229^c	-100.459500^c
Horizon R_c (Å)	0.00671	0.00038	0.00030
QMC energy[d,e] (a.u.)	-1.17447	-76.430020^e	-100.44296^d
Exact non-rel. (a.u.)	-1.174474^f		-100.4595^d
Corellation (%)	99.9^b	91.6^b	103.8
SCF-dipole (D)	0.0	1.996828	1.946698
Iso-dipole (D)	0.0	1.847437	1.841378
Exp. dipole (D)	0.0	1.85^g	1.82^g
Time[h] (min:s)	0:15.49	10:08.31	6:28.48

(DH^+) Dunning-Huzinaga (10S/6P), [6,2,1,1,1/4,1,1]+H_2P_1+3D1.
[a]LEAO-6G1S + optimized GLO-2S and GLO-2P.
[b]Relative to the basis set used here, not quite HF-limit.
[c]Iso-energy calibrated to give exact energy for HF.
[d]Hartree-Fock and QMC energies from Luchow and Anderson [33].
[e]QMC energies from Hammond *et al.* [30].
[f]First 7 sig. fig. from Kolos and Wolniewicz [34].
[g]Data from Chemical Rubber Handbook, 61st ed., p. E60.
[h]Run times on an O2 Silicon Graphics workstation (100 MFLOPS max.).

The energy obtained here results from the calibration of the pole-spike to the experimental value of HF, and is below the Quantum Monte Carlo (QMC) energy

of Luchow and Anderson [33], which requires hours on a much larger computer, as compared to less than 10 minutes for this work. In fact, the run times for HF were about 8 CPU minutes on a 100 MFLOP Silicon Graphics O2 workstation.

The principal value of the pole (9.1.48d) was calibrated for 100% energy of HF, H_2O has two tight sigma bonds and two diffuse lone-pairs so a single compromise value is a good test of the method. In HF the F^- is nearly spherical so an average r_c value does a better job of describing the "correlation hole" of transient isoelectronium. The computed dipole moments are in excellent agreement with the experimental values. The use of the same pole value for H_2O and HF degrades the H_2 energy slightly. The results of our studies for H–to–F based molecules are summarized in Table 9.2.

A comparison of the above date (particularly those on computer times) with corresponding data obtained via conventional approaches is instructive.

9.1.9 Concluding Remarks

The fundamental notion of the new model of molecular bonds studied in this chapter [5] is the bonding at short distances of pairs of valence electrons from two different atoms into a singlet quasi-particle state we have called *isoelectronium*, which travels as an individual particle on an oo-shaped orbit around the two respective nuclei.

The isoelectronium and related methodology are then characterized by a covering of contemporary chemistry called *isochemistry*, which is the branch of the more general *hadronic chemistry* specifically constructed to represent closed-isolated systems with linear and nonlinear, local and nonlocal, and potential as well as nonpotential internal forces.

A main assumption is that linear, local, and potential interactions are sufficient for atomic structures since the atomic distances are much bigger than the size of the wavepackets of the electrons. However, in the transition to molecular structures we have the additional presence of nonlinear, nonlocal, and nonpotential effects due to the deep penetration of the wavepackets of valence electrons, which is essentially absent in atomic structures (Fig. 1.7).

The attractive short-range interactions needed to overcome the repulsive Coulomb force in the isoelectronium structure originate precisely from nonlinear, nonlocal, and nonhamiltonian effects in deep wave-overlappings; they are described by *hadronic mechanics* [3b]; and their invariant formulation is permitted by the recently achieved broadening of conventional mathematics called *isomathematics*.

Specific experimental studies are needed to confirm the existence of the isoelectronium, by keeping in mind that the state may not be stable outside a molecule in which the nuclear attraction terms bring the electron density to some critical threshold for binding, a feature we have called the "*trigger*."

Nonrelativistic studies yield a radius of the isoelectronium of 0.69×10^{-10} cm. This "horizon" is particularly important for isochemical applications and developments because outside the horizon the electrons repel one-another while inside the horizon there is a hadronic attraction.

The same nonrelativistic studies also predict that, as a limit case, the isoelectronium is stable within a molecule, although partially stable configurations also yield acceptable results. The question of the stability vs. instability of the isoelectronium inside the hadronic horizon must therefore also be left to experimental resolutions.

The understanding is that, when the restriction to the hadronic horizon is lifted, and molecular dimensions are admitted for the inter-electron distance, the isoelectronium must be stable, otherwise violations of Pauli's exclusion principle could occur. In this sense, the isoelectronium is a direct representation of Pauli's exclusion principle.

The foundations of the isoelectronium can be seen in a paper by Santilli [7a] of 1978 on the structure of the π^0-meson as a bound state of one electron and one positron. The latter model also illustrates the capability of hadronic mechanics vs. quantum mechanics. In fact, quantum mechanics *cannot* represent the π^0 as the indicated bound state of one electron and one positron because of numerous inconsistencies, such as: the inability to represent the rest energy of the π^0, which would require a "positive" binding energy, since the sum of the rest energies of the constituents is much smaller than the rest energy of the bound state; the impossibility to represent the charge radius of the π^0, which can only be that of the positronium for quantum mechanics; the lack of representation of the meanlife of the π^0; and other insufficiencies.

By comparison, *all* the above insufficiencies are resolved by hadronic mechanics, which permits the first quantitative, numerical representation of *all* characteristics of the π^0 as a bound state of one electron and one positron at short distances, including its spontaneous decay with the lowest mode $\pi^0 \to e^- + e^+$, which results in being the hadronic tunnel effect of the constituents [7a].

In particular, the indicated model of the π^0 contains the first identification of the attractive character of nonlinear, nonlocal, and nonhamiltonian interactions due to deep wave-overlappings in singlet coupling (and their repulsive character in triplet coupling).

The isoelectronium also sees its foundations in subsequent studies by Animalu [7b] of 1994 and Animalu and Santilli [7c] of 1995 on the construction of *hadronic superconductivity* for a quantitative representation of the structure of the Cooper pair. We have in this case an occurrence similar to the preceding one for the structure of the π^0. In fact, quantum mechanics can indeed represent superconductivity, but only via an *ensemble of Cooper pairs*, all assumed to be point-like. In particular, quantum mechanics simply cannot represent the struc-

ture of *one* Cooper pair, due to the divergent character of the Coulomb repulsion between the identical electrons of the pair.

Again Animalu-Santilli hadronic superconductivity did indeed resolve this insufficiency and permitted, for the first time, the achievement of a structure model of *one* Cooper pair in remarkable agreement with experimental data. Hadronic superconductivity also shows predictive capacities simply absent in quantum mechanics, such as *the prediction of a new electric current mostly given by the motion of electron pairs, rather than the conventional electric current composed of individual electrons* (patent pending). Such a new hadronic current implies an evident reduction of the electric resistance due to the essentially null magnetic moment of the pair, as compared to the large magnetic moment of individual electrons, and its interactions with atomic electrons when moving within a conductor.

Note finally that the preceding hadronic model of the π^0 and of the Cooper pair are ultimately due to the capability of hadronic mechanics to eliminate divergencies at short distances, which is technically realized via the isotopies of the unit and related associative products of quantum mechanics

$$I \to \hat{I} = 1/\hat{T}, \tag{9.1.51a}$$

$$|\hat{I}| \gg 1, \quad |\hat{T}| \ll 1, \tag{9.1.51b}$$

$$A \times B \to A \times \hat{T} \times B, \tag{9.1.51c}$$

under which divergent or slowly convergent series can be evidently turned into rapidly convergent forms.

The tendency of identical valence electrons to bond into the isoelectronium is additionally confirmed by other evidence, such as ball lighting, which are composed by a very large number of electrons bonded together into a small region.

In summary, incontrovertible experimental evidence establishes that *electrons have the capability of bonding themselves at short distances contrary to their Coulomb repulsion*. Quantum mechanics simply cannot provide a scientific study of this physical reality. Hadronic mechanics resolved this impasse, by first identifying the conditions needed to achieve attraction, called "trigger," and then permitting quantitative numerical study of the bond.

The isoelectronium results in having deep connections with a variety of studies in chemistry conducted throughout the 20-th century [6, 8 – 38], and actually provides the physical-chemical foundations for these studies as well as their appropriate mathematical formulation for the invariance of the results.

In summary, *the isochemical model of molecular bonds submitted by Santilli and Shillady [5] is supported by the following conceptual, theoretical and experimental evidence:*

1) The isoelectronium introduces a new *attractive* force among the *neutral* atoms of a molecular structure which is absent in quantum chemistry and permits a quantitative understanding of the *strength* and *stability* of molecular bonds.

2) The isoelectronium permits an immediate interpretation of the reasons why the H_2 and H_2O molecules only admit *two* H-atoms.

3) The isoelectronium permits the achievement of a representation of the binding energy of the hydrogen molecule which is accurate to the *seventh digit*, thus allowing meaningful thermodynamical calculations.

4) The isoelectronium provides an explanation of the long known, yet little understood Pauli's exclusion principle, according to which electrons correlate themselves in singlet when on the same orbital without any exchange of energy, thus via a process essentially outside the representational capabilities of quantum mechanics and chemistry.

5) The isoelectronium is consistent with the known existence of superconducting electron-pairs which bond themselves so strongly to tunnel together through a potential barrier.

6) The isoelectronium provides a quantitative model for the explanation of electron correlations. Instead of a complicated "dance of electrons" described by positive energy excitations, the isochemistry explanation is that electrons are energetically just outside the horizon of a deep attractive potential well due to their wavefunctions overlapping beyond the critical threshold of the hadronic horizon.

7) The isoelectronium is consistent with the "Coulomb hole" studied by Boyd and Yee [35] as found from subtracting accurate explicitly-correlated wavefunctions from self-consistent-field wavefunctions. In our studies the "Coulomb hole" is re-interpreted as a "hadronic attraction".

8) The isoelectronium is also in agreement with the "bipolaron" calculated for anion vacancies in KCl by Fois, Selloni, Parinello and Car [36] and bipolaron spectra reported by Xia and Bloomfield [37].

9) The isoelectronium permits an increase of the speed in computer calculations conservatively estimated at least 1,000-fold, and prevents the inconsistent prediction that all molecules are ferromagnetic (see Chapter 7).

Moreover, *another remarkable result of this study is that the value of the radius of the isoelectronium,* 0.69×10^{-10} *cm, computed via dynamical equations in Sect. 9.3 has been fully confirmed by the independent calculations conducted in Sects. 9.1.6 and 9.1.7 via the Gaussian-lobe basis set, yielding 0.00671* Å.

We should also mention *preliminary yet direct experimental verifications of the isoelectronium offered by the ongoing experiments on photoproduction of the valence electrons in the helium indicating that electrons are emitted in pairs* [38]. The studies of this monograph warrant the systematic conduction of these experiments *specifically for the hydrogen molecule*, and the experimental finalization as

to whether electrons are emitted in an isolated form or in pairs, including relative percentages of both emissions. If conducted below the threshold of disintegration of the isoelectronium, the proposed experiments can evidently provide final proof of the existence of the isoelectronium.

We should finally note that *the representation of the binding energy and other characteristics of the hydrogen molecule exact to the seventh digit first achieved in Ref. [5] constitutes the strongest experimental evidence to date on the insufficiency of quantum mechanics and the validity of the covering hadronic mechanics for the representation of nonlinear, nonlocal, and nonpotential, thus nonhamiltonian and nonunitary effects due to deep overlappings of the "extended wavepackets" of electrons with a "point-like charge structure."*

It is evident that all the above results provide scientific credibility for the isoelectronium, the related isochemical model of molecular bonds, and the underlying hadronic chemistry, sufficient to warrant systematic theoretical and experimental studies.

As shown in Chapter 7, a significant feature of the proposed novel isochemistry is not only the capability to provide accurate representations of experimental data in shorter computer times, but also the capability to predict and quantitatively treat *new industrial applications*.

9.2 ISOCHEMICAL MODEL OF THE WATER MOLECULE

9.2.1 Introduction

Water is an extremely important compound on Planet Earth in a biological as well as geophysical sense. As a consequence, comprehensive studies on water have been conducted since the beginning of quantitative science with outstanding scientific achievements (see, e.g., Ref. [1]). Nevertheless, despite all these efforts, a number of fundamental issues on the structure of the water molecule remain still open, such as:

1) The total electrostatic force among the atomic constituents of a water molecule is null in semiclassical approximation, while the currently used forces (exchange, van der Waals and other forces [40]) are known from nuclear physics to be "weak," thus insufficient to fully explain the "strong" bond among the constituents (where the words "weak" and "strong" do not refer hereon to the corresponding interactions in particle physics). In different words, the representation of the nuclear structure required the introduction of the "strong nuclear force" because of the insufficient strength of the exchange, van der Waals and other forces. It appears that current models on the water molecule lack the equivalent of the "strong nuclear force" to achieve a full representation of molecular structures.

2) Quantum chemistry has not provided a rigorous explanation of the reason why the water molecules only has *two* hydrogen atoms. This is an evident consequence of the assumption of exchange and other nuclear-type forces which were built in nuclear physics for an *arbitrary number of constituents*, a feature which evidently persists in its entirety in molecular structures.

3) Quantum chemistry has been unable to achieve an exact representation of the binding energy of the water molecule under the rigorous implementation of its basic axioms, such as the Coulomb law. In fact, there is a historical 2% still missing despite efforts conducted throughout the 20-th century.

4) More accurate representations have been recently achieved although via the use of Gaussian screenings of the Coulomb law, which, however, are outside the class of equivalence of quantum chemistry, since they are *nonunitarily* connected to the Coulomb law.

5) Quantum chemistry cannot provide a meaningful representation of thermodynamical properties related to water. In fact, the value of 2% missing in the representation of binding energy corresponds to about 950 Kcal/mole while an ordinary thermodynamical reaction takes about 50 Kcal/mole. The use of quantum chemistry in thermodynamical calculations would, therefore, imply an error of the order of 20 times the value considered.

6) Quantum chemistry has been unable to reach an exact representation of the electric and magnetic dipole and multipole moments of the water molecule to such an extent that, sometimes, the models result in having even the *wrong sign* (see, e.g., Ref. [42a], p. 22). This insufficiency is generally assumed to be due to the incompleteness of the assumed basis, although one should not keep adding terms without deeper analysis.

7) Computer usages in quantum chemical calculations require excessively long periods of time. This occurrence, which is due to the slow convergence of conventional quantum series, has persisted to this day, despite the availability of more powerful computers.

8) Quantum chemistry has been unable to explain the "correlation energy" which is advocated for the missing percentages of the binding energies. Orbital theories work well at qualitative and semi-empirical levels, but they remain afflicted by yet unresolved problems, such as the currently used correlation among many electrons as compared to the evidence that the *correlation solely occurs for electron pairs.*

9) Quantum chemistry predicts that the water molecule is ferromagnetic, in dramatic disagreement with experimental evidence. This prediction is a consequence quantum electrodynamics, which establishes that, under an external magnetic field, the orbits of valence electrons must be polarized in such a way as to offer a magnetic polarity opposite to that of the external homogeneous field. As it is well known, the individual atoms of a water molecule preserve

their individuality in the current model of chemical bonds. As a result, quantum electrodynamics predicts that all valence electrons of the individual atoms of a water molecule acquire the same magnetic polarization under a sufficiently strong external magnetic field, resulting in a total net magnetic polarity North-South.

Particularly insidious are variational methods because they give the impression of achieving exact representations within the context of quantum chemistry, while this can be easily proved *not* to be the case. To begin, representations of 100% of the experimental data occur with the introduction of a number of *empirical parameters* which lack a physical or chemical meaning. Moreover, it is easy to prove that *variational solutions cannot be the solution of quantum chemical equations*, trivially, because the former provide 100% representations, while the latter do not. In reality, the arbitrary parameters introduced in variational and other calculations are a measure of the *deviation from the basic axioms of quantum chemistry*.

When passing from the structure of one water molecule to more general molecular structures the number of open, basic, unsolved issues increases. For instance, it is generally admitted that quantum chemistry has been unable to provide a systematic theory of the liquid state in general, let alone that of liquid water in particular [40].

Also, chemical reactions in general are *irreversible*, while the axiomatic structure of quantum chemistry is *strictly reversible* because the theory is strictly Hamiltonian and all known potential forces are reversible. This results in an irreconcilable incompatibility between the very axiomatic structure of quantum chemistry and chemical reactions in general, and those involving water in particular. In fact, an axiomatically consistent representation of irreversibility is expected to imply effects which are simply inconceivable for quantum chemistry, evidently because they are outside its structure.

When passing to water as a constituent of biological entities, the limitations of quantum chemistry reach their climax. In fact, biological structures (such as a cell) are not only irreversible (because they grow, age and die), but have such a complex structure to require multi-valued theories (also known in mathematics as hyperstructures). The expectation that quantum chemistry, with its reversible and single-valued structure, can effectively represent biological systems and their evolution is beyond the boundaries of science.

In view of the above numerous and basic limitations, in the preceding works [41] Santilli and other scientists have constructed a covering of quantum mechanics under the name of *hadronic mechanics*. By conception and construction, quantum and hadronic mechanics coincide everywhere, except inside a small sphere of radius of the order of 1 fm ($= 10^{-13}$ cm) called *hadronic horizon*, in which interior (only) the broader theory holds.

Hadronic mechanics results in being a form of "completion" of quantum mechanics much along the historical Einstein-Podolsky-Rosen argument, although achieved via the addition of contact, nonhamiltonian, nonlinear, nonlocal, and nonpotential forces due to deep overlappings of the wavepackets of particles.

On more technical grounds, hadronic mechanics is based on *new mathematics*, called *iso-, geno- and hyper-mathematics* [41c] (see Chapter 2) for the characterization of reversible, irreversible, and multivalued systems, respectively, possessing features not representable via the Hamiltonian.

These new mathematics are characterized by a progressive generalization of the trivial unit I of quantum mechanics into generalized units $\hat{I}$ of Hermitean single-valued, nonhermitean single-value, and nonhermitean multi-valued character, respectively, first proposed by Santilli in 1978 (see Refs. [41]),

$$I \to \hat{I} = \hat{I}^\dagger, \quad I \to \hat{I} \neq \hat{I}^\dagger, \quad I \to \{\hat{I}\} = \{\hat{I}_1, \hat{I}_2, \hat{I}_3, ...\} \neq \{\hat{I}\}^\dagger. \tag{9.2.1}$$

The new mathematics then emerge from the reconstruction of the conventional mathematics of quantum mechanics in such a way as to admit $\hat{I}$, rather than I, as the correct left and right unit at *all* levels.

The iso-, geno-, and hyper-mathematics characterize corresponding branches of hadronic mechanics, called *iso-, geno-, and hyper-mechanics*, which have been constructed for the corresponding representation of:

1) closed-isolated, reversible, single-valued systems with Hamiltonian and nonhamiltonian internal forces;

2) open-nonconservative, irreversible, single valued systems with unrestricted interactions with an external system; and

3) open-nonconservative, irreversible, multi-valued systems of arbitrary structure.

Subsequently, Animalu and Santilli [43] constructed *hadronic superconductivity*, with corresponding iso-, geno-, and hyper-branches (Sect. 9.1.9) for the representation of the *structure* (rather than an ensemble) of the Cooper pairs, in a way remarkably in agreement with experimental data.

In 1999, Santilli and Shillady [43a] constructed *hadronic chemistry* (Chapter 3) with corresponding branches called *iso-, geno-, and hyperchemistry*. Since molecules are considered as isolated from the rest of the universe, and are reversible in time, they are studied via *isochemistry*.

Santilli and Shillady [43a] also constructed *a new isochemical model of the hydrogen molecule* (Chapter 4) based on the assumption that *pairs of valence electrons from different atoms couple themselves into a singlet quasi-particle state called isoelectronium*.

As shown in Chapter 4, the new model was proved to resolve at least the major insufficiencies of the quantum chemical model of the hydrogen molecule, such as: explain why the molecule has only two H-atoms; represent the binding energy

to the seventh digit; achieve computer calculations which converge at least 1,000 times faster than those of quantum chemistry; and permit other advances.

The main scope of this chapter is that of studying the *new isochemical model of the water molecule* first submitted by Santilli and Shillady in Ref. [43b] via a suitable expansion of the results obtained for the hydrogen molecule.

The main assumption is that, when the valence electrons of the water molecule correlate-bond themselves into singlet pairs in accordance with Pauli's exclusion principle, there is the emergence of *new interactions structurally beyond any hope of representation by quantum mechanics and chemistry, trivially, because they are nonhamiltonian.*

In particular, the new interactions are strongly attractive, thus introducing, for the first time, a molecular bond sufficiently "strong" to represent reality. These and other features of the model, such as the sole possible correlation-bond being in pairs, will resolve all insufficiencies 1)–9) indicated earlier, as we shall see.

To provide introductory guidelines, let us recall that the main function of the isounit $\hat{I}$ (hereon assumed to be Hermitean, single-valued and positive-definite) is that of representing all interactions, characteristics and effects outside the representational capabilities of a Hamiltonian. This includes the representation of contact, nonpotential and nonhamiltonian interactions in deep overlapping of the wavepackets of valence electrons.

By recalling that, whether conventional or generalized, the unit is the fundamental invariant of any theory, the representation of the new interactions via the generalized unit assures invariance, that is, the prediction of the same numbers for the same quantities under the same conditions but at different times.

Representation of nonhamiltonian effects via quantities other than the generalized unit are encouraged, *provided that they achieve the indicated invariance*, as a necessary condition to avoid the catastrophic inconsistencies of Sect. 9.1.7.

The most fundamental mathematical, physical, and chemical notion of the new model of structure of the water molecule studied in this Chapter is, therefore, the generalization of the trivial unit +1 of current models into the isounit.

On pragmatic grounds, isochemistry can be easily constructed via a step-by-step application of the nonunitary transform

$$\hat{I} = 1/\hat{T} = U \times U^{\dagger} > 0, \tag{9.2.2}$$

to *all* aspects of quantum chemistry (Sect. 9.1.4). In particular, we shall assume that the above isounit recovers the conventional unit outside the hadronic horizon, and its average value is much bigger than 1,

$$\lim_{r \gg 1 \text{ fm}} \hat{I} = I. \tag{9.2.3a}$$

$$|\hat{I}| \gg 1. \tag{9.2.3b}$$

Assumption (9.2.3a) will assure the compatibility of a generalized discipline for the bonding of valence electrons, while preserving conventional quantum mechanics identically for the structure of the individual atoms composing the water molecule. Assumption (9.2.3b) will assure a much faster convergence of perturbative expansions, and other features.

In summary, the new isochemical model of the water molecule [43b] studied in this chapter can be constructed via the following steps:

1) Select a nonunitary transforms according to rules (9.2.2) and (9.2.3) which is representative of contact, nonlinear, nonlocal, and nonpotential effects in deep wave-overlapping, essentially similar to that used for the hydrogen molecule [43a] of the preceding Chapter;

2) Submitting to the selected nonunitary transform the totality of the notions, equations, and operations of the conventional quantum chemical model of the water molecule; and

3) Reconstructing the entire mathematics of the conventional model in such a way as to admit $\hat{I}$, rather than I, as the correct left and right unit at *all* levels, with no known exceptions. This lifting is necessary to avoid the catastrophic inconsistencies of Sect. 1.7 (e.g., to achieve invariance), thus requiring the isotopic lifting of numbers and fields, Cartesian and trigonometric functions, ordinary and partial differential equations, *etc.*

The axiomatically correct isochemical model of the water molecule is that formulated on isospaces over isofields. However, on pragmatic grounds, one can study its *projection* on ordinary spaces over ordinary numbers, *provided* that the results are interpreted with care.

For instance, in the indicated projection there is the general emergence of a *potential*, which, as such, may lead to imply that the model carries a *potential energy* and/or it can be treated via a conventional *potential well*. Such interpretations are correct if and only if the potential is well defined on isospaces over isofields. On the contrary, if said potential solely emerges in the projection, then it has a purely mathematical meaning without any associated energy.

The best illustration of the above seemingly contradictory occurrences was that for the isoelectronium of Sect. 9.3, whose structure did indeed exhibit the appearance of the *Hulten potential*, yet the quasi-particle had *no binding energy*. The reason is that binding energies are indeed well defined on isospaces over isofields via the isoschrödinger's equation and related isoeigenvalues, while the Hulten potential does not exist on isospaces, and solely occurs in the projection of the isoschrödinger's equation on ordinary Hilbert spaces.

To illustrate this important point, consider the isotopies of the conventional Schrödinger's equation via the nonunitary transform indicated above,

$$\begin{aligned} U\times(H\times|\psi\rangle) = (U\times H\times U^\dagger)\times(U\times U^\dagger)^{-1}\times(U\times|\psi\rangle) = \\ = \hat{H}\times\hat{T}\times|\hat{\psi}\rangle = \hat{H}\times|\hat{\psi}\rangle = U\times(E\times|\psi\rangle) = \\ = [E\times(U\times U^\dagger)]\times(U\times U^\dagger)^{-1}\times(U\times|\psi\rangle) = \hat{E}\times\hat{T}\times|\hat{\psi}\rangle = \\ = E\times|\hat{\psi}\rangle, \end{aligned} \tag{9.2.4}$$

with corresponding liftings of numbers and Hilbert spaces,

$$U\times n\times U^\dagger = n\times(U\times U^\dagger) = n\times\hat{I}, \quad \hat{n}\in\hat{\mathrm{R}}, \tag{9.2.5a}$$

$$U\times\langle\psi|\times|\psi\rangle\times U^\dagger = \langle\hat{\psi}|\times\hat{T}\times|\hat{\psi}\rangle\times(U\times U^\dagger) = \langle\hat{\psi}|\times|\hat{\psi}\rangle\times\hat{I}\in\hat{\mathcal{C}}. \tag{9.2.5b}$$

As one can see, binding energies $\hat{E} = E\times\hat{I}$ are fully defined on isohilbert spaces $\hat{\mathcal{H}}$ over isofields $\hat{\mathrm{R}}$, and actually acquire the conventional value E following the simplification $\hat{E}\times\hat{T}\times|\hat{\psi}\rangle = (E/\hat{T})\times\hat{T}\times|\hat{\psi}\rangle = E\times|\hat{\psi}\rangle$.

However, *the Hulten potential does not exist on isospaces over isofields*, trivially, because it does not exist in the Hamiltonian $\hat{H}$ which is fully conventional.

The Hulten potential of the isoelectronium of Sect. 9.3 emerge only when we project the real system, that on isohilbert spaces with equation $\hat{H}\times|\hat{\psi}\rangle = E\times|\hat{\psi}\rangle$, on conventional Hilbert spaces. As such, one should not expect that the Hulten potential necessarily carries an actual binding energy.

The reader should equally exercise caution for other aspects, and generally abstain from formulating opinions for hadronic chemistry essentially dependent on quantum chemical concepts and notions.

9.2.2 Main Characteristics of the Water Molecule

Water is a mixture of several different molecules in different percentages and molecular weights. In fact, we know *three* different isotopes of the hydrogen, ^{1}H, ^{2}H and ^{3}H, and *six* different isotopes of the oxygen ranging from ^{14}O to ^{19}O. In this monograph, we shall solely study the molecule $^1H_2-^{16}O$, and denote it H_2O = H-O-H where the symbol "−" is referred to the molecular bond. Such a water molecule will be studied hereon under the following conditions: 1) at absolute zero degrees °K; 2) in the absence of any rotational, vibrational, translational, or other motions; and 3) with all atoms in their ground state (see Ref. [40] for all details contained in this section).

The electrons of the individual H-atoms are assumed to be in the ground state $1s$. Of the eight electrons of the oxygen, two electrons with opposite spin orientation are in the lowest $1s$ state which is tightly bound to the nucleus; two electrons are in the next possible state $2s$; and the remaining four electrons are in the $2p$ state.

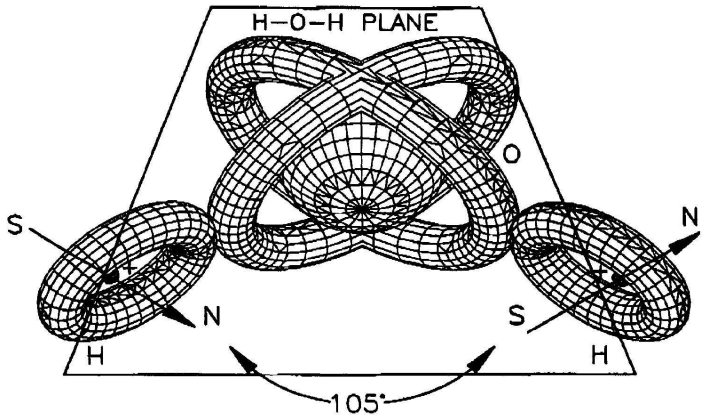

Figure 9.8. A conceptual rendering of the conventional water molecule with its typical electric polarization. Note the consequential predominance of a positive charge in the two hydrogen atoms that is responsible in part for the angle of 105° between the two HO radicals.

By using a three-dimensional reference frame with the y-z plane containing the nuclei of the H and O-atoms with origin in the latter, the $1s$ and $2s$ electrons have a spherical distribution while the $2p$ electrons are in orbitals perpendicular to the yz plane denoted $2p_x$; the remaining two electrons have orbitals perpendicular to the xz and xy planes denoted $2p_y$ and $2p_z$, respectively.

Also, the energy of formation of the water molecule from hydrogen and oxygen is -9.511 eV; the binding energy is -10.086 eV; the sum of the ground state energies of the three separate atoms is $-2,070.46$ eV; the total molecular energy at 0°K is $-2,080.55$ eV as a result of kinetic energy +2,080.6 and potential energy $-4,411.4$; the nuclear repulsion energy is +250.2 eV; the total electrostatic energy is $-2,330.8$ eV; the dissociation energy of O-H is 5.11 eV and that of H alone is 4.40 eV.

Again at 0°K and for all atoms in their ground states, the bond length of the H-O dimer is 0.95718×10^{-8} cm, while the two dimers H-O and O-H form a characteristic angle of 104.523°. Therefore, by no means the scripture H-O-H denotes that the water has a linear structure because of the indicated characteristic angles in between the two dimers H-O and O-H.

It is evident that when the individual atoms are in their excited states, the bond length and the characteristic angle change. In fact, increases of up to 8.5° have been measured for the characteristic H-O-H angle for excited states. The same characteristic angle is expected to be altered by the application of suffi-

ciently strong electric and magnetic fields, although we are unaware of accurate measurements under the indicated conditions.

The water molecule possesses an electric dipole moment of 1.83×10^{-8} e.s.u. cm and a mean quadrupole moment of -5.6×10^{-26} e.s.u. cm. It should be recalled that the very existence of a non-null value of electric dipole and quadruple moments excludes the linear structure of the water H-O-H in ordinary isolated conditions (that with a characteristic angle of 180°).

Water is a *diamagnetic* substance with a magnetic polarization (also called susceptibility) of (2.46, 0.77 and 1.42)$\times10^{-6}$ e.m.u./mole for the corresponding three space-dimension xx, yy and zz, respectively.

In first approximation, the water molecule can be represented via two individual H-O dimers with wavefunction of the molecular orbitals (m.o.'s),

$$\psi_1 = \lambda\phi(\mathrm{H}', 1s) + \mu\phi(\mathrm{O}, 2p_z), \tag{9.2.6a}$$

$$\psi_2 = \lambda\phi(\mathrm{H}'', 1s) + \mu\phi(\mathrm{O}, 2p_y), \tag{9.2.6b}$$

where λ and μ are parameters.

However, the above simple model predicts a characteristic angle of 90°. As a consequence, the model is generally modified with a mixture of electrons from the $2p$ and $2s$ states also called *hybridization*. The occurrence confirms that any model of the water with charge distributions of the valence electrons in the H-O-H plane is insufficient to represent the experimental data. In turn, this mixing creates the known two *lobes* on the side of the oxygen atom, away from the hydrogen atoms, above and below the molecular plane. This results in models of the type

$$\psi_1 = \lambda[\cos\varepsilon\psi(\mathrm{O}, 2s) + \sin\varepsilon\phi((\mathrm{O}, 2p)] + \mu\phi(\mathrm{H}', 1s), \tag{9.2.7a}$$

$$\psi_2 = \lambda[\cos\varepsilon\psi(\mathrm{O}, 2s) + \sin\varepsilon\phi((\mathrm{O}, 2p)] + \mu\phi(\mathrm{H}'', 1s), \tag{9.2.7b}$$

where ε is the hybridization parameter with generic value of the order of $\cos\varepsilon = 0.093$ confirming that the valence electrons are mainly from $2p$ states.

It should be indicated that the exact configuration, location and function of the two lone-pair electron lobes are unsettled at this writing, since they are evidently dependent on the selected theoretical model. Also, the individual electric and/or magnetic dipoles of the lobes cannot be measured (only their total values is measurable), thus implying lack of direct experimental evidence on the individual lobes.

We should also recall that the individual H-O and O-H bonds are not independent from each other, as confirmed by the different values of the dissociation energies.

Water is both an acid and a base due to dissociation of H_2O into H^+ and O-H^- to the extent that the product of the concentrations $[H^+][O\text{-}H^-]$ sets up

an equilibrium whose constant value is 1.0×10^{-14}, which is the well known pH scale of the equations

$$\text{pH} = -\log_{10}[\text{H}^+], \quad \text{pOH} = 14 - \text{pH}. \tag{9.2.8}$$

In neutral water the ion concentrations are $[\text{H}^+] = [\text{O-H}^-] = 1.004 \times 10^{-7}$ mole/liter.

Water is quite polar with a dipole moment of 1.84 to 1.834 Debye and a bulk dielectric constant of 80 at 20 °C. This implies that pure water is not a good conductor, with a direct current conductivity of only 5.7×10^{-8} ohm^{-1}·cm^{-1}.

However, it is well known that small amounts of strong acids such as HCl or H_2SO_4 can make water highly conducting due to the ease with which H^+ can attach to H_2O to form H_3O^+ which then offers a *domino effect* for one H^+ to successively "bump" an H^+ off the other side of H_3O^+ and so produce a very effective conduction mechanism [44]. In fact it is well known that in aqueous solutions the transport numbers for the anions and cations are not equal, because up to 70% of the current is carried by H^+. Although OH^- typically carries much less current than H^+ in aqueous conduction of electricity (due to its larger size and lack of the domino-effect cited earlier for H^+), once a current flow is initiated additional ions are created due to collisions in solution.

An important aspect is the known existence of an equilibrium between H-O-O-H and HO^- around pH 11.63 [45] with a voltage dependence of 1.363 ± 0.0293 pH as given by M. Pourbaix for aqueous equilibria involving H^+, O-H$^-$, H$^-$, H-O-O-H and H-O$^-$. Thus, there is no doubt of the existence of small amounts of H-O-O-H in water at high pH.

In a high current process the flow of H^+ will be much greater than that of OH^- so that as H_2O is electrolyzed to $2H_2$ and $1O_2$, local concentrations/fluctuations will slightly favor higher pH (local depletion of H^+) and hence favor the existence of H-O-O-H.

We should finally mention the inability of quantum chemistry to achieve a scientific-quantitative representation (or at least an understanding) of the *different types of water when exposed to magnetic fields*, as established by the evidence, e.g., that plants grow faster when irrigated with water exposed to one type of magnetic field, while they die rapidly when exposed to a different type of magnetic field. In fact, quantum chemistry admits only *one* type of water, H_2O.

It is easy to see that this additional insufficiency of quantum chemistry is a direct consequence of the current use of exchange, van der Waals and other forces of nuclear origin under which the individual H and O atoms in the H_2O molecule preserve their individuality, thus resulting in one single configuration.

On the contrary, isochemistry introduces a real, strong bond for the valence electrons via the notion of isoelectronium. In this latter case different types of water, that is, water molecules with different physical characteristics, are indeed readily possible, as we shall see.

9.2.3 Exactly Solvable Model of the Water Molecule with Stable Isoelectronium

In the preceding Chapter 3 [43a], we have introduced the main hypothesis of the *isochemical molecular model*, according to which two electrons from two different atoms bond themselves into a singlet quasi-stable and quasi-particle state called *isoelectronium*, which describes an *oo*-shaped orbit around the nuclei, as it is the case for planets in certain binary stars (Fig. 9.3). The main characteristics of the isoelectronium in first nonrelativistic approximation are calculated in Sect. 9.3 and resulted in being:

$$\begin{gathered}\text{charge} - 2e, \quad \text{spin } 0, \quad \text{magnetic dipole moment } 0, \\ \text{mass } 1.022\text{MeV}, \quad \text{radius} = r_c = b^{-1} \approx \\ \approx (\hbar^2/m \times V)^{1/2} = (\hbar/m \times \omega)^{1/2} = 6.8432329 \times 10^{-11}\text{cm} = \\ = 0.015424288 \text{ bohrs} = 0.006843 \text{ Å}.\end{gathered} \tag{9.2.9}$$

In the above nonrelativistic approximation, the meanlife resulted in being infinite (full stability, with the understanding that relativistic corrections are expected to render such a meanlife finite (partial stability). All conventional forces of current use in chemistry (exchange, van der Waals and other forces) then hold when the valence electrons are at mutual distances bigger than the hadronic horizon.

In this Chapter, we study the *isochemical model of the water molecule* H_2O=H-O-H first introduced by Santilli and Shillady [43b], under the assumption that the molecule is considered at °C and in the absence of any rotational, oscillation or other motion. The main hypothesis is that each electron from the two H-atoms couples in singlet with one $2p$ electron from the O-atom, resulting in *two isoelectronia*, one per each H-O dimer as in Fig. 9.8.

In this Section we shall study a hadronic/isoschrödinger equation for the water molecule under the above assumptions, which equation evidently approximate, yet *exactly solvable* for the first time to our knowledge. We shall then show that the model is extendable to all other dimers comprising one hydrogen atom, such as H-C.

For this purpose, we approximate the H-O-H molecule as being composed of two intersecting identical dimers H-O with evidently only one oxygen atom. This requires a first correction due to the lack of independence of said dimers reviewed in Sect. 9.2. Moreover, in each H-O dimer we shall assume that the oxygen appears to the isoelectronium as having only one net positive charge $+e$ located in the nucleus. This evidently requires a second correction which essentially represents the screening of the various electrons of the oxygen. Additional corrections are also in order along conventional lines [40].

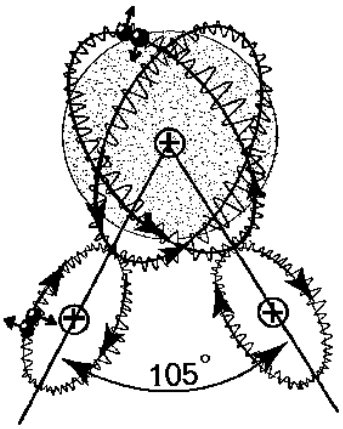

Figure 9.9. A schematic view of the proposed *isochemical model of the water molecule* here depicted at absolute zero degrees temperature and in the absence of any motion for the case of fully stable isoelectronium. It should be stressed that *at ordinary temperature rotational motions recover the conventional space distribution*, thus recovering the conventional "Mickey Mouse" configuration of the water. Also, the model is presented in terms of the *orbits* of the valence electrons (rather than in terms of *density distributions*). The fundamental assumption is that the two valence electrons, one per each pair of atoms, correlate themselves into two bonded singlet states at short distance we have called *isoelectronia*, one per each dimer H-O, which states are assumed to be mostly stable (see the text for the mostly unstable case). The water molecule is then reducible to two intersecting H-O dimers with a common O-atom. The only orbits yielding a stable water molecule are those in which each isoelectronium describes a *oo*-shaped orbit around the respective two nuclei of the H- and O-atoms. The isoelectronia are then responsible for the *attractive force* between the atoms. The *binding energy* is instead characterized by the *oo*-shaped orbits of the isoelectronia around the respective two nuclei, conceptually represented in this figure via a standing wave for a particle of spin 0 and charge $-2e$. Note that, in the absence of molecular motions, the orbits of the two isoelectronia are perpendicular to the H-O-H plane, thus confirming a characteristic of the water molecule reviewed in Sect. 9.2. Conventional exchange, van der Waals and other forces remain admitted by the model when the isoelectronia are mostly unstable. The model permits a representation of: 1) the "strong" value of the molecular bond; 2) the reason why the H_2O molecule has only two hydrogen atoms and one oxygen atom; 3) a representation of the binding energy, electric and magnetic moments accurate to several digits; and other advances studied in the text. The above model of the H-O dimer is then extendable to other H-based dimers, such as H-C.

A study of these corrections has indicated that they can all be represented via one single Gaussian screening of the Coulomb law of the type [43b]

$$\frac{+e}{r} \to \frac{+e(1 \pm e^{-\alpha r^2})}{r}, \tag{9.2.10}$$

where α is a positive parameters to be determined from experimental data, the sign "$-$" applies for the screened O-nucleus as seen from an *electron* (because of

the *repulsion* caused by the electron clouds of the oxygen), while the sign "+" applies for the screened O-nucleus as seen from the H-*nucleus* (because of the *attraction* this time caused by said electron clouds).

The resulting model is structurally equivalent to the isochemical model of the hydrogen molecule of Chapter 3 [43a], except for the modifications indicated about, and can be outlined as follows.

By denoting with the sub-indices 1 and a the hydrogen, 2 and b the oxygen, prior to the indicated screening and in the absence of all hadronic effects, the conventional Schrödinger equation of the H-O dimer with the oxygen assumed to have only one elementary charge $+e$ in the nucleus is given by

$$\left(\frac{1}{2\mu_1}p_1\times p_1+\frac{1}{2\mu_2}p_2\times p_2- \right.$$
$$\left.-\frac{e^2}{r_{1a}}-\frac{e^2}{r_{2a}}-\frac{e^2}{r_{1b}}-\frac{e^2}{r_{2b}}+\frac{e^2}{r_R}+\frac{e^2}{r_{12}}\right)\times|\psi\rangle=E\times|\psi\rangle, \tag{9.2.11}$$

As it was the case for the H_2-molecule, our task is that of subjecting the above model to a transform, which is nonunitary only at the short mutual distances $r_c=b^{-1}=r_{12}$ of the two valence electrons (here assumed to be hadronic horizon), and becomes unitary at bigger distances $\hat{I}_{r\leq 10^{-10}\text{cm}}\neq I$, $I_{r\gg 10^{-10}\text{cm}}=I$.

We assume that the state and related Hilbert space of systems (9.2.11) can be factorized in the familiar form (in which each term is duly symmetrized or antisymmetrized)

$$|\psi\rangle=|\psi_{12}\rangle\times|\psi_{1a}\rangle\times|\psi_{1b}\rangle\times|\psi_{2a}\rangle\times|\psi_{2b}\rangle\times|\psi_R\rangle, \tag{9.2.12a}$$

$$\mathcal{H}_{\text{Tot}}=\mathcal{H}_{12}\times\mathcal{H}_{1a}\times\mathcal{H}_{1b}\times\mathcal{H}_{2a}\times\mathcal{H}_{2b}\times\mathcal{H}_R. \tag{9.2.12b}$$

The nonunitary transform we are looking for shall act only on the r_{12} variable characterizing the isoelectronium while leaving all other variables unchanged. The simplest possible solution is given by

$$U(r_{12})\times U^\dagger(r_{12})=\hat{I}=e^{[\psi(r_{12})/\hat{\psi}(r_{12})]\int d\mathbf{r}_{12}\hat{\psi}^\dagger(r_{12})_{1\downarrow}\times\hat{\psi}(r_{12})_{2\uparrow}}, \tag{9.2.13}$$

where the ψ's represents conventional wavefunction and the $\hat{\psi}$'s represent isowavefunctions, for which we have, again the fundamental condition of fast convergence

$$|\hat{T}|=|(U\times U^\dagger)^{-1}|\ll 1. \tag{9.2.14}$$

We now construct the isochemical model by transforming short-range terms (isochemistry) and adding un-transformed long range ones (chemistry), thus resulting in the radial equation

$$\left(-\frac{\hbar^2}{2\times\mu_1}\times\hat{T}\times\nabla_1\times\hat{T}\times\nabla_1-\frac{\hbar^2}{2\times\mu_2}\times\hat{T}\times\nabla_2\times\hat{T}\times\nabla_2+\right.$$

$$+\frac{e^2}{r_{12}}\times\hat{T}-\frac{e^2}{r_{1a}}-\frac{e^2}{r_{2a}}-\frac{e^2}{r_{1b}}-\frac{e^2}{r_{2b}}+\frac{e^2}{R}\Big)\times|\hat{\psi}\rangle=E|\hat{\psi}\rangle. \tag{9.2.15}$$

By recalling that the Hulten potential behaves at small distances like the Coulomb one, Eq. (9.2.15) becomes

$$\Big(-\frac{\hbar^2}{2\times\mu_1}\times\nabla_1^2-\frac{\hbar^2}{2\times\mu_2}\times\nabla_2^2-V\times\frac{e^{-r_{12}\times b}}{1-e^{-r_{12}\times b}}-$$
$$-\frac{e^2}{r_{1a}}-\frac{e^2}{r_{2a}}-\frac{e^2}{r_{1b}}-\frac{e^2}{r_{2b}}+\frac{e^2}{R}\Big)\times|\hat{\psi}\rangle=E\times|\hat{\psi}\rangle. \tag{9.2.16}$$

The above model can be subjected to an important simplification. In first approximation under the assumption herein considered, the H-O dimer (9.2.16) can be reduced to a *restricted three body problem* similar to that possible for the conventional H_2^+ *ion* [41], but *not* for the conventional H_2 molecule, according to the equation

$$\Big(-\frac{\hbar^2}{2\mu_1}\times\nabla_1^2-\frac{\hbar^2}{2\mu_2}\times\nabla_1^2-V\times\frac{e^{-r_{12}b}}{1-e^{-r_{12}b}}-$$
$$-\frac{2e^2}{r_a}-\frac{2e^2}{r_b}+\frac{e^2}{R}\Big)\times|\hat{\psi}\rangle=E\times|\hat{\psi}\rangle. \tag{9.2.17}$$

The indicated corrections due to the screening of the various electrons in the oxygen and other corrections are needed in the "sensing" of the O-nucleus by the isoelectronium as well as by the H-nucleus, yielding in this way our final model

$$\Big(-\frac{\hbar^2}{2\mu_1}\times\nabla_1^2-\frac{\hbar^2}{2\mu_2}\times\nabla_2^2-V\times\frac{e^{-r_{12}b}}{1-e^{-r_{12}b}}-$$
$$-\frac{2e^2}{r_a}-\frac{2e^2(1-e^{-\alpha r_b})}{r_b}+\frac{e^2(1+e^{-\alpha R})}{R}\Big)\times|\hat{\psi}\rangle=E\times|\hat{\psi}\rangle, \tag{9.2.18}$$

where: α is a positive parameter; E is half of the binding energy of the water molecule; and, as it was the case for model (9.1.35), the mass of the isoelectronium, the internuclear distance, and the size of the isoelectronium can be fitted from the value of the binding energy and other data.

Under the latter approximation, the model admits an exact analytic solution, for the first time to our knowledge, which solution however exists only for the case of the *fully stable isoelectronium*. In fact, for the unstable isoelectronium, the model becomes a *four-body structure*, which as such admits no exact solution.

Besides being exactly solvable, model (9.2.18) exhibits a *new explicitly attractive "strong" force among the neutral atoms of the H-O dimer*, which is absent in conventional quantum chemistry; the equation also explains the reasons why the water molecule admits only *two* H-atoms.

As we shall see in the remaining sections, the model permits an essentially exact representation of the binding energy, electric and magnetic moments; the model yields much faster convergence of series with much reduced computer times, and resolves other insufficiencies of conventional models.

Finally, the model is evidently extendable with simple adjustment to an exact solution of other dimers involving the hydrogen, such as H-C. In addition, it permits the identification of electric and magnetic polarizations, which are not predictable with quantum chemistry (Chapter 8).

9.2.4 Gaussian Approximation of the Isochemical Model of the Water Molecule with Unstable Isoelectronium

The solution of the exactly solvable model (9.2.18) are not available at this writing, and its study is here encouraged. In this section, we review the studies of Ref. [43b] on a Gaussian *approximation* of the isochemical model of the water molecules, with the Hulten potential approximated to a certain Gaussian form.

It should be indicated from the onset that such an approximation implies an evident weakening of the Hulten attraction among the two isoelectrons of the isoelectronium, which, in turn, implies the instability of the isoelectronium itself, thus reaching a model which is somewhat intermediate between the full isochemical model and the conventional quantum chemical model of the water.

Despite this approximate character, the results of this section are significant because they show the capability of isochemistry to achieve an essentially exact representation of the binding energy, electric and magnetic moments and other characteristics of the water molecule.

The results of this study can be outlined as follows. Since HOOH will be slightly more allowed under the assumed conditions, collisions of HO^- with neutral H_2O and the internal repulsion within the anion could favor the release of a quasiparticle with charge $-2e$ to form OH^+. Collisions of OH^+ with OH^- will then further enhance the concentration of HOOH, and transport of $-2e$ will contribute to the current.

The question here is whether under extreme cases of forced conduction a singlet-pair of electrons (isoelectronium), can be "triggered" (Fig. 9.6) within a water molecule to form and release a $-2e$ charged isoelectronium particle which will provide an additional conduction mechanism analogous to Cooper-pairs of electrons in superconducting solids.

Since the energy depth of the V_0 parameter in the isoelectronium Hulten potential of the original 1978 derivation by Santilli [42] is not known, nor how closely the Gaussian representation fits the Hulten form, we can only match the radius of the two potentials and calculate the energy differences caused by the "sticky-electrons" model in which a transient form of isoelectronium can occur

(the Gaussian potential well may not be deep enough to ensure a permanent bound state for the isoelectronium).

The "sticky-electron" model is a parametric model which includes the magnetic dipole attraction between singlet-paired electrons, as well as the nonlocal merging of the wave-packets of each electron at short distance. The radius of the Gaussian screening is then determined empirically by fitting the calculated energy as nearly as possible to the most accurate energy values available.

As used here, it should be emphasized that the off-axis positions of the Gaussian-lobe basis sets [46-48] ensure that angular correlation is included as well as radial dependence, and can include the magnetic dipole attraction of opposite electron spins as well as merger of wavepackets.

One radial screening parameter used with off-axis basis sets parametrically covers all forms of short range attraction which may include angular dependence. Thus the present model can give us an approximate energy difference required to release an electron-pair from OH^-.

$$OH^- \to OH^+ + (2e)^{-2}. \tag{9.2.19}$$

It will be seen below that the energy difference between OH^- and OH^+ as calculated, allowing a transient form of isoelectronium, is well within the voltage accessible using capacitive discharge through water. Such a mechanism which would allow $-2e$ particles to flow through water would not be superconductivity as conventionally understood, since the freely moving molecules and ions are not constrained to lattice positions as in solids, so that resistive I^2R heating will still occur.

This is mainly due to the fact that conduction in liquids occurs by mobility of both anions and cations along with size differences, polarizability differences and special mechanisms such as the hydrogen-bonding "domino effect" for H^+ transport. In solid-state conduction, only the electrons move by ignoring in-place phonon oscillations because the atoms do not travel from one electrode to the other.

Despite the indicated lack of superconducting character, it should be indicated that yet, the essentially null magnetic moment of the $-2e$ particle would imply indeed a reduction of the resistivity.

The apparent motion of positively charges "holes" is also due to motion of electrons while the atoms merely oscillate about mean lattice positions. In solutions there is a two-way traffic with positive and negative ions travelling in opposite directions and with differing velocities, thus leading to resistive heat even up to the vaporization of the water as well as a high probability of ion collisions.

It should be noted that in recent work Ashoori *et. al.* [49] have measured migration of paired-electrons to quantum dot wells in GaAs, while Boyd and Yee [50] have observed "bipolaron" electron pairs in alkali halide lattice vacancies. Calculations leading to unexpected bipolarons in crystal lattice vacancies have

also been observed by using the method of Car and Parinello [51]. These findings in solids lend support to the concept of an electron pair as an individual particle, called by the authors isoelectronium.

The calculations given here do not prove the presence of isoelectronium particles in high current aqueous electrical conduction; they only indicate the energy threshold necessary to form the isoelectronium within the conducting solution by double-ionization of OH^-.

It is not easy to envision an experiment that would be able to analyze components of a given current, due to multiple ion species in terms of the amount of current due to $-2e$ particles, and none is proposed here. However, there may be a chemical test for such a mechanism. Once OH^- is doubly-ionized to form OH^+, collisions with $-2e$ particles would regenerate OH^- ions just as collisions of H^+ with OH^- will reform H_2O,and no new species will be evident.

However, if OH^- collides with OH^+ a new chemical species HO-OH will be formed that may last long enough in the liquid to behave as a strong oxidizing agent. Thus, organic compounds with double bonds (alkenes), which have negligible conductance, could be added to water undergoing a high current flow to cause hydroxylation of such compounds [52], (i.e., conversion of alkenes to epoxide, which are then readily hydrolyzed in the presence of H^+ to diols). Enhanced concentrations of epoxides and diols would be indirect evidence of double ionization of OH^-, according to the expressions

$$OH^+ + OH^- \rightarrow HO-OH, \tag{9.2.20}$$

$$CH_2=CHR + HO-OH \rightarrow \begin{array}{c} CH = CHR \\ \backslash \quad / \\ O \end{array} + H_2O.$$

If the isoelectronium can be detected indirectly by a chemical method, this would in itself be an important inference on the existence of a two-electrons, spin-zero particle. More importantly, "isochemical reactions" could be driven by high conduction "liquid plasma" environments where the isoelectronium is at an enhanced concentration.

Another case of interest is that of aqueous mixtures of insoluble organic compounds forming a separate oil layer over water in an intense magnetic field of several Tesla. At normal thermal energy of room temperature $kT \cong RT$ per mole the main energy form would be random Brownian motion.

However, in the presence of a strong magnetic field HO^+ and HO^- would be constrained to favor circular motions in the magnetic field by the "cyclotron effect," but there is no obvious source of HO^+.

Since two ions of opposite sign charges would be favored to collide by both electrical attraction and by opposite path curvature in a magnetic field, there is an enhancement that when created as a normal result of H^+, OH^-,H^-, H_2O_2, HO_2^-,

H_2O equilibrium system studied by Pourbaix [45], any natural concentration of HOOH would be augmented by collision of H^+ with HOO^-.

In addition there is some slight chance that H^+ would collide with OH^- with sufficient excess energy to produce OH^+ and H^-. Thus the presence of an intense magnetic field would cause positive and negative ions to collide more easily while travelling in opposite rotational arcs in such a way as to enhance the concentration of HOOH,

$$H^+ + HOO^- \to HOOH, \tag{9.2.21a}$$

$$H^+ + OH^- \to H^- + OH^+, \tag{9.2.21b}$$

$$OH^+ + OH^- \to HOOH, \tag{9.2.21c}$$

which could then epoxidate alkenes and upon hydrolysis would lead to diols.

A direct measure of this effect would be to determine the enhanced solubility of alkenes in water. The alkenes are only slightly soluble in water ("oil and water do not mix") but alkenes converted to diols will have a measurably greater solubility in water due to the attached OH-groups. Again. If such enhanced solubility of alkenes in water can be caused by intense magnetic fields, this would be indirect evidence of the existence of an electron-pair particle with charge $-2e$.

In the description of the calculations below the key to the above possibility is that it is easy to calculate the energy of OH^- when one subtracts a small amount from the two-electron repulsion terms in the usual HFR-SCF treatment, due to the attraction of singlet-paired electrons at close range within 1.0 picometer.

In the recent *Handbook of Computational Quantum Chemistry* by Cook, Ref. [53], p. 438, it is noted that solutions to the HFR-SCF scheme may not always exist for anions. However, in the method used here convergence of the HFR-SCF method was normal for an SCF process, because the so called "self-energy" error of the Hartree-Fock method [54] (in which each electron repels all electrons including itself) is largely cancelled by the new attractive terms used here. In effect, this description of OH^- is possible because of the easy convergence of the "correlated-SCF process."

9.2.5 The Method

The model adopted in Ref. [43b] is to use the usual Hartree-Fock-Roothan self-consistent-field equations [55] (which also has some formal flaws such as the self-interaction terms [54]) and lift in a nonunitary way the form of the Coulomb interaction of the electrons.

Note that reducing the values of the Coulomb integrals will lower the energy by reducing the electron-electron repulsion while reducing the exchange terms will raise the energy, but the factor 1/2 reduces the effect of the exchange terms. Thus a reduction of the value of the integrals will lower the energy.

Note that Goodgame and Goddard [54] have already recommended reducing the atomic self-energy by subtracting 1.39 eV from Hartree-Fock exchange integrals in the cases of Cr_2 and Mo_2.

$$\text{FC} = \text{ESC}; \quad \text{F}_{i,j} = H_{i,j} + \sum_{k,l} P_{k,l}[(i,j|k,l) - 1/2(i,k|j,l)], \tag{9.2.22a}$$

$$(i,j|k,l) = \iint \chi_i(l)\chi_j(l)\frac{1}{r_{12}}\chi_k(2)\chi_l(2)d\tau_1 d\tau_2, \tag{9.2.22b}$$

$$P_{i,j} = 2\sum_n c_{n,i}c_{n,j} \quad (\text{sum } n \text{ only over occupied orbitals}). \tag{9.2.22c}$$

The 1995 paper on electron-electron pairs by Animalu and Santilli [42b] invokes the non-local hadronic attractive force evident in the π^0-meson by Santilli [42a] applied to a pair of singlet-paired electrons which form a boson quasiparticle. However, the "collapsed positronium" rapidly decays since the particle-antiparticle annihilation takes place in less than a picosecond.

In the electron-electron case it is believed that there may be a stable quasiparticle singlet bond we have called the isoelectronium. After using a non-local isotopic nonlinear transformation, the hadronic attraction was projected into real-space, and modeled with a Hulten potential.

Considerable effort was made to evaluate the matrix elements for the Hulten potential without success. Examination of the original 1978 paper on positronium collapse by Santilli [6a] revealed that the Hulten potential is not necessarily a unique representation of the hadronic force. In fact, a linear combination of similar potentials could be used to represent the Hulten potential if matrix elements of such other potentials could be evaluated.

The depth of the screened Gaussian approximation is determined by requiring that the width at half height of the Gaussian is equal to the b value of the Hulten horizon (the radius at which the Coulomb repulsion is annulled by other attractive forces). Thus, the screened Gaussian potential probably has a depth which is too shallow although the V_0 depth parameter for the Hulten potential is not known at present.

This work assumes that until matrix elements of a two-electron interaction for singlet-pairs can be found for the Hulten potential, a Gaussian-screened-Coulomb potential can be used to describe the real-space form of the hadronic attraction and as a parameter fitted to experimental energies the screening exponent probably includes other effects such as the magnetic dipole interaction of two electrons with opposite spin-magnetic-moments. This form has the important property that it can be merged with the general case of the four-center Coulomb or exchange integral derived by Shavitt [56] using the famous Gaussian transform technique.

The Gaussian transform two-electron integral for four Gaussian spheres has been used in a number of Gaussian-lobe basis SCF programs written by Shillady [57, 58] and others. It is important to note that the formula is completely general in orientation of four Gaussian sphere lobe-orbitals as well as the distance between two electrons.

As modified for a description of the correlation of two electrons, such a general formula can describe angular correlation as well as distance interaction. Thus matrix elements of a screened-Coulomb interaction were subtracted from the usual $1/r$ Coulomb repulsion to model the real-space form of the hadronic attraction of two electrons. The work outlined in this section, first presented in Ref. [43b], added the Gaussian screening as $\exp[-\alpha r^2]/r$ so that the special properties of Gaussians could be used, especially the properties that the product of two Gaussians form another Gaussian (times a re-centering factor), and that polar coordinates readily separate into factorable x, y, z components.

The goal was to evaluate the two-electron four-center matrix elements of the Gaussian-screened Coulomb potential in the expression

$$Y(r) = \frac{1 - 2\exp[-\alpha r^2]}{r}. \tag{9.2.23}$$

Amazingly, the Gaussian-Gaussian exponent and carried through the original derivation until the last step when integration over "s" is required. α is usually a very high number, this work used 0.13441885×10^7. At this point the usual Coulomb interaction resorts to a well known auxiliary function F_0 which has been studied by Shillady [57] and others.

Since both $s^{1/2}$ and $(s + \alpha)^{1/2}$ occur in the denominator of the screened-Coulomb form, two poles occur in the integral. A change of variable absorbs the pole due to $(s + \alpha)^{-1/2}$ and shifts the other pole due to $s^{-1/2}$ to the lower limit of the integral. A smooth spike is evident at the lower limit of the numerical integration using a 70 point Simpson's Rule integration (two ranges are used with 20 points more closely spaced near the pole and 50 points for the remaining range).

This work was carried out using 64 bit double precision arithmetic, which provides 14 significant figures. A simple offset δ of 1.0×10^{-15} has provided useful results with this simple offset to avoid numerical overflow.

While this pole is formally a problem in needing a continuous function to integrate, numerical integration seems to handle these Coulomb integrals are known to be accurate only to 12 significant figures. The area under the pole-spike is estimated as a narrow triangle upon a rectangle 1.0×10^{-15} wide with the height of the triangle set at 3.43207×10^8 times the height of the point set 1.0×10^{-15} into the range of integration (the first Simpson point).

The present code for this screened-Coulomb integral is presently slower that the corresponding F_0 function [56] used for the Coulomb integrals due to the

70 point Simpson integration, but the integrand is nearly flat after the spike at $s = 0.0$ so that portion of the integrand can be evaluated more rapidly with fewer points. For results presented here, the simple offset of the lower limit by 1.0×10^{-15} is adequate for this monograph. Further details on the auxiliary integral can be found in a previous paper on the H_2 molecule [59].

Work in progress indicates it may be possible to express the new auxiliary integral to an analytical expression involving the erf(x) function (see Chapter 6), but until further checks are completed this work used the Simpson integration. Note the integral is a result of a simplification of a twelve-fold integration over the volume elements of two electrons, and has been reduced to a one-dimensional integration multiplied by appropriate factors.

9.2.6 The Main Results

The geometry given for H_2O by Dunning [60] was used to carry out the usual HFR-SCF calculation after an additional $3d$ orbital mimic [58] was optimized in Ref. [43b] for the O atom and ($2s$,$2p$) orbitals were added for the H atoms. The exponent for the O$3d$ orbitals was optimized to three significant figures and the (O$3d$,H$2s$,H$2p$) exponents were (2.498, 0.500, 1.000). These polarization orbitals were added to the Dunning-Huzinaga ($10s6p$) [59] basis with the H$1s$ orbitals scaled to 1.2 which produced a lower energy than that of a 6-31G^{**} basis using the GAMESS program. The bond length of OH^+ was Angströms.

The same bond length was used for OH^- since the anion calculation using the usual HFR-SCF process was not feasible, and, in any case, the bond length is only slightly longer than that in water. The horizon cutoff value of 0.00038 Angströms optimized for H_2O was also used for OH^+ and OH^-.

The spike in the numerical integral routine was optimized by fitting the R_c cut-off value so as to obtain as near as possible the non-relativistic energy of the HF molecule as determined from Quantum Monte Carlo calculations [60]. The dipole moments for the ions are not very useful since ion dipoles are origin dependent, but they were calculated using the center-of-mass as the origin.

As we see in Table 9.3, the difference in energy between OH^- and OH^+ is 0.497621 Hartrees (13.54 eV) according to the Correlated-SCF calculations. It is clear from the standard SCF energy value for H_2O that this basis is very good, but not quite at the Hartree-Fock limit of energy. In addition, the fitting of the numerical integration spike so as to most nearly reproduce the total energy of HF is not exact.

These two artifacts introduce an energy uncertainty of about 0.0115 Hartrees, but this is less uncertainty than that of the Quantum Monte Carlo (QMC) energy of Luchow and Anderson [61]. Note that the Iso-Dipoles for H_2O and HF are very close to the experimental values which indicates that the calculated wavefunctions are of high quality.

Table 9.3. Isoelectronium results for selected molecules [43b].

	OH^+	OH^-	H_2O	HF
SCF-Energy[a]	-74.860377	-75.396624	-76.058000	-100.060379
Hartree-Fock[b]				-100.07185[b]
Iso-Energy[c]	-75.056678	-75.554299	-76.388340	-100.448029
Horizon R_c (Å)	0.00038	0.00038	0.00038	0.00030
QMC Energy[b,d]	-76.430020[d]			-100.44296[b]
Exact non-rel.				-100.4595
Iso-Dipole (D)	5.552581	8.638473	1.847437	1.8413778
Exper. Dipole			1.84	1.82

[a] Dunning-Huzinaga ($10s/6p$), (6,2,1,1,1/4,1,1)+H2s1+H2p1+3d1.
[b] Iso-Energy calibrated to give maximum correlation for HF.
[c] Hartree-Fock and QMC energies from Luchow and Anderson [61].
[d] QMC energies from Hammond, Lester and Reynolds [60].

Since the ionization energy of a neutral H atom is 13.60 eV and the energy difference of 13.54 eV would convert OH^- to OH^+, a threshold of about 13.7 eV should maintain H^+ in solution as well as transfer $(2e)^{-2}$ through an aqueous solution to or from the OH^-/OH^+ system.

These calculations indicate that there may be an enhancement of current flow with a potential above 13.7 volts across an aqueous cell and that the enhanced concentration of HOOH may be measurable above a potential of 13.7 volts. It is worth repeating that this estimate is possible largely due to the easy convergence of the Correlated-SCF process for a negative ion species; a process which is formally not defined under the usual Hartree-Fock-Roothan process [53], and most quantum chemists are familiar with the difficulty in treating negative ions using the standard Hartree-Fock-Roothaan method.

Admitting that the Correlated-SCF equations are a parametrized approximation to the Santilli derivation of the Hulten potential [42a] for a bound electron-pair, the method has the advantage of easy incorporation into an existing Hartree-Fock-Roothaan Gaussian basis program merely by subtracting a small "correlation integral" from the usual two-electron integrals.

With some thought, one should realize that fitting the single parameter (Gaussian screening exponent, α) to experimental energies, and/or Quantum Monte Carlo results will incorporate another attraction in the form of a magnetic dipole interaction between the spin moments of paired electrons. Including the magnetic dipole interaction and substituting a Gaussian form for the Hulten exponential potential leaves only a simulation of the bound electron-pair Isoelectronium. Thus, these results are for a model in which the usual HFR-SCF method

is corrected for at least two attractive interactions of electrons causing them to approach each other as if they were "sticky"; hence the term "sticky-electron-pair model."

9.2.7 Conclusions

In Chapter 3, we have presented a covering of quantum chemistry under the name of *hadronic chemistry*. In Chapter 4, we have applied the new discipline to the construction of a new model of molecular structures based on the bonding of a pair of valence electrons from different atoms into a singlet quasi-particle state called *isoelectronium*.

We have then applied the model to the structure of the hydrogen molecule, by achieving results manifestly not possible with quantum chemistry, such as: a representation of the binding energy and other features of the hydrogen molecule accurate to the *seventh digit*; an explanation of the reason why the hydrogen molecule has only *two* hydrogen atoms; a reduction of computer usage at least 1,000 fold; and other advances.

In this chapter, we have applied the isochemical model of molecular bonds to the water and other molecules with similar results. In fact, *the isochemical model of the water and other molecules is supported by the following conceptual, theoretical and experimental evidence:*

1) It introduces a new strong binding force (which is absent in current models) capable of explaining the strength and stability of molecules;

2) It explains the reason why the water molecule has only *two* hydrogen atoms and one oxygen;

3) It permits a representation of the binding energy of the water and other molecules, which are accurate to *several digits*;

4) It represents electric and dipole moments and other features of the water and other molecules, also accurate to *several digits*;

5) It permits a reduction of computer usages in calculations at least 1,000 fold; as well as it permits other achievements similar to those obtained for the hydrogen molecule.

Moreover, as it happened for the hydrogen molecule in Chapter 4, *the value of the radius of the isoelectronium, Eqs. (9.2.9) computed via dynamical equations has been fully confirmed by independent calculations for the water and other molecules conducted via the Gaussian-lobe basis set.*

The emission of electron pairs in superconductivity has been emphasized in Chapter 3. In Chapter 4 we also indicated *preliminary, yet direct experimental verifications of the isochemical model of molecular bonds offered by the ongoing experiments on photoproduction of the valence electrons in the helium indicating that electrons are emitted in pairs* [62]. The systematic repetition of these experiments *specifically for water* is here recommended. The statistical percentages

of electron pairs over the total number of emitted electrons would then establish whether the isoelectronium is fully or only partially stable.

We should finally note that *the representation of the binding energy, electric and magnetic moments and other characteristics of the water and other molecules exact to the several digits, as first achieved in Refs.* [43] *constitutes the strongest experimental evidence to date on the insufficiency of quantum mechanics and the validity of the covering hadronic mechanics for the representation of nonlinear, nonlocal and nonpotential-nonunitary effects, due to deep overlappings of the "extended wavepackets" of electrons with a point-like charge structure.*

The new isochemical model of the water molecule outlined in this chapter has a number of intriguing new applications. For instance, the correlated-SCF method is used to easily obtain an energy for the OH- anion in water, while the OH^+ ion is easily treated in either the standard or modified method. The difference in energy between the 8-electron OH^+ system and the 10-electron OH^- system is found to be 13.54 eV. This represents the energy needed to remove $(2e)^{-2}$ from OH^-. This indicates there may be a threshold for current flow in terms of $(2e)^{-2}$ as a quasi-particle in aqueous media at 13.6 eV. This voltage will also maintain H^+ in solution to some extent. Organic alkenes in solution should undergo epoxidation followed by solvolysis to diols under the conditions of abundant $(2e)^{-2}$.

Another interesting result is that the natural trace amounts of HOOH in water may be increased in water by merely placing the sample in an intense magnetic field. Positive and negative ions will traverse short arc segment paths driven by simple thermal Brownian motion in a way which will lead to an increase in collisions of oppositely charged ions. In particular, OH^- and OH^+ may undergo collisions more frequently leading to an increase in HOOH.

This additional HOOH should then be available to react with alkenes to form epoxides which will then hydrolyze in water to form diols. Such diols would be much more soluble in water than the original alkenes. This leads to the important possibility that merely exposing water-insoluble alkenes to water in a magnetic field will lead to a chemical reaction of the alkenes to form modified compounds which are more soluble in water. In other words, organic oils containing some double bonds may be made somewhat more soluble in water just by mechanical emulsification of the oils in water in an environment of a high magnetic field.

Thus, mixtures of oils and water could be mechanically agitated in a magnetic field of several Tesla to produce new oils which are chemically similar to the original oils (assuming a large organic structure) but more soluble in water after exposure to the magnetic field (see Chapter 8 for details).

Similarly, it is easy to see that, while the conventional quantum chemical model of the water molecule predicts one and only configuration, our isochemical model predicts various physically inequivalent configurations depending on the relative

orientation of the two *oo*-shaped orbits and other properties, which are under separate study.

The industrial significance of the studies outlined in this chapter will be presented in Chapters 7 and 8.

9.3 VARIATIONAL CALCULATIONS OF ISOCHEMICAL MODELS

9.3.1 Introduction

In Ref. [64a] outlined in Chapter 4, Santilli and Shillady introduced a restricted isochemical three-body model of the hydrogen molecule admitting an exact solution, and a full four-body isochemical model of the hydrogen molecule which no longer admits an exact solution.

In Ref. [64b] outlined in Chapter 5, Santilli and Shillady introduced two corresponding isochemical models of the water and other molecules, one based on a restricted three-body model of the HO dimer admitting exact solutions, and a second fully isochemical four-body model.

As also reviewed in Chapters 4 and 5, Shillady's SASLOBE variational method [64] showed the capability of the isochemical models to reach an essentially exact representation of experimental data on the hydrogen, water and other molecules, as well as resolving other shortcomings or inconsistencies of conventional quantum chemical molecular models.

A greatly detailed, independent verification of models [64a,64b] was conducted by A.K. Aringazin and M.G. Kucherenko [65a] via exact solution and by A.K. Aringazin [65b] via Ritz's variational method, by confirming all numerical results of Refs. [64].

In this chapter we outline Refs. [65] since they achieve new important insights and results on isochemistry of rather general character, and possible application to a variety of other molecules and applications of isochemistry.

9.3.2 Aringazin-Kucherenko Study of the Restricted, Three-Body Isochemical Model of the Hydrogen Molecule

In this section we outline the studies by Aringazin and Kucherenko [65a] of Santilli-Shillady exactly solvable, restricted three-body isochemical model of the H_2 molecule [64a], Eq. (9.1.35), $r_{12} \simeq 0$, i.e.,

$$-\frac{\hbar^2}{2M}\nabla^2_{ab}\psi + \left(-\frac{2e^2}{r_a} - \frac{2e^2}{r_b} + \frac{2e^2}{R}\right)\psi = E\psi. \tag{9.3.1}$$

As the reader will recall from Chapter 4, model (9.3.1) constitutes a limit case in which the two valence electrons are assumed to be permanently bonded together

into the stable singlet quasi-particle state with features (9.1.25), i.e.,

$$\text{mass} \simeq 1 \text{ MeV}, \quad \text{spin} = 0, \quad \text{charge} = 2e, \quad \text{magnetic moment} \simeq 0,$$
$$\text{radius} = r_c = b^{-1} = 6.8432329 \times 10^{-11} \text{ cm} = \tag{9.3.2}$$
$$= 0.015424288 \text{ bohrs} = 0.006843 \text{ Å},$$

which we have called *isoelectronium*.

The assumption of stationary nuclei (or, equivalently, nuclei with infinite inertia), then turns the four-body hydrogen molecule H_2 into a restricted three-body system which, as such, admits exact solution.

The reader should also recall that, the assumption of the rest energy of the isoelectronium as given by twice the electron mass is merely an upper boundary occurring when the internal forces are of purely nonpotential type. In reality, a total attractive force of purely potential type is possible because the magnetostatic attraction is bigger than the electrostatic repulsion as illustrated in Fig. 9.4. It is evident that the latter bond implies a negative binding energy resulting in a value of the isoelectronium mass

$$M_{\text{isoelectronium}} < 2m_{\text{electron}}, \tag{9.3.3}$$

which is unknown, and should be derived from fitting experimental data.

As one can see, the above restricted isochemical model of the H_2 molecule is similar to the conventional restricted three-body H_2^+ ion. To avoid confusion, we shall denote the three-body isochemical model with the "hat", $\hat{H}_2$, and the conventional (four-body) model without the "hat," H_2.

More specifically, studies [65a] were conducted under the following conditions:
1) the isoelectronium is stable;
2) the effective size of the isoelectronium is ignorable, in comparison to internuclear distance of H_2;
3) the two nuclei of H_2 are at rest;
4) the rest energy of the isoelectronium is assumed to be unknown and to be determined by the fit of the binding energy of the molecule;
5) the internuclear distance R of H_2 is also assumed to be unknown and to be fitted from the stability condition of the solution, and then compared with its experimental value.

A main result of Ref. [65a] is that the restricted three-body Santilli-Shillady model $\hat{H}_2$ is capable to fit the experimental binding energy for the following value of the isoelectronium mass,

$$M = 0.308381 m_e, \tag{9.3.4}$$

although its stability condition is reached for the following internuclear distance

$$R = 1.675828 \text{ a.u.}, \tag{9.3.5}$$

which is about 19.6% bigger than the conventional experimental value $R[H_2] = 1.4011$ a.u. $= 0.742$ Å.

These results confirm that the isochemical model (9.3.1) is indeed valid, but only in first approximation, in accordance with the intent of the original proposal [64a].

In Born-Oppenheimer approximation, i.e., at fixed nuclei, the equation for the H_2^+ ion-type system for a particle of mass M and charge q is given by

$$\nabla^2\psi + 2M\left(E + \frac{q}{r_a} + \frac{q}{r_b}\right)\psi = 0. \tag{9.3.6}$$

In spheroidal coordinates,

$$x = \frac{r_a + r_b}{R}, \quad 1 \le x \le \infty; \quad y = \frac{r_a - r_b}{R}, \quad -1 \le y \le 1; \quad 0 \le \varphi \le 2\pi, \tag{9.3.7}$$

where R is the separation distance between the two nuclei a and b, we have

$$\nabla^2 = \frac{4}{R^2(x^2-y^2)}\left(\frac{\partial}{\partial x}(x^2-1)\frac{\partial}{\partial x} + \frac{\partial}{\partial y}(1-y^2)\frac{\partial}{\partial y}\right) + \tag{9.3.8}$$

$$+\frac{1}{R^2(x^2-1)(1-y^2)}\frac{\partial^2}{\partial\varphi^2}.$$

Eq. (9.3.1) then becomes

$$\left[\frac{\partial}{\partial x}(x^2-1)\frac{\partial}{\partial x} + \frac{\partial}{\partial y}(1-y^2)\frac{\partial}{\partial y} + \frac{x^2-y^2}{4(x^2-1)(1-y^2)}\frac{\partial^2}{\partial\varphi^2} + \right. \tag{9.3.9}$$

$$\left. +\frac{MER^2}{2}(x^2-y^2) + 2MqRx\right]\psi = 0,$$

where

$$\frac{1}{r_a} + \frac{1}{r_b} = \frac{4}{R}\frac{x}{x^2-y^2}. \tag{9.3.10}$$

The use of the expression

$$\psi = f(x)g(y)e^{im\varphi}, \tag{9.3.11}$$

then allows the separation

$$\frac{d}{dx}\left((x^2-1)\frac{d}{dx}f\right) - \left(\lambda - 2MqRx - \frac{MER^2}{2}x^2 + \frac{m^2}{x^2-1}\right)f = 0,$$

$$\frac{d}{dy}\left((1-y^2)\frac{d}{dy}g\right) + \left(\lambda - \frac{MER^2}{2}y^2 - \frac{m^2}{1-y^2}\right)g = 0, \tag{9.3.12}$$

where λ is the separation constant. The exact solutions for $f(x)$ and $g(y)$ are given by the angular and radial Coulomb spheroidal functions (CSF) containing infinite recurrence relations.

Aringazin and Kucherenko [65a] calculated the energy levels via the use of recurrence relations of the type

$$Q_{k+1} = Q_k \bar{\kappa}_{N-k} - Q_{k-1} \bar{\rho}_{N-k} \bar{\bar{\delta}}_{N-k+1}, \quad Q_{-1} = 0, \quad Q_0 = 1, \tag{9.3.13}$$

where the coefficients are

$$\begin{aligned} \rho_s &= \frac{(s+2m+1)[b-2p(s+m+1)]}{2(s+m)+3}, \\ \kappa_s &= (s+m)(s+m+1) - \lambda, \\ \delta_s &= \frac{s[b+2p(s+m)]}{2(s+m)-1}. \end{aligned} \tag{9.3.14}$$

Ref. [65a] then used the value $N = 16$ for the power degree approximation of both the radial and angular components. The two polynomials have 16 roots for λ from which only one root is appropriate due for its asymptotic behavior at $R \to 0$. Numerical solution of the equation,

$$\lambda^{(x)}(p,a) = \lambda^{(y)}(p,b), \tag{9.3.15}$$

gives the list of values of the electronic ground state energy,

$$E(R) = E_{1s\sigma}(R), \tag{9.3.16}$$

which corresponds to $1s\sigma_g$ term of the H_2^+ ion-like system, as a function of the distance R between the nuclei. Note that the term "exact solution" refers to the fact that by taking greater values of N, for example $N = 50$, one can achieve higher accuracy, up to a desired one (for example, twelve decimals).

Also, the scaling method based on the Schrödinger equation has been developed which enables one to relate the final $E(R)$ dependence of different H_2^+ ion-like systems to each other.

Table 9.4 presents result of the calculations of the *minimal total energy* and the corresponding *optimal distance*, at various values of the isoelectronium mass parameter

$$M = \eta m_e, \tag{9.3.17}$$

where $M = \eta$, in atomic units.

Aringazin and Kucherenko [65a] computed some 27 tables, each with the identification of the minimum of the total energy, together with the corresponding optimal distance R. Then, they collected all the obtained energy minima and optimal distances in Table 9.4.

Table 9.4. The minimal total energy E_{min} and the optimal internuclear distance R_{opt} of Santilli-Shillady restricted three-body isochemical model $\hat{H}_2$ as functions of the mass M of the isoelectronium[a].

M, *a.u.*	E_{min}, *a.u.*	R_{opt}, *a.u.*	M, *a.u.*	E_{min}, *a.u.*	R_{opt}, *a.u.*
0.10	-0.380852	5.167928	0.32	-1.218726	1.614977
0.15	-0.571278	3.445291	0.33	-1.256811	1.566041
0.20	-0.761704	2.583964	0.34	-1.294896	1.519981
0.25	-0.952130	2.067171	0.35	-1.332982	1.476553
0.26	-0.990215	1.987664	0.40	-1.523408	1.291982
0.27	-1.028300	1.914050	0.45	-1.713834	1.148428
0.28	-1.066385	1.845688	0.50	-1.904260	1.033585
0.29	-1.104470	1.782044	0.75	-2.856390	0.689058
0.30	-1.142556	1.722645	1.00	-3.808520	0.516792
0.307	-1.169215	1.683367	1.25	-4.760650	0.413434
0.308	-1.173024	1.677899	1.50	-5.712780	0.344529
0.308381	-1.174475	1.675828	1.75	-6.664910	0.295310
0.309	-1.176832	1.672471	2.00	-7.617040	0.258396
0.31	-1.180641	1.667073			

[a] See also Figs. 9.10 and 9.11.

Table 9.5. Summary of main data and results on the ground state energy E and the internuclear distance R.

	E, *a.u.*	R, *a.u.*
H_2^+ ion, exact theory, N=16 [65a]	-0.6026346	1.9971579
H_2^+ ion, experiment [66]	-0.6017	2.00
3-body $\hat{H}_2$, M=2m_e, exact theory [65a]	-7.617041	0.258399
3-body $\hat{H}_2$, M=2m_e, var. theory [64a]	-7.61509174	0.2592
3-body $\hat{H}_2$, M=0.381m_e, exact theory [65a]	-1.174475	1.675828
4-body H_2, r_c=0.01125 a.u., V_g var. theory [64a]	-1.174474	1.4011
4-body H_2, r_c=0.01154 a.u., V_e var. theory [65b]	-1.144	1.4011
4-body H_2, r_c=0.08330 a.u., V_e var. theory [65b]	-1.173	1.3184
H_2, experiment	-1.174474	1.4011

With the fourth order interpolation/extrapolation, the graphical representations of Table 9.4 (see Figs. 9.10 and 9.11) show that the minimal total energy behaves as

$$E_{min}(M) \simeq -3.808M, \tag{9.3.18}$$

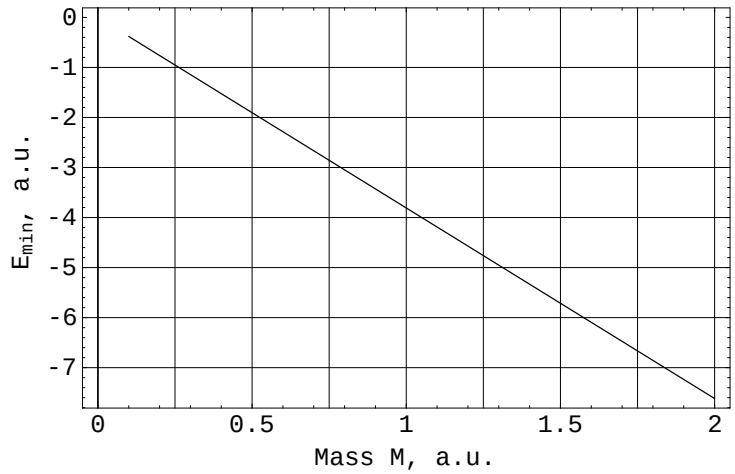

Figure 9.10. The minimal total energy $E_{min}(M)$ of the $\hat{H}_2$ system as a function of the isoelectronium mass M.

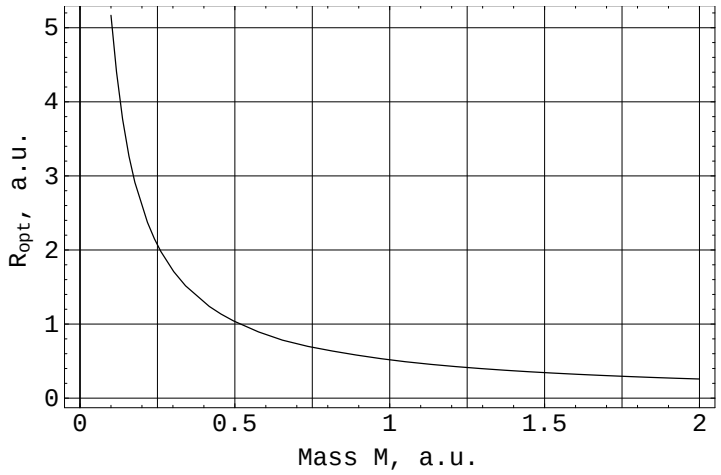

Figure 9.11. The optimal internuclear distance $R_{opt}(M)$ of the $\hat{H}_2$ system as a function of the isoelectronium mass M.

and the optimal distance behaves as

$$R_{opt}(M) \simeq 0.517/M. \tag{9.3.19}$$

One can see that at $M = 2m_e$ we have

$$E_{min}(M) = -7.617041 \text{ a.u.}, \quad R_{opt}(M) = 0.258399 \text{ a.u.}, \tag{9.3.20}$$

which recover the values obtained in Ref. [64a]

$$E_{min} = -7.61509174 \text{ a.u.}, \quad R_{opt} = 0.2592 \text{ a.u.}, \tag{9.3.21}$$

to a remarkable accuracy.

The conclusion by Aringazin and Kucherenko is that the Santilli-Shillady restricted three-body isochemical model of the hydrogen molecule is indeed valid as suggested, that is, as in first approximation. The main data and results on E_{min} and R_{opt} are collected in Table 9.5.

An important conclusion of Ref. [65a] is, therefore, that *the two valence electrons of the hydrogen molecule cannot be permanently bound inside the hadronic horizon with radius of one Fermi.*

The clear understanding, stressed in Chapter 4, is that the isoelectronium must continue to exist beyond the hadronic horizon, otherwise, in its absence, we would have a violation of Pauli's exclusion principle.

9.3.3 Aringazin Variational Study of the Four-Body Isochemical Model of the Hydrogen Molecule

In the subsequent Ref. [65b] Aringazin applied Ritz variational method to Santilli-Shillady four-body isochemical model of molecule of the hydrogen molecule (9.1.33), i.e.

$$\left(-\frac{\hbar^2}{2m_1}\nabla_1^2 - \frac{\hbar^2}{2m_2}\nabla_2^2 - V_0\frac{e^{-r_{12}/r_c}}{1-e^{-r_{12}/r_c}} + \frac{e^2}{r_{12}} - \right. \tag{9.3.22}$$

$$\left. -\frac{e^2}{r_{1a}} - \frac{e^2}{r_{2a}} - \frac{e^2}{r_{1b}} - \frac{e^2}{r_{2b}} + \frac{e^2}{R} \right) |\psi\rangle = E|\psi\rangle,$$

without restriction that the isoelectronium has the permanent dimension of about one Fermi.

In particular, Aringazin's objective was to identify the ground state energy and bond length of the H_2 molecule, in Born-Oppenheimer approximation, via a Gaussian screening of the Coulomb potential, V_g, the exponential screening of the Coulomb potential,

$$V_e = -\frac{Ae^{-r_{12}/r_c}}{r_{12}}, \tag{9.3.23}$$

as well as the original Hulten potential V_h of the model (9.3.22). The resulting analysis is quite sophisticated, and cannot be reviewed herein the necessary detail. Readers seriously interested in this verification of the new isochemical model of the hydrogen molecule are suggested to study Aringazin's original memoir [65b].

The Coulomb and exchange integrals were calculated only for V_e while for V_g and V_h Aringazin achieved analytical results only for the Coulomb integrals because of the absence of Gegenbauer-type expansions for the latter potentials.

A conclusion is that *the Ritz's variational treatment of model (9.2.45) with the potential (9.3.23) is capable to provide an exact fit of the experimental data of the hydrogen molecule in confirmation of the results obtained by Santilli and Shillady [64a] via the SASLOBE variational approach to Gaussian V_g-type model.* The main data and results on the ground state energy E_{min} and internuclear distance R_{opt} are collected in Table 9.5.

Note that in the variational approach of Ref. [65b] Aringazin used a *discrete* variation of the hadronic horizon r_c and approximate exchange integral (9.3.24) that resulted in approximate fittings of the energy and distance, as shown in Table 9.5.

In addition, Ref. [65b] computed the weight of the isoelectronium phase which results to be of the order of 1% to 6% that for the case of V_e model. However, we note that this is it not the result corresponding to the original Santilli-Shillady model, which is based on the Hulten potential V_h.

An interesting result is that in order to prevent divergency of the Coulomb integral for V_h *the correlation length parameter r_c should run discrete values* due to Eq. (9.3.25). This condition has been used in the V_e model, although it is not a necessary one within the framework of this model.

As recalled earlier, Aringazin [*loc. cit.*] assumes that the isoelectronium undergoes an increase of length beyond the hadronic horizon, and the resulting two electrons are separated by sufficiently large distance. This leads us to problem of how to compute *the effective life-time of isoelectronium.*

To estimate the order of magnitude of such a life-time, Aringazin uses the ordinary formula for radioactive α-decay since the total potential $V(r)$ is of the same shape as that here considered, with very sharp decrease at $r < r_{max}$ and Coulomb repulsion at $r > r_{max}$, where r_{max} corresponds to a maximum of the potential.

This quasiclassical model is a crude approximation because in reality the electrons do not leave the molecule. Moreover, the two asymptotic regimes act simultaneously, with some distribution of probability, and it would be more justified to treat the frequency of the decay process (i.e., the tunneling outside the hadronic horizon), rather than the life-time of the isoelectronium.

However, due to the assumption of the small size of isoelectronium in comparison to the molecule size, we can study an elementary process of decay separately, and use the notion of life-time. The results of Aringazin's calculations are presented in Table 9.6.

In Ritz's variational approach, the main problem is to calculate analytically the so-called *molecular integrals.* The variational molecular energy in which we are interested, is expressed in terms of these integrals. These integrals arise when using some wave function, usually a simple hydrogen-like ground state wave function, as an infinite separation asymptotic solution, in the Schrödinger

Table 9.6. Summary of Aringazin's calculations [65b] on the lifetime of the isoelectronium, where E is relative kinetic energy of the electrons, at large distance, $r \gg r_{max}$, in the center of mass system.

Energy E, a.u.	*eV*	*Lifetime, D_0·sec*
2	54.4	$2.6 \cdot 10^{-18}$
1	27.2	$1.6 \cdot 10^{-17}$
0.5	13.6	$2.2 \cdot 10^{-16}$
0.037	1	$5.1 \cdot 10^{-6}$
0.018	0.5	4.0
0.0018	0.1	$3.1 \cdot 10^{+25}$

equation for the diatomic molecule. The main idea of Ritz's approach is to introduce parameters into the wave function, and vary them together with the separation parameter R, to achieve a minimum of the total molecular energy, which is treated as the resulting ground state energy.

In the case under study, Aringazin [*loc. cit.*] uses two parameters, γ and ρ, where γ enters hydrogen-like ground state wave function

$$\psi(r) = \sqrt{\frac{\gamma^3}{\pi}}\, e^{-\gamma r}, \tag{9.3.26}$$

and $\rho = \gamma R$ measures internuclear distance. These parameters should be varied *analytically or numerically* in the final expression of the molecular energy, after the calculation is made for the associated molecular integrals.

However, the four-body Santilli-Shillady model H_2 suggests an additional Hulten potential interaction between the electrons, which potential contains two parameters V_0 and r_c, where V_0 is a general factor, and r_c is a correlation length parameter characterizing the hadronic horizon. Thus, four parameters should be varied, γ, ρ, V_0, and r_c.

The introducing of Hulten potential leads to a modification of some molecular integrals, namely, of the Coulomb and exchange integrals. The other molecular integrals remain the same as in the case of the usual model of H_2, with well-known analytic results. Normally, the Coulomb integral, which can be computed in bispherical coordinates, is much easier to resolve than the exchange integral, which is computed in bispheroidal coordinates.

Calculations of the Coulomb integral for Hulten potential V_h appeared to be quite nontrivial [2b]. Namely, in the used bispherical coordinates, several special functions, such as polylogarithmic function, Riemann zeta-function, digamma function, and Lerch function, appeared during the calculation.

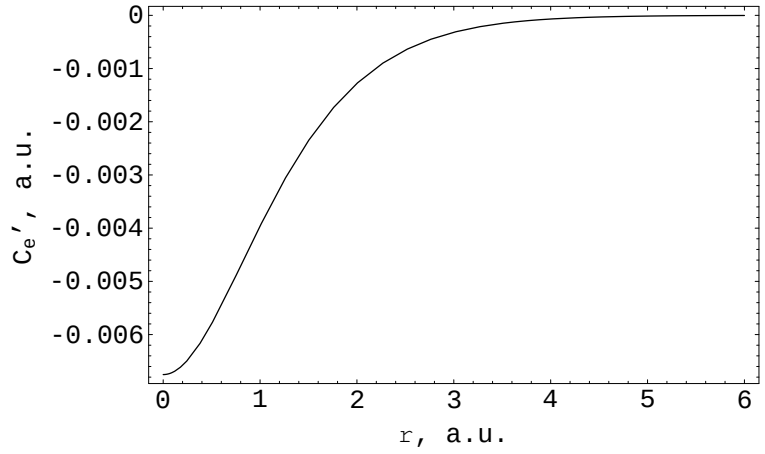

Figure 9.12. The Coulomb integral C'_e as a function of ρ, at $\lambda = 1/37$, where $\rho = \gamma R$, R is the internuclear distance, $\lambda = 2\gamma r_c$, and r_c is the hadronic horizon.

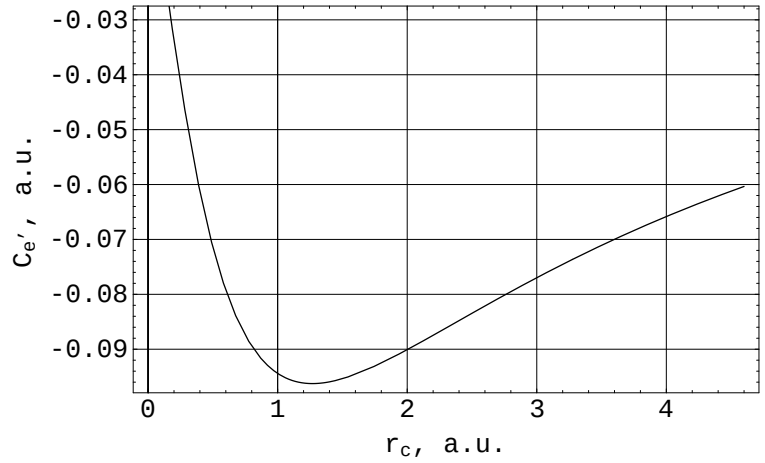

Figure 9.13. The Coulomb integral C'_e as a function of r_c, at $\rho = 1.67$. For $r_c > 0.2$ a.u., the regularized values are presented.

In order to proceed with the Santilli-Shillady approach, Aringazin [65b] invoked two different *simplified* potentials, the exponential screened Coulomb potential V_e, and the Gaussian screened Coulomb potential V_g, instead of the Hulten potential V_h. The former potentials both approximate well the Hulten potential at

short and long range asymptotics, and each contains two parameters denoted A and r_c.

In order to reproduce the short range asymptotics of the Hulten potential, the parameter A should have the value $A = V_0 r_c$, for both potentials. The Coulomb integrals for these two potentials have been calculated *exactly* owing to the fact that they are much simpler than the Hulten potential.

In particular, we note that the final exact expression of the Coulomb integral for V_g contains only one special function, the error function $\mathrm{erf}(z)$, while for V_e it contains no special functions at all. In this way, Aringazin [65b] reaches the exact expression

$$C'_e = -\frac{A\lambda^2}{8(1-\lambda^2)^4}\frac{\gamma e^{-2\rho}}{\rho}\left[-(\rho+2\rho^2+\frac{4}{3}\rho^3)+3\lambda^2(5\rho+10\rho^2+4\rho^3)-\right.$$

$$\left.-\lambda^4(15\rho+14\rho^2+4\rho^3)+\lambda^6(8+11\rho+6\rho^2+\frac{4}{3}\rho^3-8e^{2\rho-\frac{2\rho}{\lambda}})\right], \qquad (9.3.27)$$

where $\lambda = 2\gamma r_c$. This Coulomb integral is plotted in Figs. 9.12 and 9.13.

The most difficult part of calculations [65b] is the exchange integral. Usually, to calculate it one has to use bispheroidal coordinates, and needs in an expansion of the potential in some orthogonal polynomials, such as Legendre polynomials in bispheroidal coordinates. In Ref. [65b], only the exponential screened potential V_e is known to have such an expansion but it is formulated, however, in terms of bispherical coordinates (so called Gegenbauer expansion). Accordingly, the exchange integral E'_e for V_e at *null* internuclear separation, $R = 0$ (in which case one can use bispherical coordinates) was calculated exactly. After that, the R-dependence using the standard result for the exchange integral for Coulomb potential E'_C (celebrated Sugiura's result) was partially recovered,

$$E'_e \simeq \frac{A\lambda^2}{(1+\lambda)^4}\left(\frac{1}{8}+\frac{1}{2}\lambda+\frac{5}{8}\lambda^2\right)\frac{8}{5}E'_C, \qquad (9.3.28)$$

where $\lambda = 2\gamma r_c$ (see Fig. 9.14). Thus, only some approximate expression of the exchange integral for the case of V_e has been achieved. In this way, all subsequent results apply to the approximate V_e-based model.

Inserting the so-obtained V_e-based Coulomb and exchange integrals into the total molecular energy expression, the final analytical expression containing four parameters, γ, ρ, A, and r_c, was obtained. From a separate consideration of the Hulten potential case, the existence of a bound state of two electrons (which is the proper isoelectronium) leads to the following relationship between the parameters for the case of one energy level of the electron-electron system, $V_0 = \hbar^2/(2mr_c^2)$. Thus, using the relation $A = V_0 r_c$ Aringazin has $A = 1/r_c \equiv 2\gamma/\lambda$, in atomic units ($\hbar = m_e = c = 1$).

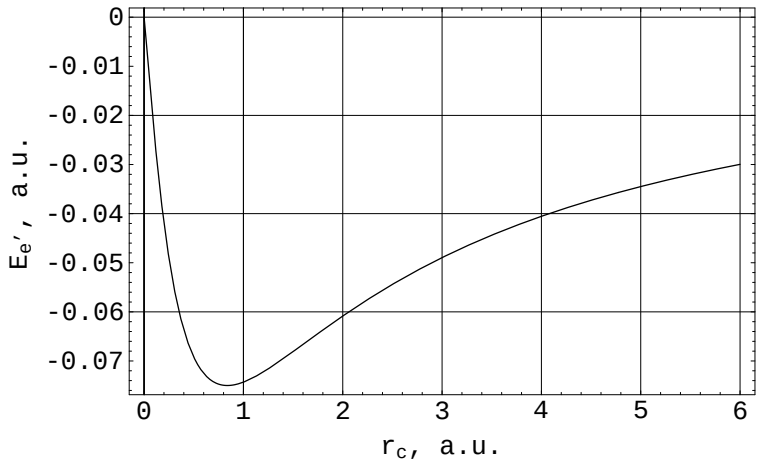

Figure 9.14. The exchange integral E'_e as a function of r_c, at $\rho = 1.67$.

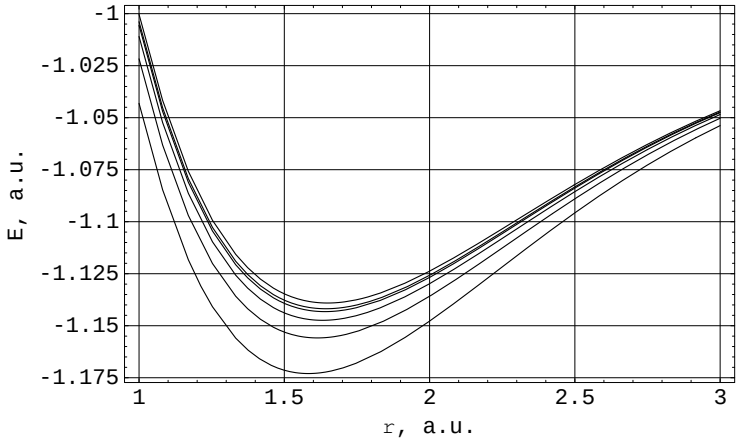

Figure 9.15. The total energy $E = E_{mol}$ as a function of ρ, at $\lambda = 1/60,\ 1/40,\ 1/20,\ 1/10,\ 1/5$. The lowest plot corresponds to $\lambda = 1/5$.

Note that Aringazin [65b] introduces the *one-level isoelectronium* characterized by the fact that the condition,

$$\lambda^{-1} = \text{ integer numbers} > 0, \tag{9.3.29}$$

follows from the analysis of the Coulomb integral for Hulten potential.

With the above set up, minimization of the total molecular energy of the V_e-based model can be made. Numerical analysis shows that the λ-dependence does

not reveal any minimum in the interval of interest,

$$4 \leq \lambda^{-1} \leq 60, \tag{9.3.30}$$

while there is a minimum of the energy for some values of γ and ρ, at fixed λ.

Therefore, 56 tables have been calculated to identify the energy minima and optimal distances for different values of λ, in the interval (9.3.30).

Table 9.7. The total minimal energy E_{min} and the optimal internuclear distance R_{opt} as functions of the correlation length r_c for the exponential screened Coulomb potential V_e.

λ^{-1}	r_c, *a.u.*	R_{opt}, *a.u.*	E_{min}, *a.u.*
4	0.10337035071618050	1.297162129235449	-1.181516949656805
5	0.08329699109108888	1.318393698326879	-1.172984902150024
6	0.06975270534273319	1.333205576478603	-1.167271240301846
7	0.05999677404817234	1.344092354783681	-1.163188554065554
8	0.05263465942162049	1.352417789644028	-1.160130284706318
9	0.04688158804756491	1.358984317233049	-1.157755960428922
10	0.04226204990365446	1.364292909163710	-1.155860292450436
11	0.03847110142927672	1.368671725082009	-1.154312372623724
12	0.03530417706681329	1.372344384866235	-1.153024886026671
13	0.03261892720535206	1.375468373051375	-1.151937408039373
14	0.03031323689615631	1.378157728092548	-1.151006817317425
15	0.02831194904031777	1.380497017045902	-1.150201529091051
16	0.02655851947236431	1.382550255552670	-1.149497886394651
17	0.02500959113834722	1.384366780045693	-1.148877823925501
18	0.02363136168905809	1.385985219224291	-1.148327310762828
19	0.02239708901865092	1.387436244558651	-1.147835285349041
20	0.02128533948435381	1.388744515712491	-1.147392910500336
21	0.02027873303335994	1.389930082626193	-1.146993041730378
22	0.01936302821907175	1.391009413196452	-1.146629840949675
23	0.01852644434336641	1.391996158084790	-1.146298491232105
24	0.01775915199935013	1.392901727808297	-1.145994983116511
25	0.01705288514774330	1.393735733699196	-1.145715952370148
26	0.01640064219648127	1.394506328745493	-1.145458555325045
27	0.01579645313764336	1.395220473843219	-1.145220372020229
28	0.01523519631632570	1.395884147817973	-1.144999330178493
29	0.01471245291356761	1.396502514589167	-1.144793644973560
30	0.01422439038752817	1.397080057337240	-1.144601770891686

Aringazin's results are collected in Tables 9.7, 9.8, and Fig. 9.15. One can see that the binding energy decreases with the increase of the parameter r_c, which corresponds to an effective radius of the isoelectronium.

In conclusion, the calculation by Aringazin [65b] reviewed in this Chapter have not identified the meanlife of the isoelectronium assumed as a quasiparticle

Table 9.8. A continuation of Table 9.8.

λ^{-1}	r_c, *a.u.*	R_{opt}, *a.u.*	E_{min}, *a.u.*
31	0.01376766836566138	1.397620687025853	-1.144422362947838
32	0.01333936209977966	1.398127830817745	-1.144254245203342
33	0.01293689977547854	1.398604504597664	-1.144096385030938
34	0.01255801083612469	1.399053372836414	-1.143947871939897
35	0.01220068312791624	1.399476798299823	-1.143807900045981
36	0.01186312715793131	1.399876883556063	-1.143675753475045
37	0.01154374612489787	1.400255505817128	-1.143550794143290
39	0.01095393745919852	1.400954915288619	-1.143320213707519
40	0.01068107105944273	1.401278573036792	-1.143213620508321
41	0.01042146833640030	1.401586548200467	-1.143112256673494
42	0.01017418516195214	1.401879953246168	-1.143015746732479
43	0.00993836493541500	1.402159797887369	-1.142923750307661
44	0.00971322867044429	1.402427000676349	-1.142835958109381
45	0.00949806639934841	1.402682399061957	-1.142752088467028
46	0.00929222969498477	1.402926758144872	-1.142671884314343
47	0.00909512514431396	1.403160778323019	-1.142595110561057
48	0.00890620863525624	1.403385101987775	-1.142521551794315
49	0.00872498034101540	1.403600319405678	-1.142451010262626
50	0.00855098030451296	1.403806973898863	-1.142383304102633
51	0.00838378454080327	1.404005566419838	-1.142318265775268
52	0.00822300158793934	1.404196559601683	-1.142255740683024
53	0.00806826944722482	1.404380381352424	-1.142195585944305
54	0.00791925286251402	1.404557428052374	-1.142137669304475
55	0.00777564089552400	1.404728067404676	-1.142081868166104
56	0.00763714476025456	1.404892640982100	-1.142028068723488
57	0.00750349588477794	1.405051466507240	-1.141976165188595
58	0.00737444417302681	1.405204839898059	-1.141926059097351
59	0.00724975644291090	1.405353037106507	-1.141877658686723
60	0.00712921502024112	1.405496315774223	-1.141830878334298

of charge radius r_c of about 1 fm. As one can see in Table 9.7, the predicted meanlife varies over a rather large range of values.

The achievement of an accurate meanlife of the isoelectronium of 1 fm charge radius can be reached only after reaching a more accurate knowledge of its rest energy. As the reader will recall from Chapter 4, the value of 1 MeV should be solely considered as an upper boundary value of the rest energy of the isoelectronium, since it holds only in the absence of internal potential forces while the latter cannot be excluded. Therefore, the actual value of the rest energy of the isoelectronium is today basically unknown.

The reader should also recall that the terms "meanlife of the isoelectronium when of charge radius of about 1 fm" are referring to the duration of time spent by two valence electrons at a mutual distance of 1 fm which is expected to be small. The understanding explained in Chapter 3 is that, *when the restriction of the charge radius to 1 fm is removed, and orbital mutual distances are admitted, the isoelectronium must have an infinite life (for the unperturbed molecule), because any finite meanlife under the latter conditions would imply the admission of two electrons with identical features in the same orbit, and a consequential violation of Pauli's exclusion principle.*

An interesting result of the Ritz variational approach to the Hulten potential studied by Aringazin [65b] is that *the charge radius of the isoelectronium r_c entering the Hulten potential and the variational energy, should run discrete set of values during the variation.*

In other words, this means that *only some fixed values of the effective radius of the one-level isoelectronium are admitted in the Santilli-Shillady model when treated via the Ritz approach.*

This result was completely unexpected and may indicate a kind of "hadronic fine structure" of the isoelectronium whose origin and meaning are unknown at this writing. It should be indicated that such a "hadronic fine structure" of the isoelectronium is solely referred to the case when r_c is restricted to be about 1 fm or less. The problem whether such a "hadronic fine structure" persists for values of r_c up to orbital distances is also unknown at this writing. It should be also indicated that this remarkable property is specific to the Hulten potential V_h, while it is *absent* in the V_e, or V_g models.

Moreover, Aringazin [65b] has achieved an estimation of *the weight of the isoelectronium phase* for the case of V_e model which appears to be of the order of 1% to 6%. This weight has been estimated from the energy contribution related to the exponentially screened potential V_e, in comparison to the contribution related to the usual Coulomb interelectron repulsive potential.

Finally, an important result of the Ritz variational four-body model studied by Aringazin [65b] is its fit to the experimental data of both the binding energy E and the bond length R of the hydrogen molecule thus providing an excellent independent confirmation of the results obtained by Santilli and Shillady [64].

Appendix 9.A
Isochemical Calculations for the Three-Body H_2 Molecule

This appendix contains a summary of the computer calculations conducted in Ref. [5] for the restricted three-body model of the hydrogen molecule according to isochemistry, Eq. (9.1.35), showing an exact representation of the binding energy. The calculations are based on the isoelectronium as per characteristics (9.1.25).

```
Gaussian-Lobe Program for Large Molecules
  set up by D. Shillady and S. Baldwin
      Richmond Virginia 1978-1997
        3 BODY H2 (Electronium)
```

ipear = 1, dt = 0.0, tk = 0.0, imd = 0, ntime = 60, mul = 1, iqd = 0, icor = 3, mdtim = 0, idb = 0.

ELECTRONIUM-PAIR CALCULATION

Atomic Core				Nuclear		Coordinates
		X		Y		Z
1.		0.000000		0.000000		0.000000
	Z1s =	6.103	Z2s =	24.350	Z2p =	24.350
	Z3s =	16.230	Z3p =	16.230	Z3d =	-16.200
	Z4p =	12.180	Z4f =	12.180		
1.		0.000000		0.000000		0.259200
	Z1s =	6.103	Z2s =	24.350	Z2p =	24.350
	Z4p =	12.180	Z4f =	12.18O	Z3d =	-16.200

Basis Size = 50 and Number of Spheres = 142 for 2 Electrons.

Distance Matrix in Angströms:

	H	H
H	0.00000	0.13716
H	0.13716	0.00000

A-B-C Arcs in Degrees for 2 Atoms.
The Center of Mass is at Xm = 0.000000, Ym = 0.000000, Zm = 0.129600.

One-Electron Energy Levels:

E(1) =	-11.473116428176	E(26) =	28.974399759209
E(2) =	-4.103304982059	E(27) =	28.974400079775
E(3) =	-1.621066945385	E(28) =	31.002613061833
E(4) =	-1.621066909587	E(29) =	31.002614578175
E(5) =	0.735166320188	E(30) =	35.201145239721
E(6) =	3.760295564718	E(31) =	38.003259639003
E(7) =	3.760295673022	E(32) =	44.948398097510
E(8) =	4.206194459198	E(33) =	44.94839B118458
E(9) =	4.813241859203	E(34) =	52.259825531212
E(10) =	11.2330B0571453	E(35) =	57.732587951875
E(11) =	15.70B645318078	E(36) =	57.732589021798
E(12) =	15.708645469273	E(37) =	68.743644612501
E(13) =	18.535761604401	E(38) =	68.743644649428
E(14) =	18.535761951543	E(39) =	73.195648957615
E(15) =	19.329445299735	E(40) =	79.303486379907
E(16) =	19.329445306194	E(41) =	85.865499885249
E(17) =	19.644048052034	E(42) =	85.865531919077
E(18) =	24.002368034839	E(43) =	127.196518644932
E(19) =	24.002368621986	E(45) =	130.602186113463
E(20) =	24.076849036707	E(46) =	130.602190550265
E(21) =	24.076853269415	E(47) =	137.484863078186
E(22) =	24.574406183060	E(48) =	158.452350229845
E(23) =	26.836031180463	E(49) =	205.158233049979
E(25) =	27.860752485358	E(50) =	446.152984041077

epair Energy = -7.615091736818.

Appendix 9.B
Isochemical Calculations for the Four-Body H_2 Molecule

In this appendix we present a summary of the computer calculations conducted in Ref. [5] for the four-body model of the hydrogen molecule, Eq. (9.1.33), according to isochemistry by using only $6G$-$1s$ orbitals for brevity. The calculations are also based on the characteristics of the isoelectronium in Eqs. (9.1.25). Note, again, the exact representation of the binding energy at -1.174447 Hartrees.

```
Gaussian-Lobe Program for Large Molecules
set up by D. Shillady and S. Baldwin
Virginia Commonwealth University
Richmond Virginia
1978-1997
Test of SASLOBE on H2
```

SANTILLI-RADIUS = 0.01184470000000.
Cutoff = (A/r)*(exp(-alp*r*r)), A = 0.20E+01, alp = 0.49405731E+04.

Atomic Core				Nuclear		Coordinates
		X		Y		Z
1.		0.000000		0.000000		0.000000
	Z1s =	1.200	Z2s =	0.000	Z2p =	0.000
	Z3s =	0.000	Z3p =	0.000	Z3d =	0.000
	Z4p =	0.000	Z4f =	0.000		
1.		0.000000		0.000000		1.401100
	Z1s =	1.200	Z2s =	0.000	Z2p =	0.000
	Z3s =	0.000	Z3p =	0.000	Z3d =	0.000
	Z4p =	0.000	Z4f =	0.000		

Basis Size = 2 and Number of Spheres = 12 for 2 Electrons.

Distance Matrix in Angströms:

	H	H
H	0.00000	0.74143
H	0.74143	0.00000

The center of Mass is at: Xm = 0.000000, Ym = 0.000000, Zm = 0.700550.

Spherical Gaussian Basis Set:

No. 1	alpha =	0.944598E+03 at X = 0.0000 Y = 0.0000 Z = 0.0000 a.u.
No. 2	alpha =	0.934768E+02 at X = 0.0000 Y = 0.0000 Z = 0.0000 a.u.
No. 3	alpha =	0.798123E+01 at X = 0.0000 Y = 0.0000 Z = 0.0000 a.u.
No. 4	alpha =	0.519961E+01 at X = 0.0000 Y = 0.0000 Z = 0.0000 a.u.
No. 5	alpha =	0.235477E+00 at X = 0.0000 Y = 0.0000 Z = 0.0000 a.u.
No. 6	alpha =	0.954756E+00 at X = 0.0000 Y = 0.0000 Z = 0.0000 a.u.
No. 7	alpha =	0.1944598E+03 at X = 0.0000 Y = 0.0000 Z = 1.4011 a.u.
No. 8	alpha =	0.7934768E+02 at X = 0.0000 Y = 0.0000 Z = 1.4011 a.u.
No. 9	alpha =	0.40798123E+01 at X = 0.0000 Y = 0.0000 Z = 1.4011 a.u.
No. 10	alpha =	0.11519961E+01 at X = 0.0000 Y = 0.0000 Z = 1.4011 a.u.
No. 11	alpha =	0.37235477E+00 at X = 0.0000 Y = 0.0000 2 = 1.4011 a.u.
No. 12	alpha =	0.12954756E+00 at X = 0.0000 Y = 0.0000 Z = 1.4011 a.u.

Contracted Orbital No. 1:
0.051420*(1), 0.094904*(2), 0.154071*(3), 0.203148*(4), 0.169063*(5), 0.045667*(6).
Contracted Orbital No.2:
0.051420*(7), 0.094904*(8), 0.154071*(9), 0.203148*(10), 0.169063*(11),
0.045667*(12).

***** Nuclear Repulsion Energy in au = 0.71372493041182. *****

Overlap Matrix:

#		at-orb	1	2
1	H	1s	1.000	0.674
2	H	1s	0.674	1.000

S(-1/2) Matrix:

#		at-orb	1	2
1	H	1s	1.263	-0.490
2	H	1s	-0.490	1.263

H-Core Matrix:

#		at-orb	1	2
1	H	1s	-1.127	-0.965
2	H	1s	-0.965	-1.127

Initial-Guess-Eigenvectors by Column:

#		at-orb	1	2
1	H	1s	0.546	1.239
2	H	1s	0.546	-1.239

One-Electron Energy Levels: E(1) = -1.249428797385, E(2) = -0.499825553916.

(1,1/1,1) =	0.75003658795676
minus (1,1/1,1) =	0.08506647783478
total (1,1/1,1) =	0.66497011012199
(1,1/1,2) =	0.44259146066210
minus (1,1/1,2) =	0.02960554295227
total (1,1/1,2) =	0.41298591770983
(1,1/2,2) =	0.55987025041920
minus (1,1/2,2) =	0.01857331166211
total (1,1/2,2) =	0.54129693875709
(1,2/1,2) =	0.30238141375547
minus (1,2/1,2) =	0.01938180841827
total (1,2/1,2) =	0.28299960533720
(1,2/2,2) =	0.44259146066210
minus (1,2/2,2) =	0.02960554295227
total (1,2/2,2) =	0.41298591770983
(2,2/2,2) =	0.75003658795676
minus (2,2/2,2) =	0.08506647783478
total (2,2/2,2) =	0.66497011012199

Block No. 1 Transferred to Disk/Memory. The Two-Electron Integrals Have Been Computed.
Electronic Energy = -1.88819368266525 a.u., Dif. = 1.8881936827,
Electronic Energy = -1.88819368266525 a.u., Dif. = 0.0000000000.
Energy Second Derivative = 0.00000000000000.

e1a =	-2.499	e1b =	-2.499		
e2a =	0.611	e2b =	0.611	e2ab =	0.611

Iteration No. = 2, alpha = 0.950000.
Electronic Energy = -1.88819368266525 a.u., Dif. = 0.0000000000.
Total Energy = -1.17446875 a.u.
One-Electron Energy Levels: E(1) = -0.638764885280, E(2) = 0.561205833046

Reference State Orbitals for 1 Filled Orbitals by Column:

#	at-orb		1	2
1	H	1s	0.546	1.239
2	H	1s	0.546	-1.239

Dipole Moment Components in Debyes:
Dx = 0.0000000, Dy = 0.0000000, Dz = 0.0000000.
Resultant Dipole Moment in Debyes = 0.0000000.
Computed Atom Charges: Q(1) = 0.000, Q(2)= 0.000.
Orbital Charges: 1.000000, 1.000000.

Milliken Overlap Populations:

#	at-orb		1	2
1	H	1s	0.597	0.403
2	H	1s	0.403	0.597

Total Overlap Populations by Atom:

	H	H
H	0.597222	0.402778
H	0.402778	0.597222

Orthogonalized Molecular Orbitals by Column:

#		at-orb	1	2
1	H	1s	0.422	2.172
2	H	1s	0.422	-2.172

Wiberg-Trindie Bond Indices:

#		at-orb	1	2
1	H	1s	0.127	0.127
2	H	1s	0.127	0.127

Wiberg-Trindie Total Bond Indices by Atoms:

	H	H
H	0.127217	0.127217
H	0.127217	0.127217

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Chapter 10

INDUSTRIAL APPLICATIONS TO NEW CLEAN BURNING, COST COMPETITIVE FUELS

10.1 THE INCREASINGLY CATACLYSMIC CLIMACTIC EVENTS FACING MANKIND

10.1.1 Foreword

Some of the biggest needs of mankind to contain increasingly cataclysmic climactic events due to global warming and other large environmental problems are: 1) Remove and recycle carbon dioxide from our atmosphere; 2) Develop means for the processing of carbon dioxide in automotive exhaust; and 3) Develop new clean burning cost competitive fuels (see the content of this chapter for details).

The biggest threat to mankind in this field is the lack at this writing in all developed countries of political will to invest public funds in serious resolutions of our environmental problems. All governmental investments in the sector known to this author have been made for the *appearance* of favoring the environment while in reality favoring the myopic and self-destructing interests of the organized petroleum cartel, as it is the case for investment of public funds in hydrogen (see Section 11.1.3 for the huge environmental problems caused by current hydrogen production via the reformation of fossil fuels, while multiplying the profits of the petroleum cartel).

It should be stressed that the solution of large societal problems must be supported by *public* funds, since it is unethical to expect that individuals pay for the cost. Yet, all the research presented in this chapter has been supported by *private* funds due to the lack of public funds following solicitations by the author in the U.S.A., Continental Europe, Russia, China, Japan, Australia, and other developed countries.

One way to understand the gravity of environmental problems is to note that this chapter has been written during the month of September 2005 at the Institute for Basic Research in Florida, when the southern belt of the U.S.A. had been

Figure 10.1. A view of one of the primary responsibilities for current increasingly cataclysmic climatic events: the pollution caused by fossil fueled electric power plants.

exposed to some eighteen hurricanes and devastated by the hurricanes Kathrina and Rita, with additional hurricanes expected before the end of the 2005 season. Increasingly cataclysmic climactic events are expected in the years ahead, until the entire southern belt of the U.S.A. will become uninhabitable.[1]

Similar increasingly cataclysmic climactic events are occurring in the rest of the world. As an example, the mountain region of the Andes in Peru is experiencing an exodus of the local farmers toward the cities due to the lack of snow in winter, with expected major drought the following summer and consequential inability to grow crops.

Also, *The Economist* in England published in the fall of 2004 a report from the U. S. Pentagon releasing for the first time data on the slow down of the Gulf Stream due to the decreased density and salinity of the North Atlantic caused by the melting of the ice in the North Pole region. The complete halting of the Gulf Stream is now beyond scientific doubt, the only debatable issue remaining is that of the date, at which time England is expected to suffer from extreme cold in winter and extreme temperature in summer.

[1] At the end of the 2005 hurricane season Florida was hit by *twenty two* major climactic events, so many that the U.S. Weather Bureau exhausted all 21 letters of the English alphabet and had to name the 22-nd storm from the Greek alphabet. There is no need to wait a few years to understand that the devastating climactic events expected in the next few years are due to the lack of serious political will NOW.

The list of similar increasingly cataclysmic climactic events all over the world could now be endless.

It is at this point were the efforts for the construction of hadronic mechanics, superconductivity and chemistry acquire their full light. In fact, all possibilities of resolving our huge environmental problems via the use of conventional doctrines were long exhausted, as better illustrated in this and in the next chapter, thus establishing the need for suitable covering disciplines beyond any possible doubt.

All scientists have a direct responsibility to contribute, or at least not to oppose, serious efforts toward the solution of these increasingly cataclysmic problems via the traditional scientific process of trial and errors, by implementing genuine scientific democracy, ethics and accountability vis a vis mankind, not via a formal academic parlance, but in actual deeds, the only ones having social as well as scientific value, beginning with the admission that *the dominance of the entire universe by the rather limited Einsteinian doctrines is a purely political - nonscientific posture, and its era has now ended in favor of covering theories for physical conditions unthinkable during Einstein's times.*

10.1.2 Origin of the Increasingly cataclysmic Climactic Events

According to official data released by the U. S. Department of Energy[2], by ignoring the world-wide consumption of natural gas and coal, *we consumed in 2003 about* 74×10^6 *barrels of crude oil (petroleum) per day, corresponding to the daily consumption of about* 3×10^9 *gallons (g) or* 1.4×10^{10} *liters (L) of gasoline per day.*

When adding the world consumption of natural gas and coal, *the world consumption of fossil fuels in 2003 should be conservatively estimated to be equivalent to* 1.5×10^7 *barrels per day, corresponding to the gasoline equivalent of* 7.5×10^8 *gallon or* 2.8×10^{11} *liters per day.*

Such a disproportionate consumption is due to the average daily use in 2003 of about $1,000,000,000$ cars, $1,000,000$ trucks, $100,000$ planes plus an unidentifiable number of additional vehicles of military, agricultural, industrial and other nature, plus the large consumption of fossil fuels by electric power plants around the world.

The data for 2004 are not reported here because still debated, and estimated to be of the order of 90×10^6 barrels of crude oil (petroleum) per day. Future consumption can be best illustrated by noting that, according to official data of the Chinese government, *China is building* $500,000,000$ *(yes, five hundred million) new cars by 2015, and that the need for petroleum, in China for the year 2006 will correspond to the world consumption for 2004, including China.*

[2]See, e.g., the web site http://www.eia.doe.gov/emeu/international/energy.html

MARKET (Fuel Source)	Current U.S. Daily Market Usage (1999 Statistics)
Oil	U.S.A. - 882.8 million tons (25.5% share of world total usage) = 18,490 thousand barrels daily
Natural Gas	U.S.A. - 555.3 million tons oil equivalent (26.9% of world total usage) = 617 billion cubic meters
Coal	U.S.A. - 543.3 million tons oil equivalent (25.5% of world total usage) = 543.3 million tons oil equivalent (25.5% of world total usage)

Figure 10.2. Official data on the 2003 disproportionate consumption of fossil fuels in the U.S.A. alone.

The extremely serious environmental problems caused by the above disproportionate combustion of fossil fuels can be summarized as follows:[3]

(1) **The combustion of fossil fuels releases in our atmosphere about sixty millions metric of tons carbon dioxide CO_2 per day that are responsible for the first large environmental problem known as "global warning" or "green house effect."**[4] Of these only 30 millions metric tons are estimated to be recycled by our ever decreasing forests. This implies the release in our atmosphere of about thirty millions metric tons of unrecycled green house gases per day, which release is the cause of the "global warming" now visible to everybody through climactic episodes such as floods, tornadoes, hurricanes, etc. of increasing catastrophic nature.

[3]See for details the web site http://www.magnegas.com/technology/part6.htm. The reader should note that the calculations in this web site only treat the 2003 consumption of crude oil for automotive use. Consequently, the data therein should be multiplied by three to reach realistic values for 2003.

[4]The value of 60 million tons of CO_2 per day is easily obtained from the chemical reaction in the combustion of the indicated daily volume of fossil fuels (see for details http://www.magnegas.com/technology/part6.htm

(2) **The combustion of fossil fuels causes the permanent removal from our atmosphere of about 21 millions metric tons of breathable oxygen per day, a second, extremely serious environmental problem known as "oxygen depletion."**[5] Even though not disclosed by political circles and newsmedia, the very admission of an "excess" CO_2 in our atmosphere (that is, CO_2 no longer recycled by plants) is an admission of oxygen depletion because the "O_2 in the excess "CO_2" was originally breathable oxygen. Hence, by recalling the atomic weight of CO_2 and O_2, we have the value $\frac{32}{44} \times 30 \times 10^6 = 21.8 \times 10^8$ tons of lost oxygen per day.

It appears that, prior the introduction of oxygen depletion by the author in 2000, everybody ignored the fact that *the combustion of fossil fuels requires atmospheric oxygen.* Since only the global warming is generally considered, it appears that *newsmedia, governments and industries alike ignored the fact that we need oxygen to breath.* Only more recently, various environmental groups, unions and other concerned groups are becoming aware that *the increasing heart problems in densely populated area are indeed due to local oxygen depletion caused by excessive fossil fuel combustion.*

(3) **The combustion of fossil fuels releases in our atmosphere about fifteen millions metric tons of carcinogenic and toxic substances per day.** This third, equally serious environmental problems is euphemistically referred to by the newsmedia as "atmospheric pollution"', while in reality it refers to the primary source of the widespread increase of cancer in our societies. For instance, it has been established by various medical studies (generally suppressed by supporters of the oil cartel) that *unless of genetic origin, breast cancer is due to the inhaling of carcinogenic substances in fossil fuels exhaust.* These studies have gone so far as to establish that breast cells are very receptive to a particular carcinogenic substance in fossil fuel exhaust. After all, responsible citizens should remember and propagate (rather than myopically suppress) the fact that *the U. S. Environmental Protection Agency has formally admitted that diesel exhaust is carcinogenic.* A moment of reflection is sufficient for anybody in good faith to see that we inhale on a daily basis carcinogenic substances from gasoline exhaust in an amount that is ten thousands times bigger than carcinogenic substances ingested with food.

This is another serious environmental problem that has remained virtually ignored by all until recently due to the widespread misinformation by the newsmedia. However, the existence of this third major environmental problem caused by fossil fuel combustion has now propagated to environmental, union and other circles with predictable legal implications for the fossil fuel industry and its ma-

[5]The "oxygen depletion" was first introduced by the author at the 2000 Hydrogen World Conference held in Munich, Germany (see the web site http://www.magnegas.com/technology/part6.htm).

Figure 10.3. A picture of frequent environmental disasters caused by the spill of crude oil from tankers following accidents. The replacement of crude oil with a gaseous fuel will eliminate the environmental damage, with the exception of hydrogen because, in the event the cargo of this tanker had been composed of hydrogen, its release in the atmosphere, its immediate rising to the ozone layer, and its very rapid reaction with O_3 would create a hole in the ozone layer of the size of the State of Rhode Island, with consequential increase of skin and other cancers on Earth (see Section 11.1.3 for details).

jor users, unless suitable corrective measures are initiated, as it occurred for the tobacco industry.

It is hoped that people trapped in traffic, thus inhaling the carcinogenic fumes from the vehicle in front, will remember the above evidence and assume an active role in the support of environmentally acceptable fuels because it is written throughout history that people have the government and system they deserve.

There exist numerous additional environmental problems caused by the *global* study of fossil fuels, that is, not only the environmental problems caused by their combustion, but also those caused by their production and transportation. The latter problems are omitted here for brevity and also because the dimension of problems 1), 2) and 3) is a sufficient call for persons in good faith.

10.1.3 Serious Environmental Problems Caused by Hydrogen, Natural Gas, Ethanol, Biogases and Fuels with Molecular Structure

Whenever facing the ever increasing cataclysmic climactic events caused by fossil fuel combustion, a rather widespread belief is that the solution already

exists and it is given by *hydrogen* for the large scale fuel uses of the future because hydrogen is believed to be "the cleanest fuel available to mankind."

Due to the potentially lethal implications for mankind, it is necessary to dispel this belief and indicate that, *the current production and combustion of hydrogen, whether for an internal combustion engine or for a fuel cell, causes a global pollution much greater than that caused by gasoline when compared for the same energy outputs.*

Hydrogen is indeed an environmentally acceptable fuel, but only when its production and use verify the following conditions:

CONDITION I: Hydrogen is produced via the electrolytic separation of water;

CONDITION II: The electricity used for electrolysis originates from clean and renewable energy sources, such as those of hydric, solar or wind nature; and

CONDITION III: The oxygen produced by the electrolytic process is freely released in the environment so that the subsequent hydrogen combustion leaves unchanged the existing oxygen content of our atmosphere.

However, the reality in the production and use of hydrogen is dramatically different than the above ideal conditions. In fact, hydrogen is today produced in its greatest percentage via reformation processes of fossil fuels such as methane CH_4, via the use of highly polluting electric power plants, and no oxygen is released in the atmosphere during production.

Reformation processes are preferred over electrolysis not only because of the low efficiency of the electrolytic separation of water,[6] but also due to the fact that the primary drive in the current international support for hydrogen as a fuel is to permit the petroleum cartel to multiply the profits (because the profits from the sale of the hydrogen content of fossil fuels are a multiple of the profits from the direct sale of fossil fuels, as better indicated below.)

Renewable sources of electricity, even though manifectly valuable, are so minute with respect to the enormity of the demand for fuel that cannot be taken into serious consideration. Nuclear power plants also cannot be taken into serious consideration until governments finally provide serious financial support for basic research on the stimulated decay of radioactive nuclear waste by nuclear power plants themselves, rather than the currently preferred "storage" of nuclear waste in in depositories nobody wants to have near-by. These aspects begin to illustrate the reason hadronic mechanics, superconductivity and chemistry were developed, as studied in more details in the next chapter.

[6]Electrolytic plants for the separation of water have an efficiency of the order of 0.8, thus yielding an efficiency for hydrogen production by volume of the order of 0.5, as compared to the efficiency in the production of magnegas discussed in the subsequent sections of this chapter that can be 10.5 in industrial recycler, that is, 21 times bigger than that of electrolysis.

When inspected in real terms, the current production, transportation and use of hydrogen, if implemented in large scale such as that of fossil fuels, cause the following very serious environmental problems:

A) **Alarming oxygen depletion caused by hydrogen combustion,** namely, the permanent removal of breathable oxygen from our atmosphere and its conversion into water vapor H_2O. By remembering that oxygen is the very basis of life, we are here referring to one of the most serious environmental problems facing mankind that can become potentially lethal for large scale combustion of hydrogen irrespective of whether used as fuel or in fuel cells. When TV programs show water vapor coming out of car exhaust running on hydrogen, they are actually showing one of the most alarming environmental problems facing mankind.

It should be indicated that *gasoline combustion causes much less oxygen depletion than hydrogen combustion,* for various reasons. The first is that gasoline combustion turns atmospheric oxygen into CO_2 that is food for plants, since the chlorophyll process turns CO_2 into breathable O_2 while maintaining C for plant growth. Therefore, the oxygen depletion caused by gasoline and fossil fuels in general is only that for the *excess* of CO_2 that cannot be any longe recycled by plants due to their enormous daily releases, combined with the ongoing forest depletion.

By comparison, hydrogen turns breathable oxygen into water vapors. At this point equivocal technicians indicate that "plants also recycle water into oxygen,", which statement is correct because without water plants die, as well known. Nevertheless, if proffered by experts, the statement may be dishonest because they do not mention the fact that *our atmosphere is full of water vapor as shown by clouds and rain.* Hence, the additional water vapor originating from hydrogen combustion cannot possibly be recycled by plants. By comparison, the CO_2 content in our atmosphere was less than 1% one century ago, in which case the excess due to fossil fuel combustion was, at least initially, recycled by plants, and this is the very reason the human race is still alive today despite the current immense fossil fuel consumption the world over.

Yet another reason favoring environmentally the combustion of gasoline over hydrogen is that *the oxygen depletion caused by hydrogen combustion is a large multiple of that caused by gasoline combustion.* This additional environmental problem can be seen as follows. Gasoline combustion is based on the synthesis of CO, one of the most esoenergetic chemical reactions known to man, that releases 255 Kcal/mole, followed by the synthesis of CO_2 that releases about 85 Kcal/mole, and other reactions for a total of at least 335 Kcal/mole. By comparison, the sole chemical reaction in hydrogen combustion is the synthesis of H_2O releasing about 57 Kcal/mole. A first year graduate student in chemistry can then compute the multiplier needed for the oxygen depletion caused by gasoline

combustion to reach that of hydrogen combustion, of course, under the same energy output.

B) **Alarming environmental problems caused by current hydrogen production.** The reformation of methane and other fossil fuels for hydrogen production requires large amounts of energy because of the necessary breaking of strong molecular bonds such as CH_4. In this case, all byproducts of the reformation, such as the "green house gas" CO_2, are released into the environment. A first year graduate student in chemistry can then prove (although his/her teacher may disagree for personal academic gains) that the CO_2 released in the atmosphere for hydrogen production from CH_4 is a large multiple of the CO_2 produced in gasoline combustion.

Hence, simple calculations establish that *the current methods of hydrogen production, transportation and use release in the atmosphere carcinogenic substances, green house gases and other contaminants that are at least twenty times bigger than the contaminants releases by the gasoline production and combustion in contemporary cars with efficient catalytic converters.*

In fact, the production of hydrogen requires large amounts of energy while, by comparison, gasoline production requires considerably less energy because crude oil comes out of the group at pressure without any need of electricity, while refining processes of crude oil into gasoline are mostly chemical in nature, thus requiring minimal electric energy. The global pollution caused by gasoline is therefore essentially restricted to the pollution caused by transportation and combustion.

Being an environmentalist, the author certainly does not support gasoline as the dominant fuel. Nevertheless, scientific honesty requires the admission that *gasoline is much less polluting than hydrogen as currently produced when considered on a global scale including production, transportation and combustion.*

C) **Alarming threat to the ozone layer caused by hydrogen seepage and losses.** Another serious environmental problem caused by hydrogen is due to its *seepage,* namely, the fact that, being composed by the smallest molecule on Earth, hydrogen escapes through container walls irrespective of the used material and thickness. Consequently, the large scale use of hydrogen must take into account the inevitable release of free hydrogen that, being very light, instantly rises to the upper layer of our atmosphere all the way to the *ozone layer,* resulting in its depletion because hydrogen and ozone have one of the fastest known chemical reactions

$$H_2 + O_3 \quad \rightarrow \quad H_2O + O_2. \tag{11.1.1}$$

Again, *gasoline is preferable over hydrogen also in regard to the ozone layer.* In fact, gasoline is liquid and its vapors are heavy, thus being unable to reach the ozone layer. Also, all byproducts of gasoline combustion are heavy and they simply cannot rise to the ozone layer. Assuming that some tornado carries byprod-

ucts of gasoline combustion all the way up to the ozone layer, they have no known reaction with the ozone that could compare with that of hydrogen, Eq. (11.1.1).

D) **Alarming environmental problems caused by the need to liquify hydrogen.** Gasoline contains about $110,000$ British Thermal Units (BTU) per gallon (g) while hydrogen contains about 300 BTU per standard cubic foot (scf). Consequently, the "Gasoline Gallon Equivalent' (GGE)' is given by 366 scf of hydrogen. Hence, the hydrogen equivalent of an average 20 gallon gasoline tank would require $7,320$ scf of hydrogen, namely, *a volume of hydrogen so big to require a trailer for its transportation in automotive uses.*

This is the reason all manufacturers testing cars running on hydrogen as a fuel, such as BMW, GM, Honda, and others, have been forced to use *liquified hydrogen.* At this point the environmental problems caused by use of hydrogen as an automotive fuel become truly serious, e.g., because hydrogen liquifies close to the absolute zero degree temperature, thus requiring large amounts of electric energy for its liquefaction, with consequential multiplication of pollution. Additional significant amounts of energy are needed to maintain the liquid state because the spontaneous transition from the liquid to the gas state is explosive without any combustion (because of the rapidity of the transition when the cooling systems ceases to operate).

At the 2000 Hydrogen World Meeting held in Munich, Germany, under BMW support, a participant from Florida stated that "If one of my neighbors in Florida purchases a car operating on liquid hydrogen, I will sell my house because in the event that neighbor leaves the car parked in his driveway to spend the weekend in Las Vegas, and the cooling systems fails to operate due to the Florida summer heat, the explosion due to the transition of state back to the gaseous form will cause a crater."

E) **Prohibitive hydrogen cost.** Commercial grade hydrogen (not the pure hydrogen needed for fuel cells) currently retails in the USA at $\$0.18/scf$. By comparison, natural gas retails at about $\$0.01/scf$. But hydrogen contains $300 BTU/scf$, while natural gas contains $1,050 BTU/scf$. Consequently, $\frac{1,050}{300} \times \$0.18 = \$0.63$, namely, *commercial grade hydrogen currently sells in the U.S.A. at* **sixty three times** *the cost of natural gas,* a very high cost that is a reflection of the low efficiency of the available processes for hydrogen production.

But, unlike magnegas and natural gas, hydrogen cannot be significantly carried in a car in a compressed form, thus requiring its liquefaction that is very expensive to achieve as well as to maintain. Consequently, simple calculations establish that *the actual cost of hydrogen in a liquified form for automotive use is at least* 200 *times the cost of fossil fuels,*

There is no credible or otherwise scientific doubt that, under the above generally untold large problems, hydrogen has no realistic chance of becoming a serious alternative for large use without basically *new* technologies and processes.

Element	MagneGas (MG)	Natural Gas	Gasoline	EPA Standards
Hydro-carbons	0.026 gm/mi	0.380 gm/mi 2460% of MG emission	0.234 gm/mi 900% of MG emission	0.41 gm/mi
Carbon Monoxide	0.262 gm/mi	5.494 gm/mi 2096% of MG emission	1.965 gm/mi 750% of MG emission	3.40 gm/mi
Nitrogen Oxides	0.281 gm/mi	.732 gm/mi 260% of MG emission	0.247 gm/mi 80% of MG emission	1.00 gm/mi
Carbon Dioxide	235 gm/mi	646.503 gm/mi 275% of MG emission	458.655 gm/mi 195% of MG emission	No EPA standard exists for Carbon Dioxide
Oxygen	9%-12%	0.5%-0.7% 0.04% of MG emission	0.5%-0.7% 0.04% of MG emission	No EPA standard exists for Oxygen

Figure 10.4. Summary of comparative measurements combustion exhaust of the new magnegas fuel (described in Section 11.3 below), natural gas and gasoline conducted at the EPA accredited automotive laboratory of Liphardt & Associated of Long Island, New York in 2000 (see for details the website http://www.magnegas.com/technology/part6.htm). As one can see, contrary to popular belief, under the same conditions (same car with same weight used with the same computerized EPA routine, for the same duration of time), natural gas exhaust contains 61% "more" hydrocarbons, about 41% "more" green house gases, and about 200% "more" nitrogen oxides than gasoline exhaust.

The above refers to the use of hydrogen as an automotive fuel for internal combustion engines. The situation for the use of hydrogen in fuel cells is essentially the same, except for different efficiencies between internal combustion engines and fuel cells that have no relevance for environmental profiles.

A possible resolution, or at least alleviation, of these problems is presented in Section 11.5.

Another widespread misrepresentation existing in alternative fuels is the belief that "the combustion of natural gas (or methane) is cleaner than that of gasoline," with particular reference to a presumed reduction of carcinogenic and green house emissions. This misrepresentation is based on the visual evidence that the flame of natural gas is indeed cleaner than that of gasoline or other liquid fuels. However, natural gas is gaseous while gasoline is liquid, with an increase of density in the trantion from the former to the latter of about $1,500$ units. Consequently, when the pollutants in the flame of natural gas are prorated to the density of gasoline, the much more polluting character of natural energes.

In any case, recent measurements reviewed later on in this chapter have disproved the above belief because, *under identical performances, natural gas is much more polluting than gasoline* (see Figure 11.3).

Further widespread misrepresentations exist for *ethanol, biogases,* and other conventional fuels, that is, fuels possessing the conventional molecular structure,

because generally presented as cleaner than gasoline. In effect, ethanol combustion exhaust is the most carcinogenic among all fuels, the pollution caused by biogases is truly alarming, and the same occur for all remaining available conventional fuels.

In addition, ethanol. biogases and otehr fuels of agricultural origin leave large carbon deposits on spark plugs, piiston rings and otehr component, by decreasing considerably the life of the engines.

Hence, the mere inspection of the tailpipe exhaust is today a view of the past millennium, if not motivated by equivocal commercial, political or academic interests. The sole approach environmentally acceptable today is *the study of the global environmental profile pertaining to fuels, that including the environmental pollution causes by the production, storage, transportation, and combustion.*

In closing, equivocal commercial, political and academic interests should be made aware that, following the success of the lawsuits against the tobacco industry, environmental groups in Berlin, Washington, Tokyo and other cities are apparently preparing lawsuits for trillion dollars punitive compensation against any large scale producer or user of polluting fuel. Therefore, it appears that the best way to confront supporters of hydrogen, ethanol, biofuels and other highly polluting fuels is that via a judicial process. After all, we should never forget that the future of mankind is at stake on these issues.

10.1.4 Basic Needs for the Survival of Mankind

The most basic need for the very survival of our contemporary societies in view of the disproportionate use of fossil fuels and the increasingly cataclysmic climactic events caused by the pollutants in their combustion exhaust can be summarized as follows:

(1) **Develop "new" processes for the nonpolluting, large scale production of electricity,** that is, processes beyond the now exhausted predictive capacities of conventional doctrines. Whether for electrolysis or other uses, electricity is and will remain the basic source of energy for the synthesis of new fuels. At the same time, hydro, thermal and wind sources of energy, even though very valuable, are dramatically insufficient to fulfill the present, let alone the future needs of clean energy. Nuclear power plants have been severely damaged by governmental obstructions, both in the U.S.A., Europe and other countries, against new processes for the stimulated decay of radioactive nuclear waste by the power plants themselves, in favor of a politically motivated storage of the radioactive waste in depositories so much opposed by local societies, thus preventing nuclear power to be a viable alternative.[7] Additionally, both the "hot fusion' and the

[7]For governmental politics opposing new methods for the stimulated decay of radioactive nuclear waste, one may visit the web site http://www.nuclearwasterecycling.com

"cold fusion" have failed to achieve industrially viable results to date, and none is in sight at this writing. The need for basically "new" clean sources of electricity is then beyond scientific doubt. This need is addressed in the next chapter because, as we shall see, the content of this chapter is a necessary pre-requisite.

(2) **Build a large number of large reactors for the large scale removal and recycling of the excess CO_2 in our atmosphere.** The containment of future production of CO_2 is basically insufficient because the existing amount in our atmosphere is sufficient to cause increasingly cataclysmic climactic events. Therefore, another major problem facing mankind is the removal of the CO_2 already existing in our atmosphere. This problem is addressed in the next subsection.

(3) **it Develop "new" fuels that are not derivable from crude oil and are capable of achieving full combustion,** that is, fuels structurally different than all known fuels due to their highly polluting character. The production of new fuels not derivable from crude oil is necessary in view of the exploding demand for fossil fuels expected from the construction in China of $500,000,000$ new cars and other factors, as well as the expected end of the petroleum reserves. This need is addressed in this chapter. the need for fuels with a new chemical structure is set by the impossibility for all available fuels, those with conventional molecular structure, to achieve full combustion. This need is addressed in this chapter.

10.1.5 Removing Carbon Dioxide from our Atmosphere and Car Exhaust

Nowadays, we have in our atmosphere a large excess CO_2 estimated to be from 100 to 300 times the CO_2 percentage existing at the beginning of the 20-th century, which excess is responsible for the "global worming" and consequential devastating climactic events.

A typical illustration is given by the Gulf of Mexico whose waters have reached in August, 2005, such a high temperature (95^oF) to kill dolphins and other marine species. This sad environmental problem is due to the fact that CO_2 is heavier than any other gas in the atmosphere, thus forming a layer on the top of the water that traps Sun light, with the resulting increase of water temperature.

All predictions establish that the current rate of CO_2 release in our atmosphere will eventually cause the water of the Gulf of Mexico to reach in the summer a steaming state, with consequential impossibility to sustain life, the only debatable aspect being the time of these lethal conditions in the absence of corrective action.

The *only* possible, rational solution of the problem is the *removal of CO_2 from our atmosphere via molecular filtration or other methods and its processing into noncontaminant gases.*

Other solutions, such as the pumping of CO_2 underground jointly with petroleum production as adopted by the petroleum company StatOil in Norway and other companies, are definitely unacceptable on environmental grounds because of the risk that the green house gas may resurface at some future time with catastrophic consequences. In fact, being a gas under very high pressure when under grounds, it is only a question of time for the CO_2 to find its way back to the surface.[8]

The technology for the molecular separation of CO_2 from our atmosphere is old and well established, thus requiring the construction of equipment in large sizes and numbers for installation in a sufficient number of location to yield appreciable results.

To understand the dimension for the sole Gulf of Mexico there is the need of a number of recyclers located in barges and/or in coastal area capable of processing at least 10 millions metric tons of air per day.

After clarifying that the technology for the removal of CO_2 from our atmosphere is fully available (only the political will is still absent at this writing in virtually all developed nations), the next issue is the selection of the appropriate processing of CO_2 into environmentally acceptable species.

According to extensive research in the problem conducted by the author and his associates, *the most efficient method for recycling CO_2 is that based on flowing the gas at high pressure through an electric arc* [5]. In fact, the arc decomposes the CO_2 molecule into carbon precipitates and breathable oxygen that can be released into the atmosphere to correct the oxygen depletion caused by fossil fuels.

Needless to say, these "CO_2 Recycling Plants can additionally remove from the environment circinogenic and other toxic pollutants via the use of the same technology of molecular sep[aration and processing.

Numerous other processes are also expected to be possible for the removal of the CO_2 excess from our atmosphere, and their indication to the author for quotation in possible future editions of this monograph would be appreciated.

Whatever environmentally acceptable solution is suggested, the main needs for serious and responsible governments is to stop the debate and discussions and initiate action *now,* when the economies of developed countries are still somewhat solid, because, later on, increasingly cataclysmic climatic events combined with increases in fossil fuel costs may eventually cause the collapse of said economies, at which points nations will not have the immense financial resources needed for the removal of the excess CO_2 in our planet.

IIn closing, the reader should be aware that current technologies permit the large scale production, thus at low cost, of special CO_2 absorbing cartridges that

[8]In reality, petroleum companies pump CO_2 underground to increase the pressure of release of near-by crude oil, and certainly not to help the environment.

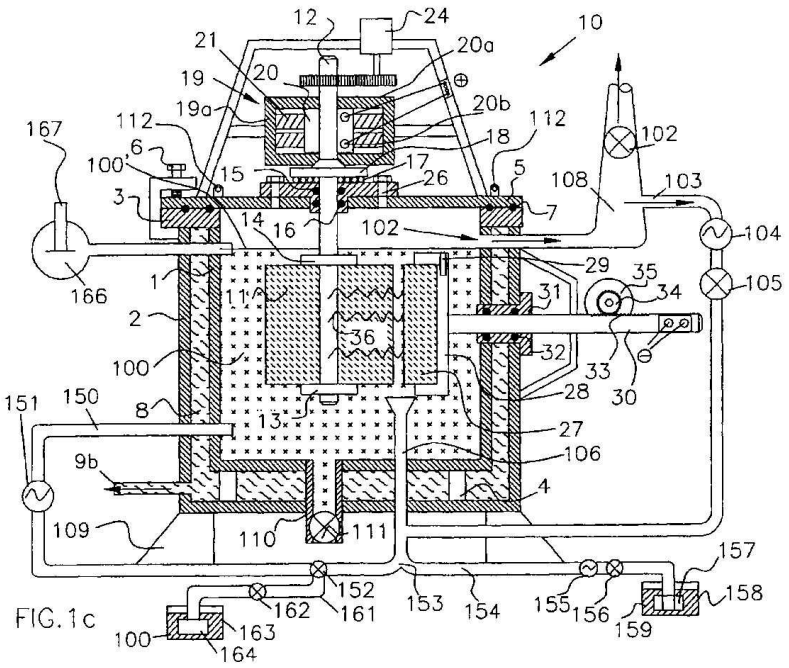


Figure 10.5. A schematic view of a preferred embodymnent for the recycling of CO_2 into C and O_2 via the use the PlasmaArcFlow technology of Refs.[5]. the main principle is that, following its separation from the atmosphere, the most efficient mean for breaking down the CO_2 bond is, by far, the electric arc..

can be houses in conventional car exhaust pipes and replaced periodically. the removal of CO_2 is done via special chemicals or other means.Additional possibilities are given by passing the exhaust through a series of arcs for the recycling of CO_2 into C and breathable O_2.

In short, in this chapter we show that current technologies do indeed permit the production of environmentally acceptable fuels, while in the next chapter we shall show that other technologies permit new clean energies. Mankind is exposed to increasing cataclysmic climactic events not only because of the *lack of political will* for any action that could be considered minimally responsible at this writing (fall 2005) in any and all so-called developed countries, but also because the political will continues to serve the oil cartel, as demonstrated by the political support of hydrogen, of course, produced from fossil fuels, despite having extremely serious environmental problems identified in the preceding subsection

10.2 THE NEW CHEMICAL SPECIES OF MAGNECULES

10.2.1 Introduction

The origin of the alarming environmental problems increasingly afflicting our planet are not due to fossil fuels per se, but rather to the strength of their conventional valence bond, since that strength has prohibited the achievement of full combustion during the past one hundred years of efforts. In fact, most of the atmospheric pollution caused by fossil fuels is due to "chunks" (such as dimers) of uncombusted fuel that are carcinogenic primarily because consisting of incomplete molecules.

In view of the above occurrence, this author proposed in Ref. [1] of 1998 a new chemical species that, by central assumption, is based on a bond much *weaker* than that of valence bonds so as to permit full combustion. For certain technical reasons indicated below the new species was submitted under the name of *magnecules* in order to distinguish the species from the conventional "molecules," and the new species is known today as *Santilli magnecules.*

In this chapter we report industrial research with the investment of several millions of dollars from private corporations that followed the proposal of Santilli magnecules [1], and resulted in the identification of three distinct new gaseous fuels with the novel magnecular structure, all achieving the original objective of full combustion without toxic substances in the exhaust. Several other substances with magnecular structure are under study and they will be reported in specialized technical journals.

This chapter is organized as follows. We shall first present the hypothesis of Santilli magnecules; we shall then study the industrial methods needed for their production, the features to be detected experimentally, and the analytic equipment needed for the detection of the new species. We shall then study three distinct gaseous fuels with magnecular structure and outline their rather vast experimental verifications. We shall finally study the experimental evidence for magnecular structures in liquids and other related aspects.

To begin, let us recall that the only chemical species with a clearly identified bond which was known prior to the advent of hadronic chemistry was that of *molecules* and related *valence bonds*, whose identification dates back to the 19-th century, thanks to the work by Avogadro (1811), Canizzaro (1858), and several others, following the achievement of scientific measurements of atomic weights.

Various candidates for possible additional chemical species are also known, such as the delocalized electron bonds. However, none of them possess a clearly identified attractive force clearly distinct from the valence.

Also, various molecular clusters have been studied in more recent times, although they either are unstable or miss a precise identification of their internal attractive bond.

An example of unstable molecular cluster occurs when the internal bond is due to an *electric polarization* of atomic structures, that is, a deformation from a spherical charge distribution without a net electric charge to an ellipsoidal distribution in which there is the predominance of one electric charge at one end and the opposite charge at the other end, thus permitting atoms to attract each other with opposite electric polarities. The instability of these clusters then follows from the known property that the smallest perturbation causes nuclei and peripheral electrons to reacquire their natural configuration, with the consequential loss of the polarization and related attractive bond.

An example of molecular clusters without a clear identification of their internal attractive bond is given by *ionic clusters*. In fact, ionized molecules have the *same positive charge* and, therefore, they *repel*, rather than attract, each other. As a result, not only the internal attractive bond of ionic clusters is basically unknown at this writing, but, when identified, it must be so strong as to overcome the repulsive force among the ions constituting the clusters.

In 1998, R. M. Santilli submitted in paper [1] (and then studied in details in monograph [2]) the hypothesis of a new type of stable clusters composed of molecules, dimers and atoms under a new, clearly identified, attractive internal bond which permits their industrial and practical use. The new clusters were called **magnecules** (patents pending) because of the dominance of magnetic effects in their formation, as well as for pragmatic needs of differentiations with the ordinary molecules, with the understanding that a technically more appropriate name would be *electromagnecules*.

The following terminology will be used herein:

1) The word *atom* is used in its conventional meaning as denoting a stable atomic structure, such as a hydrogen, carbon or oxygen, irrespective of whether the atom is ionized or not and paramagnetic or not.

2) The word *dimer* is used to denote part of a molecule under a valance bond, such as H–O, H–C, *etc.*, irrespective of whether the dimer is ionized or not, and whether it belongs to a paramagnetic molecule or not;

3) The word *molecule* is used in its internationally known meaning of denoting stable clusters of atoms under conventional, valence, electron bonds, such as H_2, H_2O, C_2H_2, *etc.*, irrespective of whether the molecule is ionized or not, and paramagnetic or not;

4) The word *magnecule* is used to denote stable clusters of two or more molecules, and/or dimers and/or atoms and any combination thereof formed by a new internal attractive bond of primarily magnetic type identified in detail in this chapter; the word *magnecular* will be used in reference to substances with the structure or features of magnecules;

5) The words *chemical species* are used to denote an essentially pure population of stable clusters with the same internal bond, thus implying the conventional

chemical species of molecules as well as that of magnecules, under the condition that each species admits an ignorable presence of the other species.

In this chapter we study the theoretical prediction permitted by hadronic mechanics and chemistry of the new chemical species of magnecules and its experimental verifications, which were apparently presented for the first time by Santilli in memoir [1] of 1998.

10.2.2 The Hypothesis of Santilli Magnecules

The main hypothesis, studied in details in the rest of this Chapter, can be formulated as follows:

DEFINITION 11.2.1 [1,2] (patented and international patents pending [5]): **Santilli magnecules** *in gases, liquids, and solids consist of stable clusters composed of conventional molecules, and/or dimers, and/or individual atoms bonded together by opposing magnetic polarities of toroidal polarizations of the orbits of at least the peripheral atomic electrons when exposed to sufficiently strong external magnetic fields, as well as the polarization of the intrinsic magnetic moments of nuclei and electrons. A population of magnecules constitutes a chemical species when essentially pure, i.e., when molecules or other species are contained in very small percentages in a directly identifiable form. Santilli magnecules are characterized by, or can be identified via the following main features:*

I) Magnecules primarily exist at large atomic weights where not expected, for instance, at atomic weights which are ten times or more the maximal atomic weight of conventional molecular constituents;

II) Magnecules are characterized by large peaks in macroscopic percentages in mass spectrography, which peaks remain unidentified following a search among all existing molecules;

III) Said peaks admit no currently detectable infrared signature for gases and no ultraviolet signature for liquids other than those of the conventional molecules and/or dimers constituting the magnecule;

IV) Said infrared and ultraviolet signatures are generally altered (a feature called "mutation") with respect to the conventional versions, thus indicating an alteration (called infrared or ultraviolet mutation) of the conventional structure of dimers generally occurring with additional peaks in the infrared or ultraviolet signatures not existing in conventional configurations;

V) Magnecules have an anomalous adhesion to other substances, which results in backgrounds (blank) following spectrographic tests which are often similar to the original scans, as well as implying the clogging of small feeding lines with consequential lack of admission into analytic instruments of the most important magnecules to be detected;

VI) Magnecules can break down into fragments under sufficiently energetic collisions, with subsequent recombination with other fragments and/or conventional

molecules, resulting in variations in time of spectrographic peaks (called time mutations of magnecular weights);

VII) Magnecules can accrue or lose during collision individual atoms, dimers or molecules;

VIII) Magnecules have an anomalous penetration through other substances indicating a reduction of the average size of conventional molecules as expected under magnetic polarizations;

IX) Gas magnecules have an anomalous solution in liquids due to new magnetic bonds between gas and liquid molecules caused by magnetic induction;

X) Magnecules can be formed by molecules of liquids which are not necessarily solvable in each other;

XI) Magnecules have anomalous average atomic weights in the sense that they are bigger than that of any molecular constituent and any of their combinations;

XII) A gas with magnecular structure does not follow the perfect gas law because the number of its constituents (Avogadro number), or, equivalently, its average atomic weight, varies with a sufficient variation of the pressure;

XIII) Substances with magnecular structure have anomalous physical characteristics, such as anomalous specific density, viscosity, surface tension, etc., as compared to the characteristics of the conventional molecular constituents;

XIV) Magnecules release in thermochemical reactions more energy than that released by the same reactions among unpolarized molecular constituents;

XV) All the above characteristic features disappear when the magnecules are brought to a sufficiently high temperature, which varies from species to species, called Curie Magnecular Temperature; in particular, combustion eliminates all magnetic anomalies resulting in an exhaust without magnecular features.

Magnecules are also called:

A) **elementary** *when only composed of two molecules*;

B) **magneplexes** *when entirely composed of several identical molecules*;

C) **magneclusters** *when composed of several different molecules.*

Finally, magnecules are called:

i) **isomagnecules** *when having all single-valued characteristics and being reversible in time, namely, when they are characterized by isochemistry (see Chapter 9);*

ii) **genomagnecules** *when having all single-valued characteristics and being irreversible in time, namely, when they are characterized by genochemistry;* and

iii) **hypermagnecules** *when having at least one multi-valued characteristic and being irreversible in time, namely, when they are characterized by hyperchemistry.*

The primary objective of this chapter is, first, to study the characteristic features of magnecules from a theoretical viewpoint, and then present independent experimental verifications for each feature.

All magnecules studied in this chapter are, strictly speaking, isomagnecules because single valued and reversible. The reader should be aware that all correct calculations implying single-valued irreversible chemical processes, such as chemical reactions in general, should be done with genomagnecules. Finally, all biological; structure will inevitably require the use of hypermagnecules as illustrated in Chapter 5.

The reader should keep in mind that *magnegas*, the new, clean combustible gas developed by the author [1,2,5], of Largo, Florida, has precisely a magnecular structure from which it derives its name. Nevertheless, we shall identify in this chapter other gases, liquids and solids with a magnecular structure.

By denoting the conventional valence bond with the symbol "–" and the new magnetic bond with the symbol "×", examples of *elementary magnecules* in gases and liquids are respectively given by

$$\{H-H\}\times\{H-H\},\quad \{O-O\}\times\{O-C-O\},\ etc., \tag{11.2.1a}$$

$$\{C_{15}-H_{20}-O\}\times\{C_{15}-H_{20}-O\},\ etc.; \tag{8.1b}$$

examples of *magneplexes* in gases and liquids are respectively given by

$$\{H-H\}\times\{H-H\}\times\{H-H\}\times\ldots,\ etc., \tag{11.2.2a}$$

$$\{H-O-H\}\times\{H-O-H\}\times\ldots,\ etc.; \tag{11.2.2b}$$

and examples of *magneclusters* are given by

$$\{H-H\}\times\{C-O\}\times\{O-C-O\}\times\{C=O\}\times\ldots,\ etc., \tag{11.2.3a}$$

$$\{C_{13}-H_{18}-O\}\times\{C_{14}-H_{12}-O_3\}\times\{C_{15}-H_{20}-O\}\times\ldots,\ etc. \tag{11.2.3b}$$

A generic representation of a gas magnecules requires the presence of individual atoms and dimers, such as:

$$\{H-H\}\times\{C-O\}\times H\times\{H-O-H\}\times C\times\{H-O\}\times\ldots,\ etc. \tag{11.2.4}$$

One of the most important features of magnecules is their anomalous release of energy in thermochemical reactions (Feature XIV of Definition 8.2.1), in view of its evident importance for the industrial development of new clean fuels such as magnegas (Sects. 7.10 and 7.11).

As we shall see in detail later on, this feature is crucially dependent on the existence within the magnecules of individual atoms, such as H, C and O, and/or individual unpaired dimers, such as H–O and H–C. In fact, at the breakdown of the magnecules due to combustion, these individual atoms and dimers coupled themselves into conventional molecules via known exothermic reactions such as

$$\begin{gathered} H+H\to H_2+105\ \text{Kcal/mole},\\ C+O\to CO+255\ \text{Kcal/mole},\\ H-O+H\to H_2O+28\ \text{Kcal/mole},\ etc., \end{gathered} \tag{11.2.5}$$

with consequential release during combustion of a large amount of energy that does not exist in fuels with a conventional molecular structure.

In reading this chapter, the reader should keep in mind that, in view of the above important industrial, consumer and environmental implications, a primary emphasis of the presentation is the study of magnecules with the largest possible number of *unpaired atoms and dimers*, rather than molecules.

In inspecting the above representation of magnecules, the reader should also keep in mind that their linear formulation in a row is used mainly for practical purposes. In fact, the correct formulation should be via *columns*, rather than rows, since the bond occurs between one atom of a given molecule and an atom of another molecule, as we shall see in detail later on.

10.2.3 The Five Force Fields Existing in Polarized Atoms

The attractive bond responsible for the creation of magnecules originates within the structure of individual *atoms*. Therefore, it is recommendable to initiate our study via the identification of all force fields existing in a conventional atomic structure.

The sole fields in the atomic structure studied by chemists prior to Ref. [1] were the intrinsic electric and magnetic fields of electrons and nuclei (see Fig. 11.6). It was proved a century ago that these fields can only produce *valence bonds*, thus explaining the reason why molecules were the only form of atomic clustering with a clear bond admitted by chemistry until recently.

Santilli's [1] main contribution has been the identification of a *new force field in the atomic structure*, which is sufficiently strong to permit a new chemical species.

Since the inception of atomic physics, the electron of the hydrogen atom (but not necessarily peripheral electrons of more complex atoms) has been assumed to have a spherical distribution, which is indeed the case for isolated and unperturbed atomic structures (see also Fig. 811.6).

However, electrons are charged particles, and all charges rotating in a planar orbit create a magnetic field in the direction perpendicular to the orbital plane, and such to exhibit the North polarity in the semi-space seeing a counter-clockwise rotation (see Fig. q11.6..B).

A main point of Ref. [1] is that the distribution in space of electron orbits is altered by sufficiently strong external magnetic fields. In particular, the latter cause the transition from the conventional spherical distribution to a new distribution with the same cylindrical symmetry of the external field, and such to exhibit magnetic polarities opposite to the external ones (Fig. 11.6.C).

Therefore, the magnetic fields of atoms *are not* solely given by the intrinsic magnetic fields of the peripheral electrons and of nuclei because, under the appli-

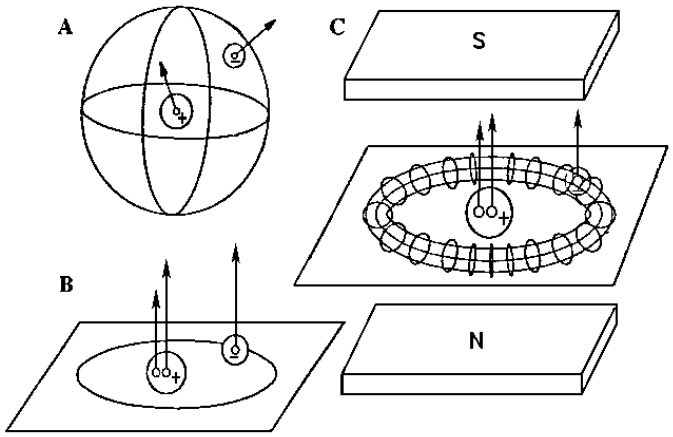


Figure 10.6. A schematic view of the force fields existing in the hydrogen atom. Fig. 11.6.A depicts an isolated hydrogen atom in its conventional spherical configuration when at absolute zero degree temperature, in which the sole force fields are given by the electric charges of the electron and of the proton, as well as by the intrinsic magnetic moments of the same particles. Fig. 11.6.B depicts the same hydrogen atom in which the orbit of the peripheral electron is polarized into a plane. In this case there is the emergence of a fifth field, the magnetic dipole moment caused by the rotation of the electron in its planar orbit. Fig. 11.6.C depicts the same hydrogen atom under an external magnetic field which causes the transition from the spherical distribution of the peripheral electron as in Fig. 11.6.A to a new distribution with the same cylindrical symmetry as that of the external field, and such to offer magnetic polarities opposite to the external ones. In the latter case, the polarization generally occurs within a toroid, and reaches the perfectly planar configuration of Fig. 11.6.B only at absolute zero degree temperature or under extremely strong magnetic fields.

cation of a sufficiently strong external magnetic field, atoms exhibit the additional magnetic moment caused by a polarization of the electron orbits. This third magnetic field was ignored by chemists until 1998 (although not by physicists) because nonexistent in a conventional atomic state.

As a matter of fact, it should be recalled that *orbits are naturally planar in nature, as established by planetary orbits, and they acquire a spherical distribution in atoms because of various quantum effects, e.g., uncertainties.* Therefore, in the absence of these, all atoms would naturally exhibit *five* force fields and not only the four fields currently assumed in chemistry.

On historical grounds it should be noted that theoretical and experimental studies in physics of the hydrogen atom subjected to an external (homogeneous) magnetic field date to Schrödinger's times.

10.2.4 Numerical Value of Magnecular Bonds

In the preceding section we have noted that a sufficiently strong external magnetic field polarizes the orbits of peripheral atomic electrons resulting in a magnetic field which does not exist in a conventional spherical distribution. Needless to say, the same external magnetic fields also polarize the intrinsic magnetic moments of the peripheral electrons and of nuclei, resulting into *three net magnetic polarities* available in an *atomic* structure for a new bond.

When considering molecules, the situation is different because valence electrons are bonded in singlet couplings to verify Pauli's exclusion principle, as per our hypothesis of the *isoelectronium* of Chapter 9. As a result, their net magnetic polarities can be assumed in first approximation as being null. In this case, only *two* magnetic polarities are available for new bonds, namely, the magnetic field created by the rotation of paired valence electrons in a polarized orbit plus the intrinsic magnetic field of nuclei.

It should be noted that the above results persist when the inter-electron distance of the isoelectronium assumes orbital values. In this case the total intrinsic magnetic moment of the two valence electrons is also approximately null in average due to the persistence of antiparallel spins and, therefore, antiparallel magnetic moments, in which absence there would be a violation of Pauli's exclusion principle.

The calculation of these *polarized magnetic moments at absolute zero degree temperature* is elementary [1]. By using rationalized units, the magnetic moment $M_{e\text{-orb}.}$ of a polarized orbit of one atomic electron is given by the general quantum mechanical law:

$$M_{\text{e-orb.}} = \frac{q}{2m} L\mu, \tag{11.2.6}$$

where L is the angular momentum, μ is the rationalized unit of the magnetic moment of the electron, $q = -e$, and $m = m_e$.

It is easy to see that *the magnetic moment of the polarized orbit of the isoelectronium with characteristics (4.25) coincides with that of one individual electron.* This is due to the fact that, in this case, in Eq. (11.2.6) the charge in the numerator assumes a double value $q = -2e$, while the mass in the denominator also assumes a double value, $m = 2m_e$, thus leaving value (8.6) unchanged.

By plotting the various numerical values for the ground state of the hydrogen atom, one obtains:

$$M_{\text{e-orb.}} = M_{\text{isoe-orb.}} = 1,859.59\mu. \tag{11.2.7}$$

By recalling that in the assumed units the proton has the magnetic moment 1.4107 μ, we have the value [1]:

$$\frac{M_{\text{e-orb.}}}{M_{\text{p-intr.}}} = \frac{1,856.9590}{1.4107} = 1,316.33, \tag{11.2.8}$$

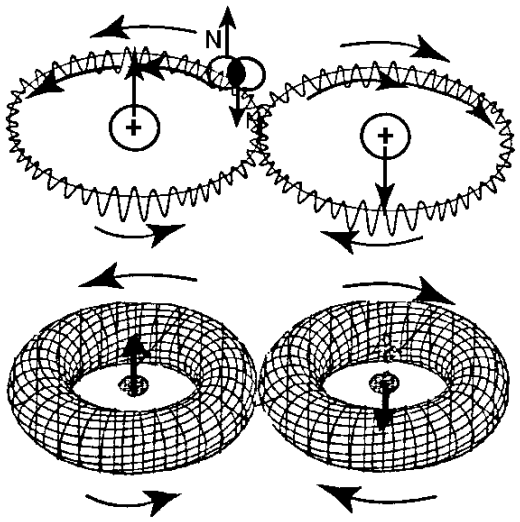


Figure 10.7. A schematic view of the magnetic fields of the isochemical model of the hydrogen molecule with isoelectronium assumed to be a stable quasi-particle. The top view represents the molecule at absolute zero degree temperature with polarization of the orbit in a plane, while the bottom view represents the molecule at ordinary temperature with a polarization of the orbit within a toroid. In both cases there is the disappearance of the *total intrinsic* magnetic moments of the electrons because they are coupled in the isoelectronium with antiparallel spin and magnetic moments due to Pauli's exclusion principle. The *lack* of contribution of the intrinsic magnetic moments of the electrons persists even when the isoelectronium has dimension much bigger than 1 fm, because the antiparallel character of the spins and magnetic moments persists, resulting in an average null total intrinsic magnetic moment of the electrons. Therefore, the biggest magnetic moment of the hydrogen molecule which can be obtained via polarizations is that of the electrons *orbits*. Note, as recalled in Sect. 9.2, the *oo*-shaped (also called figure eight) configuration has been recently proved in mathematics to be one of the most stable solutions of the N-body problem.

namely, *the magnetic moment created by the orbiting in a plane of the electron in the hydrogen atom is 1,316 times bigger than the intrinsic magnetic moment of the nucleus*, thus being sufficiently strong to create a bond.

It is evident that the *polarized magnetic moments at ordinary temperature* are smaller than those at absolute zero degrees temperature. This is due to the fact that, at ordinary temperature, the perfect polarization of the orbit in a plane is no longer possible. In this case the polarization occurs in a *toroid*, as illustrated in Fig. 8.2, whose sectional area depends on the intensity of the external field.

As an illustrative example, under an external magnetic field of 10 Tesla, an *isolated hydrogen atom* has a total magnetic field of the following order of magnitude:

$$M_{\text{H-tot.}} = M_{\text{p-intr.}} + M_{\text{e-intr.}} + M_{\text{e-orb.}} \approx 3,000\mu, \tag{11.2.9}$$

while the same hydrogen atom under the same conditions, when a component of a *hydrogen molecule* has the smaller value

$$M_{\text{H}_2\text{-tot.}} = M_{\text{p-intr.}} + M_{\text{isoe-orb.}} \approx 1,500\mu, \tag{11.2.10}$$

again, because of the absence of the rather large contribution from the intrinsic magnetic moment of the electrons, while the orbital contribution remains unchanged.

The above feature is particularly important for the study of magnecules and their applications because it establishes the theoretical foundations for the presence of isolated atoms in the structure of magnecules since *the magnetic bonds of isolated atoms can be at least twice stronger than those of the same atoms when part of a molecule.*

An accurate independent verification of the above calculations was conducted by M.G. Kucherenko and A.K. Aringazin [3], who obtained the following value via the use of alternative models,

$$\frac{M_{\text{e-orb.}}}{M_{\text{p-intr.}}} \approx 1,315\mu. \tag{11.2.11}$$

Needless to say, the quantized value of the angular momentum of the ground state of the conventional (unpolarized) hydrogen atom is null, $L = 0$, thus implying a null magnetic moment, $M = 0$. This occurrence confirms the well known feature that the magnetic moment of the orbit of the peripheral electron of a conventional (unpolarized) hydrogen atom is null.

Consequently, expressions (8.6)-(8.11) should be considered under a number of clarifications. First, said expressions refer to *the orbit of the peripheral electron under an external magnetic field* which implies an evident alteration of the value of the magnetic moment. Note that this external magnetic field can be either that of an electric discharge, as in the PlasmaArcFlow reactors, or that of another polarized hydrogen atom, as in a magnecule. This occurrence confirms a main aspect of the new chemical species of magnecules, namely, that the plane polarization of the orbits of the peripheral atomic electron is stable if and only if said polarization is coupled to another because, if isolated, the plane polarization is instantly lost due to rotations with recover the conventional spheroidal distribution of the orbits.

Moreover, expressions (11.2.6)-(11.2.11) refer to the angular momentum of the orbit of the peripheral electron *polarized in a plane*, rather than that with a spherical distribution as in the conventional ground state of the hydrogen atom. The latter condition, alone, is sufficient to provide a non-null quantized orbital magnetic moment.

Finally, the value $L = 1$ needed for expressions (11.2.6)-(11.2.11) can be obtained via *the direct quantization of the plane polarization of a classical orbit.*

These aspects have been studied in detail by Kucherenko and Aringazin [2] and Aringazin [8] (see Appendix 8.A). These studies clarify a rather intriguing property mostly ignored throughout the 20-th century according to which, contrary to popular beliefs, *the quantized angular momentum of the ground state of the hydrogen atom is not necessarily zero, because its value depends on possible external fields*.

It is important to note that the magnetic polarizations herein considered are *physical notions*, thus being best expressed and understood via *actual orbits* as treated above rather than *chemical orbitals*. This is due to the fact that *orbits are physical entities* actually existing in nature, and schematically represented in the figures with standing waves, in semiclassical approximation. By contrasts, *orbitals are purely mathematical notions* given by probability density. As a result, magnetic fields can be more clearly associated with orbits rather than with orbitals.

Despite the above differences, it should be stressed that, magnetic polarizations can also be derived via the *orbitals* of conventional use in chemistry. For example, consider the description of an isolated atom via the conventional Schrödinger equation

$$H|\psi\rangle = \left(\frac{p^2}{2m} + V\right)|\psi\rangle = E|\psi\rangle, \tag{11.2.12}$$

where $|\psi\rangle$ is a state in a Hilbert space. Orbitals are expressed in terms of the probability density $|\langle\psi| \times |\psi\rangle|$. The probability density of the electron of a hydrogen atom has a spherical distribution, namely, the electron of an isolated hydrogen atom can be found at a given distance from the nucleus with the same probability in any direction in space.

Assume now that the same hydrogen atom is exposed to a strong external homogeneous and static magnetic field B. This case requires the new Schrödinger equation,

$$\left((p - \frac{e}{c}A)^2/2m + V\right)|\psi'\rangle = E'|\psi'\rangle, \tag{11.2.13}$$

where A is vector-potential of the magnetic field B. It is easy to prove that, in this case, the new probability density $|\langle\psi'| \times |\psi'\rangle|$ possesses a *cylindrical symmetry* precisely of the type indicated above, thus confirming the results obtained on physical grounds. A similar confirmation can be obtained via the use of Dirac's equation or other chemical methods.

An accurate recent review of the Schrödinger equation for the hydrogen atom under external magnetic fields is that by A.K. Aringazin [8], which study confirms the toroidal configuration of the electron orbits which is at the foundation of the new chemical species of magnecules. A review of Aringazin studies is presented in Appendix 11 .A. As one can see, under an external, strong, homogeneous, and constant magnetic fields of the order of 10^{13} Gauss $= 10^7$ Tesla, the solutions of

Schrödinger equation of type (8.13) imply the restriction of the electron orbits within a single, small-size toroidal configuration, while the excited states are represented by the double-splitted toroidal configuration due to parity.

Intriguingly, the binding energy of the ground state of the H atom is much higher than that in the absence of an external magnetic field, by therefore confirming another important feature of the new chemical species of magnecules, that of permitting new means of storing energy within conventional molecules and atoms, as discussed later on in this chapter.

For magnetic fields of the order of 10^9 Gauss, spherical symmetry begins to compete with the toroidal symmetry, and for magnetic fields of the order of 10^5 Gauss or less, spherical symmetry is almost completely restored by leaving only ordinary Zeeman effects. This latter result confirms that the creation of the new chemical species of magnecules in gases as per Definition 8.2.1 requires very strong magnetic fields. The situation for liquids is different, as shown later on also in this chapter.

The magnetic polarization of atoms larger than hydrogen is easily derived from the above calculations. Consider, for example, the magnetic polarization of an isolated atom of oxygen. For simplicity, assume that an external magnetic field of 10 Tesla polarizes only the two peripheral valence electrons of the oxygen. Accordingly, its total polarized magnetic field of orbital type is of the order of twice value (8.9), *i.e.*, about 6,000 μ. However, when the same oxygen atom is bonded into the water or other molecules, the maximal polarized magnetic moment is about half the preceding value.

Note the dominance of the magnetic fields due to polarized electron *orbits* over the intrinsic *nuclear* magnetic fields. This is due not only to the fact that the former are 1,316 times the latter, but also to the fact that nuclei are at a relative great distance from peripheral electrons, thus providing a contribution to the bond even smaller than that indicated. This feature explains the essential novelty of magnecules with respect to established magnetic technologies, such as that based on *nuclear magnetic resonances*.

Note also that a main mechanism of polarization is dependent on an external magnetic field and the force actually providing the bond is of magnetic type. Nevertheless, the ultimate origin is that of charges rotating in an atomic orbit. This illustrates that, as indicated in Sect. 11.2.1, the name "magnecules" was suggested on the basis of the predominant magnetic origin, as well as for the pragmatic differentiation with molecules without using a long sentence, although a technically more appropriate name would be "electromagnecules."

Needless to say, the polarization of the orbits is not necessarily restricted to valence electrons because the polarization does not affect the quantum numbers of any given orbit, thus applying for all atomic electrons, including those of complete inner shells, of course, under a sufficiently strong external field. As a

consequence, *the intensity of the magnetic polarization generally increases with the number of atomic electrons*, namely, the bigger is the atom, the bigger is, in general, its magnetic bond in a magnecule.

Ionizations do not affect the *existence* of magnetic polarizations, and they may at best affect their *intensity*. An ionized hydrogen atom is a naked proton, which acquires a polarization of the direction of its magnetic dipole moment when exposed to an external magnetic field. Therefore, an ionized hydrogen atom can indeed bond magnetically to other polarized structures. Similarly, when oxygen is ionized by the removal of one of its peripheral electrons, its remaining electrons are unchanged. Consequently, when exposed to a strong magnetic field, such an ionized oxygen atom acquires a magnetic polarization which is similar to that of an unpolarized oxygen atom, except that it lacks the contribution from the missing electron. Ionized molecules or dimers behave along similar lines. Accordingly, the issue as to whether individual atoms, dimers or molecules are ionized or not will not be addressed hereon.

The magnetic polarizations here considered are also independent as to whether the substance considered is paramagnetic or not. This is evidently due to the fact that the polarization deals with the individual orbits of individual peripheral electrons, irrespective of whether paired or unpaired, belonging to a saturate shell or not. Therefore, the issue as to whether a given substance is paramagnetic or not will be ignored hereon.

Similarly, the polarizations here considered do not require molecules to have a net total magnetic polarity, which would be possible only for paramagnetic substances, again, because they act on individual orbits of individual atomic electrons.

We should also indicate that another verification of our isochemical model of molecular structures is the resolution of the inconsistency of the conventional model in predicting that all substances are paramagnetic, as illustrated in Figs. 1.4 and 1.5.

Recall that the atoms preserve their individualities in the conventional molecular model, thus implying the *individual* acquisition of a magnetic polarization under an external field, with consequential net total magnetic polarities for all molecules which is in dramatic disagreement with experimental; evidence.

By comparison, in the isochemical molecular model the valence electrons are actually bonded to each other, with consequential *oo*-shaped orbit around the respective nuclei. This implies that the rotational directions of the *o*-branches are opposite to each other. In turn, this implies that magnetic polarizations are also opposite to each other, resulting in the lack of a net magnetic polarity under an external field, in agreement with nature (see Figs. 4.5 and 8.3 for more details).

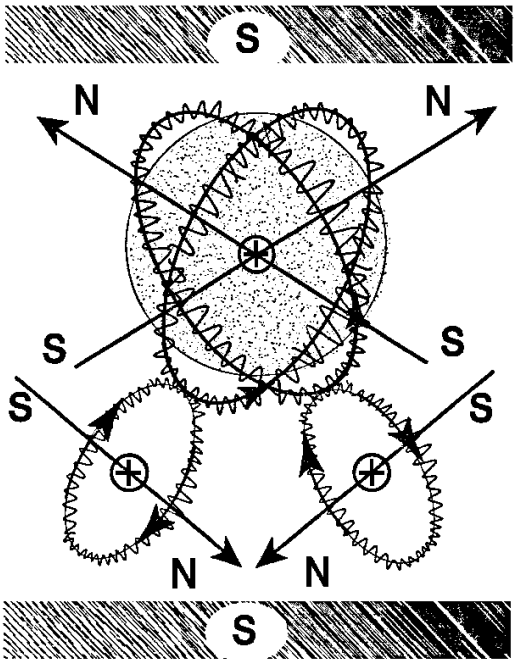


Figure 10.8. A schematic view of the resolution for the case of the water molecule of the inconsistent prediction of the conventional molecular model that water is paramagnetic (Fig. 1.14), as permitted by the Santilli-Shillady isochemical model of water molecule (Chapter 9). As one can see, the resolution is given by the impossibility for the water molecule to acquire a net magnetic polarity. Note the complexity of the geometry of the various magnetic fields which, according to ongoing research, apparently permits the first explanation on scientific record of the 105° angle between the two H–O dimers. The corresponding resolution for the case of the hydrogen is outlined in Fig. 9.5.

10.2.5 Production of Magnecules in Gases, Liquids and Solids

At its simplest, the creation of magnecules can be understood via the old method of magnetization of a paramagnetic metal by induction. Consider a paramagnetic metal which, initially, has no magnetic field. When exposed to a constant external magnetic field, the paramagnetic metal acquires a permanent magnetic field that can only be destroyed at a sufficiently high temperature varying from metal to metal and called the *Curie Temperature*.

The mechanism of the above magnetization is well known. In its natural unperturbed state, the peripheral atomic electrons of a paramagnetic metal have a space distribution that results in the lack of a total magnetic field. However, when exposed to an external magnetic field, the orbits of one or more unpaired

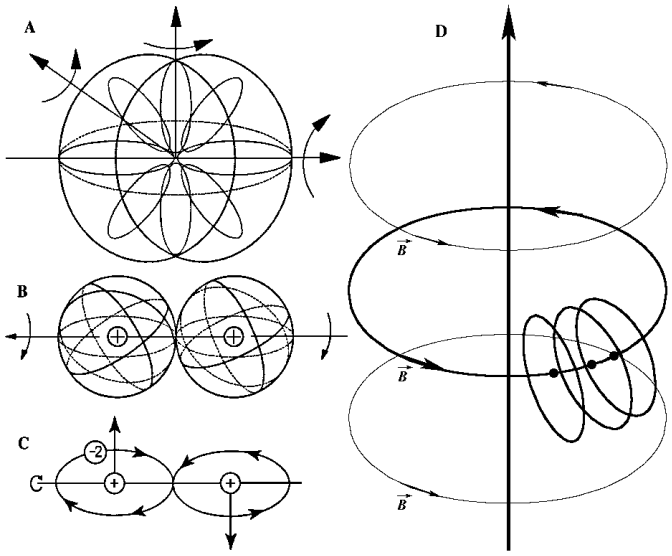


Figure 10.9. A schematic view of the main mechanism underlying the creation of magnecules, here illustrated for the case of the hydrogen molecule. It consists in the use of sufficiently strong external magnetic fields which can progressively eliminate all rotations, thus reducing the hydrogen molecule to a configuration which, at absolute zero degrees temperature, can be assumed to lie in a plane. The planar configuration of the electron orbits then implies the manifestation of their magnetic moment which would be otherwise absent. The r.h.s. of the above picture outlines the geometry of the magnetic field in the immediate vicinity of an electric arc as described in the text for the case of hadronic molecular reactors (Chapter 12). Note the *circular* configuration of the magnetic field lines around the electric discharge, the *tangential* nature of the symmetry axis of the magnetic polarization of the hydrogen atoms with respect to said circular magnetic lines, and the consideration of hydrogen atoms at *orbital distances* from the electric arc 10^{-8} cm, resulting in extremely strong magnetic fields proportional to $(10^{-8})^{-2} = 10^{16}$ Gauss, thus being ample sufficient to create the needed polarization (see Appendix 8.A for details).

electrons are polarized into a toroidal shape with end polarities opposite to those of the external field.

This mechanism is called magnetic induction, and results in a stable chain of magnetically polarized orbits from the beginning of the metal to its end with polarities North-South/North-South/North-South/ ... This chain of polarizations is so stable that it can only be destroyed by high temperatures.

The creation of magnecules can be essentially understood with a similar polarization of the peripheral electron orbits, with the main differences that: no total magnetic polarization is necessary; the polarization generally apply to all electrons, and not necessarily to unpaired electrons only; and the substance need not to be paramagnetic.

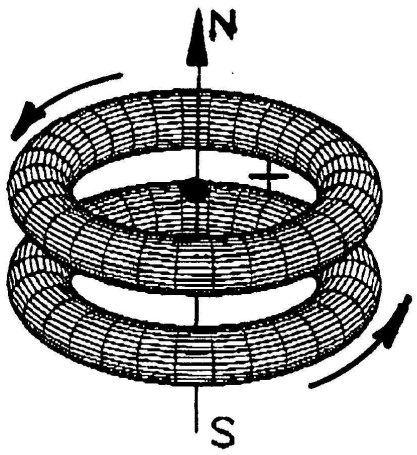


Figure 10.10. A schematic view of the simplest possible bi-atomic magnecule whose bond originates from the toroidal polarization of the orbits of peripheral atomic electrons. A first main difference with conventional molecular bonds is that, under sufficiently strong external magnetic fields, the magnecular bond may occur independently from the existence or not of valence electrons. Consequently, the two polarized atoms depicted in this figure can be arbitrarily chosen, while for conventional molecular bonds the atoms are restricted to verify known valence rules. Another major difference is that, by central conception to achieve full combustion for the case of fuels (see Section 11.1), the magnecular bond is much weaker than the molecular bond. In fact, due to its magnetic origin, the bond of this picture ceases to exist at a given temperature (the Curie Temperature) that, for the case of gaseous fuels with magnecular structure, it is usually given by the flame temperature. The main industrial as well as social result is that gaseous fuels with magnecular structure do achieve indeed total combustion without any toxic substance in its exhaust, something impossible for fuels with molecular structure, as proved by various cases studied in the subsequent sections of this chapter. Another implication also of major industrial and social relevance is that fuels with magnecular structure can be synthesized in such a way to be internally rich in oxygen (usually of liquid, rather than atmospheric origin) in order to replenish the atmospheric oxygen already depleted by fossil fuels, something equally impossible for fuels with molecular structure, as also studied later on in this chapter.

To illustrate these differences, consider a diamagnetic substance, such as the hydrogen at its gaseous state at ordinary pressure and temperature. As well known, the hydrogen molecule is then a perfect sphere whose radius is equal to the diameter of a hydrogen atom, as illustrated in Fig. 11.9.A. The creation of the needed magnetic polarization requires the use of external magnetic fields capable, first, to remove the rotation of the atoms, as illustrated in Fig. 11.9.B, and then the removal of the internal rotations of the same, resulting in a planar configuration of the orbits as illustrated in Fig. 11.9 .C.

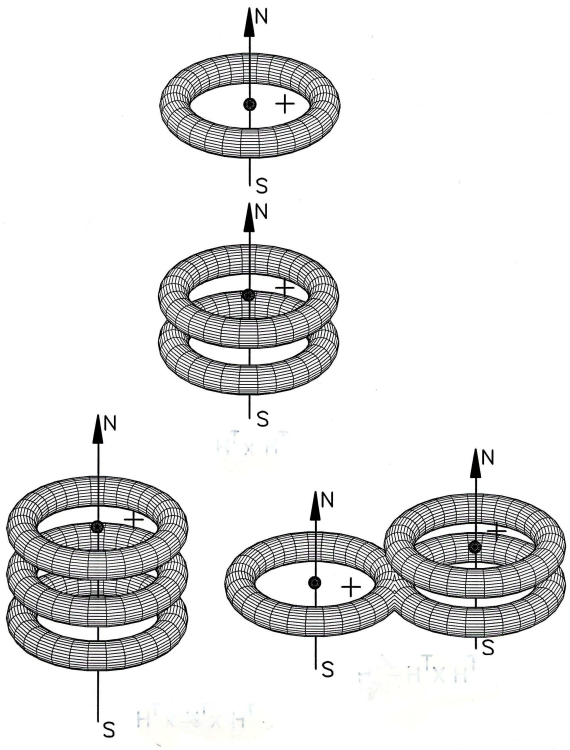


Figure 10.11. A schematic view of the simplest possible multiatomic magnecular bonds. Case A illustrates the *elementary hydrogen magnecule*. The subsequent case is that of four hydrogen atoms $(H \times H) \times (H \times H)$ (or two hydrogen molecules $H - H) \times (H - H)$) under a magnecular bond that has atomic weight very close to that of the helium. Therefore, the detection in a GC-MS scan of a peak with 4 a.m.u., by no means, necessarily identifies the helium because the peak could belong to the hydrogen magnecule. Case B illustrates a magnecule composed by a molecule and a dimer. Case C illustrates the hypothesis submitted in this monograph that the structure with 3 a.m.u. generally interpreted as a conventional "molecule" H_3 may in reality be a magnecule between a hydrogen molecule and an isolated hydrogen atom. This is due to the fact that, once the two valence electrons of the hydrogen molecule are bonded-correlated, they cannot admit the same valence bond with a third electron for numerous physical reasons, such as: the bond cannot be stable because the former is a Boson while the latter is a Fermion; the former has charge $-2e$ while the latter has charge $-e$, thus resulting in a large repulsion; *etc.*

Once the above polarization is created in two or more hydrogen molecules sufficiently near each other, they attract each other via opposite magnetic polarities, resulting in the elementary magnecules of Fig. 11.10.A. Additional elementary magnecules can then also bond to each other, resulting in clusters with a number of constituents depending on the conditions considered.

A most efficient industrial production of gas and liquid magnecules is that via the *PlasmaArcFlow Reactors* [5]. As we shall see via the experimental evidence presented below, said reactors can produce an essentially pure population of gas and liquid magnecules without appreciable percentages of molecules directly detectable in the GC- or LC-MS.

The reason for these results is the intrinsic geometry of the PlasmaArcFlow itself. Recall that this technology deals with a DC electric arc submerged within a liquid waste to be recycled. The arc decomposes the molecules of the liquid into its atomic constituents; ionizes the same; and creates a plasma of mostly ionized H, C and O atoms at about $3,500^{\circ}$ K. The flow of the liquid through the arc then continuously removes the plasma from the arc following its formation. Said plasma then cools down in the surrounding liquid, and a number of chemical reactions take place resulting in the formation of magnegas which bubbles to the surface of the liquid where it is collected for industrial or consumer use.

To understand the creation of a *new chemical species* defined according to Sect. 11.2.1 as an essentially pure population of *gas magnecules*, recall that magnetic fields are inversely proportional to the square of the distance,

$$F_{\text{magnetic}} = \frac{m_1 m_2}{r^2}. \tag{11.2.14}$$

Therefore, an atom in the immediate vicinity of a DC electric arc with 1,000 A and 30 V, experiences a magnetic field which is inversely proportional to the square of the *orbital* distance $r = 10^{-8}$ cm, resulting in a magnetic field proportional to 10^{16} units.

No conventional space distribution of peripheral atomic electrons can exist under these extremely strong magnetic fields, which are such to generally cause the polarization of the orbits of *all* atomic electrons, and not only those of valence type, as well as their essential polarization in a plane, rather than a toroid.

As soon as two or more molecules near each other possessing such an extreme magnetic polarization are created, they bond to each other via opposing magnetic polarities, resulting in the elementary magnecule of Fig. 11.8.A.

Moreover, as shown earlier, isolated atoms have a magnetic field with an intensity double that of the same atom when belonging to a molecule. Therefore, as soon as created in the immediate vicinity of the electric arc, individual polarized atoms can bond to polarized molecules without any need to belong themselves to a molecule, as illustrated in Fig. 11.10.C.

Finally, recall that the PlasmaArcFlow is intended to destroy liquid molecules such as that of water. It then follows that the plasma can also contain individual highly polarized molecular fragments, such as the dimer H–O. The notion of gas magnecules as per Definition 8.2.1 then follows as referred to stable clusters of molecules, and/or dimers, and/or isolated atoms under an internal attractive bond among opposing polarities of the magnetic polarization of the orbits of

peripheral electrons, nuclei and electrons when the latter are not coupled into valence bonds.

Effective means for the creation of an essentially pure population of *liquid magnecules* are given by the same PlasmaArcFlow Reactors. In fact, during its flow through the DC arc, the liquid itself is exposed to the same extreme magnetic fields as those of the electric arc indicated above. This causes the creation of an essentially pure population of liquid magnecules composed of highly polarized liquid molecules, dimers of the same liquid, and individual atoms, as established by LC-MS/UVD tests.

One way to create an essentially pure population of *solid magnecules* is given by freezing the new chemical species at the liquid level and then verifying that the latter persists after defrosting, as confirmed by various tests. Therefore, the case of solid magnecules is ignored hereon for simplicity.

By denoting with the arrow $\uparrow$ the vertical magnetic polarity North-South and with the arrow $\downarrow$ the vertical polarity South-North, and by keeping the study at the absolute zero degree temperature, when exposed to the above indicated extreme magnetic fields, the hydrogen molecule H–H can be polarized into such a form that the orbit of the isoelectronium is in a plane with resulting structure $H_\uparrow - H_\downarrow$ (Fig. 11.7).

The elementary hydrogen magnecule can then be written

$$\{H^a_\uparrow - H^b_\downarrow\} \times \{H^c_\uparrow - H^d_\downarrow\}, \tag{11.2.15}$$

where: a, b, c, d denote different atoms; the polarized hydrogen atom $H^a_\uparrow$ is bonded magnetically to the polarized atom $H^c_\uparrow$ with the South magnetic pole of atom a bonded to the North pole of atom c; and the North polarity of atom b is bonded to the South polarity of atom d (see, again, Fig. 8.5.A). This results in a strong bond due to the flat nature of the atoms, the corresponding mutual distance being very small and the magnetic force being consequently very large. Moreover, unlike the case of the unstable clusters due to electric polarization discussed in Sect. 11.2.1, the above magnetic bonds are very stable because motions due to temperature apply to the bonded couple (11.2.15) as a whole.

For other magnecules we can then write

$$\{H_\uparrow - H_\downarrow\} \times \{C_\uparrow - O_\downarrow\}; \tag{11.2.16}$$

or, more generally

$$\{H_\uparrow - H_\downarrow\} \times H_\downarrow \times \{C_\uparrow - O_\downarrow\} \times \{H_\uparrow - O_\downarrow\} \times \{H_\uparrow - C_\downarrow - A - B - C \dots\} \times \dots, \tag{11.2.17}$$

where A, B, and C are generic atoms in a conventional molecular chain and the atoms without an indicated magnetic polarity may indeed be polarized but are not necessarily bonded depending on the geometric distribution in space.

Magnecules can also be formed by means other than the use of external magnetic fields. For instance, magnecules can be produced by electromagnetic fields with a distribution having a cylindrical symmetry; or by microwaves capable of removing the rotational degrees of freedom of molecules and atoms, resulting in magnetic polarizations. Similarly, magnecules can be formed by subjecting a material to a pressure that is sufficiently high to remove the orbital rotations. Magnecules can also be formed by friction or by any other means not necessarily possessing magnetic or electric fields, yet capable of removing the rotational degrees of freedom within individual atomic structures, resulting in consequential magnetic polarizations.

It is, therefore, expected that a number of substances which are today listed as of unknown chemical bond, may eventually result to have a magnecular structure.

Magnecules of type (8.15) may well have been detected in past mass spectrometric measurements, but believed to be the helium (because its molecular weight is very close to that of the helium). In fact, the same happens for the "molecule" H_3 which, in reality may be the magnecule of Fig. 11.10.C.

The destruction of magnecules is achieved by subjecting them to a temperature greater than the magnecules Curie Temperature which varies from magnecule to magnecule.

10.2.6 New Molecular Internal Bonds

As indicated in Sect. 11.2.2, and verified experimentally later on, the IR signatures of conventional molecules such as CO_2 are mutated due to the appearance of two new peaks which do not exist for the conventional molecule. By recalling that peaks in the IR signature generally represent bonds, this evidence indicates the capability by the CO_2 molecule to acquire new internal bonds in addition to those of conventional valence type.

The magnetic polarization at the foundations of magnecules predicts the existence of these new internal bonds and permits their quantitative study. Recall that external magnetic fields can polarize the orbit of valence electrons, but cannot possibly break or alter valence bonds. Recall that, consequently, sufficiently strong external magnetic fields can polarize the orbits of all atomic electrons, and not only those of the valence electrons.

Consider then a conventional molecule such as C=O. When exposed to the extreme magnetic fields as existing in the PlasmaArcFlow technology, the orbits of all internal electrons can be polarized, individually, for the carbon and the oxygen, in addition to the polarization of the two pairs of valence bonds. Note that the planes of these polarizations need not be necessarily parallel to each other, because their relative orientation dependents on the geometry at hand.

One of the various possible geometries is that in which the plane of the polarization of the internal electrons is perpendicular to that of the two pairs of

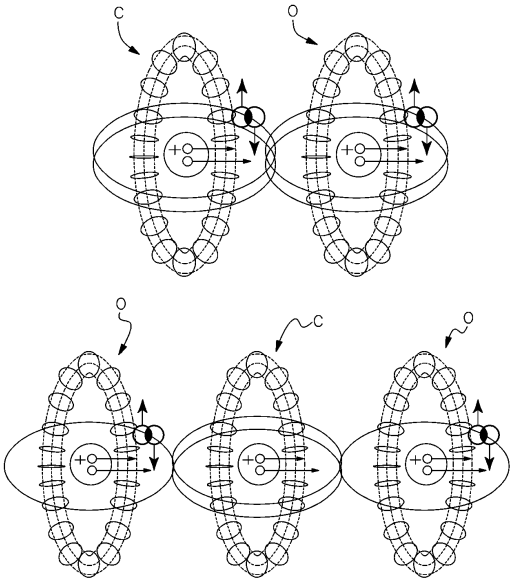


Figure 10.12. A schematic view for the cases of C=O and O–C–O of the polarization of internal atomic electrons, while preserving conventional valence bonds, and the consequential creation of new bonds in conventional molecules which are not of valence type, as later on verified experimentally via IR scans.

valence bonds. In this case we have the birth of a *new bond of magnetic origin in the interior of a conventional molecule*, which is evidently given by the alignment of the two polarities North-South and North-South in the carbon and oxygen, and the consequential attraction of opposite polarities of different atoms, as illustrated in Fig. 11.11.A.

For the case of the O–C–O molecule we can evidently have two internal bonds of magnetic type in addition to the valence bonds, which are also given by the alignment of the magnetic polarities, resulting in one new bond for the O–C dimer and a second one for the C–O dimer, as illustrated in Fig. 11.11.B.

As we shall see later on, the above new internal molecular bonds have major industrial and consumer implications, inasmuch as they permit the production of fuels capable of releasing under combustion anomalous amounts of energy, with consequential reduction of pollutants in the exhaust, as already proved by magnegas.

Needless to say, the creation of new internal bonds is an extreme case of IR mutation. In reality, numerous other weaker forms of mutations without the appearance of new peaks are possible and their study is left to the interested reader.

10.2.7 Main Features for the Detection of Magnecules

The experimental detection of gas magnecules requires the verification of a number of characteristic features of magnecules identified in Definition 8.2.1. In the following we focus the reader's attention on the main features of gas magnecules which must be verified via GC-MS tests. The remaining features will be considered later on.

Feature 1: Appearance of unexpected heavy MS peaks.
Gas magnecules are generally heavier than the heaviest molecule in a given gas. Peaks in the GC-MS are, therefore, expected in macroscopic percentages with atomic weights bigger than the heaviest molecule. As a concrete example, the heaviest molecule in magnegas in macroscopic percentage is CO_2 with 44 a.m.u. Therefore, GC-MS scans should only show background noise if set for over 44 a.m.u. On the contrary, peaks in macroscopic percentages have been detected in magnegas all the way to 1,000 a.m.u.

Feature 2: Unknown character of the unexpected MS heavy peaks.
To provide the initial premises for the detection of magnecules, all MS peaks of feature 1 should result in being "unknown" following the computer search among all known molecules, usually including a minimum of 150,000 molecules. Evidently, this lack of identification of the peaks, *per se*, does not guarantee the presence of a new chemical species.

Feature 3: Lack of IR signature of the unknown MS peaks.
Another necessary condition to claim the detection of magnecules is that the unknown MS peaks of feature 1 should have no IR signature other than that of the molecules and/or dimers constituents. This feature guarantees that said heavy peaks cannot possibly represent molecules, thus establishing the occurrence of a new chemical species. In fact, only very few and very light molecules can have such a perfect spherical symmetry to avoid IR detection, while such a perfect spherical symmetry is manifestly impossible for large clusters. In regard to the constituents we are referring to IR signatures, *e.g.*, of the CO_2 at 44 a.m.u. in a cluster having 458 a.m.u.

Feature 4: Mutation of IR signatures.
The infrared signatures of conventional molecules constituting magnecules are expected to be *mutated*, in the sense that the shape of their peaks is not the conventional one. As indicated in the preceding section, the mutations most important for industrial applications are those due to the presence of *new IR peaks* representing new internal bonds. Nevertheless, various other forms of IR muta-

tions are possible.

Feature 5: Mutation of magnecular weights.
While molecules preserve their structure and related atomic weight at conventional temperatures and pressures, this is not the case for gas magnecules, which can *mutate* in time, that is, change their atomic weight with consequential change of the shape and location of their MS peaks. Since we are referring to gases whose constituents notoriously collide with each other, magnecules can break-down during collisions into fragments which can then recombine with other fragments or other magnecules to form new clusters.

Feature 6: Accretion or emission of individual atoms, dimers or molecules.
Magnecules are expected to experience accretion or emission of individual atoms, dimer or molecules without necessarily breaking down into parts. It follows that the peaks of Feature 1 are not expected to remain the same over a sufficient period of time for the same gas under the same conditions.

Feature 7: Anomalous adhesion.
Magnetically polarized gases have anomalous adhesion to walls of disparate nature, not necessarily of paramagnetic character, as compared to the same unpolarized gas. This is due to the well-known property that magnetism can be propagated by induction, according to which a magnetically polarized molecule with a sufficiently intense magnetic moment can induce a corresponding polarization of valence and/or other electrons in the atoms constituting the wall surface. Once such a polarization is created by induction, magnecules can have strong magnetic bonds to the indicated walls. In turn, this implies that the background of GC-MS following scans and conventional flushing are often similar to the scan themselves. As a matter of fact, backgrounds following routine flushing are often used to identify the most dominant magnecules. Notice that the magnetic polarization here considered does not require that the walls of the instrument are of paramagnetic type, since the polarization occurs for the orbits of arbitrary atoms.

Magnetically polarized gases additionally have mutated physical characteristics and behavior because the very notion of polarization of electron orbits implies physical alterations of a variety of characteristics, such as average size. Mutations of other characteristics are then consequential.

We should finally recall that the above features are expected to disappear at a sufficiently high temperature, evidently varying from gas to gas (Curie Temperature), while the features are expected to be enhanced at lower temperature and at higher pressure, and survive liquefaction.

10.3 THE UNAMBIGUOUS DETECTION OF MOLECULES AND MAGNECULES

10.3.1 Selection of Analytic Instruments

Current technologies offer an impressive variety of analytic instruments (see, *e.g.*, Ref. [4]), which include: Gas Chromatography (GC), Liquid Chromatography (LC), Capillary Electrophoresis Chromatography (CEC), Supercritical Chromatography (SCC), Ion Chromatography (IC), Infrared Spectroscopy (IR), Raman Spectroscopy (RS), Nuclear Magnetic Resonance Spectroscopy (NMRS), X-Ray Spectroscopy (XRS), Atomic Absorption Spectroscopy (AAS), Mass Spectrometry (MS), Laser Mass Spectrometry (LMS), Flame Ionization Spectrometry (FIS), and others.

Only some of these instruments are suitable for the detection of magnecules and, when applicable, their set-up and use are considerably different than those routinely used with great success for molecules.

Among all available chromatographic equipment, that suitable for the detection of gas magnecules is the GC with column having ID of at least 0.32 mm operated according to certain criteria outlined below. By comparison, other chromatographs do not appear to permit the entrance of large magnecules, such as the CEC, or be potentially destructive of the magnecules to be detected, such as the IC.

Among all available spectroscopic equipment, that preferable is the IR, with the understanding that such an instrument is used in a *negative* way, that is, to verify that the magnecule considered has no IR signature. The RS may also result in being preferable in various cases, while other instruments, such as the NMRS do not appear to be capable of detecting magnecules despite their magnetic nature, evidently because NMRS are most effective for the detection of microscopic magnetic environment of H-nuclei rather than large structures. Other spectroscopic instruments have not been studied at this writing.

In regard to spectrometric equipment, the most recommendable one is the low ionization MS due to the fact that other instruments seemingly destroy magnecules at the time of their detection. The study of other spectrometric equipment is left to interested researchers. Chemical analytical methods (i.e. via chemical reactions) to *detect* gas magnecules are probably not very effective since they necessarily destroy the magnecules in reaction.

As it is well known, when used individually, the above suggested instruments have considerable limitations. For instance, the GC has a great resolution of a substance into its constituent, but it has very limited capabilities to identify them. By comparison, the MS has great capabilities to identify individual species, although it lacks the ability to separate them.

For these reasons, some of the best analytic instruments are given by the combination of two different instruments. Among them, the most recommendable

one is the GC combined with the MS, and denoted GC-MS. A similar occurrence holds for the IR combined to the GC-MS. As indicated since the early parts of this Chapter, the best instrument for the detection of both molecules and magnecules in gases is the GC-MS equipped with the IRD denoted GC-MS/IRD while that for liquids is the LC-MS equipped with UVD and denoted LC-MS/UVD.

Among a large variety of GC-MS instruments, only a few are truly effective for the detection of gas magnecules for certain technical reasons identified below. The instrument which has permitted the first identification of magnecules and remains the most effective at this writing (despite its considerable age for contemporary standards) is the GC Hewlett-Packard (HP) model 5890 combined with the MS HP model 5972 equipped with a large ID column and feeding line operated at the lowest temperature permitted by the instrument (about 10° C) and the longest elusion time (about 25 min).

A secondary function of the IRD is that of identifying the *dimers constituting a magnecule*, a task which can be fulfilled by various IRD. That which was used for the original discovery of magnecules and still remains effective (again, despite its age by current standards) is the IRD HP model 5965, when operated with certain criteria identified below.

A most insidious aspect in the detection of magnecule is the protracted use of any given instrument with great success in the detection of conventional molecules, and the consequential expectation that the same instrument should work equally well for the detection of magnecules, resulting in an analysis without any real scientific value because:

i) the species to be detected may not even have entered the instrument, as it is routinely the case for small syringes and feeding lines particularly for liquid magnecules (which can be so big as to be visible to the naked eye, as shown later on in this chapter);

ii) the species to be detected may have been destroyed by the measurement itself, as it is routinely the case for instruments operated at very high temperature, or flame ionization instruments which, when used for combustible gases with magnecular structure, cause the combustion of magnecules at the very time of their detection; or

iii) the detection itself may create magnecules which do not exist in the original species, as it is the case of peaks with 3 a.m.u. discussed in Fig. 11.10.

In conclusion, the separation between a true scientific measurement and a personal experimental belief requires extreme scientific caution in the selection of the analytic instrument, its use, and the interpretation of the results.

10.3.2 Unambiguous Detection of Molecules

As it is well known, a *gas molecule* is identifiable by unique and unambiguous GC-MS peaks, which are distinctly different from those of any other gas molecule.

In addition, this GC-MS identification can be confirmed by IRD peaks and related resonating frequencies, which are also distinctly different for different gas molecule. Additional confirmations are possible using other analytic methods, such as those based on average molecular weight, chemical reactions and other procedures.

The advent of the new chemical species of magnecules suggests a re-examination of these analytic methods and procedures so as to separate personal opinions from actual scientific identifications. Such a re-examination is warranted by the fact that, due to extended use, claims of specific molecular identifications are nowadays generally voiced via the use of only one analytic detector.

As an illustration, most contemporary analytic laboratories conduct chemical analyses on gases via the sole use of the IRD. However, *infrared detectors do not identify complete molecules, since they can only identify the bond in their dimers*. For instance, for the case of H_2O, the IRD does not identify the complete molecule, but only its dimer H–O.

This method of identification of molecules is certainly acceptable for gases whose lack of magnetic polarization has been verified by the analysts. However, the same method is highly questionable for gases of unknown origin. In fact, we shall soon show experimental evidence of clear IR signatures for molecules which have no MS identification at all, in which case the claim of such a molecule evidently has no scientific value.

The inverse occurrence is equally questionable, namely, the claim of a given molecule from its sole identification in the MS without a confirmation of exactly the same peak in the IRD. In fact, there are several MS peaks in magnetically polarized gases which may be easily identified with one or another molecule, but which have no IR signature at all at the MS value of the atomic weight, in which case the claim of molecular identification evidently has no scientific value.

Note that the great ambiguities in the separate use of disjoint GC-MS and IRD. In fact, in this case there is no guarantee or visible evidence that exactly the same peak is jointly inspected under the MS and, separately, the IRD. In fact, a given molecule can be tentatively identified in the MS at a given a.m.u., while the same molecule may indeed appear in the IRD, although at a different value of a.m.u., in which case, again, the claim to have detected a given molecule is a personal experimental belief, rather than a scientific truth.

In conclusion, *a serious scientific identification of any given molecule requires the joint use of at least two different analytic methods, both giving exactly the same result for exactly the same peak in a unique and unambiguous way, such as the detection via MS scans with unequivocal computer identifications, confirmed by IR scans without ambiguities, thus requiring the use of GC-MS equipped with IRD.*

Additional ambiguities result from the rather widespread belief that molecules are the only possible chemical species in nature, in which case small deviations from exact identifications are generally ignored for the specific intent of adapting experimental evidence to pre-existing knowledge, rather than modifying old interpretations to fit new experimental evidence. This widespread tendency is also a reason why magnecules have not been identified until now.

As an illustration, suppose that: a GC-MS equipped with IRD detects a peak with 19 a.m.u.; said peak is identified by the MS search as the water molecule with 18 a.m.u.; and the IRD confirms the presence of the HO-dimer. Under these conditions, it is almost universally accepted in contemporary analytic laboratories that said peak with 19 a.m.u. represents the water molecule, and the spurious single a.m.u. is just an "impurity" or something to be ignored, in which case, however, we do not have a true scientific identification of the species.

In fact, it is well possible that the peak at 19 a.m.u. is constituted by a highly polarized water molecule magnetically bonded to one isolated hydrogen atom with structure

$$\{H_{\downarrow} - O_{\uparrow\uparrow} - H_{\downarrow}\} \times H_{\downarrow}. \tag{11.3.1}$$

In this case, according to our terminology, the peak at 19 a.m.u. is a magnecule and *not* a molecule, even though the MS search gives 99.99% confidence and the IR search gives 100% confidence that the species is the ordinary water molecule. After all, the magnecular bond is transparent to current IR detection, then, the latter confirms an erroneous belief.

At any rate, no claim on the peak with 19 a.m.u. can be truly scientific or otherwise credibly, unless it explains in a specific and numerical way, without vague nomenclatures, how the single a.m.u. entity is attached to the water molecule.

Recall that the valence bond requires singlet couplings to verify Pauli's exclusion principle. As a consequence, coupled pairs of valence electrons are *Bosonic states with zero spin*. Under these conditions, no nomenclature suggesting one or another type of valence can credible explain the bonding of one single H atom to the H–O–H molecule because it would imply the bond of a *Fermion with spin* 1/2 (the valence electron of the hydrogen) with a *Boson* (the coupled valence electron pair of the water), which bond is an impossibility well known in particle physics. By comparison, the magnecular hypothesis identifies the *attractive* character of the bond in a clear and unambiguous way, and then its *numerical value* (8.9).

The detection of *liquid molecules* has problems greater than those for gas molecules, because liquid magnecules can be so big to be visible by the naked eye, in which case only their conventional molecular constituents are generally permitted to enter current instruments, resulting again in a lack of real detection.

In conclusion, the separation in the identification of molecules between a true scientific process and a personal experimental belief requires extreme care before claiming that a certain peak characterizes a molecule, since possible ambiguities

exist in all cases, from small to large atomic weights. In the final analysis, as stressed above, the difference between a molecule and a magnecule may be given by what is generally considered noise, or instrument malfunction.

The most unreassuring occurrence is that all GC-MS equipped with IRD identified by this author in the USA following a laborious search belong to military, governmental, or law enforcement institutions, and none of them was identified in commercial or academic laboratories. Therefore, the great majority of analytic laboratories lack the very instrument necessary for a final and unequivocal identification of a conventional *molecules*, let alone that of magnecules.

10.3.3 Unambiguous Detection of Magnecules

Since magnecules have properties very different from those of conventional molecules, the experimental detection of magnecules requires a special care. In particular, methods which have been conceived and developed for the detection of molecules are not necessarily effective for the detection of the different chemical species of magnecules precisely in view of the indicated differences.

The first indication of a possible *gas magnecule* is given by MS peaks with large atomic weight which cannot be explained via conventional molecular hypotheses. The second indication of a gas magnecule is given by the lack of identification of said heavy peaks in the MS following a search among all known molecules. A third indication of a gas magnecule then occurs when said unknown MS peak has no IR signature, except those of its constituents with much smaller atomic weight, which occurrence establishes the lack of a valence bond. Final identification of a gas magnecule requires the knowledge of the method used in the production of the gas and other evidence.

As it is the case also for molecules, a serious spectrographic analysis of magnecules requires GC-MS detectors necessarily equipped with IRD, because only such an instrument permits the direct test of the *same peaks* under both the MS and IR scan. Again, if the IRD operates separately from the GC-MS, the indicated joint inspection is not possible; the IRD can only detect ordinary molecular dimers; the experimental belief that the MS peak must be a molecule is then consequential.

As a concrete example verified later on with actual tests, consider the spectrographic analysis of magnegas. This is a light gas whose heaviest molecule in macroscopic percentages should be the CO_2 at 44 a.m.u. Consider now an MS peak of magnegas at 481 a.m.u. It is evident that, while small deviations could be adapted to quantum chemistry, large deviations of such an order of magnitude cannot be reconciled with established knowledge in a credible way, thus permitting the hypothesis that the MS peak in a *light* gas with 481 a.m.u. can be a magnecule. The MS scan of the peak soon establishes the impossibility for the computer to identify the peak among all existing molecules. When the GC-MS is

equipped with IRD, the analyst can scan the same peak with 481 a.m.u. under the IRD and detect no signature at the 481 a.m.u. value, the only IR signature being that at 44 a.m.u. of the CO_2 as well as those of smaller molecules. The production of the gas under intense magnetic fields then confirm that the peak here considered at 481 a.m.u. is indeed a magnecule composed of a large number of ordinary light molecules, dimers and individual atoms, in accordance with Definition 8.2.1.

Note that the IRD scan in the above test has solely identified conventional molecules without any additional unknown. Yet, the conclusion that the gas considered is solely composed of molecule would be nonscientific for numerous reasons, such as: 1) magnetic bonds are transparent to IR scans with available frequencies; 2) there is no IR detection, specifically, at 481 a.m.u.; and 3) IRD do not detect molecules, but only dimers.

Therefore, even though the IRD has detected CO_2 in the above test, the actual detection was for the C–O dimer, in which case the claim of the presence of the full CO_2 molecule is a personal opinion, and not an experimental fact.

The anomalous energy content, weigh and other features of magnegas confirm the above conclusions, because the latter can only be explained by assuming that a certain percentage of IR counts is indeed due to complete molecules, while the remaining percentage is due to unpaired dimers trapped in the magnecules. The freeing of these dimers and atoms at the time of the combustion, and their recombination into molecules as in Eqs. (8.5) then explains the anomalous energy content.

In addition to the above basic requirements, numerous other precautions in the use of the GC-MS equipped with IRD are necessary for the detection of magnecules, such as:

i) the MS equipment should permit measurements of peaks at ordinary temperature, and avoid the high temperatures of the GC-MS column successfully used for molecules;

ii) the feeding lines should be cryogenically cooled;

iii) the GC-MS/IRD should be equipped with feeding lines of at least 0.5 mm ID;

iv) the GC-MS should be set to detect peaks at large atomic weights usually not expected; and

v) the ramp time should be the longest allowed by the instrument, *e.g.*, of at least 25 minutes.

It should be stressed that *the lack of verification of any one of the above conditions generally implies the impossibility to detect magnecules*. For instance, the use of a feeding line with 0.5 mm ID is un-necessarily large for a conventional light gas, while it is necessary for a gas with magnecular structure such as magnegas. This is due to the unique adhesion of the magnecules against the walls

of the feeding line, resulting in occluded lines which prevent the passage of the most important magnecules to be detected, those with large atomic weight.

Similarly, it is customary for tests of conventional gases to use GC-MS with columns at high temperature to obtain readings in the shortest possible time, since conventional molecules are perfectly stable under the temperatures here considered. The use of such method would equally prevent the test of the very species to be detected, because, as indicated earlier, they have a characteristic Curie Temperature at which all magnetic features are lost. Magnecules are stable at ordinary temperatures and, consequently, they should be measured at ordinary temperatures.

Along similar lines, recall that GC-MS with a short ramp time are generally used for rapidity of results. Again, the use of such a practice, which has been proven by extensive evidence to be effective for molecules, prevents clear detection of magnecules. If the ramp time is not of the order of 25 minutes, *e.g.*, it is of the order of one minute, all the peaks of magnecules generally combine into one single large peak, as described below. In this case the analyst is generally lead to inspect an individual section of said large peak. However, in so doing, the analyst identifies conventional molecules constituting the magnecule, and not the magnecule itself.

When these detectors with short ramp times are equipped with IRD, the latter identify the infrared signatures of individual conventional molecules constituting said large unique peak, and do not identify the possible IR signature of the single large peak itself. Therefore, a GC-MS with short ramp time is basically unsuited for the detection of magnecules because it cannot separate all existing species into individual peaks.

In conclusion, the experimental evidence of the above occurrences establishes the need in the detection of gas magnecules of *avoiding, rather than using, techniques and equipment with a proved efficiency for molecules*, thus avoiding the use of GC-MS without IRD, with short ramp time, high column temperatures, microscopic feeding lines, and other techniques. On the contrary, new techniques specifically conceived for the detection of magnecules should be worked out.

The conditions for scientific measurements of *liquid magnecules* via LC-MS/UVD are more stringent than those for gases, because of the great increase, in general, of the atomic weight of liquid magnecules which are generally much larger than the IR of conventionally used feeding lines, as shown below.

This implies the possible erroneous claim that magnecules do not exist because they are not detected by the LC-MS, while in reality the magnecule to be detected could not enter into at all into the instrument.

10.3.4 Apparent Magnecular Structure of H_3 and O_3

As it is well known, chemistry has identified in GC-MS tests clusters with 3 a.m.u., which can only be constituted of three H atoms, H_3, while the familiar ozone O_3 has been known since quite some time. These structures are generally assumed to be molecules, that is, to have a valence bond according to one nomenclature or another, although this author is aware of no in depth theoretical or experimental identification of the attractive force necessary to bond the third atom to a conventional molecule.

There are serious doubts as to whether such a conventional molecular interpretation will resist the test of time as well as of scientific evidence. To begin, a fundamental property of valence bonds is that *valence electrons correlate in pairs.* Since the H_3 and O_3 structures contain the molecules H_2 and O_2 in which all available valence electrons are already bonded in pairs, the belief that an additional third valence electron could be correlated to the preceding ones violates basic chemical knowledge on valence.

Moreover, we have stressed earlier that the assumption of a third valence electron bonded to a valence pair is in violation of basic physical knowledge, because it would require the bond of a Fermion (the third electron with spin 1/2) with a Boson (the singlet valence pair with spin 0) both possessing the same negative charge. Such a hypothetical bond under molecular conditions would violate various laws in particle physics, e.g., it would imply a necessary violation of Pauli-s exclusion principle since the assumed "triplet" of electrons would have *two* identical electrons in the same structure with the same energy.

In view of the above (as well as other) inconsistencies, we here assume that *the familiar H_3 and O_3 clusters are magnecules consisting of a third H and O atom magnetically bonded to the conventional H_2 and O_2 molecules, respectively, along the structure of Fig. 11.11.C.* Note that this assumption is fully in line with Definition 8.2.1 according to which a magnecule also occurs when one single atom is magnetically bonded to a fully conventional molecule.

The plausibility of the above structure is easily illustrated for the case of O_3. In fact, the oxygen is known to be paramagnetic, and the ozone is known to be best created under an electric discharge. These are the ideal conditions for the creation of a magnetic polarization of the orbits of (at least) the paramagnetic electrons. The attraction of opposing magnetic polarities is then consequential, and so is the magnetic bond of the third oxygen to the oxygen molecule, resulting in the magnecule $O_2 \times O$.

The above magnecular interpretation of O_3 is confirmed by various GC-MS detections of peaks with 32 a.m.u. in a magnetically treated gas originally composed of pure oxygen, in which case the sole possible interpretation is that of two magnetically bonded oxygen molecules, resulting in the magnecule $O_2 \times O_2$.

The plausibility of the magnecular interpretation is less trivial for the H_3 structure since hydrogen is diamagnetic. Nevertheless, the assumption remains equally plausible by recalling that a central feature of the new chemical species of magnecules is that *the magnetic polarization occurs at the level of each individual atom, and not at the level of a diamagnetic molecule, whose total magnetic moment remains null as illustrated in Fig. 11.7.*

In particular, the magnecular interpretation of the MS peaks at 3 a.m.u. is numerical and without ambiguities. Recall that GC equipment works by ionizing molecules. When testing a hydrogen gas, a number of H_2 molecules are separated into individual H atoms by the ionization itself. Moreover, the ionization occurs via the emission of electrons from a filament carrying current, which is very similar to that of the PlasmaArcFlow Reactors producing magnecules. Under these conditions, the filament of the GC can not only separate H-molecules but also polarize them when sufficiently close to the filament. Once such polarizations are created, their bond is a known physical law, resulting in the magnecule of Fig. 11.11, *i.e.*

$$\{H_{\downarrow} - H_{\uparrow}\} \times H_{\downarrow}. \tag{11.2.19}$$

As one can see, under the magnecular structure the bond is manifestly attractive, very strong, and numerically identified in Eq. (11.3.9). Other interpretations of the peak at 3 a.m.u. are here solicited, provided that, to be credible, they are not of valence type and the internal bond is identified in a clear, unambiguous, and numerical way.

The magnecular interpretation of H_3 is confirmed by numerous GC-MS detections of a cluster with 4 a.m.u. in a magnetically treated gas which originally was composed by pure hydrogen, under which conditions such a peak can only be constituted by two hydrogen molecules resulting in the magnecule $H_2 \times H_2$ illustrated in Fig. 11.11.

It is an easy prediction that numerous peaks detected in contemporary GC-MS or LC-MS equipment may need a magnecular re-interpretation since, as indicated earlier, the method of detection itself can create magnecules. This is typically the case when the comparison of a given MS cluster with the actual peak of a given molecules contains additional lines.

As a specific example, when the peak representing a hexanal molecule (whose heaviest constituent has 100 a.m.u.) contains additional lines at 133 a.m.u., 166 a.m.u., and 207 a.m.u., it is evident that the latter lines cannot cluster with the hexanal molecule via valence bond. The plausibility of the magnecular interpretation is then evident.

For copies of the GC-MS scans mentioned in this section, which are not reproduced here for brevity, we suggest the interested reader to contact the author.

10.3.5 Need for New Analytic Methods

In closing, we should stress that the methods for the detection and identification of magnecules are at their infancy and numerous issues remain open at this writing (spring 2001). One of the open issues relates to several detections in magnegas of IR signatures apparently belonging to complex molecules, such as light hydrocarbons, while such molecules have not been identified in the MS scans. This occurrence creates the realistic possibility that certain complex magnecules may indeed have an IR signature in view of their size. More specifically, as indicated earlier, magnecules are assumed to be transparent to currently available IRD because their inter-atomic distance is expected to be 10^4 times smaller than the inter-atomic distance in molecules, thus requiring test frequencies which simply do not exist in currently available IRD.

However, such an argument solely applies for magnecules with small atomic weight, such as the elementary magnecules of Fig. 11.10. On the contrary, magnecules with heavy atomic weight may well have an IR signature and, in any case, the issue requires specific study.

This possibility is confirmed by the fact that magnegas is created via underliquid electric arcs whose plasma can reach up to $10{,}000^o$ K. The insistence that light hydrocarbons could survive in these conditions, let alone be created, is not entirely clear. This direct observation is confirmed by the fact that no hydrocarbon has been detected in the combustion of magnegas. In fact, the cars running on magnegas (see next section) operate without catalytic converter. Direct analysis of the combustion exhaust show a *negative count* of hydrocarbons, that is, the exhaust contains less hydrocarbons than the local atmosphere which is used for basic calibration of the instrument.

In summary, we have a case in which light hydrocarbons are seemingly indicated by IR scans to exist in small percentages in magnegas, while no hydrocarbon has ever been identified in the MS scans, no hydrocarbon is expected to survive at the extreme temperatures of the electric arcs used for their production, and no hydrocarbon has been detected in the combustion exhaust.

These occurrences illustrate again that the identification of conventional molecules via the sole use of IR scans or, equivalently, the sole use of MS scans, is, in general, a mere personal opinion without scientific foundations.

10.4 MAGNEGASES^{TM}, THE COMBUSTIBLE GASES WITH A MAGNECULAR STRUCTURE

10.4.1 PlasmaArcFlow^{TM} Reactors for Recycling Liquid Waste into the Clean Burning Cost Competitive Magnegas Fuel

In this section we summarize the results of corporate research following the investment of several millions of dollars for the conception and industrial development by the author of the first new gaseous fuels with magnecular structure, today known as *Santilli Magnegases*^{TM} (patented and international patents pending [5]), verifying the following main conditions:

1) Achievement of full combustion without any toxic content in the exhaust, thanks to its magnecular structure (Section 11.1.1);

2) Achievement of exhaust rich in breathable oxygen originating from liquids (rather than from our atmosphere) so as to replenish the oxygen depleted by fossil fuel combustion and converted into excess CO_2;

3) Have a thermodynamical equivalence with natural gas so that all equipment running on natural gas (cars, electric generators, furnaces, etc.) can also run on magnegas without structural modifications;

4) Be lighter than air and have a natural scent so that in case of leaks the gas can be easily detected and rises for safety;

5) Be synthesized via the recycling of liquid waste (such as automotive liquid wastes, city, farm or ship sewage, etc.), so as to decrease the environmental problems caused by the latter;

6) Be cost competitive with respect to fossil fuels thanks to a highly efficient and non-contaminant production process;

7) Permit the achievement of fuel independence from crude oil (petroleum) thanks to the continuous local availability as feedstock, for instance, of city sewage 24 hours per day.

The term "magnegases" is today referred to *all gaseous fuels possessing Santilli's magnecular structure.* from now on we shall study in this section a specific type of "magnegas" obtained via a new combustion of carbon obtained via a submerged electric arc. Consequently, the type of magnegas treated in this section contains carbon. other types of magnegases without carbon will be studied in the next sections.

The equipment that has been developed for the production of type of magnegas here considered is given by *Santilli's hadronic reactors of molecular type* (Class III), also known as PlasmaArcFlow^{TM} Reactors (patented and international patents pending [5]), that were first built by the author in 1998 in Florida, U.S.A., , and are now in regular production and sale the world over (see the figures and web site [5b] for pictures).

Figure 10.13. Picture of a 250 Kw Santilli's Hadronic Reactor (also called PlasmaArcFlow Reactor) with the panels of its completely automatic and remote controls, to recycle liquid waste into magnegas usable for any fuel application, a large amount of heat and carbonaceous precipitates used to produce the electrodes. This Reactor can produce up to 5000,000 scf (140 millions liters) of magnegas per week of 24 hours work per day corresponding to 3,000 gasoline gallon equivalent (11,000 gasoline liter equivalent) of magnegas per week computed on the basis that: 1) Gasoline contains about 110,000 BTU/g (about 29,000 BTU/liter); 2) Magnegas has the low energy content of 750 BTU/scf (26 BTU/liter); and 3) the "gasoline gallon equivalent" is given by about 150 scf of magnegas ("gasoline liter equivalent" is given by about 29 liters of magnegas). PlasmaArcFlow reactors are completely self-contained. Consequently, they release no solid, liquid or gas to the environment and cause no noise or odor pollution (see website [5b] for details).

PlasmaArcFlow Reactors use a submerged DC electric arc between carbon-base electrodes to achieve the complete recycling of essentially any type of (non-radioactive) liquid waste into the clean burning magnegas fuel, heat usable via exchangers, and carbonaceous precipitates used for the production of electrodes. The reactors are ideally suited to recycle antifreeze waste, oil waste, sewage, and other contaminated liquids, although they can also process ordinary fresh water. The best efficiency is achieved in these reactors for the recycling of carbon-rich liquids, such as crude oil or oil waste.

The new PlasmaArcFlow technology is essentially based on flowing liquids through a submerged DC arc with at least one consumable carbon electrode (see Figures 11.8 and 11.9). The arc decomposes the liquid molecules and the carbon electrode into a plasma at about $5,000^oC$, which plasma is composed of mostly ionized H, O and C atoms. The technology moves the plasma away from the electric arc immediately following its formation, and controls the recombination of H, O and C into magnegas, that bubbles to the surface where it is collected

with various means. Other solid substances generally precipitate at the bottom of the reactor where they are periodically collected.

Since magnegas is formed under the extremely intense magnetic fields at atomic distances from the electric arc, its chemical structure is that of all possible magnecules with increasing atomic mass that can be formed from the H, C and O atoms, such as

$$H-H, \quad H\times H, \quad (H-H)\times H \quad H\times H\times H;$$
$$C-H, \quad C\times H, \quad (C-H)\times H, \quad C-O,$$
$$C\times O, \quad C\times (O-O), \quad etc. \tag{11.4.1}$$

where we should note that the bond between C and O can be single, double, and triple valence type as well as of magnecular nature.

When reduced to *atomic* (rather than molecular) percentages, magnegas produced from pure water is composed of about

$$66\%H, \quad 22\%O, \quad 11\%C. \tag{11.4.2}$$

As we shall see in this section, under GC-MS/IRD detectors magnegas shows peaks from 2 amu to 1,000 amu even when produced from pure water. To understand the anomaly ands the *necessity* of a new chemical species to avoid non-scientific beliefs, the reader should be aware that the maximal molecular species predicted by quantum chemistry for magnegas produced from water is CO_2 with 44 amu.

Chemical structure (11.3.1) also explains the capability of magnegas to have combustion exhaust without any toxic components, while being rich of breathable oxygen up to 14% and more (see later on). In fact, the combustion exhaust of magnegas are given by

$$50-55\%H_2O, \quad 12-14\%O_2, \quad 5-7\%CO_2, \quad atmospheric \quad gases. \tag{11.4.3}$$

where the CO_2 content originates from the combustion of conventional carbon monoxide, that of triple bonded nature $\equiv O$ and the stochiometric ratio magnegas/atmosphere is taken into consideration.

the availability in the exhaust of a ;large percentage of breathable oxygen is primarily due to the magnecular bond of oxygen with other species that breaks down at the *Magnegas Curie temperature* generally coinciding with the flame temperature at which all bonds of magnetic origin cease to exhaust. consequently, *magnegas exhaust is solely composed of conventional molecules without any magnecular content.*

The large percentage in the exhaust of breathable oxygen is also due to the conventional single $C-O$ and double bonded species $C=O$ that are unstable and can decompose into gaseous oxygen and carbon precipitate when the combustion

Figure 10.14. Picture of a 50 Kw Santilli's Hadronic Reactor (PlasmaArcFlow Recycler) mounted on a trailer for mobility to conduct test recycling where liquid wastes are located. This recycler can produce up to $84,000$ scf (up to $2.4M$ liters) of magnegas per week corresponding to about 560 gasoline gallon equivalent ($2,100$ gasoline liter equivalent) of magnegas per week (see website [5b] for details).

is at atmospheric pressure (because high pressure $C - O$ and $C = O$ can turn into $C \equiv O$).

the efficiency of Santilli's hadronic reactor of Class III is very high because their primary source of energy is given by a new type of highly efficient and clean combustion of carbon, releasing energy that is at last 30 times the electric energy used by the arc.

In fact, we have the following *Scientific Efficiency* (SE) of PlasmaArcFlow Reactors that is evidently always *smaller* than one due to the conservation of the energy and the inevitable dispersions

$$SE = \frac{E_{tot}^{out}}{E_{tot}^{in}} = \frac{(E_{MG} + E_{heat})}{(Earc + E_{carbon} + E_{unknown})} < 1, \tag{11.4.4}$$

where E_{MG} is the combustion energy contained in magnegas, E_{heat} is the heat acquired by the liquid feedstock and the vessel,$Earc$ is the electric energy used by the arc, E_{carbon} is the energy produced by the combustion of carbon in the plasma, and $E_{unknown}$ is an unknown source of energy due to the fact that the sum $E_{arc} + E_{carbon}$ cannot explain the total energy output (see later on in this section and the next chapter).

At the same time we have the following *Commercial Efficiency* (CE) given by the preceding one *without* the inclusion of the energy produced by the carbon combustion because the carbon content of the liquid feedstock generally brings

an *income,* rather than a cost, since it is contained in the liquid waste to be, and without the unknown source of energy since it also carries no cost recycled

$$CE = \frac{E_{tot}^{out}}{E_{tot}^{in}} = \frac{(E_{MG} + E_h eat)}{Earc} >> 1, \tag{11.4.5}$$

which value is much bigger than one because, as indicated above, the energy caused by the combustion of carbon in the plasma under the electric arc and the unknown energy are a large multiple of the electric energy used by the arc.

When operated at atmospheric pressure, at 50 Kw power and at ambient temperature, the above commercial efficiency has a minimum value of about 5. However, the efficiency of Santilli's hadronic reactors increases (nonlinearly) with the increase of pressure, power and operating temperature and can assume rather high value. For instance, when operating a PlasmaArcFlow Recycler at about 150 psi (10 bars), 300 Kw and 275^oF (125^oC), the commercial efficiency can be of the order of 30, that is, per each unit of electric energy used by the arc, the reactor produces 30 times that energy in a combination of energy contained in magnegas and usable heat.

The above very high commercial efficiency of PlasmaArcFlow reactors illustrates the reason why magnegas is cost competitive with respect to all available fossil fuels.

By comparison, one should note that, in other methods based on underwater arcs, the stationary character of the plasma within the arc implies the creation of large percentages of CO_2 resulting in a CO_2 content of the exhaust much greater than that of gasoline and natural gas, measured by the author to be of the order of 18%. The resulting fuel is then environmentally unacceptable since CO_2 is responsible for the green house effect.

Recall that the primary source of the large glow created by underwater arcs is the recombination of H and O into H_2O following its separation. This recombination is the reason for the low efficiency of underwater arcs and consequential lack of industrial development until recently.

By comparison, the PlasmaArcFlow causes the removal of H and O from the arc immediately following their creation, thus preventing their recombination into H_2O, with consequential dramatic increase of the efficiency, that is, of the volume of combustible gas produced per Kwh.

A Ferrari 308 GTS, an SUV, two Honda and other automobiles have been converted by the author to operate on magnegas. One of these vehicles has been subjected to intensive tests at an EPA certified automotive laboratory in Long Island, New York reviewed in details in the next subsection, which tests have established that magnegas exhaust surpasses all EPA requirements *without catalytic converter*, and confirmed data (11.3.3).

In addition to the production of magnegas as a fuel, *the PlasmaArcFlow Reactors can be viewed as the most efficient means for producing a new form of*

Figure 10.15. A picture of a Ferrari 308 GTSi 1980 and two Honda Civic cars converted by the author to operate with the new clean burning magnegas without catalytic converter, yet surpassing all EPA exhaust requirements, having no carcinogenic or other toxic substance in the exhaust, reducing of about 50% the CO_2 emission due to gasoline combustion, reducing the operating temperature of about 25%, and emitting in the exhaust 10% to 14% breathable oxygen (see website [5b] for details).

hydrogen, called MagneHydrogen^{TM}, a carbon-free version of magnegas, with energy content and output greater than the conventional hydrogen, and at a cost smaller than that of the latter (see next section).

10.4.2 Surpassing by Magnegas Exhaust of EPA Requirements without Catalytic Converter

As indicated above, while the chemical composition of magnegas is new, the chemical composition of magnegas combustion exhaust is fully conventional, and it has been measured with accuracy.

Figure 10.16. A picture of a Chevrolet Suburban SUV 1992 converted by the author to operate as a bifuel gasoline/magnegas with a switch on the dashboard permitting to pass from one fuel to the other while driving. Bifuel cars are produced by numerous carmakers to operate on gasoline and natural gas. The same cars can operate on magnegas (in place of natural gas) with the sole adjustment of the pressure regulator to optimize the stochiometric ratio air/fuel, since the latter for magnegas is much smaller than that for natural gas because magnegas is very rich internally in oxygen, thus requiring a fraction of the air needed by natural gas to operate. These bifuel cars are ideally suited for the magnegas technology because, when magnegas runs out, one can still reach the magnegas refilling station on gasoline (see website [5b] for details).

The tests were conducted by an EPA accredited automotive laboratory of Long Island, new York, on a Honda Civic Natural Gas Vehicle (NGV) VIN number 1HGEN1649WL000160 (the white car of Fig. 11x10), produced in 1998 to operate with Compressed Natural Gas (CNG). The car was purchased new in 1999 and converted to operate on Compressed MagneGas (CMG) in early 2000. All tests reported in this section were done with magnegas produced by recycling antifreeze waste. The conversion from CNG to CMG was done via:

1) the replacement of CNG with CMG in a 100 liter tank at 3,600 psi which contains about 1,000 cf of magnegas;

2) the disabling of the oxygen sensor because magnegas has about 20 times more oxygen in the exhaust than natural gas, thus causing erroneous readings by the computer set for natural gas; and

3) installing a multiple spark system to improve magnegas combustion.

The rest of the vehicle was left unchanged, including its computer.

Comparative tests on performance (acceleration, full load, etc.) have established that *the output power of the vehicle operating on compressed magnegas is fully equivalent to that of the same car operating on compressed natural gas.*

Comparative tests on consumption also indicate similar results. In fact, measurements of magnegas consumption per hour in ordinary city driving were con-

ducted with the following results:

TANK CAPACITY:	1,096 cf at 3,500 psi,	
TOTAL DURATION:	about 2.5 hours,	(11.4.6)
CONSUMPTION:	about 7 cf/minute.	

As one can see, a magnegas pressure tank of 1,500 cf at 5,000 psi would provide a range of about 4 hours, which is amply sufficient for all ordinary commuting and travel needs. Measurements of magnegas consumption rate per mile on highway are under way, and they are expected to yield essentially the same results holding for natural gas, namely,

$$\text{Gasoline gallon equivalent: 120 cf of magnegas.} \tag{11.4.7}$$

Preliminary measurements of magnegas combustion exhaust were conducted by the laboratory *National Technical Systems, Inc.*, of Largo, Florida, resulting in the following exhaust composition under proper combustion:

WATER VAPOR:	50% - 60%,	
OXYGEN:	10% - 12%,	
CARBON DIOXIDE:	6% - 7%,	(11.4.8)
BALANCE:	atmospheric gases,	
HYDROCARBONS, CARBON MONOXIDE, NITROGEN OXIDES:	in parts per million (ppm).	

Detailed magnegas exhaust measurements were then conducted at the EPA Certified, Vehicle Certification Laboratory *Liphardt & Associates* of Long Island, New York, under the Directorship of *Peter di Bernardi*, via the Varied Test Procedure (VTP) as per EPA Regulation 40-CFR, Part 86.

These EPA tests consisted of three separate and sequential tests conducted in November 2000 on a computerized dynamometer, the first and the third tests using the vehicle at its maximal possible capability to simulate an up-hill travel at 60 mph, while the second test consisted in simulating normal city driving.

Three corresponding bags with the exhaust residues were collected, jointly with a fourth bag containing atmospheric contaminants. The final measurements expressed in grams/mile are given by the average of the measurements on the three EPA test bags, less the measurements of atmospheric pollutants in the fourth bag.

The following three measurements were released by Liphardt & Associates:

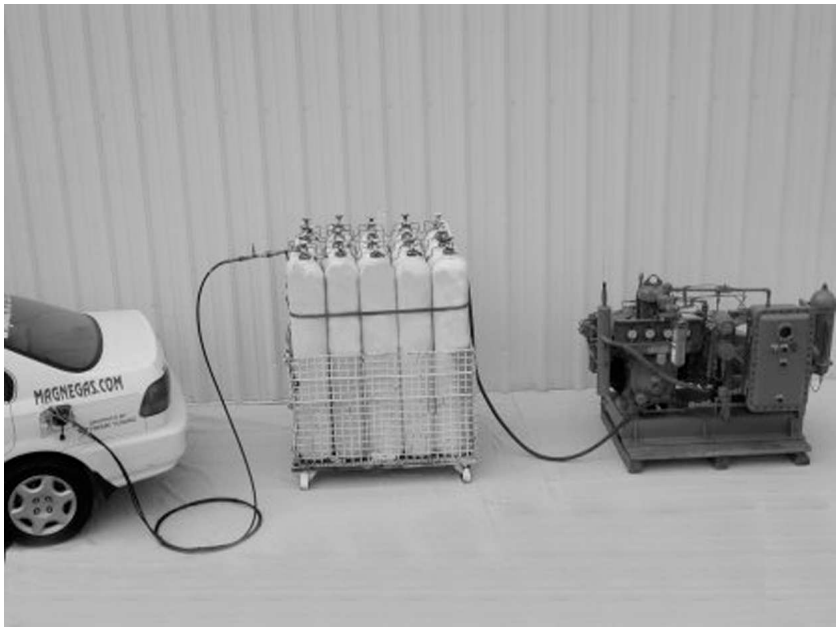


Figure 10.17. [8] A picture of the *Magnegas Refilling Station*, consisting of a standard compressor as used for natural gas and pressure bottles. The simplicity of this station should be compared with the complexity of corresponding stations for liquid hydrogen. Note that the station depicted in this figure allows current *distributors* of fuel, such as gasoline stations, to become *fuel producers*. The refill is achieved by connecting the a pressure bottle with a pressure tank in the trunk of the car; it is faster than the refill with gasoline; and it is much safer than the latter because gasoline, being liquid, spills and explodes if ignited, while magnegas, being a gas, does not spill and if ignited, burns fast in air without explosion (see website [5b] for details).

1) Magnegas exhaust measurements with catalytic converter:

HYDROCARBONS:	0.026 grams/mile, which is 0.063 of the EPA standard of 0.41 grams/mile;
CARBON MONOXIDE:	0.262 grams/mile, which is 0.077 of the EPA standard of 3.40 grams/mile;
NITROGEN OXIDES:	0.281 grams/mile, which is 0.28 of the EPA standard of 1.00 grams/mile;
CARBON DIOXIDE:	235 grams/mile, corresponding to about 6%; there is no EPA standard on CO_2 at this time;
OXYGEN:	9.5% to 10%; there is no EPA standard for oxygen at this time.

(11.4.9)

The above tests have established the important feature that *magnegas exhaust with catalytic converter imply a reduction of about 1/15 of current EPA requirement.*

2) Magnegas exhaust measurements without catalytic converter in the same car and under the same conditions as (1):

HYDROCARBONS:	0.199 grams/mile, which is 0.485 of the EPA standard of 0.41 grams/mile;
CARBON MONOXIDE:	2.750 grams/mile, which is 0.808 of the EPA standard of 3.40 grams/mile;
NITROGEN OXIDE:	0.642 grams/mile, which is 0.64 of the EPA standard of 1.00 grams/mile;
CARBON DIOXIDE:	266 grams/mile, corresponding to about 6%;
OXYGEN:	9.5% to 10%.

(11.4.10)

As a result of the latter tests, the laboratory *Liphardt & Associates* released the statement that *magnegas exhaust surpasses the EPA requirements* without *the catalytic converter*. As such, magnegas can be used in *old cars without catalytic converter while meeting, and actually surpassing EPA emission standards*.

3) Natural gas exhaust measurements without catalytic converter in the same car and under the same conditions as (1):

HYDROCARBONS:	0.380 grams/mile, which is 0.926 of the EPA standard of 0.41 grams/mile;
CARBON MONOXIDE:	5.494 gram/mile, which is 1.615 of the EPA standard of 3.40 grams/mile;
NITROGEN OXIDES:	0.732 grams/mile, which is 0.73 the EPA standard of 1.00 grams/mile;
CARBON DIOXIDE:	646.503 grams/mile, corresponding to about 9%;
OXYGEN:	0.5% to 0.7%.

(11.4.11)

The latter tests established the important property that *the combustion of natural gas emits about 2.5 times the CO_2 emitted by magnegas without catalytic converter. Note that, as well known, natural gas exhaust without catalytic converter does not meet EPA requirements*.

As an additional comparison for the above measurements, a similar Honda car running on indolene (a version of gasoline) was tested in the same laboratory with the same EPA procedure, resulting in the following data:

4) Gasoline (indolene) exhaust measurements conducted on a two liter Honda KIA:

HYDROCARBONS:	0.234 grams/mile equal to 9 times the corresponding magnegas emission;
CARBON MONOXIDE:	1.965 grams/mile equal to 7.5 times the corresponding magnegas emission;
NITROGEN OXIDES:	0.247 grams/mile equal to 0.86 times the corresponding magnegas emission;
CARBON DIOXIDE:	458.655 grams/mile equal to 1.95 times the corresponding of magnegas emission,
OXYGEN:	No measurement available.

(11.4.12)

Figure 10.18. A picture of the readings of a 4-ways exhaust analyzer testing the exhaust of the Ferrari 308 GTSi of a preceding picture operating on magnegas "without" catalytic converter. Note: the presence of 14% breathable oxygen in the exhaust; about half the CO_2 produced by the same car when running on gasoline; the very few detected hydrocarbons originate from engine oil seeping through the piston rings because magnegas "cannot" contain hydrocarbons since it is synthesized at the $5,000^oC$ of the arc at which temperature no hydrocarbon can survive; the very small content of CO in the exhaust is due to poor combustion because CO is fuel for magnegas, while it is a byproduct of the combustion for fossil fuels, as a result of which detecting CO in the exhaust of a car running on magnegas is the same as detecting gasoline in the exhaust of a car running on gasoline (see website [5b] for details).

The above data establish the environmental superiority of magnegas over natural gas and gasoline. The following comments are now in order:

1) Magnegas does not contain (heavy) hydrocarbons since it is created at $3{,}500^o$ K. Therefore, the measured hydrocarbons are expected to be due to combustion of oil, either originating from magnegas compression pumps (thus contaminating the gas), or from engine oil.

2) Carbon monoxide is fuel for magnegas (while being a combustion product for gasoline and natural gas). Therefore, any presence of CO in the exhaust is evidence of insufficient combustion.

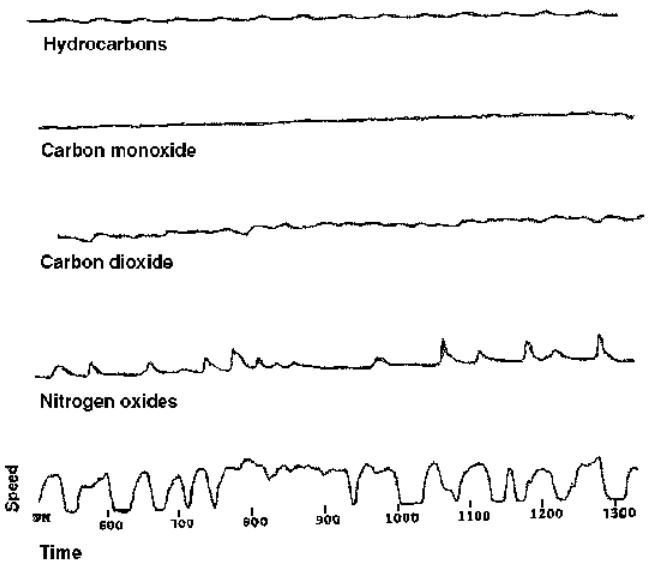


Figure 10.19. An illustration of the city part of the reported EPA test according to Regulation 40-CFR, Part 86, conducted at the Vehicle Certification Laboratory *Liphardt & Associates* of Long Island, New York on a Honda Civic Natural Gas Vehicle converted to magnegas by the author.. The first three diagrams illustrate the very low combustion emission of magnegas in city driving, by keeping in mind that most of measured emission is due to the heavy duty, hill climbing part of the EPA test. The fourth diagram on nitrogen oxides is an indication of insufficient cooling of the engine. The bottom diagram indicates the simulated speed of the car versus time, where flat tracts simulate idle portions at traffic lights.

3) The great majority of measurements originate from the first and third parts of the EPA test at extreme performance, because, during ordinary city traffic, magnegas exhaust is essentially pollutant free [5].

4) Nitrogen oxides are not due, in general, to the fuel (whether magnegas or other fuels), but to the temperature of the engine and other factors, thus being an indication of the quality of its cooling system. Therefore, for each given fuel, including magnegas, NOx's can be decreased by improving the cooling system and via other means.

5) The reported measurements of magnegas exhaust do not refer to the best possible combustion of magnegas, but only to the combustion of magnegas in a vehicle whose carburization was developed for natural gas. Alternatively, the test was primarily intended to prove that magnegas is interchangeable with natural gas without any major automotive changes, while keeping essentially the same

Figure 10.20. It is generally ignored that cruiseships leave a trail of marine death since they release in the ocean an average of 100,000 gallons of highly contaminated liquid wastes per day. The magnegas technology [5] was developed to resolve this problem via the on board recycling of all liquid waste into purified forms reusable on board without any release in the ocean.

performance and consumption. The measurements for combustion specifically conceived for magnegas are under way.

We should also indicate considerable research efforts under way to further reduce the CO_2 content of magnegas exhaust via disposable cartridges of CO_2-absorbing chemical sponges placed in the exhaust system (patent pending). Additional research is under way via *liquefied magnegas* obtained via *catalytic* (and *not* conventional) liquefaction, which liquid is expected to have an anomalous energy content with respect to other liquid fuels, and an expected consequential decrease of pollutants. As a result of these efforts, the achievement of an exhaust essentially free of pollutants and CO_2, yet rich in oxygen, appears to be within technological reach.

10.4.3 Anomalous Chemical Composition of Magnegas

As studied in the preceding section, the chemical composition of the magnegas exhaust is conventional and, therefore, can be tested with established analytic equipment and methods. However, the chemical composition of magnegas itself cannot be successfully tested with the same equipment and methods due to its novelty.

To begin, numerous tests in various analytic laboratories reviewed in below have established that magnegas results in being characterized by large peaks in macroscopic percentage all the way to 1,000 a.m.u., which peaks remain individually unidentified by the MS computer after scanning all known molecules.

By comparison, quantum chemistry predicts that the heaviest molecule in a *light* gas such as magnegas should only have 44 a.m.u., while offering no expla-

nation whatever, not even remote or indirect on the existence of detectable teaks all the way to 1,000 a.m.u.

The above differences are so drastic to provide clear experimental evidence on the fact that the magnegas structure is characterized by a *new chemical species* not predicted or considered by quantum chemistry until now.

Besides the inability to identify the clusters composing magnegas via the computer search among all known molecules, the chemical structure of magnegas is equally unidentifiable via InfraRed Detectors (IRD), because the new peaks composing magnegas have no IR signature at all, thus establishing the presence of bonds of non-valence type (because these large clusters cannot possibly be all symmetric).

Moreover, the IR signature of conventional molecules such as CO results in being *mutated* (in the language of hadronic mechanics) with the appearance of new peaks, which evidently indicate *new* internal bonds in *conventional* molecules.

In addition to all the above, dramatic differences between the prediction of quantum chemistry and reality exist for the energy content of magnegas. For instance, when produced with PlasmaArcFlow Reactors operating an electric arc between at least one consumable electrode within pure water, quantum chemistry predicts that magnegas should be a mixture of 50% H_2 and 50% CO, with traces of O_2 and CO_2.

This prediction is dramatically disproved by the fact that *both the* CO *and the* CO_2 *peaks do not appear in the MS scan in the predicted percentages, while they appear in the IR scan although in a mutated form.*

Moreover, quantum chemistry predicts that the indicated composition consisting of 50% H_2 and 50% CO should have an energy content of about 315 BTU/cf, namely, an energy content insufficient to cut metal. This prediction is also disproved by the experimental evidence that *magnegas cuts metal at least 50% faster than acetylene (which has 2,300 BTU/cf).*

Such a performance in metal cutting is more indicative of a *plasma cutting* feature, such as the metal cutting via a plasma of ionized hydrogen atoms which recombine into H_2 when cooling in the metal surface, thus releasing the energy needed for metal cutting. The problem is that magnegas is at room temperature when used for metal cutting, and it is subjected to ordinary combustion, thus requiring basically new approaches for its correct interpretation.

Nevertheless, the plasma cutting feature is indicative of the presence of isolated atoms and dimers in the magnegas structure which recombine under combustion, thus yielding a behavior and a performance similar to that of plasma cutters.

In fact, as also shown later on, GC-MS scans have indicated the presence in the anomalous peaks of *individual atoms of hydrogen, oxygen, and carbon* evidently in addition to individual molecules.

To conclude, the composition of magnegas in H, C and O *atoms* can be easily identified from the liquid used in the reactors. For instance, when magnegas is produced from water, it is composed of 50% H, 25% O, and 25% C, with corresponding percentages for other liquids such as antifreeze, crude oil, etc.

However, all attempts to reduce the chemical composition of magnegas to conventional molecules conducted by the author as well as independent chemists, have been disproved by a variety of experimental evidence.

In particular, any belief that magnegas is entirely composed by ordinary molecules, such as H_2 and CO, is disproved by experimental evidence via GC-MS and IRD detectors.

The only possible scientific conclusion at this writing is that *magnegas is composed of a new chemical species* studied below.

10.4.4 GC-MS/IRD Measurements of Magnegas at the McClellan Air Force Base

Santilli [1] had predicted that gases produced from underwater electric arcs had the new chemical structure of magnecules as clusters of molecules, dimers and individual atoms as per Definition 8.2.1, in which case conventional chemical structure (8.20) is valid only in first approximation.

Following a laborious search, Santilli [*loc. cit.*] located a GC-MS equipped with IRD suitable to measure magnecules at the *McClellan Air Force Base* in North Highland, near Sacramento, California. Thanks to the invaluable assistance and financial support by *Toups Technologies Licensing, Inc.*, of Largo, Florida, GC-MS/IRD measurements were authorized at that facility on magnegas with conventional chemical structure (8.20).

On June 19, 1998, Santilli visited the analytic laboratory of *National Technical Systems* (NTS) located at said *McClellan Air Force Base* and using instruments belonging to that base. The measurements on magnegas were conducted by analysts Louis A. Dee, Branch Manager, and Norman Wade who operated an *HP GC model 5890, an HP MS model 5972, equipped with an HP IRD model 5965.* Upon inspection at arrival, the instrument met all conditions indicated in the preceding sections then, and only then, measurements were permitted.

Thanks to a professional cooperation by the NTS analysts, the equipment was set at all the unusual conditions indicated later on. In particular, the equipment was set for the analytic method VOC IRMS.M utilizing an HP Ultra 2 column 25 m long with a 0.32 mm ID and a film thickness of 0.52 μm. It was also requested to conduct the analysis from 40 a.m.u. to the instrument limit of 500 a.m.u. This condition was necessary to avoid the expected large CO peak of magnegas at 28 a.m.u.

Moreover, the GC-MS/IRD was set at the low temperature of 10°C; the biggest possible feeding line with an ID of 0.5 mm was installed; the feeding line itself was

cryogenically cooled; the equipment was set at the longest possible ramp time of 26 minutes; and a linear flow velocity of 50 cm/sec was selected. A number of other technical requirements are available in the complete documentation of the measurements.

The analysts first secured a documentation of the *background* of the instrument prior to any injection of magnegas (also called *blank*). Following a final control that *all* requested conditions were implemented, the tests were initiated. The results, reported in part via the representative scans of Figs. 8.7 to 8.12, constitute the first direct experimental evidence of the existence of magnecules in gases.

After waiting for 26 minutes, sixteen large peaks appeared on the MS screen between 40 and 500 a.m.u. as shown in Fig. 11.21. Each of these sixteen MS peaks resulted to be "unknown," following a computer search of database on all known molecules available at *McClellan Air Force Base*, as illustrated in Fig. 11.22 No identifiable CO_2 peak was detected at all in the MS spectrum between 40 and 500 a.m.u., contrary to the presence of 9% of such a molecule in magnegas as per conventional analyses (8.20).

Upon the completion of the MS measurements, exactly the same range of 40 to 500 a.m.u. was subjected to IR detection. As expected, none of the sixteen peaks had any infrared signature at all, as shown in Fig. 11.14. Furthermore, the IR scan for these MS peaks shows only one peak, that belonging to CO_2, with additional small peaks possibly denoting traces of other substances.

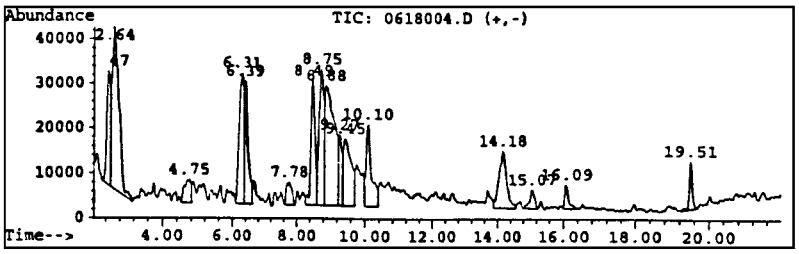
Note that the IR signature of the other components, such as CO or O_2 *cannot* be detectable in this IR test because their atomic weights are below the left margin of the scan. In addition, the IR peak of CO_2 is itself mutated from that of the unpolarized molecule, as shown in Fig. 11.24. Note that the mutation is due to the appearance of *two new peaks* which are absent in the conventional IR signature of CO_2, exactly as expected, thus confirming the hypothesis of new internal bonds as submitted in Fig. 11.12.

Note also in Fig. 24 that the computer interprets the IR signature as that belonging to CO which interpretation is evidently erroneous because CO is outside of the selected range of a.m.u.

All remaining small peaks of the IR scan resulted to be "unknown," thus being possible magnecules, following computer search in the database of IR signatures of all known molecules available at the *McClellan Air Force Base*, as illustrated in Fig. 11.25.

Following the removal of magnegas from the GC-MS/IRD, the background continued to show the same anomalous peaks of Fig. 11.21, and reached the configuration of Fig. 11.26 only after a weekend bakeout with an inert gas. Note that the latter background is itself anomalous because the slope should have been the opposite of that shown. The background finally recovered the conventional shape only after flushing the instrument with an inert gas at high temperature.

```
Information from Data File:
File       : C:\HPCHEM\1\DATA\0618004.D
Operator   : NAW
Acquired   : 18 Jun 98   3:01 pm using AcqMethod VOC_IRMS
Sample Name: TOUP'S TECH
Misc Info  : 1ML LOOP; 10C @ ULTRA COLUMN
Vial Number: 1
CurrentMeth: C:\HPCHEM\1\METHODS\DEFAULT.M
```



Retention Time	Area	Area %	Ratio %
Total Ion Chromatogram			
2.474	1753306	5.386	32.724
2.644	5091514	15.641	95.030
4.754	641528	1.971	11.974
6.307	2737749	8.411	51.098
6.390	2211258	6.793	41.272
7.782	592472	1.820	11.058
8.490	2357396	7.242	43.999
8.754	2784829	8.555	51.977
8.882	5357812	16.460	100.000
9.265	1123809	3.452	20.975
9.448	2421234	7.438	45.191
10.098	1946292	5.979	36.326
14.177	2129791	6.543	39.751
15.073	435208	1.337	8.123
16.085	389822	1.198	7.276
19.509	577433	1.774	10.777

Figure 10.21. A reproduction of the MS peaks providing the *first experimental evidence of the existence of magnecules* identified on June 19, 1998, by analysts *Louis A. Dee* and *Norman Wade* of the branch of *National Technical; Systems* (NTS) located at the *McClellan Air Force Base* in North Highland, near Sacramento, California, with support from *Toups Technologies Licensing, Inc.* (TTL) of Largo, Florida. The scan is restricted from 40 a.m.u to 500 a.m.u. The peaks refer to magnegas produced via an electric arc between consumable carbon electrodes within ordinary tap water with conventional chemical composition (8.20). Therefore, only the CO_2 peak was expected to appear in the scan with any macroscopic percentage, while no CO_2 was detected at all in the MS scan.

10.4.5 GC-MS/IRD Tests of Magnegas at Pinellas County Forensic Laboratory

Measurements on the same sample of magnegas tested at NTS were repeated on July 25, 1998, via a GC-MS/IRD located at the *Pinellas County Forensic*

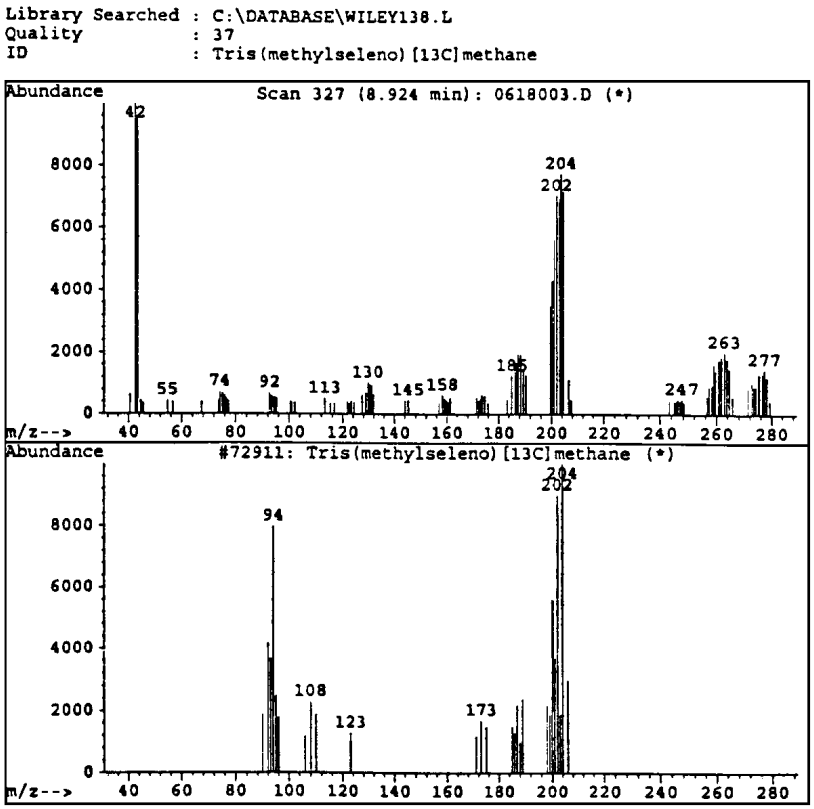


Figure 10.22. A representation of *the first experimental evidence at NTS that the peaks of Fig. 11.12 are "unknown."* The peak at the top is at 8.924 minutes, and that at the bottom shows the lack of its identification by the computer search. Note that the best fit identified by the computer does not match the peak considered. Moreover, the identified substance (methylseleno) cannot possibly exist in magnegas because of the impossible presence of the necessary elements. The same situation occurred for all remaining fifteen peaks of Fig. 11.12.

Laboratory (PCFL) of Largo, Florida, with support from *Toups Technologies Licensing, Inc.*

The equipment consisted of a *HP GC model 5890 Series II, an HP MS model 5970 and an HP IRD model 5965B.* Even though similar to the equipment used at NTS, the PCFL equipment was significantly different inasmuch as the temperature had to be increased from 10°C to 55°C and the ramp time reduced from 26 to 1 minute. The latter reduction implied the cramping of all peaks of Fig. 11.17 into one single large peak, a feature confirmed by all subsequent GC-MS tests with short ramp time.

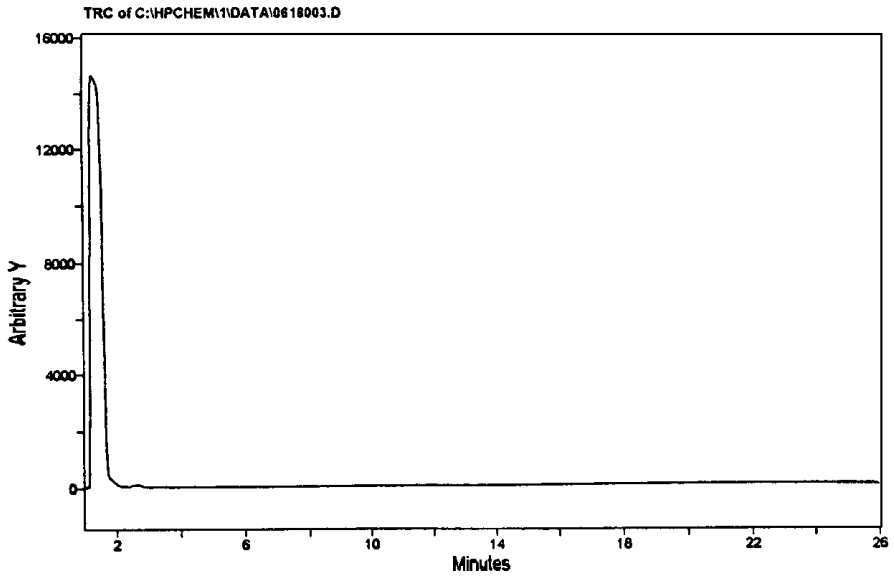


Figure 10.23. The first experimental evidence at NTS of the lack of IR signature of MS peaks. The evidence establishes the existence of large peaks in the MS that have no IR signature at all. The only identified IR signature, that for CO_2, refers to the *constituents* of the peaks of Fig. 11.12. In the above figure only the IR signature of CO_2 appears because the scan was from 40 a.m.u. to 500 a.m.u. and, as such, could not include the IR signatures of other molecules such as O_2 and CO (H_2 has no IR signature).

Despite these differences, the test at PCFL, reported in part via the representative scans of Figs. 8.13 to 8.18, confirmed *all* features of magnecules first detected at NTS. In addition, the tests provided the experimental evidence of additional features.

Following Santilli's request [1], the analysts conducted *two* MS tests of the *same* magnegas at *different times* about 30 minutes apart. As one can see in Figs. 8.13 and 8.14, *the test at PCFL provided the first experimental evidence of mutation in time of the atomic weight of magnecules.* In fact, the peak of Fig. 11.27e is macroscopically different than that of Fig. 11.28.

This difference provides evidence that, when colliding, magnecules can break down into ordinary molecules, atoms, and fragments of magneclusters, which then recombine with other molecules, atoms, and/or magnecules to form new clusters. The same scan provides first experimental evidence of the accretion or loss by magnecules of individual atoms, dimers and molecules, as discussed later on.

Figure 8.15 depicts the failure by the GC-MS/IRD to identify the peaks of Figs. 8.13 and 8.14 following a search in the database among all known molecules.

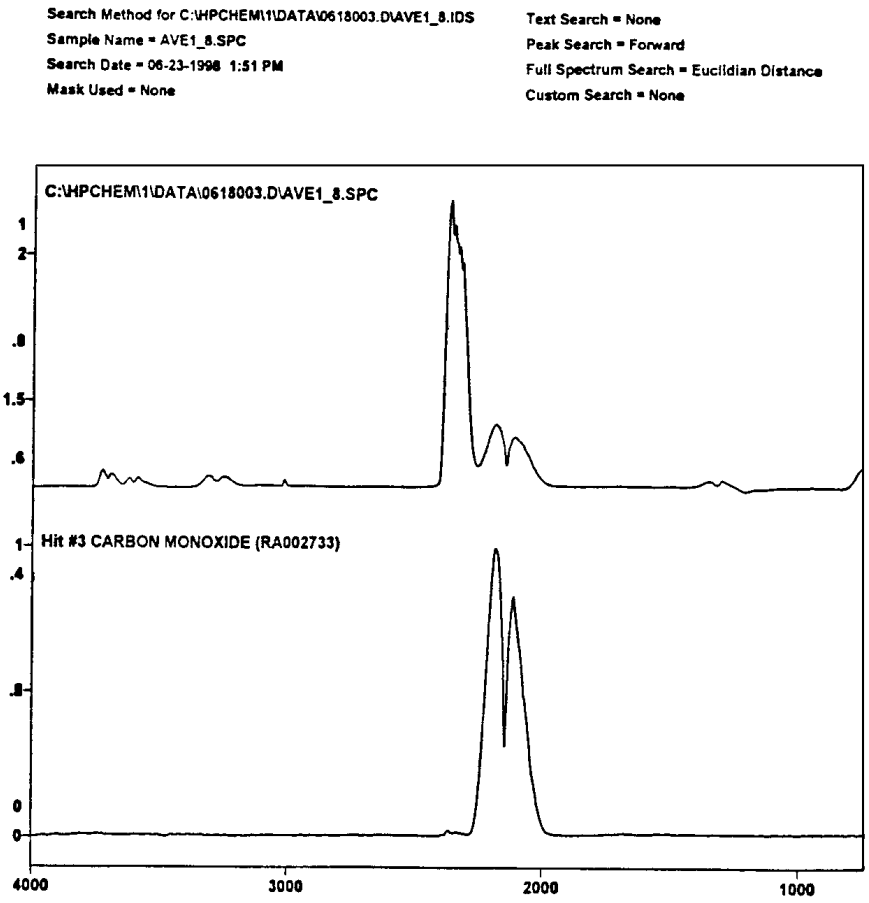


Figure 10.24. The first experimental evidence at NTS on the mutation of the IR signature of magnetically polarized conventional molecules, here referring to the CO_2 (top) compared to the result of the computer search (bottom). Note that the known, double-lobe peak of CO_2 persists in the detected peak with the correct energy, and only with decreased intensity. Jointly, there is the appearance of *two new peaks*, which are evidence of *new internal bonds within the conventional CO_2 molecule.* This evidently implies an increased energy content, thus establishing experimental foundations for the new technology of magnetically polarized fuels such as magnegas [2].*Note that the computer interprets the IR signature as that of CO, which is erroneous since CO is out of the selected range of detection.*

Figure 8.16 provides an independent confirmation that the IR scan of Fig. 11.23, namely, that the MS peaks, this time of Figs. 8.13 and 8.14, have no IR signature except for the single signature of the CO_2. However, the latter was not detected at all in said MS scans. Therefore, the CO_2 detected in said IR scan is

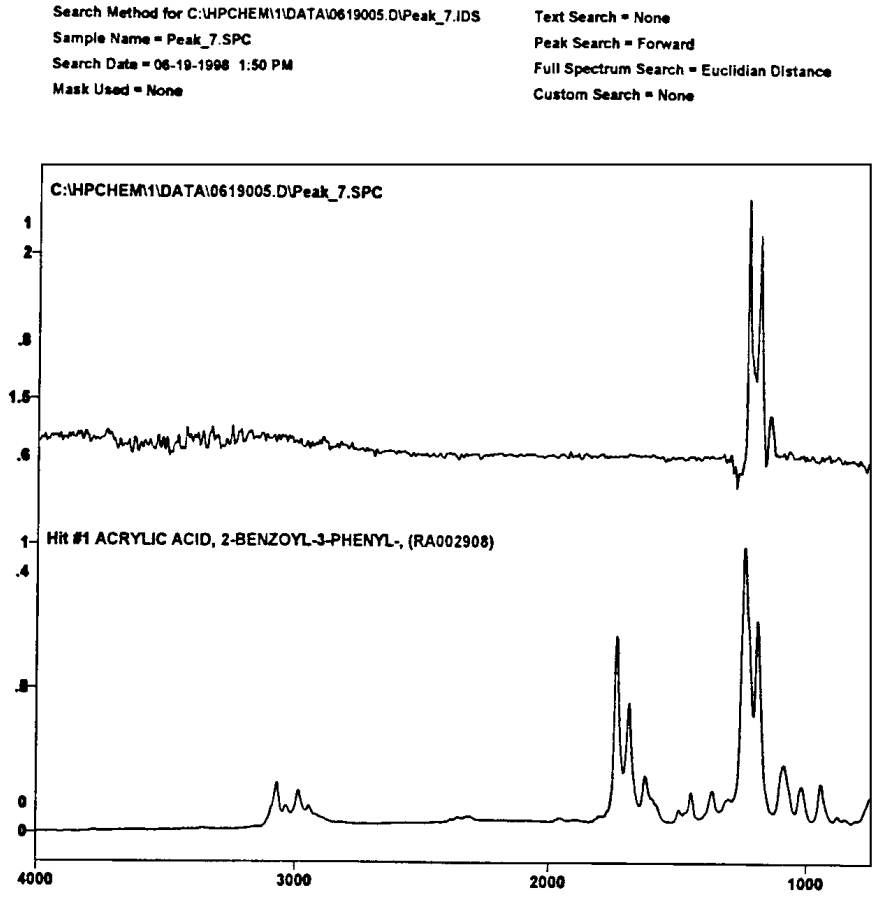


Figure 10.25. A reproduction of the lack of identification in the computer search of small peaks in the IR scan, which can therefore be additional magnecules, or IR signatures of the magnecules appearing in the MS scan.

a *constituent* of the new species detected in Figs. 8.13 and 8.14. The lack of IR signature of the MS peaks confirms that said peaks *do not* represent molecules.

Figure 8.17 confirms in full the mutated IR signature of CO_2 previously identified in Fig. 11.24, including the important presence of two new peaks, with the sole difference that, this time, the computer correctly identifies the IR signature as that of carbon dioxide.

Figure 8.18 presents the background of the instrument after routine flushing with an inert gas, which background essentially preserves the peaks of the MS scans, thus confirming the unique adhesion of magnecules to the instrument walls.

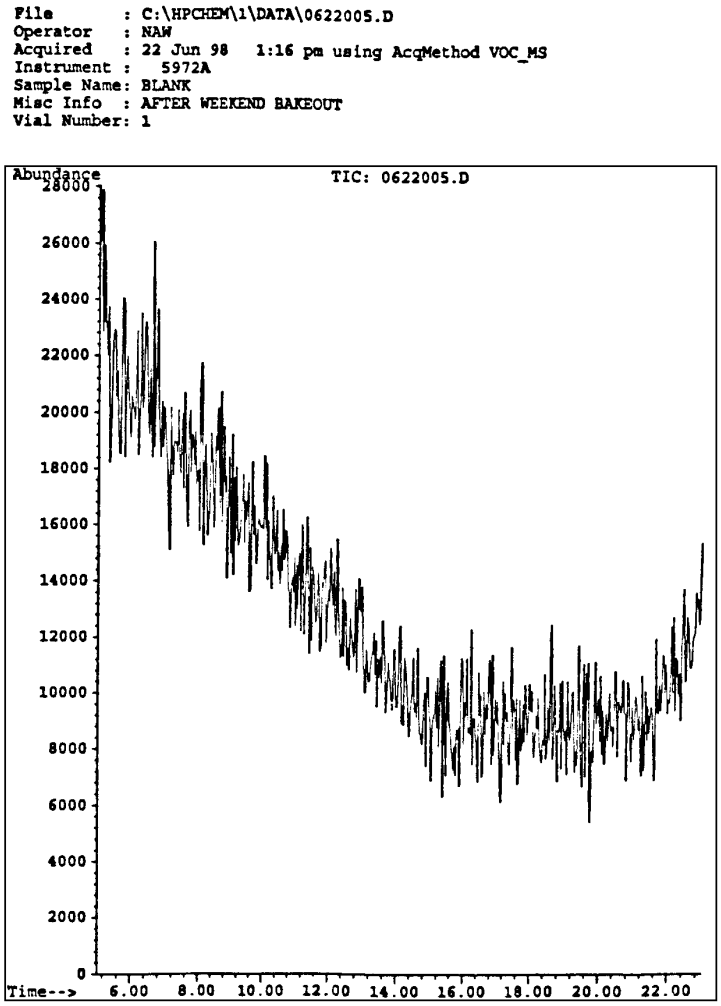


Figure 10.26. A view of the background of the preceding tests following a weekend bakeout.

10.4.6 Interpretations of the Results

A few comments are now in order for the correct interpretation of the results. First, note in the GC-MS/IRD scans that the CO_2 detected in the IRD has no counterpart in the MS scans, while none of the peaks in the MS have a counterpart in the IR scans. Alternatively, the CO_2 peak detected in the IR scans of Figs. 8.10 and 8.17 *does not* correspond to any peak in the MS scans in Figs. 8.7, 8.13 and 8.14. Therefore, said IR peak identifies a *constituent* of the MS clusters, and not an isolated molecule.

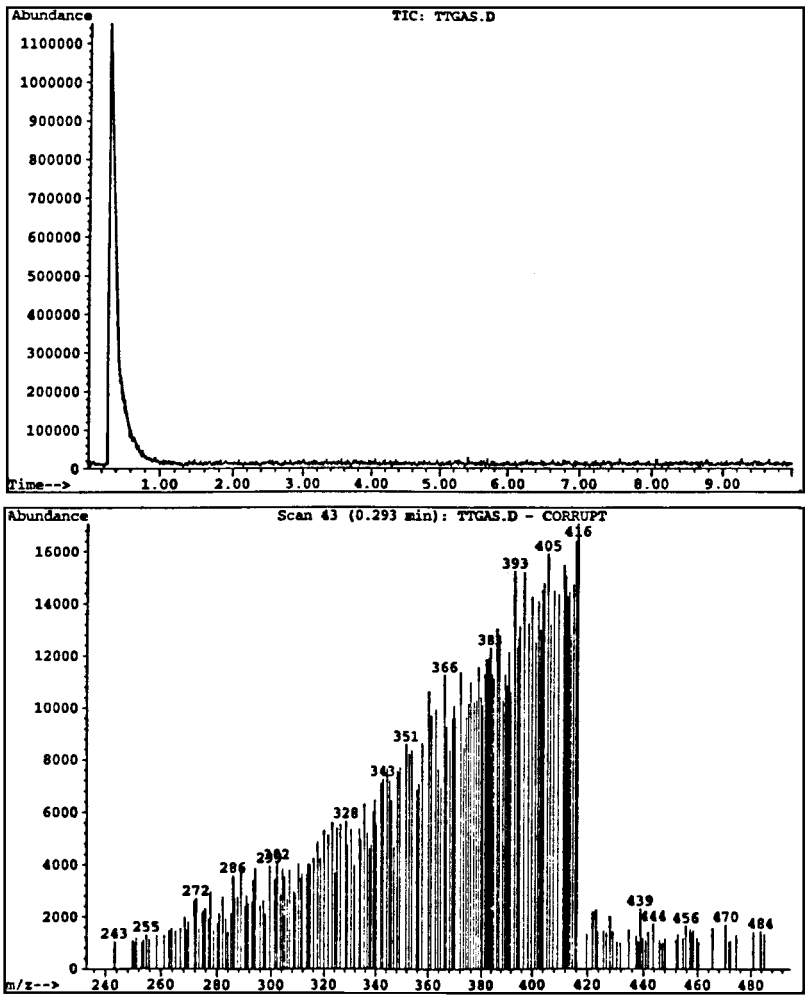


Figure 10.27. A view of the Total Ion Count (top) and MS spectrum (below) of magnegas conducted on July 25, 1998, via a HP GC-MS/IRD at the *Pinellas County Forensic Laboratory* (PCFL) of Largo, Florida, under support from *Toups Technologies Licensing, Inc.* (TTL) also of Largo, Florida. The scan is restricted to the range 40 a.m.u to 500 a.m.u. and confirm all results of the preceding NTS tests.

Moreover, the IR scan was done for the entire range of 40 to 500 a.m.u., thus establishing that said IR peak is the sole conventional constituent in macroscopic percentage in said a.m.u. range of *all* MS peaks, namely, the single constituent identified by the IRD is a constituent of all MS peaks.

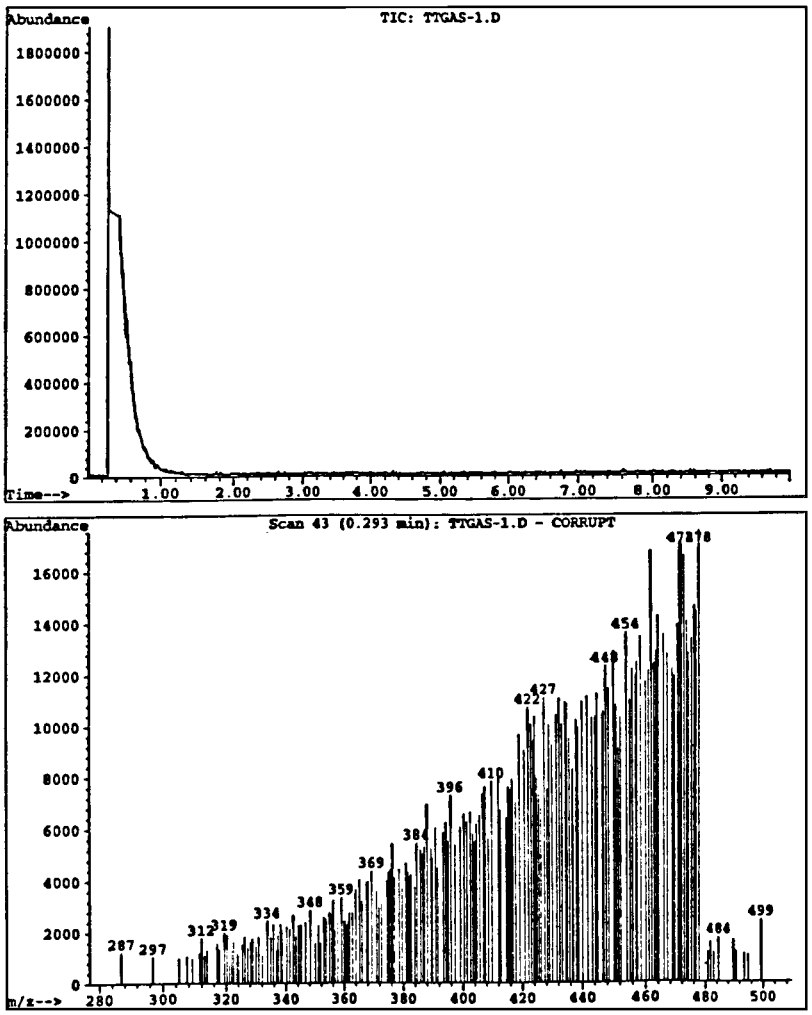


Figure 10.28. A repetition of the scan of the preceding figure conducted at PCFL in the same sample of magnegas on the same instrument and under the same conditions, but 30 minutes later. The scan provides *the first experimental evidence of the mutation of atomic weight of magnecules,* as one can see from the variation of the peaks of this figure compared with that of the preceding figure.

It should also be noted that, as recalled earlier, the IR only detects *dimers* such as C–O, H–O, *etc.*, and does not detect complete molecules. Therefore, the peak detected by the IRD *is not* sufficient to establish the presence of the complete molecule CO_2 unless the latter is independently identified in the MS. Yet the MS scan does not identify any peak for the CO_2 molecule, as indicated earlier.

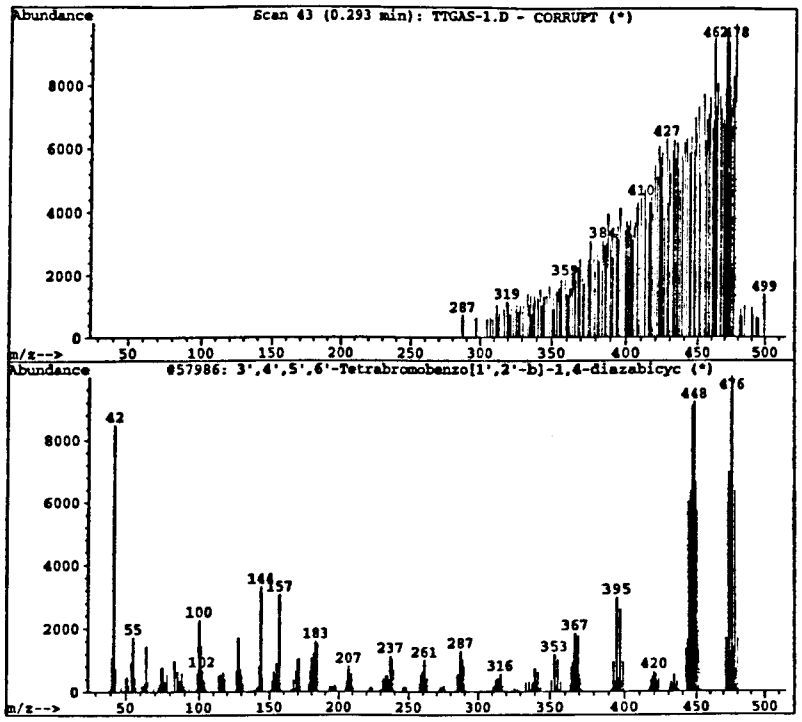


Figure 10.29. Lack of identification by the computer of the GC-MS/IRD at PCFL of the MS peaks of the preceding two scans following search among the database on all available molecules.

Despite that, the presence in the MS peaks of complete molecules CO_2 cannot be ruled out. Therefore, the most plausible conclusion is that the MS peaks represent clusters composed of a percentage of C–O dimers and another percentage of CO_2 molecules, plus other dimers, and/or molecules, and/or atoms with atomic weight smaller than 40 a.m.u., thus outside the range of the considered scans.

As indicated earlier, the presence of dimers and individual atoms in magnegas is essential for a quantitative interpretation of the large excess of energy contained in this new fuel, the order of at least three times the value predicted by quantum chemistry, which energy is released during combustion. The admission of dimers and atoms as constituents of magnecules readily explains this anomalous energy content because said dimers and atoms are released at the time of the combustion, thus being able at that time to form molecules with exothermic reactions of type (8.5). In the event magnecules would not contain dimers and atoms, their only possible constituents are conventional molecules, in which case no excess energy is possible during combustion.

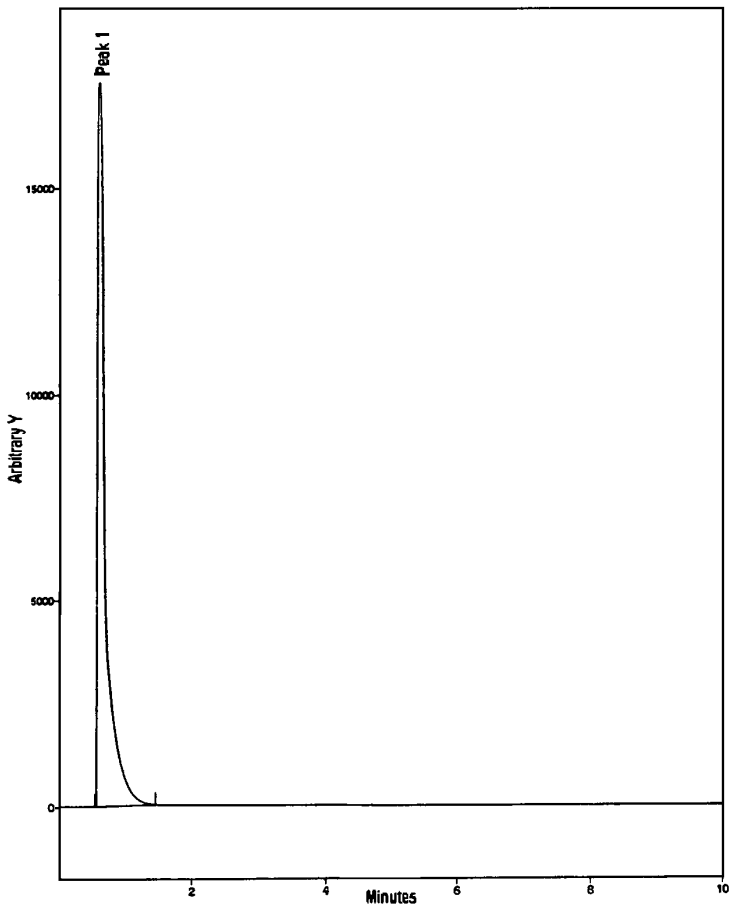


Figure 10.30. A confirmation of the lack of IR signature of the peaks of Figs. 8.13 and 8.14, as occurred for Fig. 11.14, which establishes that the MS peaks of Figs. 8.13 and 8.14 cannot have a valence bond, thus constituting a new chemical species.

The large differences of MS peaks in the two tests at NTS and at PCFL of exactly the same gas in exactly the same range from 40 to 500 a.m.u., even though done with different GC-MS/IRD equipment, illustrates the importance of having a ramp time of the order of 26 minutes. In fact, sixteen different peaks appear in the MS scan following a ramp time of 26 minutes, as illustrated by Fig. 11.12, while all these peaks collapsed into one single peak in the MS scan of Figs. 8.13 and 8.14, because the latter were done with a ramp time of about 1 minute. Therefore, *the collapse of the sixteen peaks of Fig. 11.12 into the single large peak of Figs. 8.13 and 8.14 is not a feature of magnecules, but rather it is due to the insufficient ramp time of the instrument.*

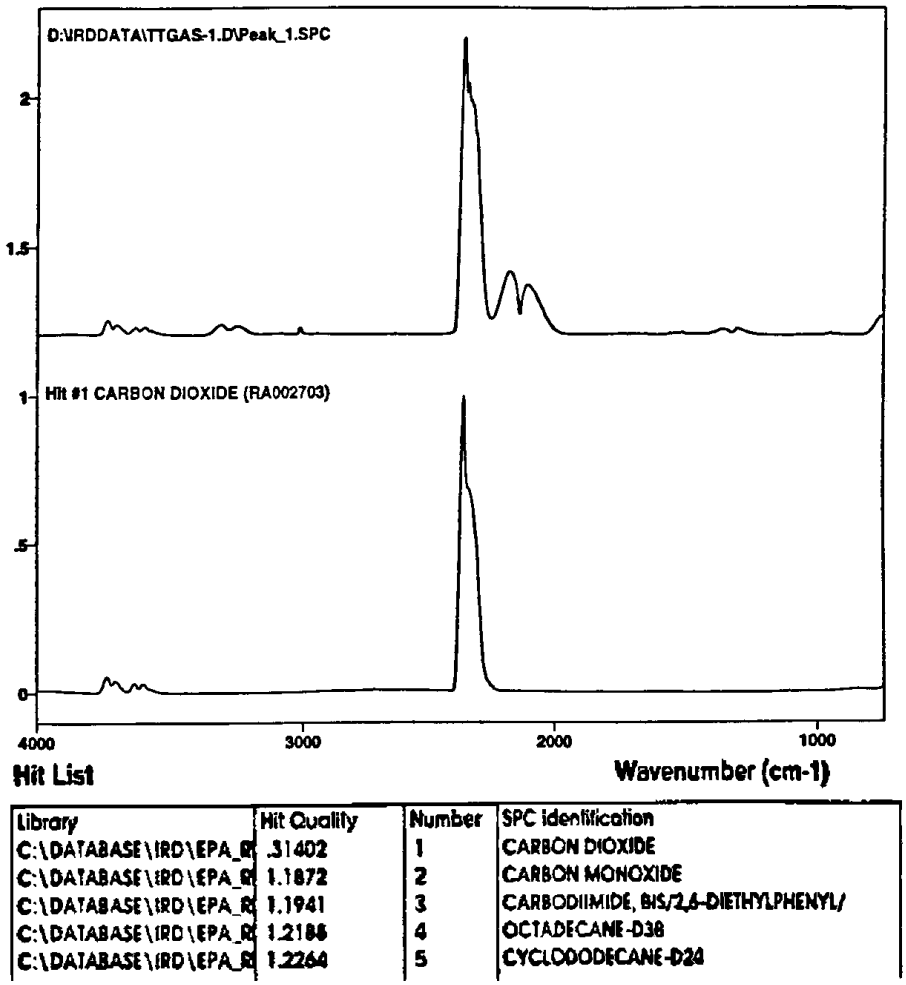


Figure 10.31. The independent confirmation at the PCFL of the NTS finding of Fig. 11.15 regarding the mutated IR signature of the CO_2 in magnegas. Note the identical shapes of the mutated IR peak in the top of the above figure, and that in Fig. 11.15 obtained via a different instrument. Note also the appearance again of two new peaks in the IR signature of CO_2, which indicate the presence of *new internal bonds* not present in the *conventional* molecule. Note finally that the instrument now correctly identifies the signature as that of the CO_2.

10.4.7 Anomalous Energy Balance of Hadronic Molecular Reactors

As is well known, the *scientific efficiency* of any equipment is *under-unity* in the sense that, from the principle of conservation of the energy and the unavoidable

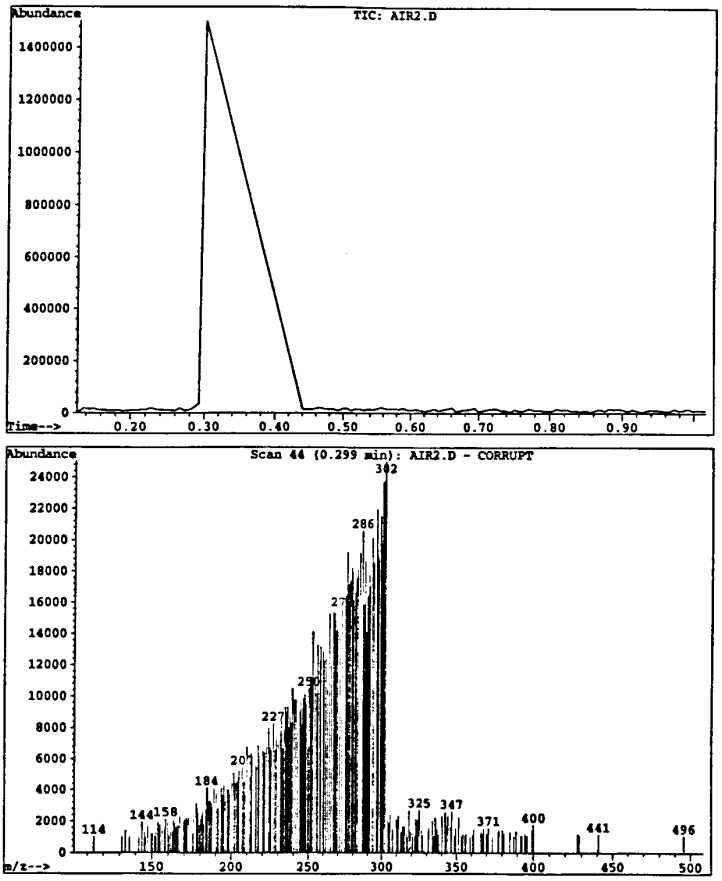


Figure 10.32. The first direct experimental verification at PCFL of the anomalous adhesion of magnecules. The figure reproduces the background of the instrument upon completion of the measurements, removal of magnegas, and conventional flushing. As one can see, the background results in being very similar to the MS scan during the tests, thus establishing that part of the gas had remained in the interior of the instrument. This behavior can only be explained via the induced magnetic polarization of the atoms in the walls of the instrument, with consequential adhesion of magnecules. It should be noted that this anomalous adhesion has been confirmed by all subsequent tests for both the gaseous and liquid states. The removal of magnecules in the instrument after tests required flushing with an inert gas at high temperature.

energy losses, *the ratio between the total energy produced and the total energy used for its production is smaller than one.*

For the case of magnegas production, the total energy produced is the sum of the energy contained in magnegas plus the heat acquired by the liquid, while the total energy available is the sum of the electric energy used for the production of

magnegas plus the energy contained in the liquid recycled. Therefore, from the principle of conservation of the energy we have the scientific energy balance

$$\frac{\text{Total energy produced}}{\text{Total energy available}} = \frac{E_{mg} + E_{heat}}{E_{electr} + E_{liq}} < 1. \tag{11.4.13}$$

An important feature of hadronic reactors is that they are *commercially over-unity*, namely, the ratio between the total energy produced and only the electric energy used for its production, is bigger than one,

$$\frac{E_{mg} + E_{liq}}{E_{electr}} > 1. \tag{11.4.14}$$

In this commercial calculation the energy contained in the liquid is not considered because liquid wastes imply an income, rather than costing money.

As a result, Santilli's hadronic molecular reactors can be viewed as reactors capable of tapping energy from liquid molecules, in much of the same way as nuclear reactors can tap energy from nuclei. An important difference is that the former reactors release no harmful radiation and leave no harmful waste, while the latter reactors do release harmful radiations and leave harmful waste.

The energy used for the production of the carbon rod, the steel of the reactors, etc. is ignored in commercial over-unity (7.34) because its numerical value per cubic foot of magnegas produced is insignificant.

The commercial over-unity of hadronic reactors is evidently important for the production of the combustible magnegas or magnetically polarized hydrogen (MagH^{TM}) at a price competitive over conventional fossil fuels.

A first certification of the commercial over-unity (7.34) was done on September 18 and 19, 1998, for the very first, manually operated prototype of hadronic reactors by the independent laboratory *Motorfuelers, Inc.*, of Largo, Florida, and included (see [8]):

1) Calibrating the cumulative wattmeter provided by *WattWatchers, Inc.*, of Manchester, New Hampshire, which was used to measure the electric energy drawn from the power lines per each cubic foot of magnegas produced;

2) The verification of all dimensions, including the volume of the column used for gas production, the volume of the liquid used in the process, etc.;

3) Repetition of numerous measurements in the production of magnegas and its energy content, calculation of the average values, identification of the errors, etc.

During the two days of tests, *Motorfuelers* technicians activated the electric DC generator and produced magnegas, which was transferred via a hose to a transparent plexyglass tower filled up with tap water, with marks indicating the displacement of one cubic foot of water due to magnegas production.

After the production of each cubic foot, the gas was pumped out of the tower, the tower was replenished with water, and another cubic foot of magnegas was

Figure 10.33. A view of metal cutting via magnegas. Independent certifications by various users have established that: 1) magnegas has a pre-heat time at least half that by acetylene (which is currently used for metal cutting and has an energy content of 2,300 BTU/cf); 2) magnegas cuts metal at least 50% faster than acetylene; 3) the cut produced by magnegas is much smoother without edges as compared to that by acetylene; 4) magnegas exhaust does not contain carcinogenic or other toxic substances, while that of acetylene is perhaps the most carcinogenic and toxic of all fuels; 5) magnegas cutting does not produce the "flash-back" (local explosion of paint over metal) typical of acetylene; 6) magnegas is dramatically safer than acetylene, which is unstable and one of the most dangerous fuels currently used; and 7) magnegas cost about 1/2 that of acetylene.

produced. The procedure was repeated several times to have sufficient statistics. The electric energy from the electric panel required to produce each cubic foot of magnegas was measured via the previously calibrated cumulative wattmeter.

As a result of several measurements, *Motorfuelers, Inc.* certified [8] that the production of one cubic foot of magnegas with the first prototype required an average electric energy of

$$E_{electr} = 122 \text{ W/cf} = 416 \text{ BTU/cf } \pm 5\%. \tag{11.4.15}$$

It should be stressed that this is the electric energy from the electric panel, thus including the internal losses of the DC rectifier. Alternatively, we can say that the arc is served by only 65% of the measured electric energy, corresponding to

$$E_{electr} = 79.3 \text{ W/cf} = 270 \text{ BTU/cf}. \tag{11.4.16}$$

The energy content of magnegas was measured on a comparative basis with the BTU content of natural gas (1,050 BTU/cf). For this purpose, technicians of *Motorfuelers, Inc.*, used two identical tanks, one of natural gas and one of magnegas, at the same initial pressure of 110 psi. Both tanks were used for 5 psi pressure decreases, under the same gas flow, to increase the temperature of the same amount of water in the same pot at the same initial temperature. The ratio of the two temperature increases is evidently proportional to the ratio of the respective BTU contents.

Following several measurements, *Motorfuelers, Inc.* certified [8] that magnegas produced from the antifreeze waste used in the reactor has about 80% of the BTU content of natural gas, corresponding to

$$E_{mg} = 871 \text{ BTU/cf } \pm 5\%. \tag{11.4.17}$$

All other more scientific tests of BTU content of magnegas conducted at various academic and industrial laboratories failed to yield meaningful results due to the energy content of magnegas for various reasons. Despite their empirical character, the measurement of BTU content done by *Motorfuelers, Inc.*, remains the most credible one.

It should be noted that the value of 871 BTU/cf is a lower bound. In fact, automotive tests reviewed in Sect. 7.9 have established that the energy output of internal combustion engines powered by magnegas is fully equivalent to that of natural gas, thus yielding a realistic value of about

$$E_{mg} = 1,000 \text{ BTU/cf}. \tag{11.4.18}$$

During the tests, it was evident that the temperature of the liquid waste in the reactor experienced a rapid increase, to such an extent that the tests had to be stopped periodically to cool down the equipment, in order to prevent the boiling of the liquid with consequential damage to the seals.

Following conservative estimates, technicians of *Motorfuelers, Inc.*, certified [8] that, jointly with the production of 1 cf of magnegas, there was the production of heat in the liquid of 285 BTU/cf plus 23 BTU/cf of heat acquired by the metal of the reactor itself, yielding

$$E_{heat} = 308 \text{ BTU/cf}. \tag{11.4.19}$$

In summary, the average electric energy of 122 W = 416 BTU calibrated from the electric panel produced one cf of magnegas with 871 BTU/cf, plus heat in the liquid conservatively estimated to be 308 BTU/cf. These independent certifications established the following *commercial over-unity* of the first, manually operated hadronic reactor within ±5% error:

$$\frac{871 \text{ BTU/cf} + 308 \text{ BTU/cf}}{416 \text{ BTU/cf}} = 2.83. \tag{11.4.20}$$

Note that, if one considers the electric energy used by the arc itself corresponding to 79.3 W/cf = 270 BTU/cf), we have the following commercial over-unity:

$$\frac{871 \text{ BTU/cf} + 285 \text{ BTU/cf}}{270 \text{ BTU/cf}} = 4.36. \tag{11.4.21}$$

In releasing the above certification, *Motorfuelers, Inc.*, noted that the arc had a poor efficiency, because it was manually operated, thus resulting in large variation of voltage, at times with complete disconnection of the process and need for its reactivation.

Motorfuelers technicians also noted that the BTU content of magnegas, Eq. (11.4.37), is a minimum value, because measured in comparison to natural gas, not with a specially built burner, but with a commercially available burner that had large carbon residues, thus showing poor combustion, while the burner of natural gas was completely clean.

Immediately after the above certification of commercial over-unity, a number of safety and health measurements were conducted on hadronic molecular reactors, including measurements on the possible emission of neutrons, hard photons, and other radiation.

David A. Hernandez, Director of the *Radiation Protection Associates*, in Dade City, Florida conducted comprehensive measurements via a number of radiation detectors placed around the reactor, with particular reference to the only radiations that can possibly escape outside the heavy gauge metal walls, low or high energy neutrons and hard photons.

Under the presence of eyewitnesses, none of the various counters placed in the immediate vicinity of the reactor showed any measurement of any radiation at all. As a result, Radiation Protection Associates released an official Certificate stating that:

> "Santilli's PlasmaArcFlow^{TM} Reactors met and exceed the regulatory regulations set forth in Florida Administrative Code, Chapter 64-E. Accordingly, the reactors are declared free of radiation leakage."

Subsequent certifications of more recent hadronic reactors operating at atmospheric pressure with 50 kW and used to recycled antifreeze waste, this time done on fully automated reactors, have produced the following measurements:

$$E_{mg} = 871 \text{ BTU/cf}, \tag{11.4.22a}$$

$$E_{liq} = 326 \text{ BTU/cf}, \tag{11.4.22b}$$

$$E_{electr} = 100 \text{ W/cf} = 342 \text{ BTU/cf}, \tag{7.42c}$$

resulting in the following commercial over-unity of automatic reactors recycling antifreeze with about 50 kW and at atmospheric pressure:

$$\frac{871 \text{ BTU/cf} + 326 \text{ BTU/cf}}{342 \text{ BTU/cf}} = 3.5. \tag{11.4.23}$$

When ordinary tap water is used in the reactors, various measurements have established a commercial over-unity of about 2.78.

It should be indicated that the commercial over-unity of the hadronic reactors increases nonlinearly with the increase of the kiloWatts, pressure and temperature. Hadronic reactors with 250 kW are under construction for operation at 250 psi and 400° F. The latter reactors have a commercial over-unity considerably bigger than (7.43).

The origin of the commercial over-unity (7.43) is quite intriguing and not completely known at this writing. In fact, conventional chemical structures and reactions have been studied by Aringazin and Santilli [9] and shown not to be sufficient for a quantitative explanation, thus requiring a new chemistry.

Following Aringazin and Santilli [9], our first task is to compute the electric energy needed to create one cubic foot of plasma in the PlasmaArcFlow reactors as predicted by conventional quantum chemistry. Only after identifying the deviations of the experimental data from these predictions, the need for the covering hadronic chemistry can be properly appraised.

For these objectives we make the following assumptions. First, we consider PlasmaArcFlow reactor processing distilled water with the DC arc occurring between a consumable pure graphite cathode and a non-consumable tungsten anode. As indicated earlier, said reactors yield a commercial over-unity also when used with pure water. Therefore, quantum chemical predictions can be more effective studied in this setting without un-necessary ambiguities. We also assume that water and the solid graphite rod are initially at 300° K and that the plasma created by the DC electric arc is at $3{,}300^o$ K.

The electric energy needed to create one cubic foot of plasma must perform the following transitions (see Appendix 7.A for basic units and their conversions):

1) Evaporation of water according to the known reaction

$$H_2O(\text{liquid}) \to H_2O(\text{vapor}) - 10.4 \text{ Kcal/mole}, \tag{11.4.24}$$

2) Separation of the water molecule,

$$H_2O \to H_2 + \frac{1}{2}O_2 - 57 \text{ Kcal/mole}, \tag{11.4.25}$$

3) Separation of the hydrogen molecule,

$$H_2 \to H + H - 104 \text{ Kcal/mole}, \tag{11.4.26}$$

4) Ionization of H and O, yielding a total of 1,197 Kcal.

We then have the evaporation and ionization of the carbon rod,

$$C(\text{solid}) \to C(\text{plasma}) - 437 \text{ Kcal/mole}, \tag{11.4.27}$$

resulting in the total 1,634 Kcal for 4 moles of plasma, i.e.

$$\begin{aligned} 408.5 \text{ Kcal/mol} = 0.475 \text{ kWh/mol} = 1621 \text{ BTU/mol} = \\ = 515.8 \text{ Kcal/cf} = 0.600 \text{ kWh/cf} = 2,047 \text{ BTU/cf}, \end{aligned} \tag{11.4.27}$$

to which we have to add the electric energy needed to heat up the non-consumable tungsten anode which is estimated to be 220 BTU/cf, resulting in the total of 2,267 BTU/cf. This total, however, holds at the electric arc itself without any loss for the creation of the DC current from conventional alternative current. By assuming that rectifiers, such as the welders used in PlasmaArcFlow reactors have an efficiency of 70%, we reach the total electric energy from the source needed to produce one cubic foot of plasma

$$\text{Total Electric Energy } = 3,238 \text{ BTU/cf} = 949 \text{ W/cf}. \tag{11.4.28}$$

We now compute the total energy produced by PlasmaArcFlow reactors according to quantum chemistry. For this purpose we assume that the gas produced is composed of 50% hydrogen and 50% carbon monoxide with ignorable traces of carbon dioxide. The latter is indeed essentially absent in PlasmaArcFlow reactors, as indicated earlier. In addition, CO_2 is not combustible. Therefore, the assumption of ignorable CO_2 in the gas maximizes the prediction of energy output according to quantum chemistry, as desired.

Recall that the glow of underwater arcs is mostly due to the combustion of hydrogen and oxygen back into water which is absorbed by the water surrounding the arc and it is not present in appreciable amount in the combustible gas bubbling to the surface. Therefore, any calculation of the total energy produced must make an assumption of the percentage of the original H and O which recombine into H_2O (the evidence of this recombination is established by the production of water during the recycling of any type of oil by the hadronic reactors).

In summary, the calculation of the energy produced by the PlasmaArcFlow reactors requires: the consideration of the cooling down of the plasma from $3{,}300^o$ K to 300° K with consequential release of energy; the familiar reactions

$$H + H \to H_2 + 104 \text{ Kcal/mole}, \tag{11.4.29a}$$

$$H_2 + \frac{1}{2}O_2 \to H_2O + 57 \text{ Kcal/mole}, \tag{11.4.29b}$$

$$C + O \to CO + 255 \text{ Kcal/mole}. \tag{11.4.29c}$$

Under the assumption of 100% efficiency (that is, no recombination of water), the total energy produced is given by

$$398 \text{ Kcal/mole} = 1,994 \text{ BTU/cf}. \tag{11.4.30}$$

By assuming that the entire energy needed to heat up the non-consumable tungsten is absorbed by the liquid surrounding the electric arc in view of its continuous cooling due to the PlasmaArcFlow, we have the total heat energy of 2,254 BTU/cf.

In addition, we have the energy content of the combustible gas produced. For this purpose we recall the following known reactions:

$$\mathrm{H_2(mg)} + \frac{1}{2}\mathrm{O_2(atm)} \rightarrow \mathrm{H_2O} + 57 \text{ Kcal/mole}, \tag{11.4.31a}$$

$$\mathrm{CO(mg)} + \frac{1}{2}\mathrm{O_2(atm)} \rightarrow \mathrm{CO_2} + 68.7 \text{ Kcal/mole}. \tag{11.4.32b}$$

Consequently, the 50%-50% mixture of conventional gases $\mathrm{H_2}$ and CO has the following

$$\text{Conventional energy content of magnegas produced from water} =$$
$$= 62.8 \text{ Kcal/mole} = 249.19 \text{ BTU/mole} = 315 \text{ BTU/cf}. \tag{11.4.33}$$

Therefore, the total energy output of the PlasmaArcFlow Reactors is given by

$$E(\mathrm{mg}) + E(\mathrm{heat}) = 315 \text{ BTU/cf} + 2,254 \text{ BTU/cf} = 2,569 \text{ BTU/cf}. \tag{11.4.34}$$

It then follows that the energy efficiency of the PlasmaArcFlow reactors is underunity for the case of maximal possible efficiency,

$$\text{Energy efficiency predicted by quantum chemistry} =$$
$$= \frac{\text{Total energy out}}{\text{Electric energy in}} = \frac{E_{mg} + E_{heat}}{E_{electr}} = \frac{2,569 \text{ BTU/cf}}{3,238 \text{ BTU/cf}} = 0.79. \tag{11.4.35}$$

It is possible to show that, for the case of 50% efficiency (i.e., when 50% of the original H and O recombine into water) the total energy output evidently decreases. For detail, we refer the interested reader to Aringazin and Santilli [9].

10.4.8 Cleaning Fossil Fuel Exhaust with Magnegas Additive

Electric power plants continue to attempt the cleaning of their atmospheric pollution (see Figure 11.1) via the cleaning of their exhaust. Since the related equipment is very expensive and notoriously inefficient, these are attempts literally belonging to the past millennium. Nowadays, the exhaust of fossil fueled electric power plants can be cleaned via cost competitive improvement of the combustion.

It is known that, whether burning petroleum or coal, about 60% of the energy in the original fuel is literally thrown through the fluke, and so is the relates cost, due to the notoriously poor combustion.

It is also known in chemistry that hydrogen is the best additive to improve combustion, with consequential improvement of the environmental quality of the exhaust. In fact, hydrogen has the biggest flame temperature and speed among all known fuels. Consequently, the injection of hydrogen as an additive in the flame of fossil fuels burns the uncombusted component of the exhausts in a way proportional to the used percentage of hydrogen. A reason hydrogen as currently available has not (and cannot) be used as additive in fossil fueled electric power plants is its prohibitive cost (that in the U.S.A. is of the order of 50 times the cost of natural gas per same energy content, as recalled in Section 11.1.3).

Magnegas is the best additive for the cleaning of fossil fuel exhaust known to the author[9] because:

1) When produced from the recycling of water-base liquid wastes, magnegas contains about 65% hydrogen, thus qualifying as an effective additive to improve fossil fuel combustion;

2) The remaining components of magnegas are internally rich in oxygen, thus helping to alleviate the large oxygen depletion caused by fossil fuel combustion (Section 11.1); and

3) The cost of magnegas is competitive over that of fossil fuel, particularly when produced by the electric power plants themselves, because of the grossly reduced cost of electricity plus the possibility of producing magnegas from the recycling of city sewage, with a consequential income that covers most of the operating costs of PlasmaArcFlow Recyclers. Un der these conditions, the percentage of magnegas additive to be injected in the flame of fossil fuels becomes a corporate, rather than technical or financial decision.

Besides incontrovertible environmental advantages, the increase of profits for electric power plants in the use of magnegas additive are substantial, such as: the utilization of at least half of the fuel and related cost literally thrown through the fluke due to poor combustion; the capability of producing green electricity that notoriously brings bigger income; and the gaining of the so-called *Kyoto Credits* that, alone, bring millions of dollars of additional income.

Despite these trans[parent gains and numerous solicitations as well as the international exposure of the website [5b], no electric power plant nowhere in the world has expressed interest to this day (fall 2005) interest in at least inspecting the use of magnegas additive. This behavior was expected by the author because, as stated in the opening sentences of this chapter, profits are no longer the dominant drive in the contemporary corporate world. Politics is the dominant drive. Lack of interest for major environmental and financial gains is then another confirmation of the lack of political will toward serious environmental actions in all developed countries (for more details, visit the website [5b]).

[9]The documented indication of other additives comparable to magnegas would be sincerely appreciated.

10.4.9 Hy-Gasoline, Hy-Diesel, Hy-Ethanol, Hy-NG, Hy-Coal

Fossil fuels are sold in a disproportionate daily volumes recalled in Section 11.1, and we should expect that they will continue to be sold in ever increasing disproportionate volumes until the extinction of all petroleum reserves.

Rather than dreaming of eliminating fossil fuels from the market, scientists in general, and chemists in particular, have the ethical duty to seek additives to clean fossil fuel combustion in automotive use, namely, an usage logistically and technically different than the combustion of fossil fuels in power plants furnaces of the preceding section.

It is at this point where the irreconcilable conflict between academic interest on pre-existing theories and the societal need for new theories emerges in its full light. In fact, the best additive to clean fossil fuel combustion is, again, hydrogen (see the preceding section). However, hydrogen is a gas, while gasoline, diesel, ethanol and other fuels are liquids. Consequently, quantum chemistry provides no possibility of achieving new fuels characterized by a stable mixture of liquid fuels and gaseous hydrogen.

However, the abandonment of quantum chemistry in favor of the covering hadronic chemistry permits indeed the possible resolution of the problem. In fact. magnecular bonds are completely insensitive as to whether the constituents of a magnecular cluster partially originated from liquids and part from gases, trivially, because the bond occurs at the level of individual atoms.

The above principle has permitted the formulation of basically new *liquid* fuels known as Hy-Gasoline^{TM}, Hy-Diesel^{TM}, Hy-Ethanol^{TM}, HyCoal^{TM}, etc. (patented and international patents pending [5]), where the prefix "Hy" is used to denote a high hydrogen content. These new fuels are essentially given by ordinary fossil fuels as currently produced, subjected to a bond with magnegas or hydrogen from magnegas (see next section) via the use of special PlasmaArcFlow Reactors.

As predicted, no petroleum company has expressed to date any interest at all in even inspecting the evidence, let alone take serious initiative in these new fuels despite numerous solicitations and the transparent environmental and, therefore, financial gains, because of the origin of the current environmental problems threatening mankind: the lack of serious political will in all developed countries to this day (fall 2005), and actually the subservience of current political will to the petroleum cartel, as denounced in the opening words of this chapter (for more details, visit the website [5b]).

10.4.10 Catastrophic Inconsistencies of Quantum Mechanics, Superconductivity and Chemistry for Submerged Electric Arcs

In Chapter 9 we identified the *approximate* yet still applicable character of quantum mechanics and chemistry for molecular structures.

The analysis of this section has confirmed the content of section 1.2.11 to the effect that the divergences between submerged electric arcs and the predictions of conventional disciplines are so huge to be called "catastrophics inconsistencies" such as:

1) **Inability by quantum chemistry to identify the chemical composition of magnegas.** This occurrence is due to the fact that quantum chemistry predicts that magnegas produced via a electric arc between pure graphite electrodes submerged within distilled water is composed primarily of the molecule $H-H$ with 2 a.m.u and $C-O$ with 28 a.m.u, with traces of H_2O with 18 a.m.u. and CO_2 with 44 a.m.u. No additional species is predicted by quantum chemistry. By comparison , magnegas is composed of fully identifiable peaks in the MS ranging from 1 a.m.u to $1,000$ a.m.u. *none* of which is identifiable with the preceding molecules, resulting in catastrophic divergences in the sense that the application of quantum chemistry to magnegas would have no scientific sense, not even approximate.

2) **Inability by quantum superconductivity to represent submerged electric arcs.** Distilled water is known to be dielectric. In fact, the electric resistance between electrodes submerged within distilled water at large distance (open arc) can be of the order of 100 Ohms or so. However, when the electric arc is initiated the resistance collapses to fractional Ohms, resulting in a very high temperature kind of "superconductor" (since the arc has about $5,000^oC$). Such a collapse of electric resistance is beyond any hope of representation by quantum superconductivity. in reality, as studied in preceding chapters, the collapse is due to the basic inapplicability of Maxwell' s equations for submerged electric arcs , thus implying the basic inapplicability of the Lorentz and Poincaré symmetry, special relativity and all that in favor of covering theories.

3) **A ten-fold error in defect in the prediction of the CO_2 content of magnegas exhaust.** In fact, quantum chemistry predicts the presence of about 50% of CO in magnegas from distilled water resulting in about $40\% CO_2$ in the exhaust,, while magnegas has about 1/10-th that value;

4) **A ten fold error in excess in the prediction of heat generated by carbon combustion by the arc.** In fact, in the preceding subsection we showed that quantum chemistry predicts about $2,250$ Kcal/scf of magnegas, while the measured amount is of the order of 250 for water as feedstock. Note that the latter error confirms the preceding one.

5) **A fourteen-fold error in the prediction of oxygen in the exhaust of magnegas.** In fact, quantum chemistry predicts that, under full combustion in atmosphere, there is no oxygen in the exhaust, while magnegas shows up to 14% breathable oxygen in the exhaust.

an additional large inconsistency of quantum chemistry will be shown in the next section in regard to the hydrogen content of magnegas.

However, the most catastrophic inconsistencies are given by the fact that *magnegas has a variable energy content, a variable specific weight, and a variable Avogadro number.* The first two features are established by the fact that the energy content and density of magnegas produced from the same reactor with the same liquid feedstock increases nonlinearly with the sole increase of the operating pressure, trivially, because bigger pressures produce heavier magnecules.

The all important variation of the Avogadro number is established by the fact, verified every day in the magnegas factories around the world when compressing magnegas in high pressure bottles according to which the same increase of pressures. For instance, the transition from 20 to 120 psi requires about 40 scf, while the transition from $3,500$ psi to $3,600$ psi may require 70 scf of magnegas, an occurrence that can only be explained via the *decrease of the Avogadro number with the increase of pressure.*

The latter anomaly is necessary for gases with magnecular structure for the evident reason that the increase of pressure bonds different magnecules together, thus reducing the Avogadro number. Alternatively, the magnecular structure can be also interpreted as an unusual form of "semi-liquid" in the sense that the magnecular bond is much closer to the so called "h-bridges" of the liquid state of water. the increase of pressure evidently brings magnegas progressively closer to the liquid state, which continuous process can only occur for a variable Avogadro number.

on historical grounds, it should be recalled that *Avogadro conceived his celebrated number as being variable with physical characteristics of pressure and temperature,* a conception clearly stated on the expectation that the gaseous constituents can break down into parts due to collision and subsequent recombinations.

Subsequently, the chemistry of the time believed for decades that the Avogadro number was variable. In fact, the first measurements of the constancy of the Avogadro number maed by Canizzaro also in Italy, were initially very controversial until verified numerous times. Today we know that *the constancy of the Avogadro number for gases wit molecular structure is due to the strength of the valence bond under which no breaking of molecules is possible under increasing temperature and pressure, resulting in a constant number of constituents per mole.*

For over one century chemistry was restricted to the study of gases with molecular structure and Avogadro original conception was forgotten until resumed by the author with his gases with magnecular structure that verify all original intuition by Avogadro.

10.4.11 Concluding Remarks

The first important experimental evidence presented in this section is the independent certification of hadronic reactors of molecular type as being "commercially over-unity", that is, the ratio between the total energy produced and the electric energy needed for its production can be much bigger than one, Eq. (11.4.14).

This occurrence establishes that said hadronic reactor are based on a *a new combustion of carbon* realized via the electric arc, which combustion is much cleaner and more efficient than the combustion of carbon in a conventional furnace. In fact, the new combustion of carbon occurs in the plasma surrounding the electric arc due to the presence of oxygen originating from the liquid feedstock.

Rather than producing highly polluting exhaust, as for the combustion of carbon in a furnace, the plasma combustion produced a clean burning fuel and heat without pollution. Consequently, the plasma combustion of carbon is much more efficient than conventional combustion because pollutants in the exhaust are uncombusted fuel.

The third experimental evidence presented in this section is that establishing the existence of the new chemical species of Santilli magnecules. More specifically, said experimental evidence, plus additional tests not reported here for brevity, confirm the following features of Definition 11.4.1:

I) Magnecules have been detected in MS scans at high atomic weights where no molecules are expected for the gas considered. In fact, the biggest molecule in macroscopic percentages of the magnegas tested, that produced from tap water with conventional chemical composition (8.20), is CO_2 with 44 a.m.u., while peaks in macroscopic percentages have been detected with *ten times* such an atomic weight and more.

II) The MS peaks characterizing magnecules remain unidentified following a computer search among all known molecules. This feature has been independently verified for *each* of the sixteen peaks of Fig. 11.12, for all peaks of Figs. 8.13 and 8.14, as partially illustrated in Figs. 8.8 and 8.15, as well as for all additional MS scans not reported here for brevity.

III) The above MS peaks characterizing magnecules admit no IR signature, thus confirming that they do not have a valence bond. In fact, none of the peaks here considered had any IR signature as partially illustrated in Figs. 8.9 and 8.16, thus confirming the achievement of an essentially pure population of magnecules.

IV) The IR signature of the only molecule detected in macroscopic percentage, that of the CO_2, is mutated precisely with the appearance of two additional peaks, as shown in Fig. 11.15 and independently confirmed in Fig. 11.22. Since any peak in the IR signature represents an internal bond, the mutation here considered confirms the creation by the PlasmaArcFlow technology of new internal magnetic bonds within conventional molecules, as per Fig. 11.11.

V) The anomalous adhesion of magnecules is confirmed in both tests from the evidence that the background (blank) at the end of the tests following conventional flushing continued to show the presence of essentially the same magnecules detected during the tests, as illustrated in Figs. 8.12 and 8.18.

VI) The atomic weight of magnecules mutates in time because magnecules can break down into fragments due to collisions, and then form new magnecules with other fragments. This feature is clearly illustrated by the macroscopic differences of the two scans of Figs. 8.13 and 8.14 via the same instrument on the same gas under the same conditions, only taken 30 minutes apart.

VII) Magnecules can accrue or lose individual atoms, dimers or molecules. This additional feature is proved in the scans of Figs. 8.13 and 8.14 in which one can see that: the peak at 286 a.m.u. of the former becoming 287 a.m.u. in the latter, thus establishing the accretion of one hydrogen *atom*; the peak at 302 a.m.u. in the former becomes 319 a.m.u. in the latter, thus establishing the accretion of the H–O dimer; the peak at 328 a.m.u. in the former becomes 334 a.m.u. in the latter, thus establishing the accretion of one O_2 molecule; the peak at 299 a.m.u. in the former become 297 a.m.u. in the latter, thus exhibiting the loss of one H_2 molecule; *etc.* It should be indicated that these features have been confirmed by all subsequent GC-MS/IRD scans not reported here for brevity.

The other features of Definition 11.4.1 require measurements other than those via GC-MS/IRD and, as such, they will be discussed in the next section.

A most forceful implication of the experimental evidence presented in this section is that it excludes valence as the credible origin of the attractive force characterizing the detected clusters. This feature is forcefully established by the detection of peaks all the way to 1,000 a.m.u. in a gas solely composed of H, C and O atoms that are combined at the $10,000^oF$ of the electric arc, thus excluding hydrocarbons and other standard molecules. Even more forceful experimental evidence on new non-valence bonds will be presented in the next sections.

It is easy to predict that the emergence of "new" non-valence bonds, we have called magnecular, will inevitably imply a revision of a number of current views in chemistry, the first case coming to mind being that of the so-called *H-bridges* in the liquid state of water.

As recalled in Chapter 9, this author never accepted quantum chemistry as "the final theory" for molecular structure because *quantum chemistry lacks the explicit and numerical identification of the attractive force in valence bonds, besides the*

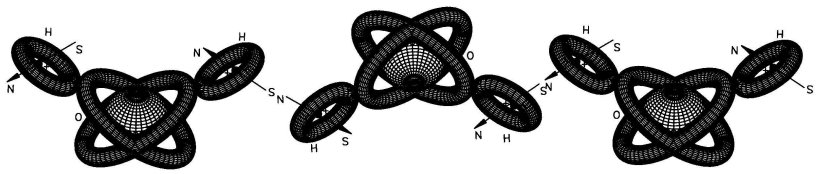


Figure 10.34. A schematic view of the magnecular interpretation of the liquid state of water. Such a state requires an ATTRACTIVE FORCE between the water molecules. But the latter are electrically neutral, diamagnetic and no unbounded electron available for valance bonds. hence, a basically new, non-valence force is needed to represent the water liquid state. Quantum chemistry suggests that such liquid state is due to the so-called "H-bridges" although the latter are pure nomenclature because they do not identify at all explicitly and numerically the attractive force among water molecules. The new chemical species of Santilli magnecules resolves the problem because the H atoms in the H_2O molecule have a polarization in a plane perpendicular to the $H-O-H$ plane, that is precisely a toroidal polarization permitting attractive forces among different H atoms identified in their attractive as well as numerical character in this section. In summary, the main hypothesis here submitted apparently for the first time is that *the liquid state of water, as well as any other liquid state, is a magnecule*, by illustrating in this way the prediction that magnecules can acquire macroscopic dimensions (see additional studies on magnecules in liquids later on in this chapter).

fact that, according to quantum mechanics, two identical electrons should repel, rather than attract each other, as a consequence of which the name "valence" is a mere nomenclature without sufficient scientific content.

This was essentially the situation in molecular structures such as the water molecule H_2O. Hadronic mechanics and chemistry have resolved this insufficiency by identifying explicitly and numerically the ATTRACTIVE force between IDENTICAL ELECTRONS that is responsible for the water and other molecules.

In this section we have learned that molecules admit non-valence bonds originating from toroidal polarizations of the orbitals. The magnecular origin of the H-bridges in the liquid state of water is then inevitable because, as recalled in Chapter 9, the orbitals of the H atoms in H_2O *do not* have a spherical distribution, but a distribution that is perpendicular to the $H-O-H$ plane, thus being precisely of the toroidal type underlying magnecules (see Fig. 11.34 for details).

In closing the author would like to stress that the above findings, even though independently confirmed numerous times, should be considered preliminary and in need of additional independent verifications, which are here solicited under the suggestion that:

1) Only peaks in macroscopic percentages should be initially considered to avoid shifting issues of primary relevance into others of comparatively marginal importance at this time;

2) The internal *attractive* force necessary for the very existence of cluster is identified in clear numerical terms without vague nomenclatures deprived of an actual physical reality, or prohibited by physical laws; and

3) The adopted terminology is identified with care. The word "magnecule" is a mere name intended to denote a chemical species possessing the specifically identified characteristics I) to XV) of Definition 11.4.1 which are distinctly different than the corresponding characteristics of molecules. Therefore, the new species can not be correctly called molecules. The important features are these distinctly new characteristics, and not the name selected for their referral.

10.5 THE NEW MAGNECULAR SPECIES OF HYDROGEN AND OXYGEN WITH INCREASED SPECIFIC WEIGHT

10.5.1 Resolution of Hyrogen Problems Permitted by the Magnegas Technology

In Section 11.1.3 we have pointed out serious problematic aspects caused by large scale use of hydrogen, including its large oxygen depletion, vast pollution caused by its current production methods, threat to the ozone layer, seepage and excessive costs due to the need of liquefaction. It is important to note that the new chemical species of magnecules permits the resolution, or at least the alleviation of these problems.

As indicated in Section 11.3, magnegas is synthesized from liquids that are very rich in hydrogen, such as water-base or oil-base liquid wastes. Consequently, magnegas generally contains about 66% hydrogen, not in a valence bond with other atoms as it is the case for CH_4, but *in a magnecular mixture* with other gases, thus permitting simple methods of molecular or other separations without the need of large energies to break valence bonds. Hence, the Magnegas Technology [5b] offers the following possibilities:

A) **Reduction of oxygen depletion caused by hydrogen combustion.** As indicated in the preceding sections, the new magnecular bond has been developed to achieve full combustion as well as to permit the inclusion of oxygen when prohibited by valence bonds, resulting in a fuel that is internally rich in oxygen originating not from the atmosphere, but from liquid wastes. in fact, magnegas exhaust routinely contains up to 14% of breathable oxygen, and such a percentage can be increased following suitable development. It then follows that *the combustion of hydrogen produced via its separation from magnegas causes dramatically less oxygen depletion than that of hydrogen originating from reformation or electrolysis,* since none of the latter processes release oxygen in the atmosphere.

B) **Reduction of environmental pollution in hydrogen production.** Admittedly, the production of magnegas currently requires the use of commer-

cially available electricity that is polluting because of generally fossil origin. However, PlasmaArcFlow Recyclers release no solid, liquid or gaseous contaminant in the environment; the electric energy used by the arc is about 1/20-th the operating energy (since the rest is given by a very clean carbon combustion via the arc); and the efficiency of PlasmaArcFlow Recyclers can be up to twenty times that of electrolysis. Consequently, the production of hydrogen from magnegas is dramatically less polluting then conventional methods, with the understanding that, when the new clean energies presented in the next chapter achieve industrial maturity, hydrogen production from magnegas will release zero environmental pollutants.

C) **Reduction of the threat to the ozone layer caused by hydrogen seepage and leaks.** Besides a basically new production method, a necessary condition for hydrogen to be a really viable fuel for large scale use is that of achieving a *new magnecular form of hydrogen* consisting of clusters sufficiently large to avoid seepage, as well as to prevent that, in case of leaks, hydrogen quickly rises to the ozone layer. This new species in studied in the next subsections.

D **Elimination of the need for liquefaction of hydrogen.** This objective is related to the preceding one. In fact, the achievement of a magnecular form of hydrogen automatically implies an increase of the specific weight over the standard value of 2.016 a.m.u. that, in turn, automatically implies the reduction of container volumes, with consequential possibility of using hydrogen in a compressed form without any need for its liquefaction. Note that, lacking such heavier form, hydrogen has no realistic possibility of large scale use due to the extreme costs and dangers of changes of state from liquid to gas.

E) **Dramatic reduction of hydrogen cost.** Magnegas produced in volumes is cost competitive with respect to fossil fuels such as natural gas. Consequently, the biggest contribution of the Magnegas Technology to the hydrogen industry is the dramatic reduction of current hydrogen production costs down to values compatible with fossil fuels costs, as shown in more details in the next subsection. Additional advantages over conventional hydrogen are permitted by its magnecular structure as shown below.

10.5.2 The Hypothesis of the New Chemical Species of MagneHydrogen^{TM} and MagneOxygen^{TM}

In paper [18] the author submitted, apparently for the first time, the hypothesis that conventional hydrogen H_2 and oxygen O_2 gases can be turned into a new species with magnecular structure here called *MagneHydrogen*^{TM} and *MagneOxygen*^{TM} 9as well as of other gases), with suggested chemical symbols MH and MO, respectively (patented and international patents pending).

The foundations of the above hypothesis are essentially those given in preceding sections. As recalled earlier, the hydrogen molecule is diamagnetic and, therefore,

it *cannot* acquire a total net magnetic polarity. Nevertheless, the orbits of the *individual H atoms* can acquire a toroidal polarization under a sufficiently strong external magnetic field. The opposite magnetic moments of the two H atoms then explain the diamagnetic character of the hydrogen molecule as illustrated in Figure 11.7.

The aspect important for the hypothesis of MH and MO is that the toroidal polarization of the orbits of the electrons of the individual H atoms, plus the polarization of the intrinsic magnetic moments of nuclei and electrons in the H_2 molecule is sufficient for the creation of the desired new chemical species with bigger specific weight, because the new bonds can occur between pairs of individual H atoms, as illustrated in Figures 11.10 and 11.11.

The creation of MO is expected to be considerably simpler than that of MH because oxygen is paramagnetic, thus having electrons free to acquire an overall magnetic polarity which is absent for the case of MH. Nevertheless, the achievement of a significant increase of the specific weight of the oxygen will require the toroidal polarization of at least some of the peripheral atomic electrons, in addition to a total magnetic polarization.

The primary technological objective is, therefore, that of achieving physical conditions and geometries suitable for the joint polarization of *atoms*, rather than molecules, in such a way to favor their coupling into chains of opposing magnetic polarities. In the final analysis, the underlying principle here is similar to the magnetization of a ferromagnet, that is also based on the polarization of the orbits of unbounded electrons. The main difference (as well as increased difficulty) is that the creation of MH requires the application of the same principle to a *gaseous*, rather than a solid substance.

Under the assumption that the original gases are essentially pure, MH can be schematically represented

$$(H_\uparrow - H_\downarrow) \times H_\uparrow, \tag{11.5.1a}$$

$$(H_\uparrow - H_\downarrow) \times (H_\uparrow - H_\downarrow), \tag{11.5.1b}$$

$$(H_\uparrow - H_\downarrow) \times (H_\uparrow - H_\downarrow) \times H_\uparrow, etc. \tag{11.5.1c}$$

while MagneO can be schematically represented

$$(O_\uparrow - O_\downarrow) \times O_\uparrow, \tag{11.5.2a}$$

$$(O_\uparrow - O_\downarrow) \times (O_\uparrow - O_\downarrow), \tag{11.5.2b}$$

$$(O_\uparrow - O_\downarrow) \times (O_\uparrow - O_\downarrow) \times O_\uparrow .etc. \tag{11.5.3c}$$

where the arrows now indicate possible polarizations of more than one electron orbit.

By keeping in mind the content of the preceding sections, the achievement of the above magnecular structure does imply that MH and MO have specific

weight and energy content greater than the corresponding values for unpolarized gases. The numerical values of these expected increases depend on a variety of factors discussed in the next subsections, including the intensity of the external magnetic field, the pressure of the gas, the time of exposure of the gas to the external field, and other factors.

A first important feature to be subjected to experimental verification (reviewed below) is the expected increase of specific weight. By recalling that the *gasoline gallon equivalent for hydrogen* is about 366 scf, the achievement of a form of MH with five times the specific weight of conventional hydrogen would reduce the prohibitive volume of $7,660$ scf equivalent to 20 g of gasoline to about $1,500$ scf. This is a volume of MH that can be easily stored at the pressure of $4,500$ psi in carbon fiber tanks essentially similar in volume and composition to that of a natural gas tank. As a result, the achievement of MH with sufficiently high specific weight can indeed eliminate the expensive liquefaction of hydrogen in automotive use, with consequential reductions of costs.

Another basic feature to be subjected to experimental verification (reviewed below) is that the combustion of MH and MO releases more energy than the combustion of conventional H and O gases. It then follows that

I) The use for internal combustion engines of MH with a sufficiently high specific weight is expected to eliminate liquefaction, yield essentially the same power as that produced with gasoline, and permit a dramatic decrease of operating costs;

II) The use of MH and MO in fuel cells is expected to yield a significant increase of voltage, power and efficiency; and

III) The use of liquefied MH and MO as fuels for rocket propulsion is expected to permit an increase of the payload, or a decrease of the boosters weight with the same payload.

Moreover, recent studies scheduled for a separate presentation have indicated that the *liquefaction of MH and MO appears to occur at temperatures bigger than those for conventional gases,* thus implying an additional reduction of costs. This expectation is due to the fact that magnecules tend to aggregate into bigger clusters with the increase of the pressure, evidently due to their magnetic polarizations, which feature evidently favors liquefaction.

It is evident that the same principles outlined above also apply for other gases, and not necessarily to H and O gases alone. In fact, the processing of any gaseous fossil fuel via the principles here considered permits the increase of its specific weight as well as of its energy output, thus permitting a consequential decrease of storage volume, increase of performance and decrease of costs.

Note that the hypothesis of MH and MO is an extension of H_3 and O_3 to arbitrary values H_n and O_m as permitted by local values of pressure and temperature. Alternatively, the experimental evidence on MH and MO reviewed later

on in this section confirms the magnecular structure of H_3 and O_3 presented in Section 11.3.4.

10.5.3 Industrial Production of MagneHydrogen^{TM} and MagneOxygen^{TM}.

As indicated earlier, the magnetic polarization of the orbits of peripheral atomic electrons requires extremely strong magnetic fields of the order of billions of Gauss. These values are of simply impossible realization in our laboratories with current technologies, that is, at distances of the order of inches or centimeters. These magnetic fields cannot be realized today even with the best possible superconducting solenoids cooled with the best available cryogenic technology.

The only possible, industrially useful method of achieving magnetic fields of the needed very high intensity is that based on direct current (DC) electric arcs with currents of the order of thousands of Amperes (A) when considered at atomic distances, i.e., of the order of 10^{-8} cm. As illustrated in Fig. 11.9, the magnetic field created by a rectilinear conductor with current I at a radial distance r is given by the well known law

$$B = kI/r, \tag{11.5.4}$$

where k = 1 in absolute electromagnetic units. It then follows that, for currents in the range of 10^3 A and distances of the order of the size of atoms r = 10^{-8} cm, the intensity of the magnetic field B is of the order of 10^{13} Oersted, thus being fully sufficient to cause the magnetic polarization of the orbits of peripheral atomic electrons.

Under the above conditions schematically represented in Fig. 11.9, atoms with the toroidal polarization of their orbits find themselves aligned one next to the other with opposing polarities which attract each other, thus forming magnecules. The electric arc decomposes the original molecule, thus permitting the presence of isolated atoms or radicals in the magnecular structure as needed to increase the energy output (Section 3).

In this way, the process transforms the original gas with its conventional molecular structure into a new chemical species consisting of individual atoms, radicals and complete molecules all bonded together by attractive forces among opposite magnetic polarities of the toroidal polarization of the orbits of peripheral atomic electrons.

In the event the original gas has a simple diatomic molecular structure, such as H_2, the magnecular clusters are composed of individual polarized H atom and ordinary polarized molecules H_2 as in Fig. 11.11. In the event the original gas has the more complex diatomic structure of O_2, the magnecular clusters are composed of individual polarized O atoms, O-O single bonds, and O_2 molecules with additional internal bonds as in Fig. 11.12. In the event the original gas has the more complex diatomic structure CO with triple valence bonds, the magnecular

clusters are more complex and are generally composed of individual C and O atoms, single bonds C-O, double bond C=O, conventional molecules CO and O_2 with internal new bonds as in Fig. 11.12, plus possible C-complexes. Original gases with more complex conventional molecular structure evidently imply more complex magnecular clusters with all possible internal atomic arrangements.

It is evident that the resulting new species is not composed of all identical magnecules, and it is composed instead of a variety of magnecules from a minimum to a maximum number of atomic components, which have been measured to reach 1,000 a.m.u. and even more. The specific weight of the magnecular gas is then given by the average weight of all different magnecules, as indicated earlier.

Needless to say, a number of alternative methods for the industrial production of MH and MO are possible as identified in the existing patent applications. An alternative method worth mentioning here is the use of solenoids. The reader should however be aware that the latter cannot decompose molecules. Therefore, the MagneGases produced via the use of electric discharges and solenoids are different.

Another type of MH important for this study is that obtained from MagneGas [5]. When MagneGas is produced from a hydrogen rich liquid feedstock (such as water or liquids of fossil origin), it may contain up to 60% hydrogen in a form already polarized by the electric arc used for its production. Therefore, the hydrogen content of MagneGas is indeed a particular form of MH which can be separated via a variety of available technologies, such as filtration, cryogenic cooling and other processes.

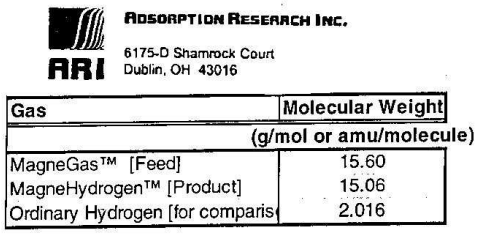
This particular form of MH (whose features are identified in the next subsection) is particularly suited as fuel for internal combustion engines, rather than for fuel cells. This is due to the expected presence of very small C and O impurities which do not permit their use in fuel cells.

This particular type of MH derived from MagneGas has already been tested for automotive usage and proved to have a performance essentially similar to that of gasoline without any need of liquefaction, as needed instead by hydrogen vehicles currently tested by BMW, GM and other automakers. The tests were conducted via the conversion of two Honda and one Ferrari cars to operate on the new fuels (see [5] for brevity).

Above all, this particular type of MH has resulted to be cost competitive with respect to fossil fuels, of course, when produced in sufficiently large volumes. This cost competitiveness is due to a variety of factors, including (see [5] for detail):

1) the use of hydrogen rich wastes as liquid feedstock, such as city and farm sewage, antifreeze and or oil waste, etc., which implies an *income*, rather than a cost;

2) the possible utilization of steam at 400° produced by the cooling of the highly esoenergetic processes of the reactors, which steam can be used for other *income*


ADSORPTION RESEARCH INC.
6175-D Shamrock Court
Dublin, OH 43016
ARI

Gas	Molecular Weight (g/mol or amu/molecule)
MagneGas™ [Feed]	15.60
MagneHydrogen™ [Product]	15.06
Ordinary Hydrogen [for comparis	2.016

Figure 10.35. A view of the main results on the measurement of specific weight on a specific form of MH produced from magnegas released by Adsorptions Research Laboratory, in Ohio, under signature by its laboratory director. It should be stressed that the high value of specific weight was due to a specific treatment not expected to be possible on a industrial basis. Therefore, the specific weight ofg MH industrially production from magnegas is expected to have about three times the specific weight of H_2, thus sufficient to render MH equivalent to natural gas as far as energy content is concerned (because natural gas contains about $1,000$ BTU/scf, $H2$ contains about 300 BTU/scf, consequently $MH = 3H_2$ would contain BTU/scf close to those of natural gas)

producing applications, such as desalting seawater via evaporation, production of electricity via turbines, heating of buildings, and other income producing uses; and

3) the unusually high efficiency of Santilli Hadronic Reactors of molecular types used for the process which brings the cost of electricity down to $0.005/scf$.

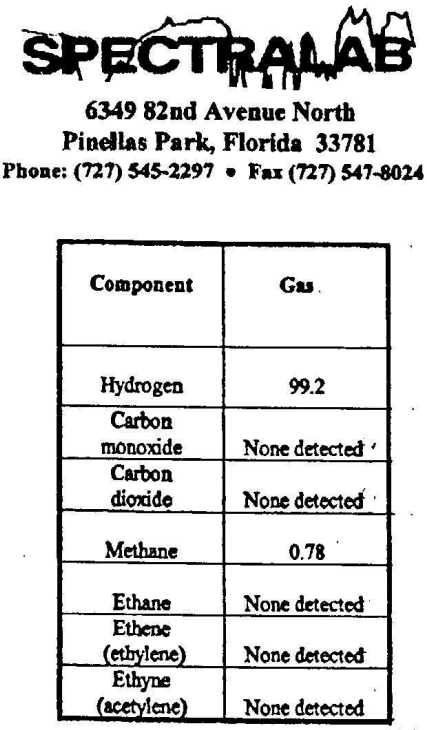
Specific equipment and designs for the industrial production of MH, MO, and other magnetically polarized gases are available on request.

10.5.4 Experimental Evidence on MagneHydrogen^{TM} and MagneOxygen^{TM}

It is now important to review the experimental evidence supporting the existence of MH and MO.

The first tests were conducted with MH produced from MagneGas as indicated in the preceding subsection. MagneGas was first produced by using antifreeze waste as liquid feedstock. The combustible gas was then passed through 5 Armstrong zeolite filters, which essentially consist of a microporous molecular sieve selecting a gas via the so-called "molecular sieving," or molecular size exclusion.. The filtered gas was then subjected to the following three measurements:

1) This type of MH was first subjected to analytic measurements by a laboratory via Gas Chromatography (CG) and independent tests for confirmation were conducted via Fourier Transform Infrared Spectroscopy (FTIS). All measurements were normalized, air contamination was removed, and the lower detection limit was identified as being 0.01%. The results are reported in Fig. 11.35. As



SPECTRALAB

6349 82nd Avenue North
Pinellas Park, Florida 33781
Phone: (727) 545-2297 • Fax (727) 547-8024

Component	Gas
Hydrogen	99.2
Carbon monoxide	None detected
Carbon dioxide	None detected
Methane	0.78
Ethane	None detected
Ethene (ethylene)	None detected
Ethyne (acetylene)	None detected

Figure 10.36. A summary view of the spectroscopic analyses conducted by Spectra lab of largo, Florida, showing 99.2% hydrogen in the species of MH here considered. Note the "experimental belief" that the species here considered contains 0.78% methane. MH produced from magnegas cannot possibly contain methane since magnegas is formed at about $10,000^oF$ of the electric arc at which methane cannot possibly survive. in reality, the analytic instrument has detected a magnecular species with 16 a.m.u and identified that species with methane due to lack of info in the computer data banks.

one can see, these measurements indicate that this particular type of MagneH is composed of 99.2% hydrogen and 0.78% methane, while no carbon monoxide was detected.

2) The average specific weight of this type of MH was measured by two independent laboratories as being 15.06 a.m.u., while conventional pure hydrogen has the specific weight of 2.016 a.m.u., thus implying a 7.47 fold increase of the specific weight of conventional hydrogen.

3) The same type of MH used in the preceding tests was submitted to CG-MS scans via the use of a HP GC 5890 and a HP MS 5972 with operating conditions specifically set for the detection of magnecules (Section 5 and Ref. [5]). The results of these third tests are reproduced in Fig. 11.37. As one can see, by

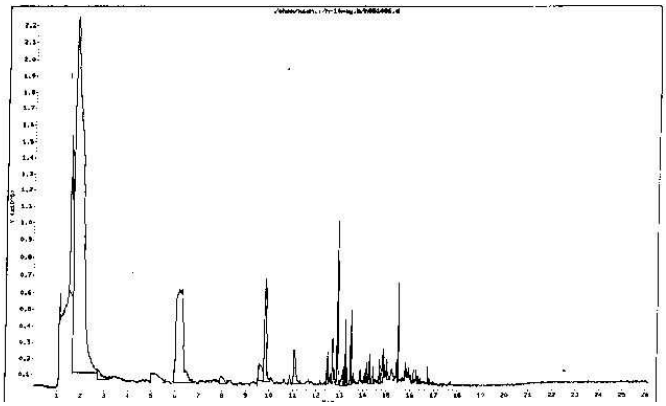


Figure 10.37. A view of one of the numerous GC-MS scans conducted at the Toxic Analytic Laboratory in California establishing in a final form the magnecular character of the species here studied. In fact, the molecular seeving process used by Adsorption Research Laboratory could only allow the separation of hydrogen and definitely not the numerous heavy clusters identified in this scan. Since hydrogen has only one electron and, consequently can only form under valence bond H_2, the heavy species of hydrogen here considered establishes the existence of a *non-valence* bond beyond any possible or otherwise credible doubt.

keeping in mind the results of GC-FTIS of Fig. 11.36, the GC-MS measurements should have shown only two peaks, that for hydrogen H_2 at about 2 a.m.u., and that for methane CH_4 at about 16 a.m.u. On the contrary, these GC-MS tests confirm the existence of a large peak at about 2 a.m.u. evidently representing hydrogen, but do not show any peak at 16 a.m.u. proportional to the 0.78% of methane, and exhibit instead the presence of a considerable number of additional peaks in macroscopic percentages all the way to 18 a.m.u. This GC-MS scan establishes the existence beyond credible doubt of a magnecular structure in the type of MH here studied. Note, in particular, *the existence of well identified peaks in macroscopic percentage with atomic weight of 3, 4, 5, 6, 7, 8 and higher values which peaks, for the gas under consideration here, can only be explained as magnecules composed of individual H atoms as well as H molecules in increasing numbers.*

The above measurements 1), 2) and 3) confirm the capability to produce hydrogen with a multiple value of their standard specific weight, and consequential increased energy content.

Next, to test MO in fuel cells, the author had constructed by technicians in Florida a rudimentary apparatus based on the use of automotive sparks powered by an ordinary car battery, the system operating at about 15 psi. Two types of MO, denoted by MO_1 and MO_2, were produced from pure oxygen for comparative purposes.

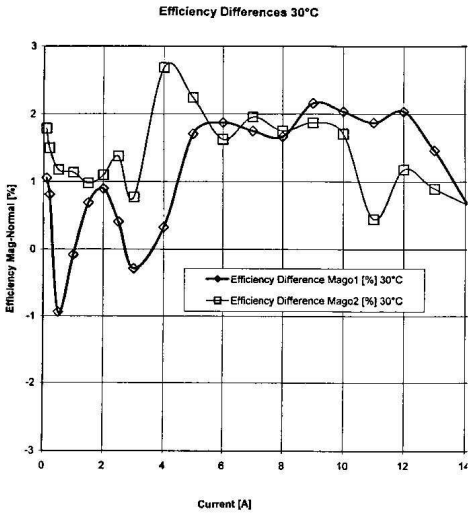


Figure 10.38. A schematic view of the voltage increase in a test fuel cell operated with ordinary pure hydrogen and the two samples of MO produced by rudimentary equipment.

This type of MO was tested in lieu of ordinary oxygen in a 2-cell Proton Exchange Membrane (PEM) fuel cell operated with conventional high purity hydrogen. The membrane material was Nafion 112; the catalyst in the electrodes was platinum acting on carbon; the plates for heat transfer were given by two nickel/gold plated material; the temperature of the fuel cell was kept constant via ordinary cooling means; the current was measured via a HP 6050A electronic load with a 600 W load module; a flow rate for oxygen and hydrogen was assigned for each current measurement; both oxygen and hydrogen were humidified before entering the cell; the measurements reported herein were conducted at 30 degrees C.

The results of the measurements are summarized in Figs. 11.38, 11.39 and 11.40 that report relative measurements compared to the same conditions of the cell when operated with ordinary pure oxygen. As one can see, these measurements show a clear increase of the voltage, power and efficiency of the order of 5% when the cell was operated with MO_1 and MO_2. The increase was consistent for both samples except differences within statistical errors.

To appraise these results, one should note that the types of MO used in the test were produced via rudimentary equipment based on intermittent sparks operated with an ordinary automotive battery, and with the pressure limited to 15 psi. By comparison, the industrial production of MO should be done with an array of arcs each operated with continuous currents of thousands of Amperes, and at

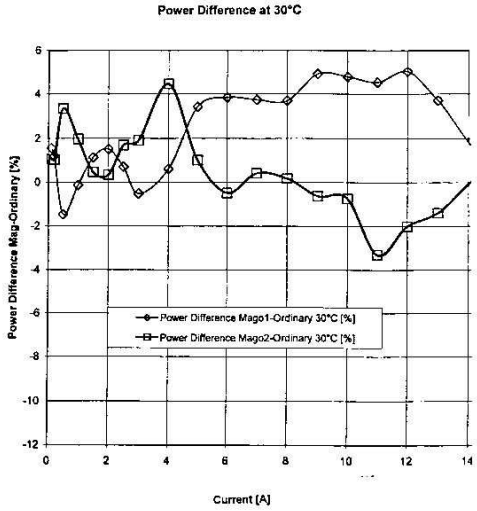


Figure 10.39. A schematic view of the power increase in a test fuel cell operated as in Fig. 11.38 confirming the results of the latter.

pressures of thousands of psi. It is evident that the latter conditions are expected to imply a significant increase of the performance of the fuel cells when operated with MO. Still bigger increases in voltage, power and efficiency occur when the fuel cells are operated with both MO and MH for the reasons discussed in Section 3. These latter tests are under way and are contemplated for reporting in a future research..

In summary, the systematic character of the experimental results, combined with the limited capabilities of the used equipment, appear to confirm the hypothesis of new forms of hydrogen and oxygen with magnecular structure capable of producing an industrially significant increase in voltage, power and efficiency of fuel cells. Independent measurements are here solicited for the finalization of these issues.

10.5.5 Conclusions

Despite the known uneasiness created by novelty, the rather vast experimental evidence, only partially reproduced in this section to avoid a prohibitive length, supports the following results:

1) The *existence of a new chemical species whose bonding force is not of valence type* (from the absence of infrared signature and various other evidence as in Figs. 6 and 7), which has been interpreted by this author as being due to the only fields available in a molecular structure, the electric and magnetic fields, and called

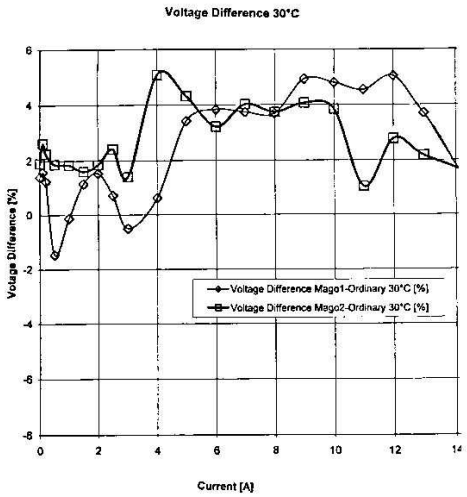


Figure 10.40. A schematic view of the efficiency increase in a test fuel cell operated as in Fig. 11.38, which provide additional confirmation of the latter results.

electromagnecules in general, the name *Santilli magnecules* being used to denote the dominance of magnetic over electric effects (Section 2). Other researchers may prefer different nomenclatures and search for esoteric fields other than the electric and magnetic fields, with the understanding that the *non-valence novelty* of the new species is outside scientific debate.

2) The *existence of a form of hydrogen with about seven times the atomic weight of molecular hydrogen which eliminates the need for liquefaction in automotive use, while having a power output essentially similar to that of gasoline, and being cost competitive with respect to fossil fuel when produced in large scale.* This is the new species of hydrogen, called by this author MagneH^{TM} (patented and international patents pending) which is derived via filtering, cryogenic separation or other means from the new combustible fuel called *Santilli MagneGas*^{TM} (international patents pending). The latter gas s is produced via DC electric arcs between carbon-base consumable electrodes submerged within a hydrogen rich liquid feedstock, such as fresh or salt water, antifreeze or oil waste, city or farm sewage, crude oil, etc.

3) The *industrial capability of turning conventional hydrogen and oxygen into new species with bigger atomic weight and energy content for use in fuel cells with increased voltage, power and efficiency.*

4) The *existence of new forms of liquid hydrogen and oxygen for rocket propulsion with increased trust, and consequential increased payload or decreased boosters' weight with the same payload.*

5) The *experimental evidence of dramatic departures from quantum chemistry in support of the covering hadronic chemistry* [5].

Evidently, these studies are in their infancy and much remains to be done, both scientifically and industrially. Among the existing intriguing open problems we mention:

A) The identification of *new analytic equipment specifically conceived for the detection of magnecules*. In fact, researchers in the field know well the dramatic insufficiency for tests on magnecular substances of currently available analytic equipment specifically conceived for molecular substances.

B) The *identification of the possible frequency at which magnecules may have an infrared signature.* For instance, the detection of methane in the MH tests of Fig. 11.36 has a mere indicative value, rather than being an actual experimental fact. In any case, the detection of methane is not confirmed by at least one second independent test to achieve final scientific character. Also, a peak at 16 a.m.u. which is necessary in the GC-MS scans of Fig. 11.27 to confirm the presence of methane (CH_4), is missing. Finally, the original MagneGas is created in the $10{,}000^o$ F of electric arcs at which temperature no methane can survive. In view of the above, a more plausible possibility is that the "methane" detected by the analyses of Fig. 11.37 is, in reality, the infrared signature of a magnecule.

C) The *study of the liquefaction of MagneGases* on a comparative basis with the liquefaction of the same gases with conventional molecular structure. This study is recommended particularly for rocket propulsion, due to the expected new species of *liquid magnecules* [5], the liquefaction itself at a temperature bigger than the conventional ones, the increase in trust and the reduction in liquefaction costs.

D) The *study of the possible storage of energy in inert gases* via the mechanism of internal magnetic polarization and resulting new molecular bonds illustrated in Figs. 5 and 8. In fact there exist patents as well as reported test engines operating on inert gases which are generally dismissed by academia because of the believed "inert" character of these cases. Perhaps, a more open mind is recommendable for truly basic advances.

E) The *study of nonlinear deviations from the perfect gas law and the Avogadro number* which are inherent in magnecular clustering since they can break down into fragments due to collision and then have different recombinations, resulting in a population with generally varying number of constituents, while keeping constant statistical averages.

Needless to say, the author solicits the independent verification of all results presented in this section without which no real scientific advance is possible.

10.6 HHO, THE NEW GASEOUS AND COMBUSTIBLE FORM OF WATER WITH MAGNECULAR STRUCTURE

10.6.1 Introduction

Studies on the electrolytic separation of water into hydrogen and oxygen date back to the 19-th century (for a textbook on the water molecule see, e.g., Ref. [20a] and for an account on its electrolytic separation see, e.g., Ref. [20b]). More recently, there has been considerable research in the separation of water into a mixture of hydrogen and oxygen gases. These studies were initiated by Yull Brown in 1977 via equipment generally referred to as electrolyzers and the resulting gas is known as "Brown gas" (see patents [21]).

In accordance with these patents as well as the subsequent rather vast literature in the field, the Brown gas is defined as a combustible gas composed of conventional hydrogen and conventional oxygen gases having the exact stochiometric ratio of 2/3 (or 66.66% by volume) of hydrogen and 1/3 (or 33.33% by volume) of oxygen.

In this section the author (a physicist) presents to the chemistry community for its independent verification various measurements on an apparently new mixture of hydrogen and oxygen hereon referred to as the HHO gas (international patent pending) developed by Hydrogen Technology Applications, Inc., of Clearwater, Florida (www.hytechapps.com). The new HHO gas is regularly produced via a new type of electrolyzer and has resulted to be distinctly different in chemical composition than the Brown gas, even though both gases share a number of common features.

The main scope of this section is to report, apparently for the first time, new clusters of hydrogen and oxygen atoms contained in the HHO gas, which clusters appear to escape the traditional valence interpretation and constitute one of the novelties of the HHO gas over the Brown gas.

Another objective of this sec tion is to initiate quantitative studies on the rather unique features of the HHO gas that do not appear to be representable via the conventional quantum chemistry of hydrogen and oxygen gases.

Yet another objective of this section is to present a working hypothesis to initiate the understanding of the capability by the HHO electrolyzers to perform the transition of water from the liquid to a gaseous state via a process structurally different than evaporation or separation, due to the use of energy dramatically less than that required by said evaporation or separation.

The final objective of this section is the submission, apparently for the first time, of it a new form of the water molecule created by the removal of its natural electric polarization and consequential collapse of the two HO dimers, from their conventional configuration with 105° to a new configuration in which the two

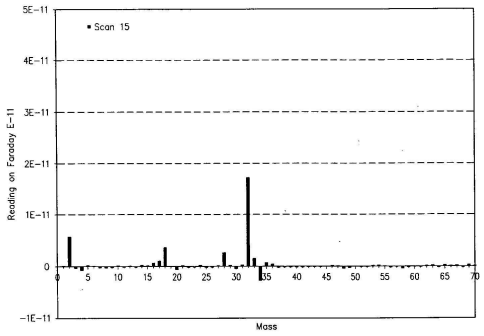


Figure 10.41. A view of one of the GC scans on the HHO gas conducted by Adsorption Research Laboratories showing conventional as well as anomalous peaks.

dimers are collapsed one against the other due to strongly attractive opposing magnetic polarizations (see below for details and pictures).

Due to the loss of electric polarization, polymerization and other features, the above new form of the water molecule permits a plausible representation of the creation of the HHO gas from liquid water without the evaporation energy. Its unstable character also permits a plausible interpretation on the experimental measurements of all anomalous features of the HHO gas.

Independent verification by interested chemists of the various measurements reported in this section are solicited, jointly with the conduction of additional much needed tests. Samples of the HHO gas can be obtained at any time by contacting Hydrogen Technology Applications, Inc. at their website www.hytechapps.com.

10.6.2 Experimental Measurements on the New HHO Gas

Under visual inspection, both the HHO gas results to be odorless, colorless and lighter than air, as it is also the case for the Brown gas. Their first remarkable feature is the efficiency E of the electrolyzer for the production of the gas, here simply defined as the ratio between the volume of HHO gas produced and the number of Watts needed for its production. In fact, the electrolyzers rapidly convert water into 55 standard cubic feet (scf) of HHO gas at 35 pounds per square inch (psi) via the use of 5 Kwh, namely, an efficiency that is at least ten times the corresponding efficiency of conventional water evaporation, thus permitting low production costs.

The above efficiency establishes the existence of a transition of water from the liquid to the gaseous state that is not caused by evaporation. By keeping in mind the combustible character of the HHO gas compared to the noncombustible char-

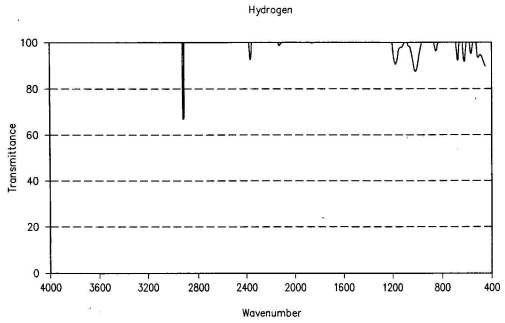


Figure 10.42. The IR signature of a conventional H_2 gas made by the PdMA laboratory.

acter of water vapor, the above efficiency suggests the existence of new chemical processes in the production of the gas that deserve quantitative studies.

A second important feature is that the HHO gas does not require oxygen for combustion since the gas contains in its interior all oxygen needed for that scope, as it is also the case for the Brown gas. By recalling that other fuels (including hydrogen) require atmospheric oxygen for their combustion, thus causing a serious environmental problem known as oxygen depletion, the capability to combust without any oxygen depletion (jointly with its low production cost) render the gas particularly important on environmental grounds.

A third feature of the gas is that it does not follow the PVT of gases with conventional molecular structure, since the gas reacquires the liquid water state at a pressure of the order of 150 psi, while conventional gases acquire the liquid state a dramatically bigger pressures. This feature suggests that the gas here considered does not possess a conventional molecular structure, namely, a structure in which the bond is of entire valence type.

A fourth feature of the gas is its anomalous adhesion (adsorption) to gases, liquids and solids, as verified experimentally below, thus rendering its use particularly effective as an additive to improve the environmental quality of other fuels, or other applications. This feature is manifestly impossible for conventional gases H_2 and O_2, thus confirming again a novel chemical structure.

A fifth feature of the gas is that it exhibits a widely varying thermal content, ranging from a relatively cold flame in open air at about 150^oC, to large releases of thermal energy depending on the substance to which the flame is applied to, such as the instantaneous melting of bricks requiring up to $9,000^oC$.

The measurements conducted by the author at various independent laboratories on the HHO gas can be summarized as follows.

On June 30, 2003, Adsorption Research Laboratory of Dublin, Ohio, measured the specific weight of the HHO gas and released a signed statement on the result-

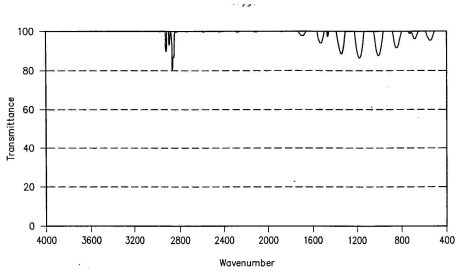


Figure 10.43. The IR signature of a conventional O_2 gas made by the PdMA laboratory.

ing value of 12.3 grams/mole. The same laboratory repeated the measurement on a different sample of the gas and confirmed the result.

The released value of 12.3 grams/mole is anomalous. In fact, the conventional separation of water into H_2 and P_2 produces a mixture of 2/3 HBN_2 and 1/3 O_2 that has the specific weight $(2 + 2 + 32)/3 = 11.3$ grams/mole.

Therefore, we have the anomaly of 12.3 - 11.2 = 1 gram/mole, corresponding to 8.8% anomalous increase in the value of the specific weight. Rather than the predicted 66.66% of H_2 the gas contains only 60.79% of the species with 2 atomic mass units (amu), and rather than having 33.33% of O_2 the gas contains only 30.39% of the species with 32 amu.

These measurements provide direct experimental evidence that the HHO gas is not composed of a sole mixture of H_2 and O_2, but has additional *heavier* species.

Moreover, the HHO gas used in the tests was produced from distilled water. Therefore, there cannot be an excess of O_2 over H_2 to explain the increased specific weight. The above measurement establishes the presence in HHO of 5.87% of hydrogen and 2.94% oxygen bonded together into species heavier than water, as identified below via mass spectroscopy and other analytic measurements.

Adsorption Research Laboratory also conducted scans of the HHO gas via a Gas Chromatographer (GC) reproduced in Fig. 11.41 establishing the presence in the HHO gas of the following species here presented in order of their decreasing percentages:

1) A first major species with 2 amu expectedly representing gaseous hydrogen;

2) A second major species with 32 amu expectedly representing gaseous oxygen;

3) A large peak at 18 amu expectedly representing water vapor;

4) A significant peak with 33 amu expectedly representing a new species expectedly of non-molecular nature;

5) A smaller yet clearly identified peak at 16 amu expectedly representing atomic oxygen;

6) Another small yet fully identified peaks at 17 amu expectedly representing the radical OH whose presence in a gas is also anomalous;

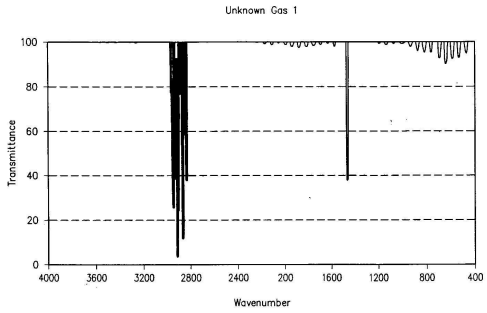


Figure 10.44. The IR signature of the HHO gas made by the PdMA laboratory. When compared to the IR scans of Figures 2 and 3, this scan shows that the HHO gas is not a mixture of H_2 and O_2 gases.

7) A small yet fully identified peak at 34 amu expectedly representing the bond of two dimers HO that is also anomalous for a gas;

8) A smaller yet fully identified peak at 35 amu that cannot be identified in any known molecule;

9) Additional small peaks expected to be in parts per million.

It should be added that the operation of the GC detector was halted a few seconds following the injection of the HHO gas, while the same instrument was operating normally with other gases. This anomalous behavior can be best interpreted via an anomalous adhesion of the gas to the walls of the feeding line as well as of the column and other parts of the instruments, an anomalous adhesion confirmed by additional tests reviewed below.

On July 22, 2003, the PdMA Corporation in Tampa, Florida, conducted InfraRed (IR) scans reported in Figures 2, 3 and 4 via the use of a Perkin-Elmer IR scanner model 1600 with fixed point/single beam. The reported scans refer to a conventional H_2 gas (Fig. 11.42), a conventional O_2 gas (Fig. 11.43), and the HHO gas Fig. 11.44).

Inspection of these scans shows a substantial differences between HHO gas and H_2 and O_2 gases. In fact, the latter gases are symmetric molecules, thus having very low IR peaks, as confirmed by scans 2 and 3. The first anomaly of HHO is that of showing comparatively much stronger resonating peaks. Therefore, the indicated IR scans establish that the HHO gas has an asymmetric structure, which is remarkable since the same feature is absent for the conventional mixture if H_2 and O_2 gases.

Moreover, H_2 and O_2 gases can have at most two resonating frequencies each, one for the vibrations and the other for rotations. Spherical distributions of orbitals and other features imply that H_2 has essentially only one IR signature as

confirmed by the scan of Fig. 11.42, while O_2 has one vibrational IR frequency and three rotational ones, as also confirmed by the scans of Fig. 11.43.

Inspection of the IR scans for the HHO gas in Fig. 11.44 reveals additional novelties. First, the HHO scan show the presence of at least nine different IR frequencies grouped around wavenumber 3000, plus a separate distinct frequency at around wavenumber 1500.

These measurements provide experimental evidence that the species with 18 amu detected in the GC scans of Fig. 11.41 is not water vapor, but a yet unknown bond of two hydrogen and one oxygen atoms.

In fact, water vapor has IR frequencies with wavelengths 3756, 3657, 1595, their combination and their harmonics (here ignored for simplicity). The scan for the HHO gas in Fig. 11.44 confirms the presence of an IR signature near 1595, thus confirming the molecular bond HO, but the scan shows no presence of the additional very strong signatures of the water molecules at 3756 and 3657, thus establishing the fact that the peak at 18 amu is not water as conventionally understood in chemistry.

On July 22, 2003, the laboratory of the PdMA Corporation in Tampa, Florida measured the flash point, first on commercially available diesel fuel, detecting a flash point of 75^oC, and then of the same fuel following the bubbling in its interior of the HHO gas, detecting the flash point of 79^oC.

The latter measurement too is anomalous because it is known that the addition of a gas to a liquid fuel *reduces* its flash point generally by half, rather than *increasing* it as in the above measurement, thus implying the expected flash value of about 37^C for the mixture of diesel and HHO gas. Therefore, the anomalous increase of the flash point is not of 4^oC, but of about 42^oC.

Such an increase cannot be explained via the assumption that HHO is contained in the diesel in the form of a gas (otherwise the flash point would decrease), and requires the occurrence of some type of anomalous bond between the gas and the liquid that cannot possibly be of valence type.

An experimental confirmation of the latter bond was provided on August 1, 2003, by the Southwest Research Institute of Texas, that conducted mass spectrographic measurements on one sample of ordinary diesel as used for the above flash point measurements, here reported in Fig. 11.45, and another sample of the same diesel with HHO gas bubbled in its interior, here reported in Fig. 11.46.

The measurements were conducted via a Total Ion Chromatogram (TIC) and Gas Chromatography Mass Spectrometry GC-MS manufactured by Hewlett Packard with GC model 5890 series II and MS model 5972. The TIC was obtained via a Simulated Distillation by Gas Chromatography (SDGC).

The column was a HP 5MS $30 \times 0,25$ mm; the carrier flow was provided by helium at 50^oC and 5 psi; the initial temperature of the injection was 50^oC with a temperature increase of 15^oC per minute and the final temperature of 275^oC.

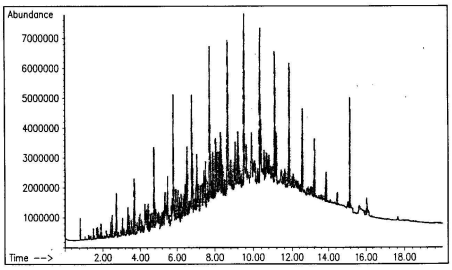


Figure 10.45. A TIC of the GC-MS scans of conventionally sold diesel fuel made by Southwest Research Institute.

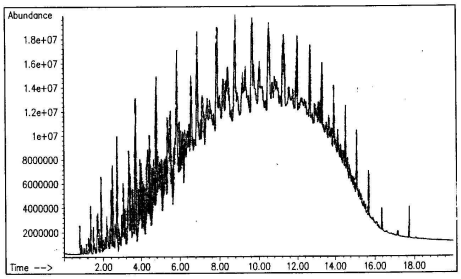


Figure 10.46. A TIC of the GC-MS scans made by Southwest Research Institute on the same diesel fuel of Figure 5 in which the HHO gas had been bubbled through, showing the alteration of the TIC both in shape as well as increased mass, thus indicating a new bond between diesel and HHO that cannot be of valence type (since HHO is gaseous and diesel is liquid. In any case, all valence electrons in both the gas and the liquid are used by conventional molecular bonds.

The chromatogram of Fig. 11.45 confirmed the typical pattern, elusion time and other feature of commercially available diesel. However, the chromatograph of the same diesel with the HHO gas bubbled in its interior of Fig. 11.46 shows large structural differences with the preceding scan, including a much stronger response, a bigger elusion time and, above all, a shift of the peaks toward bigger amu values.

Therefore, the latter measurements provide additional confirmation of the existence of an anomalous bond between the diesel and the HHO gas, precisely as predicted by the anomalous value of the flash point and the clogging up of GC feeding lines. In turn such a bond between a gas and a liquid cannot possibly be

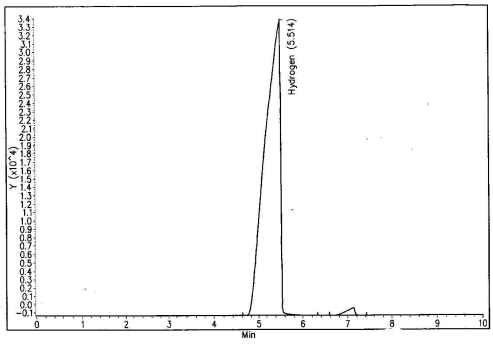


Figure 10.47. A TIC of the GC-MS scans on the HHO gas made by Toxic LTD Laboratories showing the H_2 content of the HHO gas.

of valence type, since all valence electrons are expected to be coupled in both the liquid and the gas.

Further mass spectrographic measurements on the HHO gas were done on September 10, 2003, at SunLabs, of the University of Tampa, Florida, via the use of a very recent GC-MS Clarus 500 by Perkin Elmer, one of the most sensitive instruments currently available to detect hydrogen.

Even though the column available at the time of the test was not ideally suited for the separation of all species constituting the HHO gas, the latter measurements confirmed the preceding results.

In fact, the scan of Fig. 11.50 confirms the presence in the HHO gas of a basic species with 2 amu representing hydrogen, plus a species with 5 amu that cannot admit any valence or molecular interpretation for the HHO gas even if the species is formed by the spectrometer.

In conclusion, the experimental measurements of the flash point and of the scans of Figs. 5 and 6 establish beyond doubt the capability by the HHO gas to have an anomalous bond with liquid fuels, that is, a bond that is not of valence type.

Additional analyses on the chemical composition of the HHO gas were done by Air Toxic LTD of Folsom, California, via the scans reproduced in Figs. 7, 8 and 9. These scans confirmed that H_2 and O_2 are the primary constituents of the HHO gas. However, the same measurements identify the following anomalous peaks:

a) A peak in the H_2 scan at 7.2 minutes elusion times (Fig. 11.47);

b) A large peak in the O_2 scan at 4 minutes elusion time (Fig. 11.48); and

c) An anomalous blank following the removal of the HHO gas (Fig. 11.49), because said blank shows the preservation of the peaks of the preceding scans,

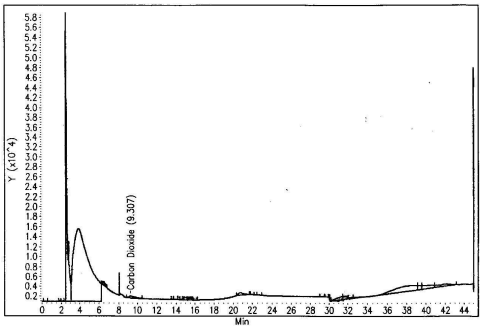


Figure 10.48. A TIC of the GC-MS scans on the HHO gas made by Toxic LTD Laboratories showing the peaks belonging to H_2 and O_2 , plus anomalous peaks.

an occurrence solely explained via anomalous adhesion of the HHO gas to the interior walls of the instrument.

The scan of Fig. 11.51 provides evidence of a species with mass 16 amu that can only be interpreted as atomic oxygen, thus providing additional indication of the presence in the HHO gas of atomic hydrogen as expected from its capabilities, although the species, again, could be separated by the spectrometer due to the expected weak nature of the bond. The latter could not be detected in the preceding scan due to the impossibility of the instrument here considered to detect a species with 1 amu. The same scan of Fig. 11.51 confirms the presence in the HHO gas of a species with 17 amu and a species with 18 amu detected in earlier tests.

The scan of Fig. 11.52 establishes the presence in the HHO gas of species with 33 and 34 amu, while the species with 35 amu detected in preceding measurements was confirmed in other scans here not reported for brevity.

The tests also confirmed the blank anomaly, namely, the fact that the blank of the instrument following the removal of the gas continues to detect the basic species constituting the gas, which blank is not reproduced here for brevity, thus confirming the anomalous adhesion of the HHO gas to the interior walls of the instrument.

In summary, the above analytic measurements establish the following properties of the HHO gas:

I) An anomalous increase in specific weight of 1 gram/mole (or 8.8% in volume) establishing the presence in the HHO gas of species heavier than the predicted mixture of H_2 and O_2, thus establishing the presence in the HHO gas of new species composed of H and O atoms that cannot possibly have valence bonds.

II) The GC scans done by Adsorption Research (Fig. 11.41) confirm the presence of chemical species in the HHO gas that cannot have a valence interpre-

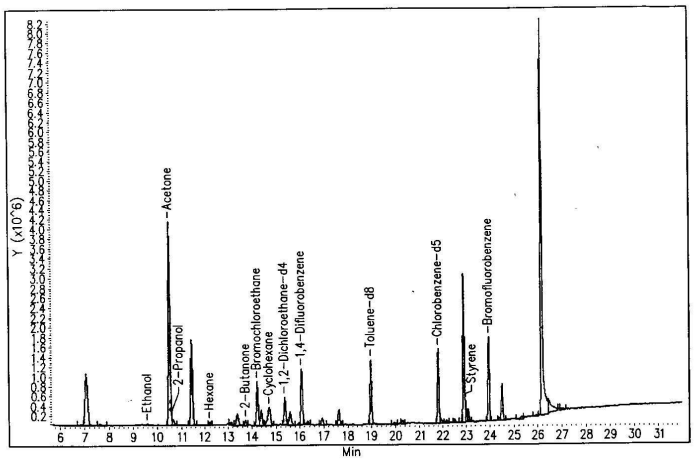


Figure 10.49. One of the anomalous blanks of the GC-MS scans made by Toxic LTD Laboratories following the tests of the HHO. The blank is firstly anomalous because only the background should have been detected, thus indicating a bond between the HHO gas and the walls of the instrument, whose most plausible explanation is the magnetic polarization by induction of said walls by a form of magnetic polarization of the species composing the HHO gas. the second reasons for the anomalous nature of the blank is that the substances detected cannot possibly exist in the HHO gas produced from distilled water, thus showing an accretion of bonds to the instrument walls.

tation, such as the species with 17 amu, 33 amu, 34 amu, and 35 amu, besides conventional species with 2 amu, 16 amu and 18 amu, all species independently confirmed by other tests, such as the scans of Figs. 10, 11 and 12

III) The halting of the GC instrument in the scans of Fig. 11.41 after a few seconds following the injection of the HHO gas, while the same instrument works normally for conventional gases, is experimental evidence for an anomalous adhesion by the HHO gas to the internal walls of the instrument, to such a level of occluding the column and causing the shut down of the scan;

IV) The large increase of the flash point of diesel fuel following inclusion of the HHO gas also constitutes experimental evidence of anomalous adhesion by the HHO gas, this time, to a liquid fuel that cannot also be of valence type since all valence electrons available in both the liquid and the gas are expected to be paired;

V) The mass spectrometric measurements on the mixture of diesel and HHO (Figs. 5 and 6) provide additional experimental confirmation of an anomalous bond between the HHO gas and diesel;

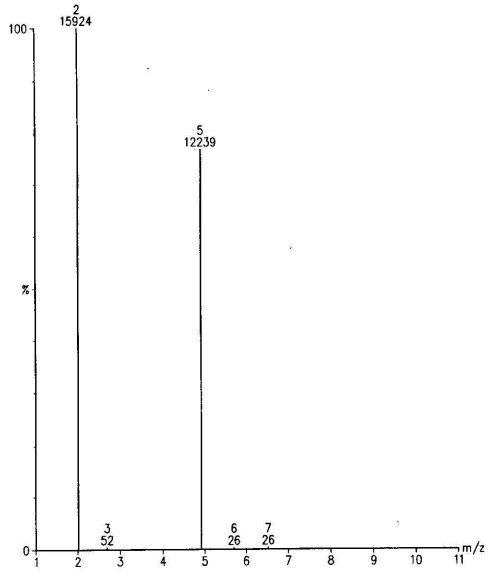


Figure 10.50. The scan conducted by SunLabs on the HHO gas confirming the presence of H_2, plus additional anomalous peaks, such as the species at 5 amu, that cannot possibly admit a molecular interpretation.

VI) The additional scans of Figs. 7, 8 and 9 confirm all the preceding results, including the anomalous blank following the removal of the HHO gas, thus confirming the anomalous adhesion of the HHO gas to the internal walls of the instrument;

VII) The capability by the HHO gas to melt instantaneously tungsten and bricks is the strongest evidence on the existence in the HHO gas of basically new chemical species that cannot possibly have a valance bond, since a mixture of $2/3$ H_2 and $1/3$ O_2 cannot melt instantly tungsten and bricks , as any interested chemist is encouraged to verify.

It should be indicated that a number of species in the HHO gas, particularly those with higher specific weight, are expected to be unstable and, as such, decomposed by the analytic instrument itself, In different terms, by no means GC, IR and other scans should be expected to detect *all* constituents of the HHO gas, since a number of them are expected to be decomposed or altered by the ionization and other processes connected to the scans themselves.

10.6.3 Magnecular Interpretation of the Measurements

The first experimental evidence supporting the magnecular structure of the HHO gas is its capability of instantly melting tungsten and bricks. In fact, such

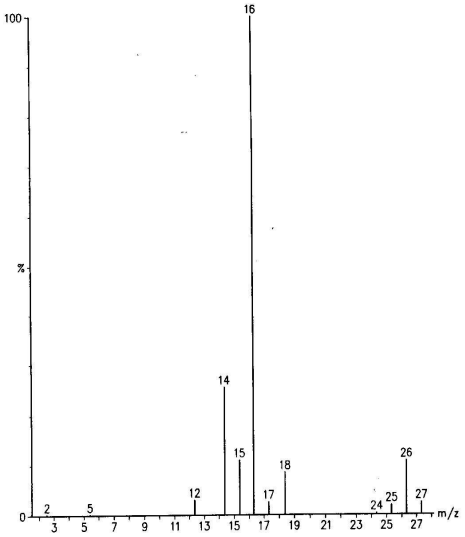


Figure 10.51. The scan conducted by SunLabs on the HHO gas detecting a peak at 16 amu that confirms the presence of atomic oxygen in the HHO gas of Fig. 11.51, plus a peak at 17 amu indicating the presence of traces of the radical $O-H$, a peak at 18 amu indicating the presence of water vapor all three species also detected in the scan of Fig. 11.51, as well as additional anomalous peaks at 12, 14, 25, 26, 27 amu that, for the case of the HHO gas produced from distilled water cannot admit a molecular interpretation.

a capability can only be explained via the presence in the HHO gas, not only of atomic (that is, unbounded) hydrogen as depicted in the top of Fig. 11.9, but also of atomic hydrogen with the toroidal polarization of their orbitals as depicted in the bottom of Fig. 11.10.

In fact, no instantaneous melting of bricks is possible without the hydrogen contained in the HHO gas rapidly penetrating within deeper layers of the brick structure. Such a rapid penetration cannot be explained with atomic hydrogen, although it can be readily explained via the polarized hydrogen atom of the bottom of Fig. 11.10.

Besides having a smaller sectional area that favors fast penetration, polarized H-atoms cause an induced polarization of the orbitals of the atoms of the brick, their consequential attraction to the polarized H atoms, and the latter rapid penetration within deep layers of the brick structure. In turn, faster penetration within the lattice of solids implies a bigger reactivity that, in turn, causes a bigger melting temperature.

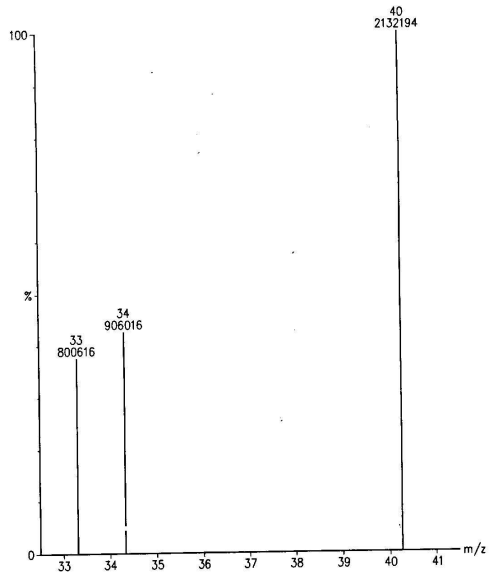


Figure 10.52. A sample of various additional scans conducted by SunLabs on the HHO gas detecting anomalous peaks at 33, 34 and 40 amu that cannot possibly have a consistent molecular interpretation. Intriguingly, the peak at 35 amu detected in other tests did not appear sequentially in this scan, and appeared instead in other scans here not reported for brevity, thus indicating that the peaks of this and of the preceding scans conducted by SunLabs are, in actuality, the constituents of the clusters composing the HHO gas, and not the actual constituents themselves.

Moreover, polarized atomic hydrogen as well as oxygen are needed to explain the anomalous adhesion of the HHO gas to internal walls of detection instruments as well as to other substances.

Note that the studies of the Brown gas [2] have indicated the need for *atomic hydrogen.* Therefore, the presence of *atomic and polarized hydrogen* is a novelty of the HHO gas.

Evidently, individual hydrogen atoms cannot maintain their polarization as in Fig. 11.9 in view of motions caused by temperature, as well known. The only known possibility for maintaining said polarization is that polarized H atoms bond themselves with opposing magnetic polarities as depicted in Fig. 11.11. In fact, rotations and vibrations due to temperature occur for such bonded H atoms as a whole, while individually preserving said polarization.

In turn, bonds of polarized atomic hydrogen constitute the very basic bond of magnecules, thus supporting the hypothesis of the magnecular structure of the HHO gas.

Note that a conventional hydrogen gas cannot acquire any magnetic polarization because the conventional hydrogen molecules is diamagnetic. However, as established in Refs. [21], the diamagnetic character refers to the hydrogen *molecule* as a whole, because quantum mechanics establishes that each individual hydrogen *atom* of a hydrogen molecule can indeed acquire a magnetic polarization under sufficiently strong external magnetic fields.

The diamagnetic character of the hydrogen molecules, as depicted in Fig. 11.10, is due to the fact that the individual magnetic polarizations of its H atoms are opposite to each other, and are at such a close mutual distances to cancel each other when inspected at sufficiently large distances.

Needless to say, the above hypothesis on the polarization of atomic hydrogen also applies to oxygen, the latter being known to be paramagnetic, resulting in atomic oxygen with the spherical distribution of orbitals, polarized atomic oxygen with the polarization of at least the valance electrons, and pairs of bonded polarized oxygen atoms as depicted in Fig. 11.11.

The first prediction of the magnecular structure of the HHO gas is that the species at 2 amu and 32 amu detected by mass spectroscopy could, in actuality, be constituted by a mixture of the conventional molecules H_2 and O_2 and a percentage of the same atoms although with the magnecular bond, since the latter are expected to have essentially the same atomic weight than the former.

The separation of hydrogen molecules and magnecules is possible via instruments based on magnetic resonance techniques because the conventional hydrogen molecule is diamagnetic (Fig. 11.9) while the hydrogen magnecule has a distinct magnetic polarity (Fig. 11.11).

It is easy to see that the magnecular hypothesis on the chemical structure of the HHO gas permits a quantitative interpretation of all anomalous species reported in the preceding section.

As now familiar, let us denote the conventional valence bond with the usual symbol "-" and the magnecular bond with the symbol "$\times$". According to this notation, $H_2 = H - H$ represents the molecule of Fig. 11.10 while $H \times H$ represents the magnecule of Fig. 11.11. Molecular bonds are notoriously restricted to valence pairing, in the sense that no additional atom can be bonded when all available valence pairs are coupled. By contrast, magnecular bonds do not have such a restriction, in the sense that atoms can indeed be added to a magnecule under the sole condition of the availability of opposite magnetic polarizations.

Needless to say, for the HHO gas at ambient temperature and pressure, the stability of the magnecular clusters is inversely proportional to the number of their constituents. As a result, magnecular clusters with relatively low atomic weight are expected to exist in significant percentages, while those with large atomic weight are expected to be present at best in parts per millions.

The magnecular hypothesis permits the following interpretations of the species composing the HHO gas: the species with 3 amu is interpreted as a combination of the magnecules $H \times H \times H$ or $(H-H) \times H$; the species with 4 amu is interpreted as a combination of $(H-H) \times (H-H$, $(H-H) \times H \times H$, or $H \times H \times H \times H$, heavier magnecular bonds solely of hydrogen atoms being unstable due to collisions; the species with 17 amu is interpreted as a combination of the traditional dimer $H - O$ and the magnecular bond $H \times O$; the species with 33 amu is interpreted as a mixture of $(O - O) \times H$, $(H - O) \times O$ and $O \times O \times H$; the species with 34 amu is interpreted as a mixture of $(H - H) \times (O - O) \times (H - H) \times H$ and similar configurations; the species with 35 amu is interpreted as a mixture of $(O-O) \times (H-H) \times (H-H) \times H$ and equivalent configurations (see Fig. 11.11); and other magnecular species in progressively smaller percentages.

10.6.4 the New Gaseous and Combustible Form of Water

Besides a quantitative interpretation of the chemical structure of all species contained in the HHO gas, as well as of its anomalous thermal content and adhesion, perhaps the biggest contribution of the magnecular hypothesis is a quantitative interpretation of the formation of the HHO gas despite the lack of evaporation or separation energy.

Recall that nature has set the water molecule $H_2O = H - O - H$ in such a way that its H atoms do not have the spherical distribution, and have instead precisely the polarized distribution of Fig. 11.10 along a toroid whose symmetry plane is perpendicular to that of the $H - O - H$ plane, as depicted in Fig. 153, and established in the technical literature (see, e.g., Ref. [1=20a]).

It is also known that the H-O-H molecule at ambient temperature and pressure, even though with a null total charge, has a high electric polarization (namely, a deformation of electric charge distributions) with the predominance of the negative charge density localized in the O atom and the complementary predominant positive charge density localized in the H atoms [1a]. This feature causes a repulsion of the H atoms due to their predominantly positive charges, resulting in the characteristic angle of (about) 105° between the $H - O$ and $O - H$ dimers as depicted in Fig. 11.54.

It is well established in quantum mechanics that toroidal polarizations of the orbitals of the hydrogen atom as in the configuration of Fig. 11.11 create very strong magnetic fields with a symmetry axis perpendicular to the plane of the toroid, and with a value of said magnetic field sufficient for the creation of the new chemical species of magnecules [3].

It then follows that, in the natural configuration of the $H - O - H$ molecule, the strong electric polarization caused by the oxygen is such to weaken the mag-

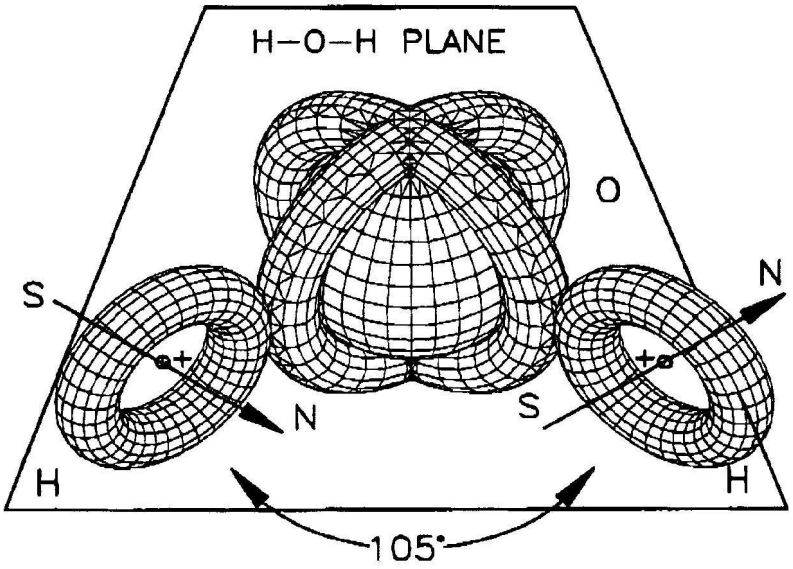


Figure 10.53. A conceptual rendering of the conventional water molecule without any electric polarization. This rendering is primarily intended to illustrate the experimentally established feature that the orbitals of the two hydrogen atoms do not have a spherical distribution as in Fig. 11.413, but have instead a distribution essentially perpendicular to the $H-O-H$ plane (see Refs. [20] for details) here conceptually represented with a toroid. The strong valence bond needed to achieve the first known exact representation of the experimental data of the water molecule achieved in Ref. [21] requires that the corresponding orbitals of the valence electrons of the oxygen have a corresponding polarized distribution here also conceptually depicted with toroids perpendicular to the $H-O-H$ plane around the spherical core of the remaining electrons of the oxygen atom.

netic field of the toroidal polarization of the H-orbital resulting in the indicated repulsion of the two H-atoms in the $H-O-H$ structure.

However, as soon as the strong electric polarization of the molecule $H-O-H$ is removed, the strong attraction between opposite polarities of the magnetic fields of the polarized H atoms become dominant over the Coulomb repulsion of the charges, resulting in a new configuration of the water molecule depicted in Figs. 19 and 20 apparently presented in this section for the first time.

Therefore, a central hypothesis of this section is that the electrolyzer developed by Hydrogen Technology Applications, Inc., is such to permit the transformation

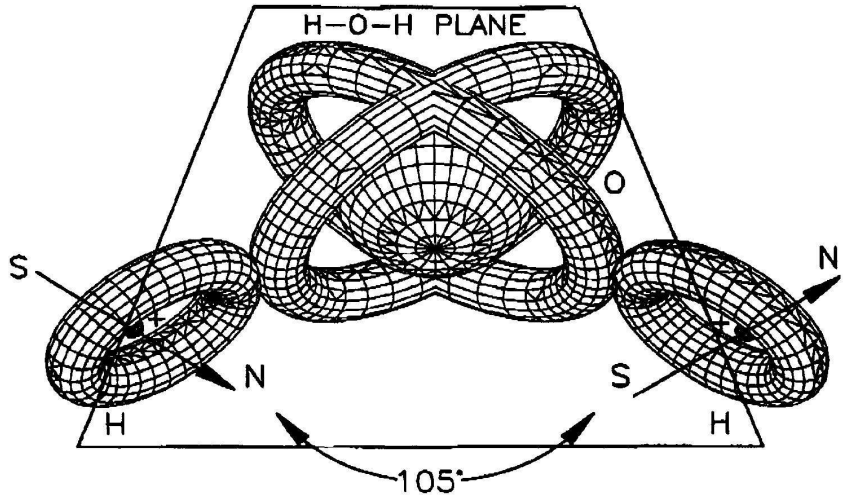


Figure 10.54. A conceptual rendering of the conventional water molecule of Fig. 16, this time with the electric polarization as occurring in nature. Note the consequential the predominance of a positive charge in the two hydrogen atoms that is responsible in part for the angle of 105° between the two $H-O$ radicals.

of the water molecule from the conventional $H-O-H$ configuration of Fig. 11.54 to the basically novel configuration of Fig. 11.55.

By using the above identified symbols for molecules and magnecules, the conventional water molecule is represented by $H-O-H$ while the new configuration of Fig. 11.55 is represented by $(H \times H)-O$, where the symbol "-" evidently denotes double valence bond.

The plausibility of the new form of water is supported by the fact that, when $H-O-H$ is liquid, the new species $(H \times H)-O$ is expected to be gaseous. This is due to various reasons, such as the fact that the hydrogen is much lighter than the oxygen in the ratio 1 to 16 amu. As a result, the new species $(H \times H)-O$ is essentially equivalent to ordinary gaseous oxygen in conformity with conventional thermodynamical laws, since the transition from the liquid to the gas state implies the increase of the entropy, as well known.

Alternatively, the loss of electric polarization in the transition from $H-O-H$ to $(H \times H)-O$ is expected to cause the loss of the processes permitting the very existence of the water molecule, such as the hydrogen bridges between dimers $O-H$ of different molecules. Transition to a gaseous form is then consequential,

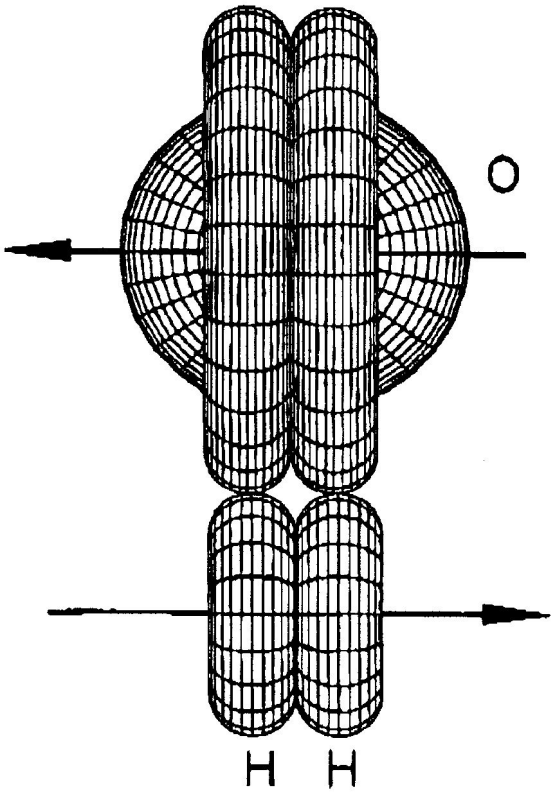


Figure 10.55. A conceptual rendering of the central hypothesis submitted for the first time in this section, namely, the $H - O - H$ molecule in which all electric polarizations have been removed, with the consequential collapse of the two polarized H-atoms one into the other due to their neutral charge and strongly attractive opposing magnetic polarities. This hypothesis permits a quantitative interpretation of the transition of state from liquid to gas achieved by the HHO electrolyzers via processes structurally different than evaporation energy. In fact, unlike the configuration of Fig. 11.11, that of this figure can only exist at the gaseous state due to the loss of the processes permitting the liquid state, such as hydrogen bridges between pairs of water molecules. It should be noted that the configuration here depicted is unstable and decomposes into atomic oxygen, as detected in the HHO gas, plus the new magnecular species $H \times H$ that has indeed been detected but it is generally interpreted as $H - H$.

thus confirm the plausibility of the new form of water $(H \times H) - O$ proposed in this section.

However, it can also be seen that the new form of water $(H \times H) = O$ is *unstable,* and decomposes in $H \times H$ and O. This decomposition is supported by the clear evidence in the HHO gas of atomic oxygen, as well as of the species

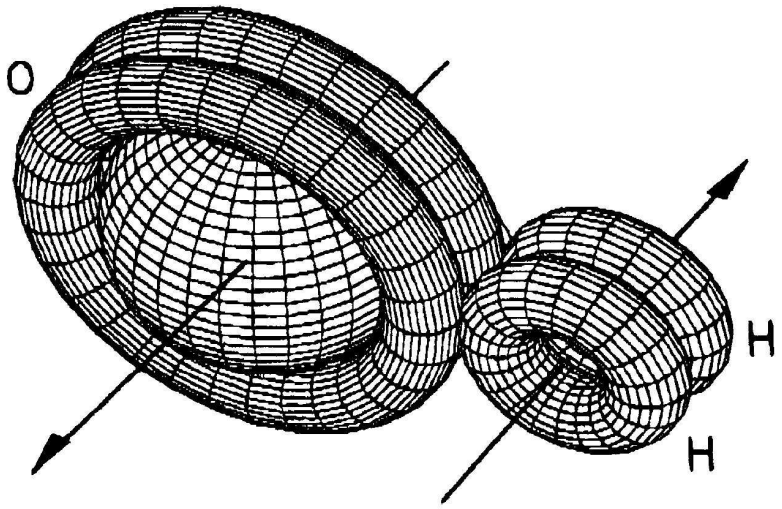


Figure 10.56. A conceptual rendering of a perspective view of the central hypothesis submitted for the first time in this section via Fig. 11.55, better illustrating the bond via opposing magnetic polarities of the two H-atoms, as well as the unstable character of the configuration due to collision with other species and intrinsic instabilities to be studied in a forthcoming section.

with 2 amu that is normally interpreted as being $H - H$, while we suggest the additional possibility that such a species is, at least in part, $H \times H$.

10.6.5 Contributions of Hadronic Chemistry Toward the Future Understanding of the Complexities of Water

There is no doubt that, being the foundation of life, water is by far the most complex chemical structure in nature. Any chemist who believes to have achieved a final understanding of water via quantum chemistry should be removed from the scientific community because of either mental or ethical problems, and the same holds for chemists using hadronic chemistry.

It is merely hoped that the efforts presented in this section have achieved another step in the study of water beyond those permitted by quantum chemistry, with the understanding that a serious understanding of water may well require efforts throughout this third millennium.

Recall that quantum chemistry was unable to achieve an exact and invariant representation of the main characteristics of the water molecule from unadulterated first principles despite efforts over the past century. In fact, a historical 2% has been missing in the representation of the water binding energy, while the

representation of its electric and magnetic moments was embarrassingly wrong even in the signs.

An improvement of the numerical representation was achieved via the so-called "screening of the Coulomb law", that is, the multiplication of the Coulomb potential by an arbitrary function of unknown physical or chemical origin, $\frac{q_1 \times q_2}{r} \rightarrow f(r) \times \frac{q_1 \times q_2}{r}$. However, as indicated since Chapter 1, this type of screening implies the abandonment of the notion of "quantum" of energy, trivially, due to the loss of all quantized orbits, as well as the exiting from the basic axioms of quantum mechanics, because the transition from the Coulomb potential to its screened form requires nonunitary transforms.

Independently from these basic shortcomings, the fundamental problem of quantum chemistry, whether with or without screening processes, remains the fact that the name "valence" is a pure nomenclature, since it does not identify in explicit and numerical terms the *attractive force* needed for two hydrogen atoms to be bounded to the oxygen atom in the structure $H - O - H$, and electrons repel each other in any case for quantum mechanics and chemistry.

Besides fundamental insufficiencies in a numerically exact and invariant representation of the main characteristics of the water molecules, additional vast insufficiencies exist for the liquid and solid state of water. As an example, the use of the "H-bridges" to represent the liquid state of water is another case of basically ascientific nomenclature because, again, of the lack of any identification of the *attractive force* needed to explain the bond of neutral and diamagnetic water molecules in their liquid state.

When water becomes part of biological organisms, the open problems became so great to be beyond our imagination at this writing (also because most chemists believe that the water molecule remains the same).

As shown in Chapter 9, the *isotopic branch of hadronic chemistry,* or *isochemistry* for short, was first and most fundamentally focused in the identification of the *attractive force* in the singlet coupling of two valence electrons, which identification required a necessary nonunitary theory since the valence force resulted to have a contact, thus non-Hamiltonian character.

Thanks to this basic advance, the isochemistry permitted, for the first time in scientific history, the numerically exact and invariant representation not only of the binding energy but also of the electric and magnetic moments of the water molecules (Section 9.3).

Subsequently, in Section 11.5 we indicated that the liquid state of water appears to be of magnecular character since the H-atoms in the H_2O structure have by nature a toroidal polarization in a plane perpendicular to the $H - O - H$ plane, thus permitting the magnecular bond between two H atoms of different water molecules $H_\uparrow \times H \downarrow$ that is referred to as "H-bridges" (see Figure 11.34.

In this section, we have shown that water admits a previously unknown gaseous and combustible state achievable from the liquid state *without* the evaporation energy believed to be necessary by quantum chemistry. In turn, such a feature indicates our basic lack of understanding of the conventional water evaporation itself, trivially, because of the lack of conventional identification of the force responsible for the liquid state.

To understand the limited character of the advances permitted by isochemistry, it is important to recall that they have been achieved via a lifting of quantum chemistry that is strictly reversible in time as the original theory.

Consequently, *isochemistry is strictly inapplicable (rather than violated) for any irreversible process involving the water molecule,* such as the very creation of the molecule itself

$$2 \times H + \frac{O_2}{2} \quad \rightarrow \quad H_2O + 57Kcal/mole. \tag{11.6.1}$$

Any insistence in the use of a reversible theory, whether quantum chemistry of its isotopic covering, for the above irreversible process may imply severe scientific drawbacks. As one example among many, it is generally believed in chemistry that the above process is unique and immutable.

On the contrary, the use of the *genotopic branch of hadronic chemistry,* or *genochemistry* for short, establishes that the rate of the above process depends on the distribution of the orbitals.

Recall that the H atoms in the H_2 molecule have a spherical distribution. Consequently, to achieve reaction (11.6.1), nature has to first break down the H_2 molecule and then polarize the orbitals of the individual H atoms from their spherical to the above indicated toroidal polarization.

Genochemistry then predicts that basically new advances over reaction (1.6.xx) can be achieved with the combustion of H and O, firstly, if we start from *atomic* H and/or O atoms (because in this case there is no need to separate atoms prior to their new bond) and, secondly, via the use of *atomic and polarized* H and O atoms, that is, by preparing them in the form as appearing in the $H-O-H$ molecule. Similar basic advances can be obtained in various other chemical reactions.

Despite these possibilities, genochemistry remains basically insufficient for further advances in the study of the water molecule because the theory is indeed irreversible but single-valued. It is an easy prediction that further advances in the study of water, particularly when a member of a biological structure, will require the *hyper-structural branch of hadronic chemistry,* or *hyperchemistry* for short, due to its multi-valued character. In turn, the latter broadening will inevitably require the notion of *hypermagnecule* (Definition 11.2.1).

At that point the complexities of water and its role as the basis of life appear in their full light, e.g., because of the joint need of all four directions of time (Section 2.1), each time being multivalued (Chapter 5).

In summary, water is perhaps the best illustration of the fact that the human adventure in science will never end.

10.7 EXPERIMENTAL EVIDENCE OF MAGNECULES IN LIQUIDS AND SOLIDS

10.7.1 Preparation of Liquid Magnecules used in the Tests

In early 1998 Santilli [1] obtained a number of samples of *fragrance oils* from *Givaudan-Roure Corporation* (GR) with headquarters in Teaneck, New Jersey. About 50 cc of various samples of perfectly transparent fragrance oils were placed in individual glass containers. One polarity of an alnico permanent magnet with 12,000 G and dimension $1/2'' \times 1'' \times 2''$ was immersed within said oils.

Starting with a perfect transparency, after a few days a darkening of the oils became visible, jointly with a visible increase of the viscosity, with changes evidently varying from oil to oil. Subsequently, there was the appearance of granules of dark complexes in the interior of the oil which were visible to the naked eye. Both the darkening and the viscosity increased progressively in subsequent days, to reach in certain cases a dark brown color completely opaque to light. The viscosity increased to such an extent that the oil lost all its fluidity.

It should be stressed that the above visible effects are of pure magnetic origin because of the lack of any other contribution, *e.g.*, the complete absence of any additives. After the immersion of the permanent magnets, all samples were left undisturbed at ordinary room conditions. The indicated effects remain unchanged to this day, thus showing that the changes were stable at ordinary conditions of temperature and pressure.

Santilli's [1] main hypothesis on the darkening of the oils is that their molecules acquire a magnetic polarization in the orbits of at least some of their atomic electrons (called in chemistry *cyclotron resonance orbits*), by therefore bonding to each other according to Definition 11.2.1 in a way similar to the corresponding occurrence for gases.

It should also be indicate that the immersion of one polarity of a permanent magnet in fragrance oils is, evidently, a rudimentary way to create magnecules in detectable percentage although not an essentially pure population of magnecules as requested for a new chemical species (see Sect. 11.2). A number of more sophisticated magnetic polarization techniques are now available with rather complex geometries. Also, as indicated in Sect. 11.6, an essentially pure population of liquid magnecules can be reached via the PlasmaArcFlow reactors described in Section 11.4.

10.7.2 Photographic Evidence of Magnecules in Liquids

The above alteration of the structure of fragrance oils was confirmed by photographs taken by the GR Research Laboratory in Dubendorf, Switzerland, via a microscope with minimal magnification, as illustrated in the pictures of Figs. 8.19 and 8.20.

The pictures of Fig. 11.57 refer to the GR fragrance oil received under the code "ING258AIN, Text 2" subjected to the rudimentary magnetic polarization indicated in the preceding section under the respective magnification 10X and 100X.

As one can see, these photographs establish that, under the indicated magnetic treatment, the oil has acquired a structure of the type of "brick layering" which is visible under only 10X magnification, and is per se highly anomalous for a liquid that was originally fully transparent. Note that the magnecules are not constituted by the individual "bricks," but rather by the dark substance which interlock said "bricks." This point is important to understand the size of the magnecule here considered which covers the entire 50 cc of the liquid.

The photographs in Figs. 8.20 were taken at the University of South Florida in St. Petersburg via a microscope with the same magnifications 10X and 100X, but refer to a different GR fragrance oil received under the code "Mixture 2" and magnetically treated to such a point of completely losing transparency and fluidity. As one can see, the latter picture provides confirmation that, following exposure to a 12,000 G magnetic field, fragrance oil molecules bond together into rather large clusters estimated to be well in excess of 10,000 a.m.u., that is, with an atomic weight which is dramatically bigger than that of the largest molecule composing the oil, as per Feature I) of Definition 11.2.1.

Inspection of the various photographs shows a variety of sizes of magnecules, thus establishing their lack of unique characteristics for any given liquid. This evidently confirms the *lack* of a valence bond. Inspection of the samples also show the magnecules capability of increasing their size via the accretion of further oil molecules.

Other photographic documentations of various magnecules in liquids were done, by confirming the findings of Figs. 8.19 and 8.20.

10.7.3 Spectroscopic Evidence of Liquid Magnecules at the Tekmar-Dohrmann Corporation

The first experimental evidence of magnecules in liquids was established on May 5, 1998, by analysts *Brian Wallace* and *Mia Burnett* at *Tekmar-Dohrmann Corporation* (TDC) in Cincinnati, Ohio, operating a *Tekmar 7000 HT Static Headspacer Autosampler* equipped with a Flame Ionization Detector (FID). The tests were repeated on May 8 and 11, 1998, by confirming the preceding results. It should be noted that the Tekmar equipment lacks the computer search as

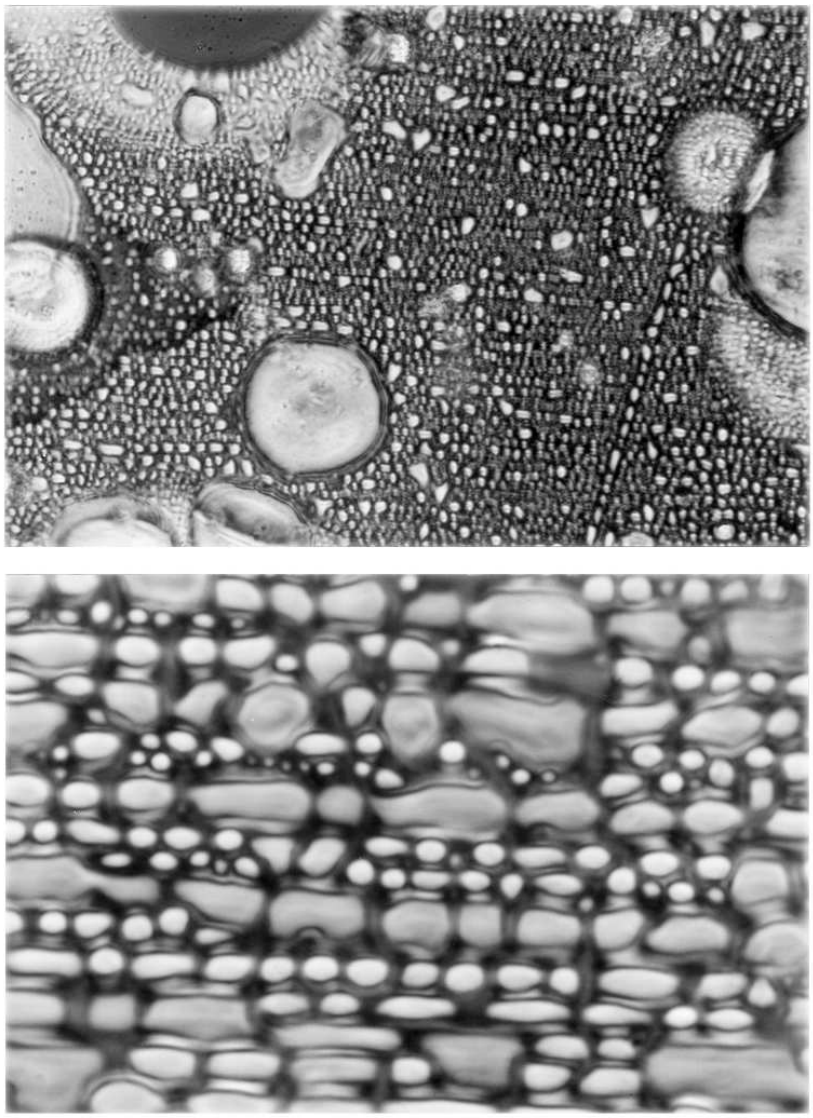


Figure 10.57. A photographic evidence of magnecules in liquids obtained at the *Givaudan-Roure Research Laboratory* in Dubendorf, Switzerland, in the GR fragrance oil "ING258IN Test 2" under magnifications 10X and 100X [1].

well as the UV scan. Also, the instrument had limited capability in atomic weight. Finally, the FID was permitted in this case because the liquids were not combustible.

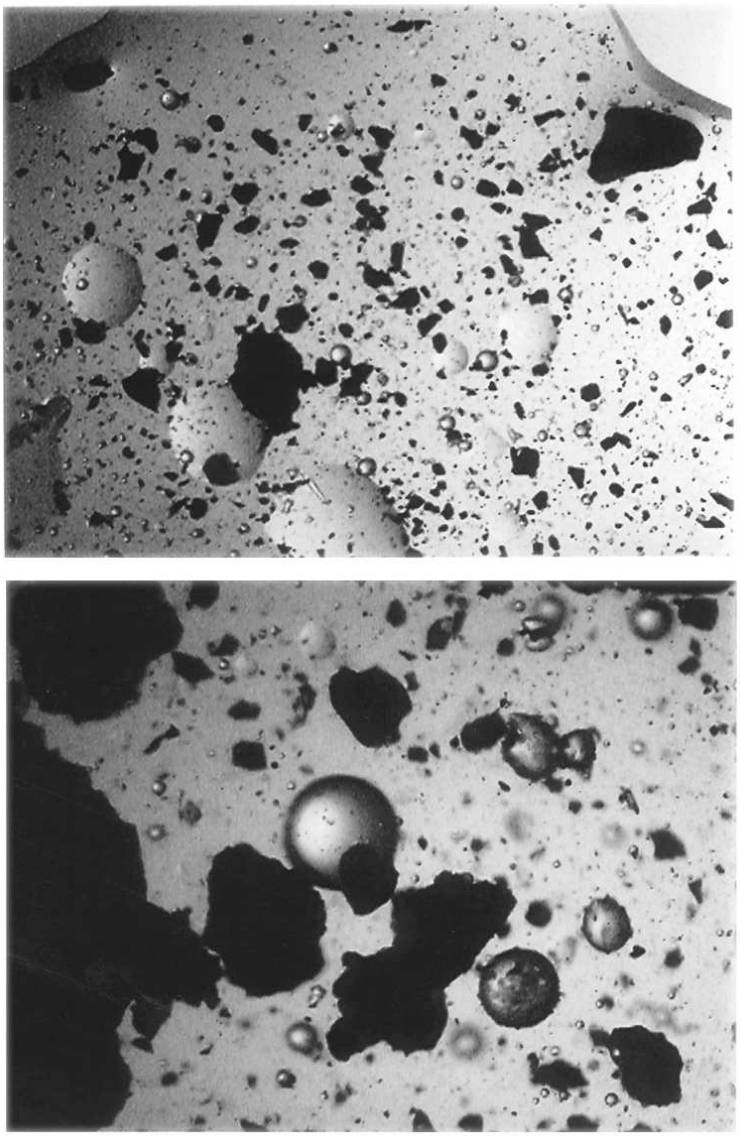
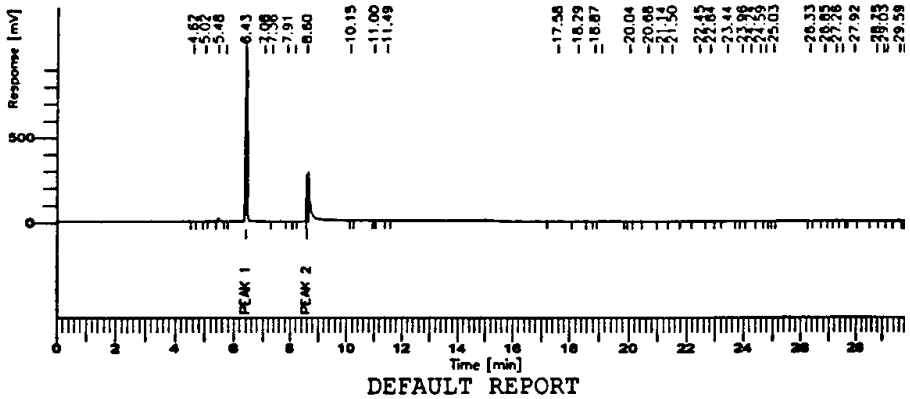


Figure 10.58. Confirmation of magnecules in GR fragrance oil "Mixture 2" under 10X and 100X obtained at the University of South Florida in St. Petersburg. Note the difference in sizes of the magnecules and their difference with those of Fig. 11.57 [1].

The measurements were done on: Sample 1, pure (magnetically untreated) GR "Fragrance Oil 2"; Sample 2, magnetically untreated tap water; and Sample 3, a magnetically treated mixture of the two.

```
Software Version: 4.0<4J28>
Date: 5/5/98  08:18 AM
Sample Name   : 500ul Perfume Oil ID#1
Data File     : C:\TC4\HP210\MY04003.RAW   Date: 5/4/98  04:44 PM
  Sequence File: C:\TC4OLD\HP210\MY04.SEQ   Cycle: 3   Channel : B
Instrument    : 772_-_2   Rack/Vial: 0/0   Operator: mb
Sample Amount     : 1.0000                  Dilution Factor  : 1.00
```

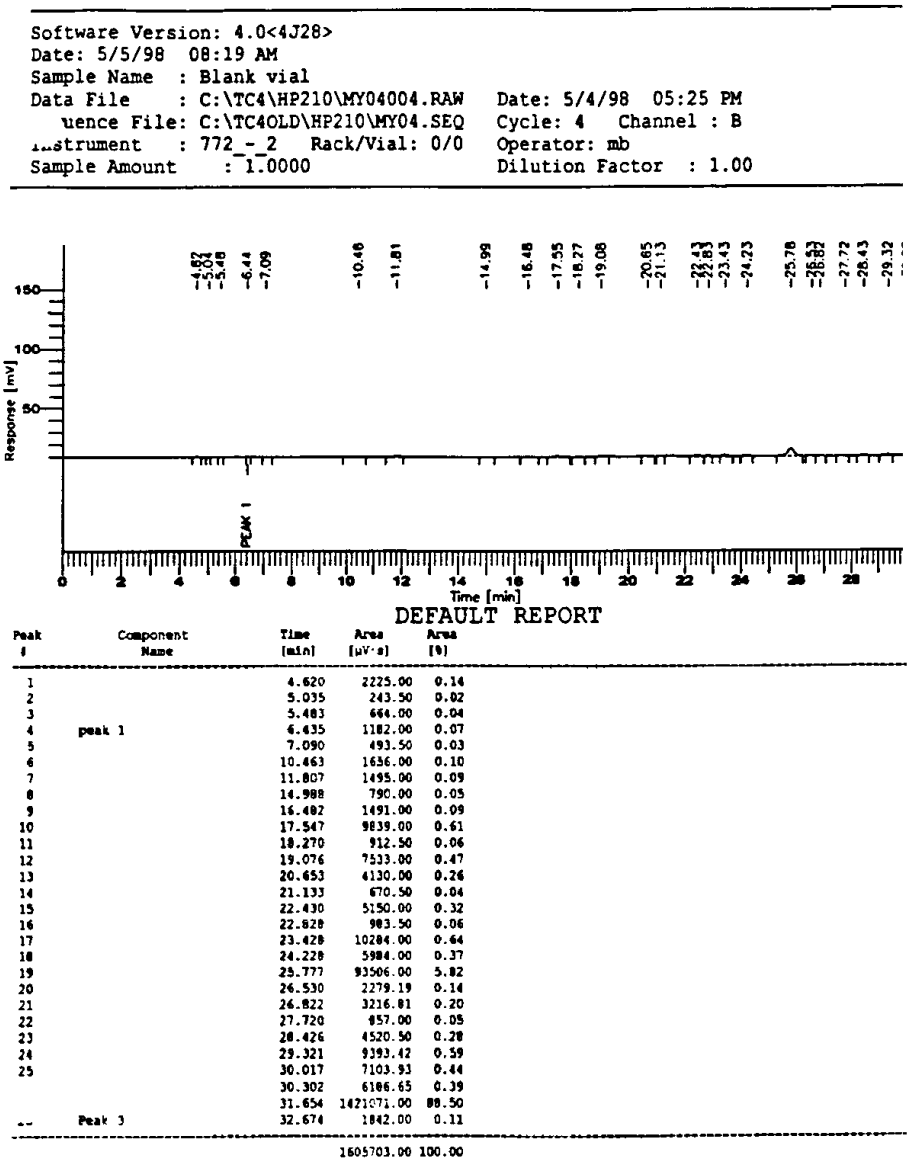


DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [µV·s]	Area [%]				
1		4.620	2106.00	0.01				
2		5.022	432.00	0.00	25		23.958	1292.73	0.01
3		5.479	68060.38	0.43			24.241	5968.77	0.04
4		5.731	1120.12	0.01			24.587	980.85	0.01
5	peak 1	6.430	3894142.72	24.38			24.764	700.15	0.00
6		7.077	23106.00	0.14	29		25.034	221.00	0.00
7		7.355	8426.66	0.05	30		26.330	189.00	0.00
8		7.911	1549.62	0.01	31		26.849	7912.00	0.05
9		8.163	190.00	0.00	32		27.264	19913.14	0.12
10	peak 2	8.604	509716.00	3.19	33		27.461	10844.36	0.07
11		10.146	829.00	0.01	34		27.918	1332.00	0.01
12		10.999	338.00	0.00	35		28.753	751.69	0.00
13		11.485	798.00	0.00			29.026	3094.14	0.02
14		17.582	9646.00	0.06			29.163	2312.68	0.01
15		18.294	814.50	0.01			29.589	30846.00	0.19
16		18.871	748.51	0.00	39		29.750	383.00	0.00
17		19.082	12390.99	0.08	40		30.320	6254.00	0.04
18		20.043	582.50	0.00	41		31.370	3617.37	0.02
19		20.679	4000.46	0.03	42		31.720	51605.63	0.32
20		21.139	654.15	0.00	43		32.296	268.00	0.00
21		21.500	716.38	0.00	44		32.519	87913.29	0.55
22		22.452	4196.12	0.03	45	Peak 3	32.742	11181133.21	70.00
23		22.837	1128.88	0.01					
24		23.437	10546.00	0.07				15973772.00	100.00

Figure 10.59. A first scan done on May 5, 1998, 8.18 a.m. at *Tekmar Dohrmann Company* (TDC) in Cincinnati, Ohio, via a Tekmar 7000 HT Static Headspacer Autosampler with a Flame Ionization Detector (FID).

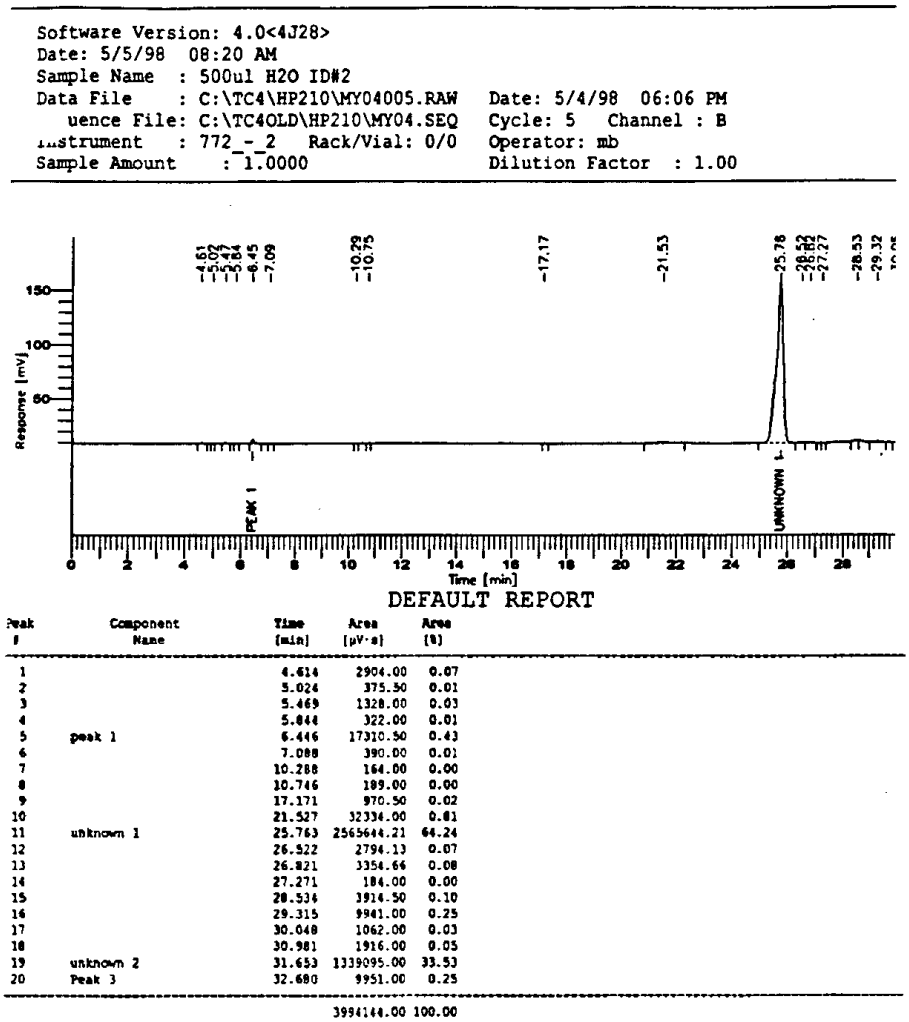
Despite these limitations, *the results of the Tekmar tests provided the first direct spectroscopic evidence of the existence of magnecules in liquids, including the first direct experimental evidence of water magneplexes* as per Definition 11.2.1. In particular, these tests established that magnecules in liquids have the same main features of the magnecules in gases.



Peak #	Component Name	Time [min]	Area [µV·s]	Area [%]
1		4.620	2225.00	0.14
2		5.035	243.50	0.02
3		5.483	664.00	0.04
4	peak 1	6.435	1182.00	0.07
5		7.090	493.50	0.03
6		10.463	1636.00	0.10
7		11.807	1495.00	0.09
8		14.988	790.00	0.05
9		16.482	1491.00	0.09
10		17.547	9839.00	0.61
11		18.270	912.50	0.06
12		19.076	7533.00	0.47
13		20.653	4130.00	0.26
14		21.133	670.50	0.04
15		22.430	5150.00	0.32
16		22.828	903.50	0.06
17		23.428	10284.00	0.64
18		24.228	5984.00	0.37
19		25.777	93506.00	5.82
20		26.530	2279.19	0.14
21		26.822	3216.81	0.20
22		27.720	857.00	0.05
23		28.426	4520.50	0.28
24		29.321	9393.42	0.59
25		30.017	7103.93	0.44
		30.302	6186.65	0.39
		31.654	1421071.00	88.50
--	Peak 3	32.674	1842.00	0.11
			1605703.00	100.00

Figure 10.60. The scan at TDC on 5/5/98 at 8.19 a.m. to check that the background is correct.

To avoid a prohibitive length we reproduce only a few representative scans in Figs. 8.21 to 8.25 [1]. Figure 8.21 reproduces the origin test of the fragrance oil without magnetic treatment. Note the dominance of three molecules denoted "Peak 1" with 24.28%, "Peak 2" with 3.19% and "Peak 3" with 70.00%. Fig-



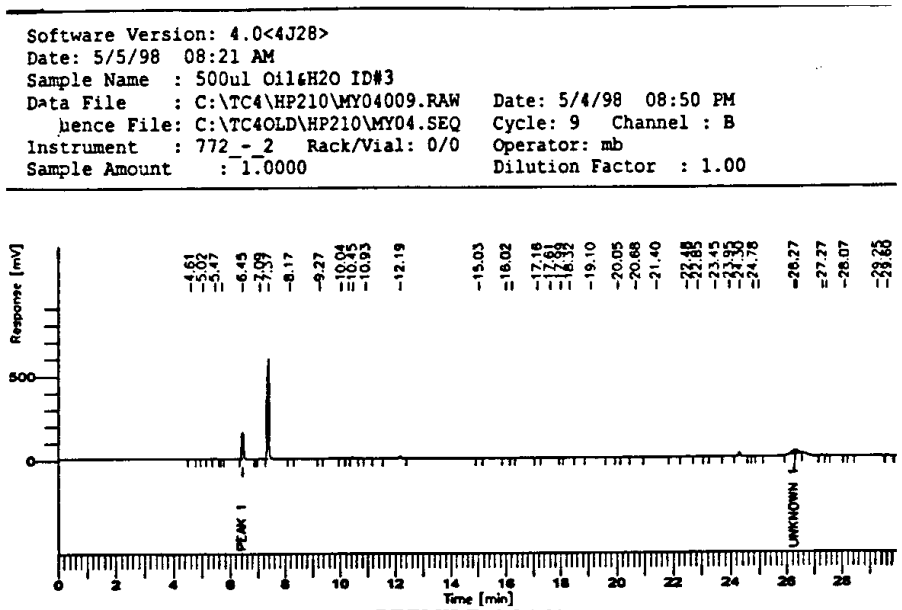
Software Version: 4.0<4J28>
Date: 5/5/98 08:20 AM
Sample Name : 500ul H2O ID#2
Data File : C:\TC4\HP210\MY04005.RAW Date: 5/4/98 06:06 PM
uence File: C:\TC4OLD\HP210\MY04.SEQ Cycle: 5 Channel : B
Instrument : 772_-_2 Rack/Vial: 0/0 Operator: mb
Sample Amount : 1.0000 Dilution Factor : 1.00

DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [µV·s]	Area [%]
1		4.614	2904.00	0.07
2		5.024	375.50	0.01
3		5.469	1328.00	0.03
4		5.844	322.00	0.01
5	peak 1	6.446	17310.50	0.43
6		7.088	390.00	0.01
7		10.288	164.00	0.00
8		10.746	189.00	0.00
9		17.171	970.50	0.02
10		21.527	32334.00	0.81
11	unknown 1	25.763	2565644.21	64.24
12		26.522	2794.13	0.07
13		26.821	3354.66	0.08
14		27.271	184.00	0.00
15		28.534	3914.50	0.10
16		29.315	9941.00	0.25
17		30.048	1062.00	0.03
18		30.981	1916.00	0.05
19	unknown 2	31.653	1339095.00	33.53
20	Peak 3	32.680	9951.00	0.25
			3994144.00	100.00

Figure 10.61. The scan at TDC on 5/5/98 at 8.19 a.m. on the magnetically treated water which constitutes experimental evidence of magnecules in water given by the large unknown peak.

ure 8.22 depicts the background which is shown to be correct. Figure 8.23 represent the scan of magnetically treated water with a large "unknown 1" with 64.24% and "unknown 2" with 33.53% totaling 97.78%. This is evidence of the creation of magnecules in water, also called magneplexes according to Definition 11.2.1. Figure 8.24 represents a scan of the magnetically treated combination of water and fragrance oil with "unknown 1" 1.75% and "unknown 2" with 0.45%. An important information of this scan is that the original Peak 1 of Fig. 11.59

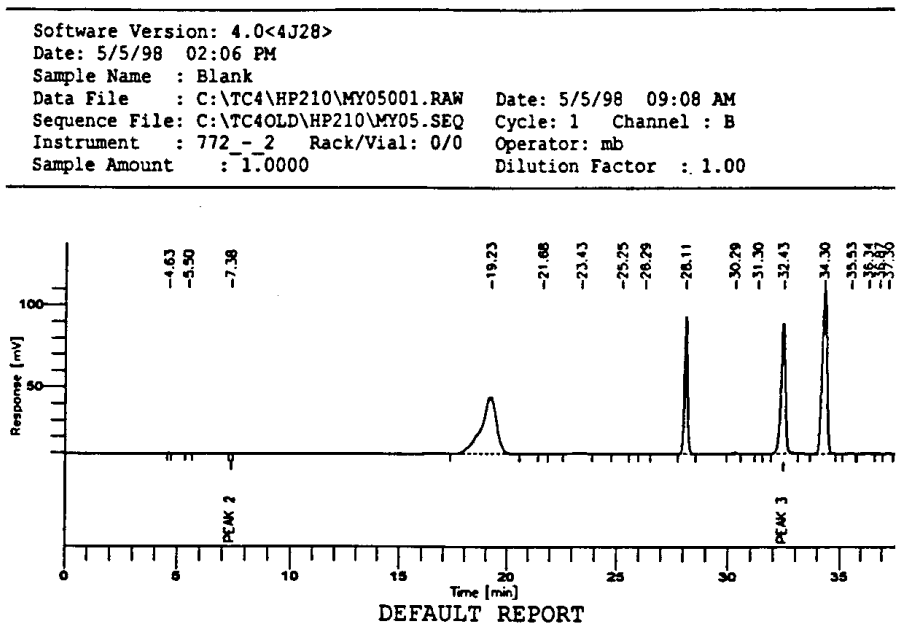


DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [µV·s]	Area [%]				
1		4.612	2960.00	0.02	--			
2		5.021	482.50	0.00			22.477	3617.00	0.03
3		5.466	14446.00	0.11			22.848	1399.00	0.01
4		5.716	302.00	0.00			23.453	8746.50	0.07
5	peak 1	6.449	700997.00	5.33	29		23.945	5373.77	0.04
6		7.085	17702.00	0.13	30		24.296	89748.23	0.68
7		7.373	2463631.95	18.74	31		24.777	1228.40	0.01
8		8.174	1041.55	0.01	32		24.964	2011.60	0.02
9		9.273	398.50	0.00	33	unknown 1	26.272	229566.61	1.75
10		10.038	693.50	0.01	34		26.347	152811.39	1.16
11		10.287	407.59	0.00	35		27.273	23098.00	0.18
12		10.454	32776.91	0.25			27.410	13015.00	0.10
13		10.932	455.00	0.00			28.070	324.00	0.00
14		12.185	45046.00	0.34			29.254	52774.58	0.40
15		15.029	735.50	0.01	--		29.599	19904.00	0.15
16		16.018	363.50	0.00	39		30.345	65596.75	0.50
17		16.215	289.50	0.00	40		30.880	2408.67	0.02
18		17.163	405.10	0.00	41		31.387	6170.93	0.05
19		17.607	8138.75	0.06	42		31.491	59456.07	0.45
20		17.989	258.64	0.00	43	unknown 2	32.089	664.00	0.01
21		18.323	773.50	0.01	44		32.528	64277.94	0.49
22		19.101	7936.00	0.06	45		32.758	9034646.06	68.71
23		20.050	1513.00	0.01	46	Peak 3			
24		20.684	3329.69	0.03				13148362.00	100.00
25		21.403	6640.01	0.05					

Figure 10.62. The scan on 5/5/98 at 8.21 a.m. on the magnetically treated mixture of water and fragrance oil of scan 8.21 which constitutes evidence of magnecules given by two unknown peaks.

with 24.28% and Peak 3 with 70.00% have been decreased to the values 5.33% and 68.71%, respectively. This is evidence that the missing percentages of these molecules have been used in the formation of magnecules. Figure 8.25 reproduces the background following the tests and routine flushing. As one can see, the scan



DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [μV·s]	Area [%]
1		4.633	2621.00	0.05
2		5.496	695.50	0.01
3	peak 2	7.379	293.00	0.01
4		19.227	1795761.00	33.57
5		21.679	1071.00	0.02
6		23.432	18393.00	0.34
7		25.247	6824.50	0.13
8		26.290	2393.00	0.04
9		28.110	835986.00	15.63
10		30.291	12877.00	0.24
11		31.296	1435.00	0.03
12	Peak 3	32.425	1135236.50	21.22
13		34.296	1508602.50	28.20
14		35.532	6202.50	0.12
15		36.344	9033.76	0.17
16		36.866	1934.19	0.04
17		37.297	7005.45	0.13
18		37.914	2731.10	0.05
			5349096.00	100.00

Figure 10.63. The scan at TDC on 5/5/98 at 2.26 p.m. on the background with anomalous adhesion confirming the corresponding anomalous background for gas magnecules.

preserves macroscopic percentages of the preceding scans, thus confirming the anomalous adhesion also existing in gas magnecules.

10.7.4 Spectroscopic Evidence of Liquid Magnecules at Florida International University

Additional comprehensive tests via a modern equipment for LC-MS equipped with UVD were conducted on the GR fragrance oil "ING258IN Test 2" of Figs. 8.19 on December 1, 1998, at the chemistry laboratory of *Florida International Uni-*

versity (FIU) in Miami, Florida. The tests were then repeated on December 17 and 18 by confirming the preceding results.

The tests were conducted under a number of technical characterizations specifically selected to detect magnecules, among which include:

1) Total Ion Chromatogram (TIC) collected under the positive ion atmospheric pressure electrospray ionization (ESI+) mode;

2) Integrated TIC with retention times and areas for the most abundant peaks;

3) Raw mass spectra for all peaks identified in item 2;

4) HP LC chromatograms collected at fixed wavelength of 254 cm; and

5) UV-visible spectra form the HPLC diode array detector with 230–700 mm.

The tests were conducted on the following samples:

I) Sample GR331, the magnetically untreated, fully transparent GR fragrance oil "ING258IN Test 2";

II) Sample GR332, magnetically treated "ING258IN Test 2" with 10% Dipropylene Glycol (DPG);

III) Sample GR332S, bottom layer of the preceding sample;

IV) Sample GR335, magnetically treated mixture 4% GR fragrance oil "ING258IN Test 2", 0.4% DPG and 95% tap water; and

V) Sample GR335O, visible dark clusters in the preceding sample.

To avoid a prohibitive length of this presentation, only representative scans are reproduced in Figs. 8.26 to 8.30 [1]. As one can see, these scans provide a second experimental evidence of magnecules in liquids as evident in comparing the peaks of the untreated liquid with those of the treated one.

A few comments are in order. To understand the FIU measurements the reader should keep in mind that the liquid is that of Fig. 11.57. Consequently, *the magnecules to be tested are visible to the naked eye. Therefore, only minute fragments entered the capillary feeding lines of the LC-MS/UVD instrument.*

Finally, the reader should keep in mind that the magnetic polarization of the test has been minimal, and *the liquid does not constitute a pure population of liquid magnecules.* The latter case is available from the PlasmaArcFlow reactors of Section 11.4 whose study is here omitted.

10.7.5 Experimental Verification of Mutated Physical Characteristics

In addition to the preceding *chemical* features, the existence of magnecules implies the mutation of *physical* characteristics, such as increase of the specific density and viscosity. This is due to the fact that magnetic bonds among ordinary molecules imply an evident reduction of intermolecular distances, thus resulting in more molecules per unit volume, as compared to the magnetically untreated substance. The increases in density and viscosity are then consequential.

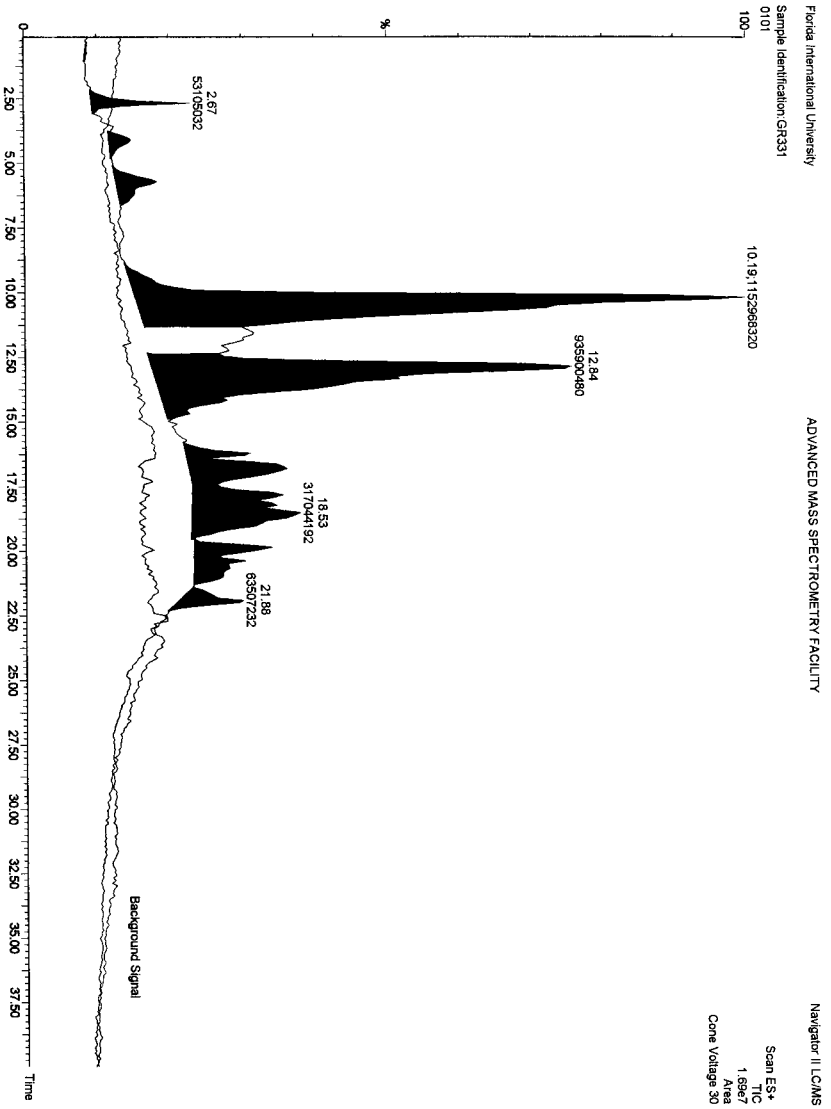


Figure 10.64. Scan on the untreated GR oil "ING258IN Test 2" of Fig. 11.56 (GR331 of the text) conducted at *Florida International University* (FIU).

A most intriguing feature of gas magnecules with important scientific and industrial implications is that *the Avogadro number of a gas with magnecular structure is not constant, or, equivalently, the so-called "gas constant" R of a gas with magnecular structure is an (expectedly nonlinear) function of P, V, T,*

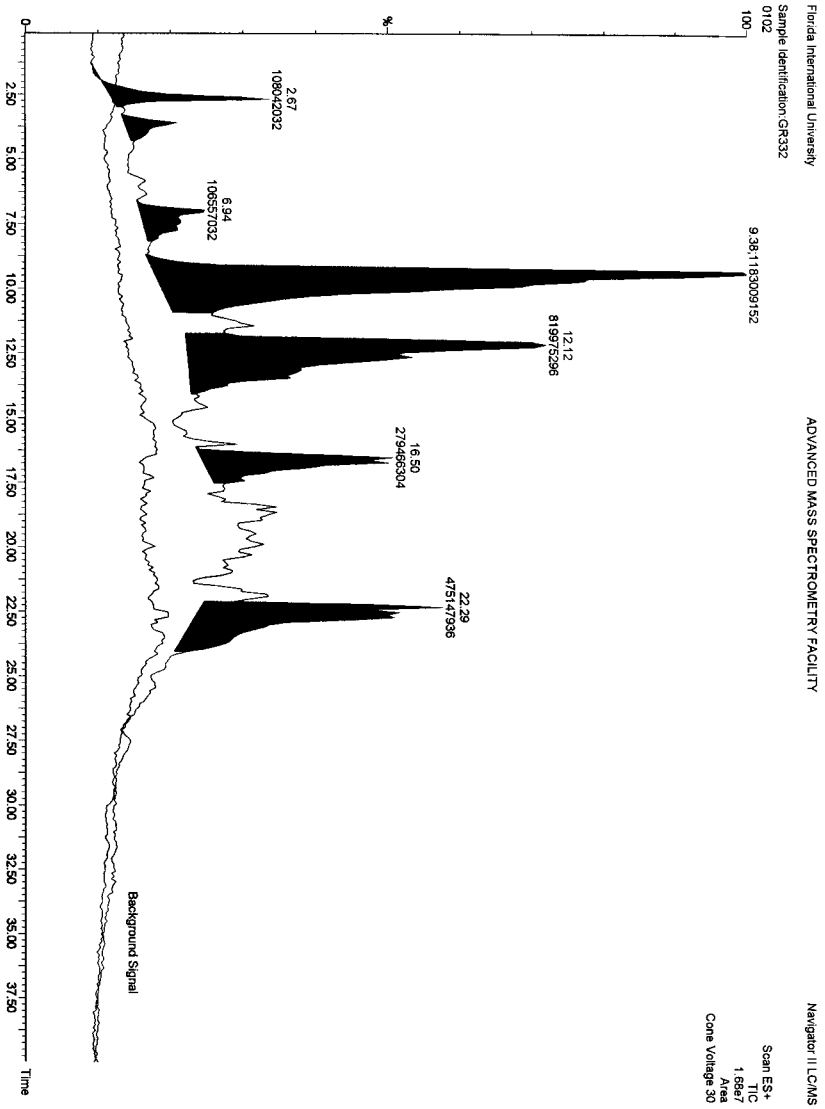


Figure 10.65. Scan at FIU of Sample GR332.

$R = R(P, V, T)$, resulting in the generalized gas law

$$\frac{PV}{T} = nR(P, V, T), \tag{8.21}$$

where the explicit dependence of R on P, V, and T depends on the magnecular gas considered.

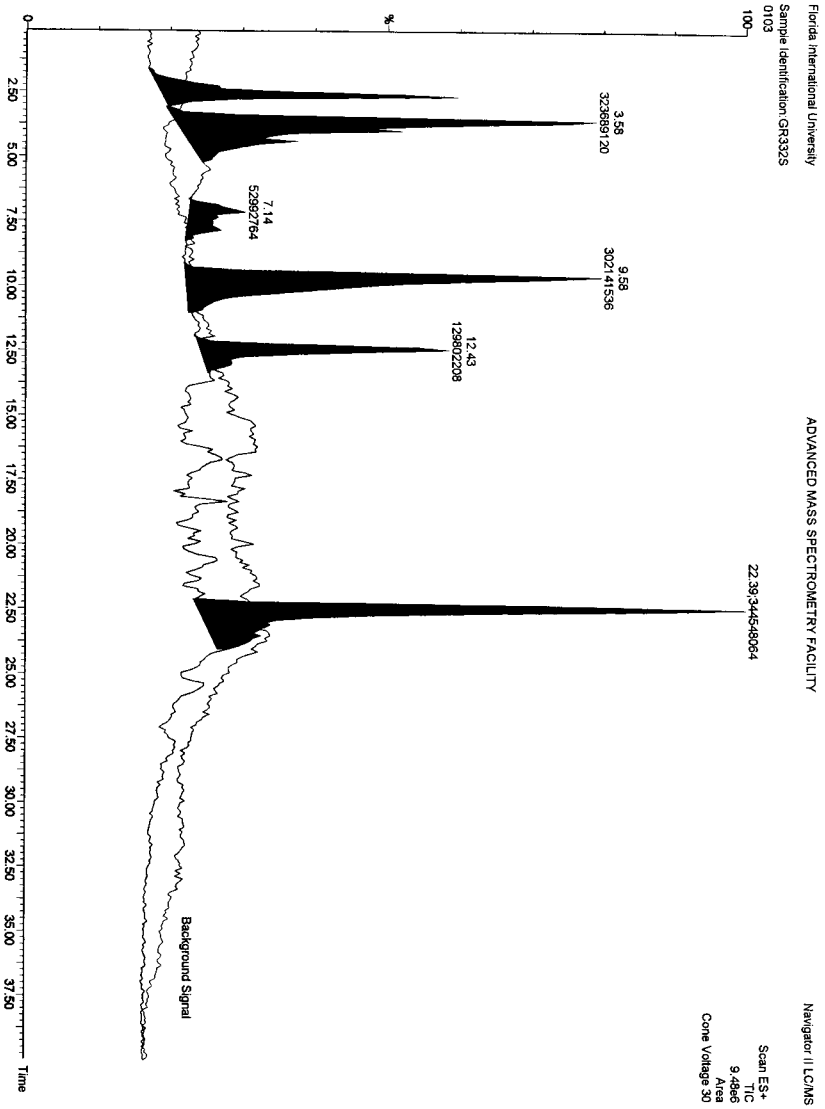


Figure 10.66. Scan at FIU of Sample GR332S.

The variation of the Avogadro number for gas with magnecular structure has been proved by routine tests at *USMagnegas, Inc.,* Largo, Florida, establishing that:

1) The number of constituents of a gas with magnecular structure decreases with a sufficient increase of the pressure;

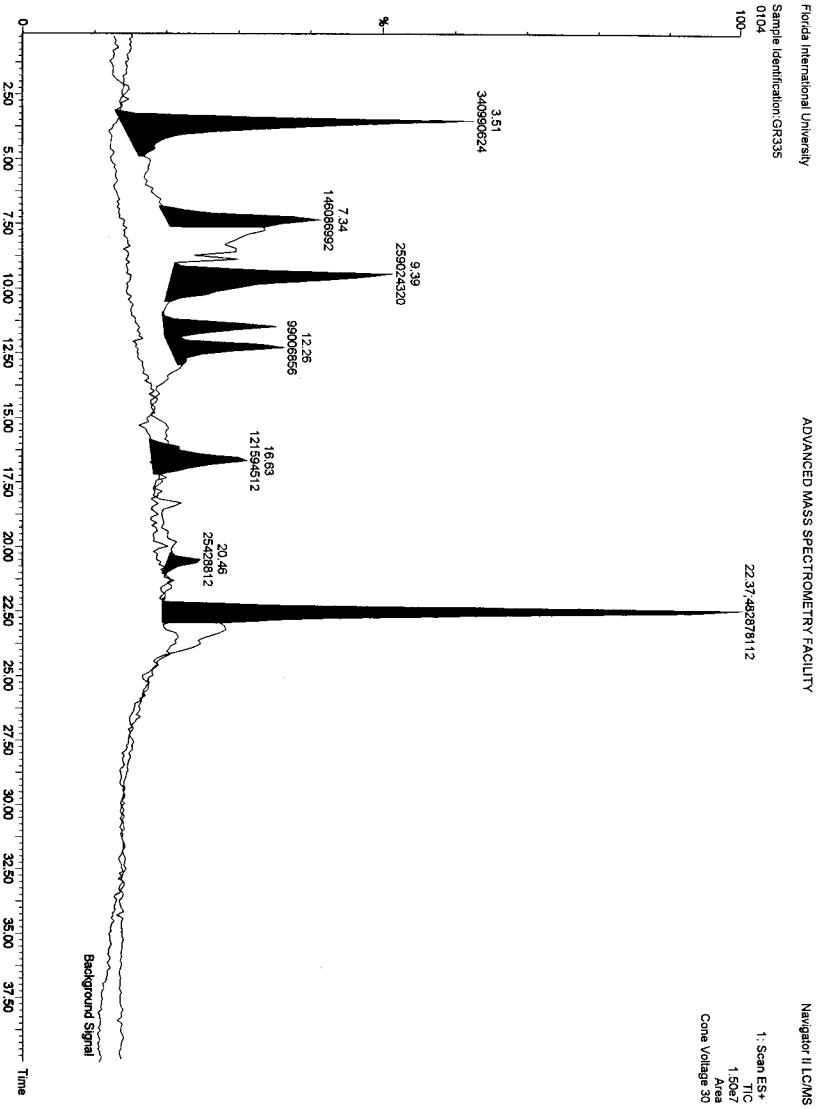


Figure 10.67. Scan at FIU of Sample GR335.

2) Given a fixed and sealed tank with volume V of a gas with magnecular structure at given pressure P and temperature T, after bringing this tank to a sufficiently higher temperature $T' > T$, and then returning it to the original temperature T, the pressure of the tank is not the original pressure P but a generally bigger pressure $P' > P$;

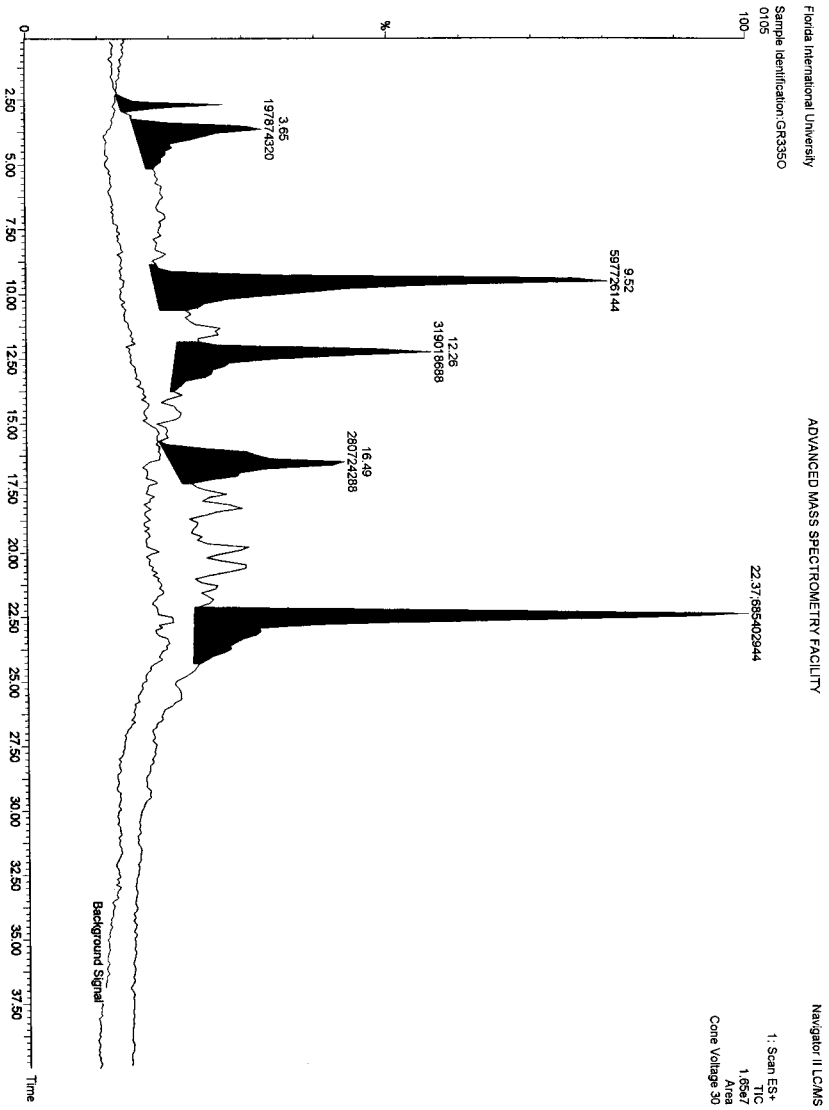


Figure 10.68. Scan at FIU of Sample GR335O.

3) The increase of pressure of a gas with magnecular structure requires a volume which generally increases with the pressure itself, that is, if the increase of pressure in a given tank from 100 psi to 200 psi requires V cf of magnecular gas, the same increase of pressure in the same tank via the same gas, this time from 4,000 psi to 4,100 psi at the same temperature does not require the same vol-

ume V but a volume V' of the magnecular gas bigger than the original volume, $V' > V$.

The above deviations from the conventional gas law are easily explained by the fact that *the increase of pressure in a gas with magnecular structure generally implies the aggregation of magnecules into bigger clusters, with consequential decrease of the number of constituents.* Similarly, *the increase of temperature generally implies the breaking down of magnecules into smaller clusters, with consequential increase of the number of constituents and resulting anomalous increase of pressure.* It then follows that, if the increase of temperature of a given fixed volume is beyond the Curie Magnecular Point (Definition 8.2.1), all magnetic polarizations are terminated with consequential increase of the number of constituents due to the reduction of magnecules to molecules. This implies that the return of the gas to the original temperature does not restore the original magnecules, and, consequently, the return to the original temperature generally occurs at an increased pressure due to the increased number of constituents.

We now report measurements of specific density, viscosity and other characteristics of fluids with magnecular structure which confirm the above GC-MS/IRD and LC-MS/UVD tests, by providing final evidence on the existence of magnecules as per Definition 8.2.1.

All tests were done via the use of ordinary tap water and a number of GR fragrance oils. All samples here considered were prepared by conventionally mixing tap water and one fragrant oil, and then submitting that mixture to rather weak permanent magnets of 200 G (much weaker than those used for the fragrance oils of Figs. 8.18 and 8.19). All samples resulted in being very stable without any measurable change over a period of about one year, and survived freezing followed by defrosting. The various samples were numbered from 1 to 25.

The measurements of the specific density were conducted on March 9, 1998 by the *U.S. Testing Company, Inc.* (USTC) of Fairfield, New Jersey. The results of the tests are presented in Figs. 8.31 and 8.32.

Sample 1 is ordinary untreated tap water. Sample 2 is ordinary tap water magnetically treated for about 5 minutes. Samples 3 and 4 were tap water treated with other magnetic equipment. Sample 5 was ordinary untreated GR fragrance oil "APC Fragrance." Sample 6 was a mixture of fragrance oil 5 with tap water magnetically treated for about 5 minutes. Mixtures 7 and 8 were the same mixture 5 although treated with other equipment. Sample 17 was a magnetically treated GR oil "Air Freshener 1." Mixture 19 was Fragrance 17 with tap water 16 magnetically treated for 5 minutes. Note that all measurements were done to an accuracy of the fourth digit. Therefore, numerical results up to the third digit can be considered accurate.

In the transition from Sample 1 (untreated water) to Sample 2 (magnetically treated water) there is an increase in the specific density in the macroscopic

REPORT OF TEST

SGS U.S. Testing Company Inc.

291 Fairfield Avenue
Fairfield, NJ 07004-3833
Tel: 973-575-5252
Fax: 973-244-1694

Report Number: 103947
Date: 03/09/98
Page: 1 of 1

Millennium Results

Density of	g/mL	% Change Density vs Ordinary Water
Sample #1	0.9805	0
Sample #2	0.9889	+0.86
Sample #3	0.9804	0
Sample #4	0.9853	+0.49
Fragrant #5	0.9720	NA
Mixture #6	0.9967	+1.65
Mixture #7	0.9982	+1.80
Mixture #8	0.9902	0.99
Treated Water #16	0.9893	0.89
Frag Treated # 17	0.9453	NA
Mixture #18	0.9902	0.99
Mixture #19	0.9929	1.26

Samples were transferred to a separatory funnel. The layers were allowed to separate. The water layer was withdrawn into a funnel with Whatman #4 filter paper. The filtrate was transferred to a preweighed 10 mL volumetric flask. The sample was weighed to 0.0001 grams and the density calculated.

When the samples were pure substances, they were transferred directly to preweighed 10 mL volumetric flasks.

Calculations:

Weight flash with sample - weight flask ÷ volume of flask = g/ mL

Arlyn Sibille, Ph.D.

Figure 10.69. USTC measurements of specific density on magnetically treated liquids.

REPORT OF TEST

SGS U.S. Testing Company Inc.
291 Fairfield Avenue
Fairfield, NJ 07004-3833
Tel: 973-575-5252
Fax: 973-244-1694

Report Number: 103947
Date: 03/09/98
Page: 1 of 1

SUBJECT: Three (3) samples received on 02/09/98 and identified by the client as:

PURPOSE: Determine the density and viscosity of the three samples.

TEST DATE: 02/25/98

PROCEDURE: Three 10 milliliter volumetrtic flasks were pre-weighed. One of the samples was transferred to each of the volumetric flasks with a pipet. The samples were weighed again. The density of each sample was calculated.

The three oil samples were measured for viscosity using a Kinematic viscometer (ASTM D-445).

RESULTS:

Sample Identification	Density, g/mL)	Viscosity (cps)	Increase Viscosity, %
1) Motor Oil, "as is"	0.8682	199.8	0
2) Motor Oil, Treatment Type A	0.8714	288.7	44.5
3) Motor Oil, Treatment Type B	0.8689	302.0	51.2

SIGNED FOR THE COMPANY BY:

James R. Tyminski
Laboratory Supervisor

Arlyn Sibille, Ph.D.
Laboratory Director

/mo

Member of the SGS Group

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Figure 10.70. USTC measurements of viscosity on magnetically treated liquids.

amount of 0.86%, thus confirming the indicated mutation of the specific density of water under a magnetic treatment. In turn, the increase in density supports the existence of magneplexes in magnetically treated water as per the scan of Fig. 11.65.

As well known, fragrance oils are (generally) *lighter* than water, *i.e.*, the specific density of the untreated fragrance in Sample 5 is *smaller* than that of the untreated water in Sample 1. According to quantum chemistry, the specific den-

sity of any mixture of the above two liquids, whether solution, suspension or dispersion, should be *in between* the lighter and heavier specific densities.

On the contrary, as one can see, *the specific density of the magnetically treated mixture of GR fragrance with tap water, Sample 6, resulted in being bigger than that of the densest liquid, the water.* This measurement constitutes additional, rather strong, direct experimental verification of the mutation of physical characteristics in liquids under magnetic fields.

A remarkable point is that the *magnetic mutations of density are macroscopically large.* In fact, they were called by an analyst "UPS-type anomalies", meaning that the shipment via UPS of a given volume of a magnetically treated liquid may require an increase of the shipping cost of the same volume of untreated liquid due to the macroscopic increase in the weight.

A further prediction of magnetically polarized liquids is the increase of its viscosity. This is evidently due to the arbitrary size of an individual magnecule, as well as the tendency of the same to bond to near-by molecules, resulting in accretions, not to mention the anomalous adhesion to the walls of the container, which has been systematically detected for all magnetically polarized liquids.

As indicated earlier, in certain cases the increase of viscosity is so large as to be first visible to the naked eye, and, when the treatment is sufficiently protracted, the increase in viscosity is such as to lose the customary liquid mobility.

Ordinary engine oils are particularly suited for magnetic treatment because, when properly treated, their increase in viscosity is so dramatic as to be visible to the naked eye jointly with a visible change in visual appearance (color, texture, opacity, *etc.*).

The measurements on viscosity are reported in Fig. 11.70. The selected engine oil was an ordinarily available 30-40 Castrol Motor Oil subjected to a particular type of magnetic treatments via two different kinds of equipment called of Type A and B. All treatments were done at ordinary conditions without any additive or change of any type. As one can see, *measurement 2 shows a dramatic increase in the viscosity in the magnetically treated oil of 44.5%.*

The above experimental results evidently provide additional support for the existence of magnecules.

The tests also provide evidence of the anomalous adhesion of liquids with magnecules, which is established in this case by a dramatic, macroscopic increase of adhesion of the oil to the walls of the glass container.

The same macroscopic anomaly is confirmed at the microscopic level. During the measurement of viscosity there was such an anomalous adhesion of the magnetically treated oils to the walls of the instrument that said oil could not be removed via routine cleaning with acetone and required the use of strong acids.

This anomalous adhesion is further experimental evidence of the existence of magnecules, because of their predicted capability to induce the polarization of

the orbits of the valence electrons of the atoms in the walls of the container, thus resulting in anomalous adhesion via magnetic bonds due to induction.

It is evident that the mutations of density and viscosity implies the expected mutation of *all* other physical characteristics of the liquid considered. These measurements are left to the interested researchers.

The existence of mutation of *physical* characteristics then implies the mutation of *chemical* features. At this moment, we can only indicate the visual evidence reported by the analysts of USTC according to whom the reaction of magnetically treated oils with acetone is dramatically different from that with untreated oil, including mutations in color, texture and other appearances.

10.7.6 Concluding Remarks

The theoretical and experimental evidence presented in this Chapter establishes that the chemical species of molecules, defined as stable clusters of atoms under a valance bond, does not exhaust all possible chemical species existing in nature.

This conclusion is proved beyond scientific doubt, for instance, by macroscopic percentage of stable clusters, with atomic weight of several hundreds a.m.u., in light gases without an infrared signature where heaviest possible detected molecule is the CO_2 with 44 a.m.u.; the mutation of transparent oils into a completely opaque substance without fluidity; the joint increase of the specific density for both gaseous and liquid cases; and other evidence.

Needless to say, the final *characterization* and *detection* of the new chemical species submitted in Refs. [1,2] and reviewed in this chapter will require a considerable collegial effort, since the methods presented in this chapter are manifestly preliminary, with the understanding that, again, the *existence* of the new chemical species is outside scientific doubts.

As a matter of fact, the proposed new chemical species of magnecules, which, according to Definition 11.2.1 includes that of molecules, cannot be considered itself as the final chemical species in nature as it is the fate proved by history for all scientific discoveries.

As an example, the reformulation of magnecules via the hyperstructural branch of hadronic chemistry implies the prediction of the broader chemical species of *hypermagnecules* which is apparently more suitable to represent living organisms due to its inherent irreversibility, multidimensional structure compatible with our three-dimensional sensory perception, and other features needed for a more adequate representation of the complexities of living organisms. The *novelty* of this possible species is then an evident consequence of its novel features. Its *need* is established by the fact that current attempts to decipher the DNA code via the numbers used for molecules and magnecules dating back to biblical times have

little chance of success, thus mandating the use of broader numbers, such as the hypernumbers and related multi-dimensional structures.

All in all, we can safely conclude that science is a discipline that will never admit final theories.

Appendix 10.A
Aringazin's Studies on Toroidal Orbits of the Hydrogen Atom under an External Magnetic Field

In the main text of this chapter we have presented the theoretical and experimental foundations of the new chemical species of magnecules which is centrally dependent on individual atoms acquiring a generally toroidal configuration of the orbits of at least the peripheral electrons when exposed to sufficiently intense external magnetic fields, as originally proposed by Santilli [1] and reviewed in the main text of this Chapter.

In this Appendix we outline the studies by Aringazin [8] on the Schrödinger equation of the hydrogen atom under a strong, external, static and uniform magnetic field which studies have confirmed the toroidal configuration of the electron orbits so crucial for the existence of the new chemical species of magnecules.

It should be stressed that when considered at orbital distances (i.e., of the order of 10^{-8} cm), atoms and molecules near the electric arc of hadronic reactors (Section 11.4), and in the plasma region, are exposed to a strong magnetic field, whose intensity may be high enough to cause the needed magnetic polarization (see Fig. 11.4.D).

A weak, external, static, and uniform magnetic field B causes an anomalous Zeeman splitting of the energy levels of the hydrogen atom, with ignorably small effects on the electron charge distribution. In the case of a more intense magnetic field which is strong enough to cause decoupling of a spin-orbital interaction (in atoms), $e\hbar B/2mc > \Delta E_{jj'} \simeq 10^{-3}$ eV, i.e., for $B \simeq 10^5$ Gauss, a normal Zeeman effect is observed, again, with ignorably small deformation of the electron orbits.

More particularly, in the case of a *weak* external magnetic field B, one can ignore the quadratic term in the field B because its contribution is small in comparison with that of the other terms in Schrödinger equation, so that the *linear* approximation in the field B can be used. In such a linear approximation, the wave function of electron remains unperturbed, with the only effect being the well known Zeeman splitting of the energy levels of the H atom. In both Zeeman effects, the interaction energy of the electron with the the magnetic field is assumed to be much smaller than the binding energy of the hydrogen atom, $e\hbar B/2mc \ll me^4/2\hbar^2 = 13.6$ eV, i.e., the intensity of the magnetic field is much smaller than some characteristic value, $B \ll B_0 = 2.4 \cdot 10^9$ Gauss $= 240000$ Tesla

(recall that 1 Tesla = 10^4 Gauss). Thus, the action of a weak magnetic field can be treated as a small perturbation of the hydrogen atom.

In the case of a *very strong* magnetic field, $B \gg B_0$, the quadratic term in the field B makes a great contribution and cannot be ignored. Calculations show that, in this case, a considerable deformation of the electron charge distribution in the hydrogen atom occurs. More specifically, under the influence of a very strong external magnetic field a magnetic confinement takes place, i.e., in the plane perpendicular to the direction of magnetic field (see Fig. 8.4.D), the electron dynamics is determined mainly by the action of the magnetic field, while the Coulomb interaction of the electron with the nucleus can be viewed as a small perturbation. This adiabatic approximation allows one to separate variables in the associated Schrödinger equation [9]. At the same time, in the direction of the magnetic field the motion of electron is governed both by the magnetic field and the Coulomb interaction of the electron with the nucleus.

The highest intensities of magnetic fields maintained macroscopically at large distances in modern magnet laboratories are of the order of $10^5 - 10^6$ Gauss (~ 50 Tesla), i.e., they are much below $B_0 = 2.4 \cdot 10^9$ Gauss ($\sim 10^5$ Tesla). Extremely intense external magnetic fields, $B \geq B_c = B_0/\alpha^2 = 4.4 \cdot 10^{13}$ Gauss, correspond to the interaction energy of the order of the mass of electron, $mc^2 = 0.5$ MeV, where $\alpha = e^2/\hbar c$ is the fine structure constant. In this case, despite the fact that the extremely strong magnetic field does characterize a stable vacuum in respect to creation of electron-positron pairs, one should account for relativistic and quantum electrodynamics (QED) effects, and invoke Dirac or Bethe-Salpeter equation. These contributions are of interest in astrophysics, for example, in studying the atmosphere of neutron stars and white dwarfs which are characterized by $B \simeq 10^9 \ldots 10^{13}$ Gauss.

Aringazin [8] has focused his studies on magnetic fields with intensities of the order of $2.4 \cdot 10^{10} \leq B \leq 2.4 \cdot 10^{13}$ Gauss, at which value nonrelativistic studies via the Schrödinger equation can be used to a very good accuracy, and the adiabatic approximations can be made.

Relativistic and QED effects (loop contributions), as well as effects related to finite mass, size, and magnetic moment of the nucleus, and the finite electromagnetic radius of electron, reveal themselves even at low magnetic field intensities, and can be accounted for as very small perturbations. Additional effects are related to the apparent deviation from QED of strongly correlated valence bonds as studies in Chapter 4. These effects are beyond the scope of the presented study, while being important for high precision studies, such as those on stringent tests of the Lamb shift.

It should be noted that locally high-intensity magnetic fields may arise in plasma as the result of nonlinear effects, which can lead to the creation of stable self-confined structures having nontrivial topology with knots [10]. More

particularly, Faddeev and Niemi [10] recently argued that the static equilibrium configurations within the plasma are topologically stable solitons describing knotted and linked fluxtubes of helical magnetic fields. In the region close to such fluxtubes, we suppose the magnetic field intensity may be as high as B_0. In view of this, a study of the action of strong magnetic field and the fluxtubes of magnetic fields on atoms and molecules becomes of great interest in theoretical and applicational *plasmachemistry*. Possible applications are conceivable for the new chemical species of magnecules.

As a result of the action of a very strong magnetic field, atoms attain a great binding energy as compared to the case of zero magnetic field. Even at intermediate $B \simeq B_0$, the binding energy of atoms greatly deviates from that of the zero-field case, and even lower field intensities may essentially affect chemical properties of molecules of heavy atoms. This occurrence permits the creation of various other bound states in molecules, clusters and bulk matter [9, 11, 12].

The paper by Lai [12] is focused on very strong magnetic fields, $B \gg B_0$, motivated by astrophysical applications, and provides a good survey of the early and recent studies in the field, including studies on the intermediate range, $B \simeq B_0$, multi-electron atoms, and H_2 molecule. Several papers using variational/numerical and/or analytical approaches to the problem of light and heavy atoms, ions, and H_2 molecule in strong magnetic field, have been published within the last years (see, e.g., references in [12]). However, highly magnetized molecules of heavy atoms have not been systematically investigated until Santilli's proposal for the new species of magnecules [1]. One of the surprising implications is that for some diatomic molecules of heavy atoms, the molecular binding energy is predicted to be several times bigger than the ground state energy of individual atom [13].

To estimate the intensity of the magnetic field which causes considerable deformation of the ground state electron orbit of the H atom, one can formally compare Bohr radius of the H atom in the ground state, in zero external magnetic field, $a_0 = \hbar^2/me^2 \simeq 0.53 \cdot 10^{-8}$ cm $= 1$ a.u., with the radius of orbit of a single electron moving in the external static uniform magnetic field $\vec{B}$.

The mean radius of the orbital of a single electron moving in a static uniform magnetic field can be calculated exactly by using Schrödinger's equation, and it is given by

$$R_n = \sqrt{\frac{n + 1/2}{\gamma}}, \tag{11.A.1}$$

where $\gamma = eB/2\hbar c$, B is intensity of the magnetic field pointed along the z axis, $\vec{B} = (0, 0, B)$, $\vec{r} = (r, \varphi, z)$ in cylindrical coordinates, and $n = 0, 1, \ldots$ is the principal quantum number. Thus, the radius of the orbit takes *discrete* set of values (10.A), and is referred to as Landau radius. This is in contrast to well

known *classical* motion of electrons in an external magnetic field, with the radius of the orbit being of a continuous set of values.

The energy levels E_n of a single electron moving in said external magnetic field are referred to as Landau energy levels,

$$E_n = E_n^{\perp} + E_{k_z}^{\parallel} = \hbar\Omega(n + \frac{1}{2}) + \frac{\hbar^2 k_z^2}{2m}, \qquad (11.A.2)$$

where $\Omega = eB/mc$ is so called cyclotron frequency, and $\hbar k_z$ is a projection of the electron momentum $\hbar\vec{k}$ on the direction of the magnetic field, $-\infty < k_z < \infty$, m is mass of electron, and $-e$ is charge of electron.

Landau's energy levels $E_n^{\perp}$ correspond to a discrete set of round orbits of the electron which are projected to the transverse plane. The energy $E_{k_z}^{\parallel}$ corresponds to a free motion of the electron in parallel to the magnetic field (*continuous* spectrum), with a conserved momentum $\hbar k_z$ along the magnetic field.

In regard to the above review of Landau's results, we recall that in the general case of a *uniform* external magnetic field the coordinate and spin components of the total wave function of the electron can always be separated.

The corresponding coordinate component of the total wave function of the electron, obtained as an exact solution of Schrödinger equation for a single electron moving in the external magnetic field with vector-potential chosen as $A_r = A_z = 0$, $A_\varphi = rB/2$,

$$-\frac{\hbar^2}{2m}\left(\partial_r^2 + \frac{1}{r}\partial_r + \frac{1}{r^2}\partial_\varphi^2 + \partial_z^2 - \gamma^2 r^2 + 2i\gamma\partial_\varphi\right)\psi = E\psi, \qquad (11.A.3)$$

is of the following form [9]:

$$\psi_{n,s,k_z}(r,\varphi,z) = \sqrt{2\gamma}I_{ns}(\gamma r^2)\frac{e^{il\varphi}}{\sqrt{2\pi}}\frac{e^{ik_z z}}{\sqrt{L}}, \qquad (II.A.4)$$

where $I_{ns}(\rho)$ is Laguerre function,

$$I_{ns}(\rho) = \frac{1}{\sqrt{n!s!}}e^{-\rho/2}\rho^{(n-s)/2}Q_s^{n-s}(\rho); \qquad (II.A.5)$$

Q_s^{n-s} is Laguerre polynomial, L is normalization constant, $l = 0, \pm1, \pm2, \ldots$ is azimuthal quantum number, $s = n - l$ is radial quantum number, and $\rho = \gamma r^2$.

Spin components of the total wave function are trivially given by

$$\psi(\frac{1}{2}) = \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \quad \psi(-\frac{1}{2}) = \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \qquad (II.A.6)$$

with the corresponding energies $E_{spin} = \pm\mu_0 B$, to be added to the energy (10.A); $\mu_0 = e\hbar/2mc$ is Bohr magneton.

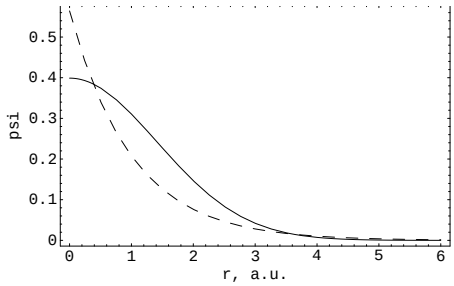

Figure 10.A.1. Landau's ground state wave function of a single electron, ψ_{000} (solid curve), Eq. (10.A), in a strong external magnetic field $B = B_0 = 2.4 \cdot 10^9$ Gauss, as function of the distance r in cylindrical coordinates, and (for a comparison) the hydrogen ground state wave function (at *zero* external magnetic field), $(1/\sqrt{\pi})e^{-r/a_0}$ (dashed curve), as function of the distance r in spherical coordinates. The associated probability densities are shown in Fig. **??**; 1 a.u. $= a_0 = 0.53 \cdot 10^{-8}$ cm.

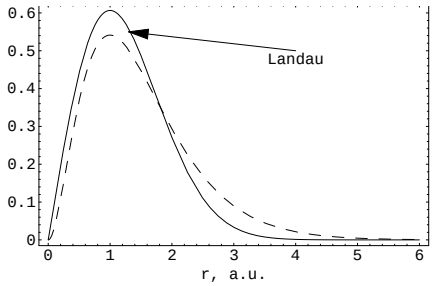

Figure 10.A.2. Probability density for the case of Landau's ground state of a single electron, $2\pi r|\psi_{000}|^2$ (solid curve), Eq. (10.A), in a strong external magnetic field $B = B_0 = 2.4 \cdot 10^9$ Gauss, as a function of the distance r in cylindrical coordinates, and (for a comparison) the probability density of the hydrogen atom ground state (at *zero* external magnetic field), $4\pi r^2|(1/\sqrt{\pi})e^{-r/a_0}|^2$ (dashed curve), as function of the distance r in spherical coordinates. The associated wave functions are shown in Fig. 10.A.1; 1 a.u. $= 0.53 \cdot 10^{-8}$ cm.

For the *ground* Landau level, i.e. at $n = 0$ and $s = 0$, and zero momentum of electron in the z-direction, i.e. $\hbar k_z = 0$, we have from (10.A)

$$E_0^{\perp} = \frac{e\hbar B}{2mc}, \tag{$II.A.7$}$$

and due to Eq. (10.A) the corresponding normalized ground state wave function is

$$\psi_{000}(r, \varphi, z) = \psi_{000}(r) = \sqrt{\frac{\gamma}{\pi}}\, e^{-\gamma r^2/2}, \tag{$II.A.8$}$$

$\int_0^{\infty}\int_0^{2\pi} r dr d\varphi \; |\psi_{000}|^2 = 1.$

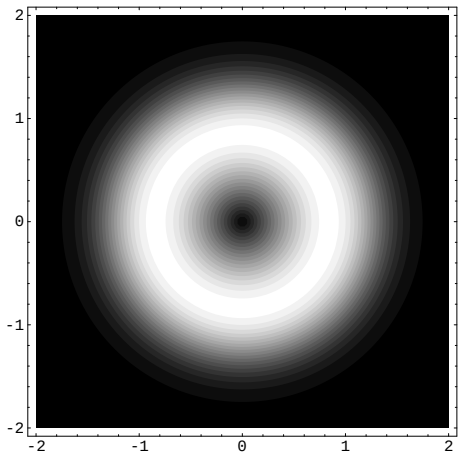

Figure 10.A.3. Contour plot of the (r, φ) probability density for the case of Landau's ground state of a single electron, $2\pi r|\psi_{000}|^2$, Eq. (10.A), in strong external magnetic field $B = B_0 = 2.4 \cdot 10^9$ Gauss, as a function of the distance in a.u. (1 a.u. $= 0.53 \cdot 10^{-8}$ cm). The lighter area corresponds to a bigger probability of finding the electron. The set of maximal values of the probability density is referred to as an "orbit".

The corresponding (smallest) Landau's radius of the orbit of electron is

$$R_0 = \sqrt{\frac{\hbar c}{eB}} \equiv \sqrt{\frac{1}{2\gamma}}, \qquad (II.A.9)$$

in terms of which ψ_{000} reads

$$\psi_{000} = \sqrt{\frac{1}{2\pi R_0^2}}\; e^{-\frac{r^2}{4R_0^2}}. \qquad (II.A.10)$$

Figure 10.A.1 depicts Landau's ground state wave function of a single electron, ψ_{000}, in the strong external magnetic field $B = B_0 = 2.4 \cdot 10^9$ Gauss ($R_0 = 1$ a.u.), and (for a comparison) of the hydrogen ground state wave function, at *zero* external magnetic field, $(1/\sqrt{\pi})e^{-r/a_0}$. Figures 10.A.2 and 10.A.3 display the associated probability density of the electron as a function of the distance r from the center of the orbit, the radius of which is about 1 a.u.

The condition that Landau's radius is smaller than Bohr's radius, $R_0 < a_0$ (which is adopted here as the condition of a considerable "deformation" of the electron orbit of the H atom) then implies

$$B > B_0 = \frac{m^2 c e^3}{\hbar^3} = 2.351 \cdot 10^9 \text{ Gauss}, \qquad (II.A.11)$$

where m is mass of electron. Equivalently, this deformation condition corresponds to the case when the binding energy of the H atom, $|E_0^{Bohr}| = |-me^4/2\hbar^2| = 0.5$ a.u. = 13.6 eV, is smaller than the ground Landau energy $E_0^{\perp}$.

The above critical value of the magnetic field, B_0, is naturally taken as an *atomic unit* for the strength of the magnetic field, and corresponds to the case when the pure Coulomb interaction energy of the electron with nucleus is equal to the interaction energy of the single electron with the external magnetic field, $|E_0^{Bohr}| = E_0^{\perp} = 13.6$ eV, or equivalently, when Bohr radius is equal to Landau radius, $a_0 = R_0 = 0.53 \cdot 10^{-8}$ cm.

It should be stressed here that the characteristic parameters, Bohr's energy $|E_0^{Bohr}|$ and Bohr's radius a_0, of the H atom have the purpose to establish a criterium for the critical strength of the external magnetic field of the hydrogen atom under the conditions here considered. For other atoms the critical value of the magnetic field may be evidently different.

After outlining the quantum dynamics of a single electron in an external magnetic field, Aringazin [8] turns to the consideration of the H atom under an external static uniform magnetic field.

In the cylindrical coordinate system (r, φ, z), in which the external magnetic field is $\vec{B} = (0, 0, B)$, i.e., the magnetic field is directed along the z-axis, Schrödinger's equation for an electron moving around a fixed proton (Born-Oppenheimer approximation) in the presence of the external magnetic field is given by

$$-\frac{\hbar^2}{2m}\left(\partial_r^2 + \frac{1}{r}\partial_r + \frac{1}{r^2}\partial_\varphi^2 + \partial_z^2 + \frac{2me^2}{\hbar^2\sqrt{r^2+z^2}} - \gamma^2 r^2 + 2i\gamma\partial_\varphi\right)\psi = E\psi, \tag{II.A.12}$$

where $\gamma = eB/2\hbar c$.

The main problem in the nonrelativistic study of the hydrogen atom in an external magnetic field is to solve the above Schrödinger equation and find the energy spectrum. This equation is not analytically tractable so that one is led to use approximations.

In the approximation of a *very* strong magnetic field, $B \gg B_0 = 2.4 \cdot 10^9$ Gauss, Coulomb interaction of the electron with the nucleus is not important, in the transverse plane, in comparison to the interaction of the electron with external magnetic field. Therefore, in accord to the exact solution (10.A) for a single electron, one can look for an approximate ground state solution of Eq. (10.A.3) in the form of factorized transverse and longitudinal parts,

$$\psi = e^{-\gamma r^2/2}\chi(z), \tag{II.A.13}$$

where $\chi(z)$ is the longitudinal wave function to be found. This is so called *adiabatic approximation*. In general, the adiabatic approximation corresponds to the case when the transverse motion of electron is totally determined by the

intense magnetic field, which makes the electron "dance" at its cyclotron frequency. Specifically, the radius of the orbit is then *much smaller* than Bohr radius, $R_0 \ll a_0$. The remaining problem is thus to find longitudinal energy spectrum, in the z direction.

Inserting tehe wave function (10.A.3) into the Schrödinger equation (10.A.3), multiplying it by ψ^*, and integrating over variables r and φ in cylindrical coordinate system, one gets the following equation characterizing the z dependence of the wave function:

$$\left(-\frac{\hbar^2}{2m}\frac{d^2}{dz^2} + \frac{\hbar^2\gamma}{m} + C(z)\right)\chi(z) = E\chi(z), \qquad (II.A.14)$$

where

$$C(z) = -\sqrt{\gamma}\, e^2 \int_0^\infty \frac{e^{-\rho}}{\sqrt{\rho + \gamma z^2}}\, d\rho = -e^2\sqrt{\pi\gamma}\, e^{\gamma z^2}[1 - \mathrm{erf}(\sqrt{\gamma}|z|)], \qquad (II.A.15)$$

where $\mathrm{erf}(x)$ is the error function.

The arising effective potential $C(z)$ is of a nontrivial form, which does not allow to solve Eq. (10.A.3) analytically, so one can approximate it by simple potentials, to make an estimation on the ground state energy and wave function of the H atom.

At high intensity of the magnetic field, $\gamma \gg 1$ so that under the condition $\gamma\langle z^2\rangle \gg 1$ one can ignore ρ in the square root in the integrand in Eq. (10.A.3). Then, one can perform the simplified integral and obtain the result

$$C(z) \simeq V(z) = -\frac{e^2}{|z|}, \quad \text{at } \gamma\langle z^2\rangle \gg 1, \qquad (II.A.16)$$

which appears to be a pure Coulomb interaction of electron with the nucleus, in the z direction. Due to the exact result (10.A.3), $C(z)$ tends to zero as $z \to \infty$. However, a remarkable implication of the exact result is that $C(z)$ is *finite* at $z = 0$, namely, $C(0) = -\sqrt{\pi\gamma}\, e^2$, so that the effective potential $C(z)$ can *not* be well approximated by the Coulomb potential.

The exact potential $C(z)$ can be well approximated by the *modified* Coulomb potential,

$$C(z) \simeq V(z) = -\frac{e^2}{|z| + z_0}, \qquad (II.A.17)$$

where z_0 is a parameter, $z_0 \neq 0$, which depends on the field intensity B due to

$$z_0 = -\frac{e^2}{C(0)} = \frac{1}{\sqrt{\pi\gamma}} = \sqrt{\frac{2\hbar c}{\pi e B}}. \qquad (II.A.18)$$

The analytic advantage of this approximation is that $V(z)$ is *finite* at $z = 0$, being of Coulomb-type form. Therefore, Eq. (10.A.3) reduces to *one-dimensional* Schrödinger equation for the Coulomb-like potential,

$$\left(\frac{\hbar^2}{2m}\frac{d^2}{dz^2} + \frac{e^2}{|z| + z_0} + \frac{\hbar^2\gamma}{m} + E\right)\chi(z) = 0. \qquad (II.A.19)$$

In the atomic units ($e = \hbar = m = 1$), using the notation

$$E' = \frac{\hbar^2\gamma}{m} + E, \quad n^2 = \frac{1}{-2E'}, \qquad (II.A.20)$$

introducing the new variable $x = 2z/n$, and dropping $x_0 = 2z_0/n$, to simplify representation, the above equation can be rewritten as

$$\left[\frac{d}{dx^2} + \left(-\frac{1}{4} + \frac{n}{x}\right)\right]\chi(x) = 0, \qquad (II.A.21)$$

where $x > 0$ is assumed. Introducing new function $v(x)$ defined as $\chi(x) = xe^{-x/2}v(x)$, one gets the final form of the equation,

$$xv'' + (2 - x)v' - (1 - n)v = 0. \qquad (II.A.22)$$

Noting that it is a particular case of Cummer's equation,

$$xv'' + (b - x)v' - av = 0, \qquad (II.A.23)$$

the general solution is given by

$$v(x) = C_1\,{}_1F_1(a, b, x) + C_2U(a, b, x), \qquad (II.A.24)$$

where

$${}_1F_1(a, b, x) = \frac{\Gamma(b)}{\Gamma(b - a)\Gamma(a)}\int_0^1 e^{xt}t^{a-1}(1 - t)^{b-a-1}\,dt \qquad (II.A.25)$$

and

$$U(a, b, x) = \frac{1}{\Gamma(a)}\int_0^\infty e^{-xt}t^{a-1}(1 + t)^{b-a-1}\,dt \qquad (II.A.26)$$

are the confluent hypergeometric functions, and $C_{1,2}$ are constants; $a = 1 - n$ and $b = 2$. Hence, for $\chi(x)$ one has

$$\chi(x) = (|x|+x_0)e^{-(|x|+x_0)/2}\left[C_1^{\pm}\,{}_1F_1(1 - n, 2, |x| + x_0) + C_2^{\pm}U(1 - n, 2, |x| + x_0)\right], \qquad (II.A.27)$$

where the parameter x_0 has been restored, and the "$\pm$" sign in $C_{1,2}^{\pm}$ corresponds to the positive and negative values of x, respectively (the modulus sign is used for brevity).

Let us consider first the $x_0 = 0$ case. The first hypergeometric function ${}_1F_1(1-n, 2, x)$ is finite at $x = 0$ for any n. At big x, it diverges exponentially, unless n is an integer number, $n = 1, 2, \ldots$, at which case it diverges polynomially. The second hypergeometric function $U(1-n, 2, x)$ behaves differently, somewhat as a mirror image of the first one. In the limit $x \to 0$, it is finite for integer $n = 1, 2, 3, \ldots$, and diverges as $1/x$ for noninteger $n > 1$ and for $0 \leq n < 1$. In the limit $x \to \infty$, it diverges polynomially for integer n, tends to zero for noninteger $n > 1$ and for $n = 0$, and diverges for noninteger $0 < n < 1$.

In general, because of the prefactor $xe^{-x/2}$ in the solution (10.A.3) which cancels some of the divergencies arising from the hypergeometric functions, we should take into account *both* of the two linearly independent solutions, to get the most general form of normalizable wave functions.

As a consequence, for $x_0 \neq 0$ the eigenvalues may *differ* from those corresponding to $n = 1, 2, \ldots$ (which is a counterpart of the principal quantum number in the ordinary hydrogen atom problem) so that n is allowed to take some *non-integer* values from 0 to ∞, provided that the wave function is normalizable.

For even states, in accord to the symmetry of wave function under the inversion $z \to -z$, one has

$$C_1^+ = C_1^-, \quad C_2^+ = C_2^-, \quad \chi'(0) = 0. \tag{$II.A.28$}$$

Also, since $n = 1$ gives $E' = -1/(2n^2) = -1/2$ a.u., one should seek normalizable wave function for n in the interval $0 < n < 1$, in order to achieve lower energy value. If successful, $n = 1$ indeed does not characterize the ground state. Instead, it may correspond to some excited state.

Analysis shows that *normalizable* wave functions, as a combination of *two* linearly independent solutions, for the modified Coulomb potential *does exist* for various *non-integer* n. Focusing on the ground state solution, Aringazin considers values of n ranging from 0 to 1. Remind that $E' = -1/2n^2$ so that for $n < 1$ the energy lower than $E' = -0.5$ a.u.

For $n < 1$, the first hypergeometric function is not suppressed by the prefactor $xe^{-x/2}$ in the solution (10.A.3) at large x so we are led to discard it as an unphysical solution by putting $C_1 = 0$. A normalizable ground state wave function for $n < 1$ is thus may be given by the second term in the solution (10.A.3). Indeed, the condition $\chi'(x)_{|x=0} = 0$ implies

$$\begin{aligned} \tfrac{1}{2}e^{-(x+x_0)/2}C_2[(2-x-x_0)U(1-n,2,x+x_0) - \\ -2(1-n)(x+x_0)U(2-n,3,x+x_0))]_{|x=0} = 0. \end{aligned} \tag{$II.A.29$}$$

The l.h.s of this equation depends on n and x_0, so one can select some field intensity B, calculate associated $x_0 = x_0(B)$ and find n, from which one obtains the ground state energy E'. On the other hand, for the ground state this condition can be viewed, *vice versa*, as an equation to find x_0 at some selected n.

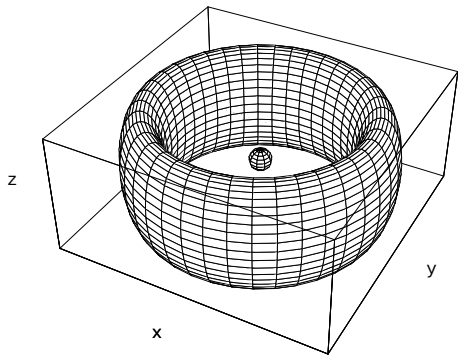

Figure 10.A.4. A schematic view on the H atom in the ground state under a very strong external magnetic field $\vec{B} = (0, 0, B)$, $B \gg B_0 = 2.4 \cdot 10^9$ Gauss, due to the *modified* Coulomb approximation studied in the text. The electron moves on the Landau orbit of small radius $R_0 \ll 0.53 \cdot 10^{-8}$ cm resulting in the toroidal structure used for the new chemical species of magnecules. The vertical size of the atom is comparable to R_0. The spin of the electron is antiparallel to the magnetic field.

For example, taking the noninteger value $n = 1/\sqrt{15.58} \simeq 0.253 < 1$ Aringazin found $x_0 = 0.140841$. This value is in confirmation with the result $x_0 = 0.141$ obtained by Heyl and Hernquist [14]. On the other hand, x_0 is related in accord to Eq. (10.A.3) to the intensity of the magnetic field, $x_0 = 2z_0/n$, from which one obtains $B \simeq 4.7 \cdot 10^{12}$ Gauss. Hence, at this field intensity the ground state energy of the hydrogen atom is determined by $n = 1/\sqrt{15.58}$.

The total ground state wave function is given by

$$\psi(r, \varphi, x) \simeq \sqrt{\frac{1}{2\pi R_0^2}} e^{-\frac{r^2}{4R_0^2}} (|x| + x_0) e^{(|x|+x_0)/2} U(1 - n, 2, |x| + x_0), \quad (II.A.30)$$

where n is determined due the above procedure, and the associated three-dimensional probability density is schematically depicted in Fig. 10.A.4.

One can see that the problem remarkably difference than the ordinary three-dimensional problem of the hydrogen atom, for which the principal quantum number n must be integer to get normalizable wave functions, and the value $n = 1$ corresponds to the lowest energy.

The modified Coulomb potential approach provides qualitatively correct behavior, and suggests a *single* Landau-type orbit shown in Fig. 10.A.4 for the *ground* state charge distribution of the hydrogen atom. This is in full agreement with Santilli's study [1, 11] of the hydrogen atom in a strong magnetic field.

Accurate analytic calculation of the ground and excited hydrogen wave functions made by Heyl and Hernquist [14] in the adiabatic approximation leads to

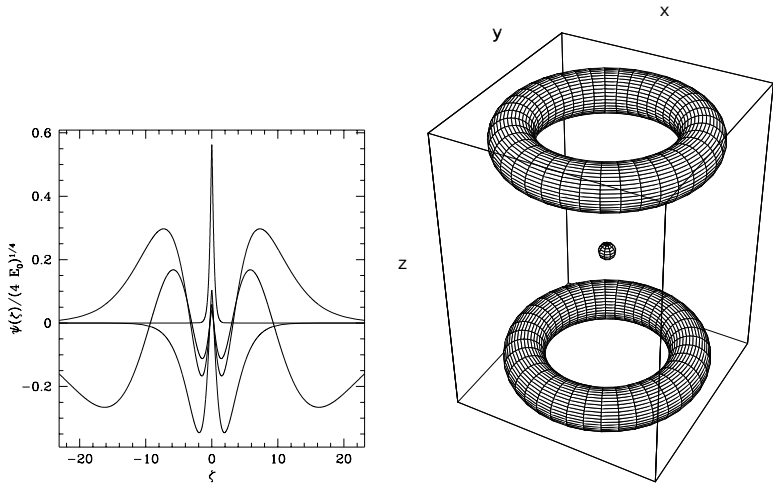

Figure 10.A.5. The axial wavefunctions of hydrogen in an intense magnetic field (analytic calculation) for $B = 4.7 \cdot 10^{12}$ Gauss. The first four even states with axial excitations, $|000\rangle$ (ground state), $|002\rangle$, $|004\rangle$, and $|006\rangle$ (left panel), and odd states $|001\rangle$ and $|003\rangle$ (right panel) are depicted; $n = 1/\sqrt{15.58}$, $\zeta = 2z/n$ corresponds to x in the used notation; z in a.u., 1 a.u. $= 0.53 \cdot 10^{-8}$ cm (reproduction of Figure 3 by Heyl and Hernquist [14]).

the longitudinal parts of the wave functions shown in Fig. 10.A.5, which reproduces the original Fig. 3 of their work; $\zeta = 2\pi\alpha z/\lambda_e$; $B = 4.7 \cdot 10^{12}$ Gauss. They used the modified Coulomb potential of the type (10.A.3), and the additional set of linearly independent solutions of the one-dimensional modified Coulomb problem in the form

$$(|x| + x_m)e^{-(|x|+x_m)/2}{}_1F_1(1-n, 2, |x| + x_m) \int^{|x|+x_m} \frac{e^t}{(t\,{}_1F_1(1-n, 2, t))^2}\, dt, \qquad (II.A.31)$$

where $m = 0$ corresponds to the ground state. For the ground state with $n = 1/\sqrt{15.58}$, they found $x_0 = 0.141$, which corresponds to $B = 4.7 \cdot 10^{12}$ Gauss. This result is in agreement with the study made above.

One can see from Fig. 10.A.5 that the peak of the ground state wave function $|000\rangle$ is at the point $z = 0$, while the largest peaks of the excited wave functions are away from the point $z = 0$ (as it was expected to be). Consequently, the associated longitudinal probability distributions (square modules of the wave functions multiplied by the volume factor of the chosen coordinate system) are symmetric with respect to $z \to -z$, and their maxima are placed in the center $z = 0$ for the ground state, and away from the center for the excited states. The computed ground state $|000\rangle$ binding energy of the hydrogen atom for different field intensities are [14]:

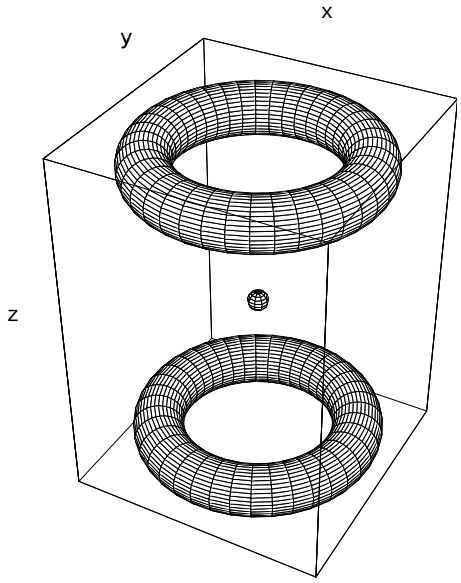

Figure 10.A.6. A schematic view on the H atom in an excited state under a very strong external magnetic field $\vec{B} = (0, 0, B)$, $B \gg B_0 = 2.4 \cdot 10^9$ Gauss. One electron moves simultaneously on two toroidal orbits of radius R_0 which are shown schematically as torii in the different $(x,\ y)$ planes, one torus at the level $z = -L_z$ and the other at the level $z = +L_z$, with the nucleus shown in the center at $z = 0$. Each torus represents the $(x,\ y)$ probability distribution as shown in Fig. 10.A.3 but with small Landau radius, $R_0 \ll a_0$. The spin of electron is aligned antiparallel to the magnetic field.

Magnetic field B (Gauss)	Binding energy, $\|000\rangle$ state (Rydberg)
4.7×10^{12}	15.58
9.4×10^{12}	18.80
23.5×10^{12}	23.81
4.7×10^{13}	28.22
9.4×10^{13}	33.21
23.5×10^{13}	40.75
4.7×10^{14}	47.20

Heyl and Hernquist calculated the first-order perturbative corrections to the above energies and obtained the values, which are in a good agreement with the results by Ruder *et al.* [9] and Lai [12].

The associated probability density of the above *excited* states is evidently of a cylindrical (axial) symmetry and can be described as *two* Landau orbits of radius R_0 in different (r, φ) planes, one at the level $z = -L_z$, and the other at the level $z = +L_z$, with the nucleus at $z = 0$, as schematically depicted in Fig. 10.A.6.

Presence of two Landau orbits occurs in accord to the excited wave functions, which is symmetrical with respect to the inversion, $z \to -z$, and the largest peaks of which are away from the center $x = 0$. The electron moves simultaneously on these two Landau orbits.

A review of approximate, variational, and numerical solutions can be found in the paper by Lai [12]. The accuracy of numerical solutions is about 3%, for the external magnetic field in the range from 10^{11} to 10^{15} Gauss. Particularly, due to the variational results [12], the z-size of the hydrogen atom in the ground state is well approximated by the formula $L_z \simeq [\ln(B/B_0)]^{-1}$ a.u.; the transverse (Landau) size is $L_\perp \simeq (B/B_0)^{-1/2}$ a.u.; and the ground state energy $E \simeq -0.16[\ln(B/B_0)]^2$ a.u., with the accuracy of few percents, for $b \equiv B/B_0$ in the range from 10^2 to 10^6. One can see for $B = 100B_0$, that the variational study predicts the ground state energy $E = -3.4$ a.u. $= -92.5$ eV, the transverse size $L_\perp$ of about 0.1 a.u. $= 0.53 \cdot 10^{-9}$ cm, and the z-size L_z of about 0.22 a.u. This confirms the result of the modified Coulomb analytic approach.

Since a zero-field ground state case is characterized by perfect spherically symmetric electron charge distribution in the H atom, intermediate intensities of the magnetic field are naturally expected to imply a distorted spherical distribution. However, a deeper analysis is required for the intermediate magnetic field intensities because the adiabatic approximation is not longer valid in this case.

As to the multi-electron atoms, an interesting problem is to study action of very strong external magnetic field on He atom (see. e.g., Refs. [12, 14]) and on the multi-electrons heavy atoms, with outer electrons characterized by a *nonspherical* charge distribution, such as the p-electrons in Carbon atom, orbitals of which penetrate the orbitals of inner electrons. In fact, a very intense magnetic field would force such outer electrons to follow *small round* toroidal orbits. In addition to the effect of a direct action of the magnetic field on the inner electrons, a series of essential rearrangements of the whole electron structure of the atom seems to occur with the variation of the field strength. The magnetic field competes with the Coulomb energy, which is different for different states of electrons, and with the electron-electron interactions, including spin pairings. However, it is evident that at sufficiently strong fields, all the electron spins are aligned antiparallel to the magnetic field — fully spin polarized configuration — while at lower field intensities various partial spin polarized configurations are possible.

In accord to the numerical calculations based on the density matrix theory by Johnsen and Yngvason [13], which is in good agreement with the Hartree-Fock treatment of a very strong magnetic field, the inner domain in iron atom (26 electrons) is characterized by a slightly distorted spherically symmetric distribution, even at the intensities as high as $B = 100B_0 \ldots 1000B_0$. The outer domain appears to be of specific, highly elongated distribution along the direction of the magnetic field as shown in Fig. 10.A.7. The possible interpretation that the inner

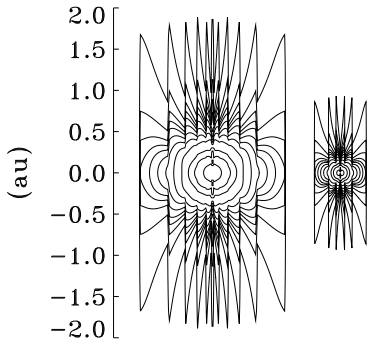

Figure 10.A.7. Contour plots of the (r, z) plane electronic density of iron atom according to the density matrix theory at two different magnetic field strengths, 10^{11} Gauss (left) and 10^{12} Gauss (right). The outermost contour encloses 99% of the negative charge, the next 90%, then 80% etc., and the two innermost 5% and 1% respectively (reproduction of Fig. 5 by Johnsen and Yngvason [13]).

electrons remain to have a spherical distribution while outer electrons undergo the squeeze seems to be not correct unless the spin state of the iron atom is verified to be partially polarized. So, we can conclude that all the electrons are in the highly magnetically polarized state (Landau state mixed a little by Coulomb interaction), and the electronic structure is a kind of *Landau multi-electron cylindrical shell*, with the spins of all the electrons being aligned antiparallel to the magnetic field (fully spin polarized configuration).

Another remark regarding Fig. 10.A.7 is that the contours indicating a nearly spherical distribution will always appear since the Coulomb center (nucleus) is not totally eliminated from the consideration (non-adiabatic approximation), and it forces a spherical distribution to some degree, which evidently depends on the distance from the center (closer to the center, more sphericity). We note that outer contours in Fig. 10.A.7 is in qualitative agreement with Fig. 10.A.6 in the sense that the predicted charge distribution reveals symmetry under the inversion $z \to -z$, with the characteristic z-elongated Landau-type orbits.

An interesting problem is to study H_2 molecule under the action of a strong external static uniform magnetic field using Schrödinger's equation. However, prior to that study, it would be useful to investigate the simpler two-center H_2^+ ion, since it can give valuable information on the features of the full hydrogen molecule under the action of a strong magnetic field. We refer the interested reader to Refs. [12, 14, 15] for studies on H_2^+ ion and H_2 molecule in strong magnetic field. Figure 10.A.8 displays the ground and first excited state wave functions of H_2^+ [14].

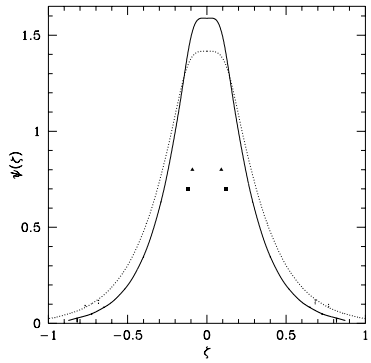

Figure 10.A.8. A schematic view of the ground and first-excited state of H_2^+ ion. The solid line traces $|000\rangle$, and the dashed line follows $|0\text{-}1\,0\rangle$. The triangles give the positions of the protons for the ground state and the squares for the excited state. The magnetic field $B = 4.7 \cdot 10^{12}$ Gauss is pointed along the internuclear axis; $\zeta = 2\pi\alpha z/\lambda_e$ denotes z in a.u.; 1 a.u. $= 0.53 \cdot 10^{-8}$ cm (reproduction of Figure 5 by Heyl and Hernquist [14]).

APPENDIX 10.A

Table 10.A.1. Basic units and their conversions.

1 kWh	860 Kcal = 3413 BTU	1 cf	28.3 liters
1 Kcal	3.97 BTU	1 cf[a]	1.263 mol
1 eV	3.83×10^{-23} Kcal	N_A	6.022×10^{23} mol^{-1}
1 cal	4.18 J	$N_Ak/2$	1 cal/(mol·K)
1 mole[a]	22.4 liters = 0.792 cf	R	8.314 J/(mol·K) = 1.986 cal/(mol·K)

[a] An ideal gas, at normal conditions.

Table 10.A.2. Specific heat capacities. $p = 1$ atm, $T = 25^o$ C.

H_2(gas)	29.83 J/(mol·K)	7 cal/(mol·K)	
H_2O (liquid)	4.18 J/(gram·K)	1 cal/(gram·K)	18 cal/(mol·K)
Graphite (solid)	0.71 J/(gram·K)	0.17 cal/(gram·K)	2 cal/(mol·K)
O_2 (gas)	29.36 J/(gram·K)	7 cal/(gram·K)	
H (gas)	14.3 J/(gram·K)	3.42 cal/(gram·K)	
O (gas)	0.92 J/(gram·K)	0.22 cal/(gram·K)	
Fe (solid)	0.45 J/(gram·K)	0.11 cal/(gram·K)	6 cal/(mol·K).

Table 10.A.3. Average binding energies, at T=25° C.

	Kcal/mol		*Kcal/mol*		*Kcal/mol*
H–H	104.2[a]	C=O	192.0[d]	O=O	119.1[b]
C–C	82.6	O–H	110.6	C=C	145.8
C–O	85.5	C≡C	199.6	C=O	255.8[c]

[a] in H_2; [b] in O_2; [c] in carbon monoxide; [d] in carbon dioxide.

Table 10.A.4. Evaporation heats and first ionization potentials.

	Kcal/mol	*Atoms*	*eV*
Water	10.4	H	13.6
Graphite	171.7	C	11.26
		O	13.6

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Chapter 11

INDUSTRIAL APPLICATIONS TO NEW CLEAN ENERGIES

11.1 IN PREPARATION - NOVEMBER 1, 2005

For a summary of the content of this chapter, consult

The Physics of New Clean Energies and Fuels According to Hadronic Mechanics, R. M. Santilli, Special issue of the Journal of New Energy, 318 pages (1998).

Foundations of Hadronic Chemistry with Applications to New Clean Energies and Fuels, R. M. santilli, Kluwer Academic Publishers, Boston-Dordrecht-London (2001).

Isodual Theory of Antimatter with Applications to Antigravity, Grand Unification and Cosmology, R. M. Santilli, Sprionger (in press)

Chapter 12

APPLICATION TO ANTIGRAVITY

12.1 THEORETICAL PREDICTIONS OF ANTIGRAVITY

12.1.1 Introduction

Antigravity is one of the most ancient dreams of mankind, that has stimulated the imagination of many researchers, from various engineering fields (see, e.g., Refs. [1,2] that also list patents), to the most advanced branches of physics (see the prediction of antigravity in supergravity theories [3,4] and proceedings [5] for other more recent approaches).

A comprehensive study of antigravity was conducted by the author in monograph [30]. In this chapter we essentially present an update of the content of Ref. [30].

An experiment on the gravity of antiparticles was considered by Fairbank and Witteborn [6] via low energy positrons in vertical motion. Unfortunately, the measurements could not conclusive because of interferences from stray fields, excessive upward kinetic energy of the positrons and other reasons.

Additional data on the gravity of antiparticles are those from the LEAR machine on antiprotons at CERN [7], although these data too are inconclusive because of the excessive energy of the antiprotons and other factors, including the care necessary to extend the gravity of antiprotons to all antiparticles pointed out in Chapter 2, the proved impossibility for quarks to experience gravity, let alone antigravity, and other factors.

Additional experiments on the gravity of antiparticles are based on neutron interferometry, such as the experiments by Testera [8], Poggiani [9] and others. These experiments are extremely sensitive and, as such, definite and conclusive results continue to be elusive. In particular, the latter experiments too deal with

antiprotons, thus inheriting the ambiguities of quark conjectures with respect to gravity, problems in the extension to other antiparticles, and other open issues.

All further data on the gravity of antiparticles known to this author are of indirect nature, e.g., via arguments based the equivalence principle (see, e.g., Ref. [10] and papers quoted therein). Note that the latter arguments do not apply under isoduality and will not be considered further.

A review on the status of our knowledge prior to isodual theories is available in Ref. [11], that includes an outline of the arguments against antigravity, such as those by Morrison, Schiff and Good. As we shall see, the latter arguments too cannon even be formulated under isodualities, let alone be valid.

We can therefore conclude by stating that at this writing there exists no experimental or theoretical evidence known to this author that is resolutory and conclusive either against or in favor of antigravity.

One of the most intriguing predictions of isoduality is the existence of *antigravity* conceived as a reversal of the gravitational attraction, first theoretically submitted by Santilli in Ref. [12] of 1994.

The proposal consists of an experiment that is feasible with current technologies and permits a definite and final resolution on the existence or lack of the existence of the above defined antigravity.

These goals were achieved by proposing the test of the gravity of positrons in horizontal flight on a vacuum tube. The experiment is resolutory because, for the case of a 10 m long tube and very low kinetic energy of the positrons (of the order of μeV), the displacement of the positrons due to gravity is sufficiently large to be visible on a scintillator to the naked eye.

Santilli's proposal [12] was studied by the experimentalist Mills [13] to be indeed feasible with current technology, resolutory and conclusive.

The reader should be aware from these introductory lines that *the prediction of antigravity exists, specifically, for the isodual theory of antimatter and not for conventional treatment of antiparticles.*

For instance, no prediction of antigravity can be obtained from Dirac's hole theory or, more generally, for the treatment of antimatter prior to isoduality, that solely occurring in second quantization.

Consequently, antigravity can safely stated to be the ultimate test of the isodual theory of antimatter.

In this chapter, we study the prediction of antigravity under various profiles, we review the proposed resolutory experiment, and we outline some of the far reaching implications that would follow from the possible experimental verification of antigravity, such as the consequential existence of a fully *Causal Time Machine,* although not for ordinary matter, but for an isoselfdual combination of matter and antimatter.

12.1.2 Newtonian and Euclidean Prediction of Antigravity

It is important to show that the prediction of antigravity can be first formulated at the most primitive possible level, that of Newtonian mechanics and its isodual. All subsequent formulations will be merely consequential.

The current theoretical scene on antigravity is dominated by the fact that, as it is well known, the Euclidean, Minkowskian and Riemannian geometries offer no realistic possibility to reverse the sign of a gravitational mass or of the energy of the gravitational field.

Under these conditions, existing theories can at best predict a decrease of the gravitational force of antiparticles in the field of matter (see Ref. [11] for a review of these conventional studies). In any case the decreased interaction, as such, remains attractive.

Isodual mathematical and physical theories alter this scientific scene. In fact, antigravity is predicted by the interplay between the classical Euclidean geometry and its isodual. The resulting prediction of antigravity persists at all levels, that is, for flat and curved spaces and for classical or quantum formulations, in a fully consistent way without known internal contradictions.

Also, antigravity is a simple consequence of Corollary 2.3.1 according to which the observed trajectories of antiparticles under a magnetic field are the *projection* in our spacetime of inverted trajectories in isodual spacetime.

Once these aspects are understood, the prediction of antigravity becomes so simple to appear trivial. In fact, antigravity merely originates from the projection of the gravitational field of matter in that of antimatter and vice-versa. We therefore have the following:

PREDICTION 13.1.1 [11,15]: *The existence of antigravity, defined as a gravitational repulsion experienced by isodual elementary particles in the field of matter and vice-versa, is a necessary consequence of a consistent classical description of antimatter.*

Let us begin by studying this prediction in Euclidean and isodual Euclidean spaces. Consider the Newtonian gravitational force of two conventional (thus, positive) masses m_1 and m_2

$$F = -G \times m_1 \times m_2/r < 0, \quad G, m_1, m_2 > 0, \tag{13.1.1}$$

where G is the gravitational constant and the minus sign has been used for similarity with the Coulomb law.

Within the context of conventional theories, the masses m_1 and m_2 remain positive irrespective of whether referred to a particle or an antiparticle. This yields the well known "universal law of Newtonian attraction", namely, the predic-

tion that the gravitational force is attractive irrespective of whether for particle-particle, antiparticle-antiparticle or particle-antiparticle.

Again, the origin of this prediction rests in the assumption that antiparticles exist in our spacetime, thus having positive masses, energy and time. Under isoduality the situation is different. For the case of antiparticle-antiparticle under isoduality we have the different law

$$F^d = -G^d \times^d m_1^d \times^d m_2^d /^d r^d > 0, \quad G^d, m_1^d, m_2^d < 0. \tag{13.1.2}$$

But this force exists in the different isodual space and is defined with respect to the negative unit -1. Therefore, isoduality correctly represents the *attractive* character of the gravitational force between two isodual particles.

The case of particle-antiparticle under isoduality requires the *projection* of the isodual particle in the space of the particle (or vice versa), and we have the law

$$F = -G \times m_1 \times m_2^d / r > 0, \tag{13.1.3}$$

that now represents a *repulsion,* because it exists in our spacetime with unit $+1$, and it is opposite to force (13.1.1). This illustrates antigravity as per Prediction 13.1.1 when treated at the primitive Newtonian level.

Similarly, if we project the particle in the spacetime of the antiparticle, we have the different law

$$F^d = -G^d \times^d m_1^d \times^d m_2 /^d r^d < 0, \tag{13.1.4}$$

that also represents *repulsion* because referred to the unit -1.

We can summarize the above results by saying that *the classical representation of antiparticles via isoduality renders gravitational interactions equivalent to the electromagnetic ones, in the sense that the Newtonian gravitational law becomes equivalent to the Coulomb law, thus necessarily including both attraction and repulsions.*

The restriction in Prediction 13.1.1 to "elementary" isodual particles will soon turn out to be crucial in separating science from its political conduct, and *de facto* restricts the experimental verification of antigravity to positrons in the field of Earth.

Note also that Prediction 13.1.1 is formulated for "isodual particles" and *not* for antiparticles. This is due to the fact indicated in preceding sections that, according to current terminologies, antiparticles are defined in our spacetime and have positive masses, energy and time. As such, no antigravity of any type is possible for antiparticles as conventionally understood.

12.1.3 Minkowskian and Riemannian Predictions of Antigravity

It is important to verify the above prediction at the classical relativistic and gravitational levels.

Let $M(x,\eta,R)$ be the conventional Minkowskian spacetime with coordinates $x=(r,t)$ (as a column) and metric $\eta=Diag.(1,1,1,-1)$ over the field of real numbers $R(n,+,\times)$ with unit $I=Diag.(1,1,1,1)$. The *Minkowski-Santilli isodual space* [16] is given by (Section 2.2.8)

$$M^d(x^d,\eta^d,R^d),\ \ x^d=-x^t,\ \ \eta^d=Diag.(-1,-1,-1,+1), \tag{13.1.5a}$$

$$I^d=Diag.(-1,-1,-1,-1). \tag{13.1.5b}$$

The *isodual electromagnetic field* on $M^d(x^d,\eta^d,R^d)$ is given by

$$F^d_{\mu\nu}=\partial^d_\nu A^d_\mu-\partial^d_\mu A^d_\nu=-F^d_{\nu\mu},\quad \mu,\nu=1,2,3,4, \tag{13.1.6}$$

with *isodual energy-momentum tensor*

$$T^d_{\mu\nu}=(1^d/^d4^d\times m^d)\times^d[F^{d\,\alpha}_\mu\times^d F^d_{\alpha\nu}+$$

$$+(1^d/^d4^d)\times^d g^d\times^d F^d_{\alpha\beta}\times^d F^{d\,\alpha\beta}]=-T^t_{\nu\mu}, \tag{13.1.7}$$

where g is a known constant depending on the selected unit (whose explicit value is irrelevant for this study). Most importantly, the fourth component of the isodual energy-momentum tensor is negative-definite,

$$T^d_{00}<0. \tag{13.1.8}$$

As such, antimatter represented in isodual Minkowski geometry has negative-definite energy, and other physical characteristics, and evolves backward in time. It is an instructive exercise for the interested reader to prove that the results of the Newtonian analysis of the preceding section carry over in their entirety to the Minkowskian formulation [16].

Consider now a Riemannian space $\mathcal{R}(x,g,R)$ in (3+1)-dimensions with space-time coordinates x and metric $g(x)$ over the reals R with basic unit $I=Diag.(1,1,1,1)$ and related Riemannian geometry as presented, e.g., in Refs. [10,17]. As outlined in Section 2.1.7, the *isodual iso-Riemannian spaces* are given by

$$\mathcal{R}^d(x^d,g^d,R^d):x^d=-x^t,\ \ g^d(x^d)=-g^t(-x^t), \tag{13.1.9a}$$

$$I^d=Diag.(-1,-1,-1,-1). \tag{13.1.9b}$$

Recall that a basic drawback in the use of the Riemannian geometry for the representation of antiparticles is the positive-definite character of its energy-momentum tensor.

In fact, this character causes unsolved inconsistencies at all subsequent levels of study of antimatter, such as lack of a consistent quantum image of antiparticles.

These inconsistencies are resolved *ab initio* under isoduality. In fact, the isodual Riemannian geometry is defined over the isodual field of real numbers R^d for which the norm is negative-definite (Section 2.2.1).

As a result, all quantities that are positive in Riemannian geometry become negative under isoduality, thus including the energy-momentum tensor. In particular, energy-momentum tensors in the Riemannian geometry are given by relativistic expression (2.1.49*i*) and, as such, they remain negative-definite when treated in a Riemannian space.

It then follows that in the isodual Riemannian treatment of the gravity of antimatter, all masses and other quantities are negative-definite, including the *isodual curvature tensor,* Eq. (2.1.49*c*).

Despite that, the gravitational force between antimatter and antimatter remain *attractive,* because said negative curvature is measured with a negative unit.

As it was the case at the preceding Euclidean and Minkowskian levels, the isodual treatment of the gravitation of matter-antimatter systems requires its projection *either* in our spacetime *or* in the isodual spacetime. This again implies a *negative curvature in our spacetime* [16] resulting in Prediction 13.1.1 of antigravity at the classical Riemannian level too.

12.1.4 Prediction of Antigravity from Isodual Einstein's Gravitation

Einstein's gravitation is generally defined (see, e.g., Ref. [10]) as the reduction of gravitation in the exterior problem in vacuum to pure curvature in a Riemannian space $\mathcal{R}(x, g, R)$ with local spacetime coordinates x and metric $g(x)$ over the field of real numbers R *without a source,* according to the celebrated field equations

$$G_{\mu\nu} = R_{\mu\nu} - g_{\mu\nu} \times R/2 = 0, \tag{13.1.10}$$

where $G_{\mu\nu}$ is generally referred to as the *Einstein tensor,* $R_{\mu\nu}$ is the *Ricci tensor,* and R is the *Ricci scalar.*

As it is well known, *Einstein's conception of gravitation as above identified does not permit antigravity,* and this occurrence has been a motivation for the absence of serious experimental studies in the field, as indicated in Section 1.4.1.

However, we have indicated in preceding chapters that *the problem of antigravity cannot be confidently formulated, let alone treated, in Einstein's gravitation, due to the impossibility of consistently treating antimatter.*

As indicated earlier, the only possible formulation of antimatter is that by *only* changing the sign of the charge. However, this formulation is inconsistent with quantization since it leads to particles, rather than antiparticles, with the wrong sign of the charge.

At any rate, *the most important formulation of the gravity of antimatter is that for astrophysical bodies with null total charge, as expected for an antimatter star or an antimatter neutron star.*

The impossibility for any credible treatment of antimatter is then established by the fact that *according to Einstein's conception of gravitation the gravitational*

fields equations for matter and antimatter stars with null total charge are identical.

These inconsistencies are resolved by the isodual theory of antimatter because it implies the novel *isodual field equations for antimatter* defined on the isodual Riemannian space [16] $\mathcal{R}^d(x^d, g^d, R^d)$ with local isodual spacetime coordinates $x^d = -x^t$ and isodual metric $g^d(x^d) = -g^t(-x^t)$ over the isodual field of real numbers R^d

$$G^d_{\mu\nu} = R^d_{\mu\nu} - g^d_{\mu\nu} \times R^d /^d 2^d = 0. \tag{13.1.11}$$

The latter representation is based on a negative-definite energy-momentum tensor, thus having a consistent operator image, as shown in Chapter 3.

We, therefore, conclude this analysis with the following:

THEOREM 13.1.1 : Antigravity is a necessary and sufficient condition for the existence of a classical formulation of antimatter compatible with its operator counterpart.

Proof. Assume the validity of Einstein's gravitation for matter and its isodual for antimatter. Then, the former has a positive curvature tensor and the latter has a negative curvature tensor.

Therefore, the projection of the gravitational field of antimatter in the spacetime of matter implies a negative curvature tensor in our spacetime, namely, antigravity, or, vice-versa, a positive curvature tensor in the isodual spacetime, that is also repulsive, and this proves the sufficiency. The necessity comes from the fact that the only formulation of antimatter compatible with operator counterparts is that based on negative energies and masses.

In turn, geometric formulations of negative energies and masses necessarily imply, for consistency, a negative curvature tensor. Still in turn, when projected in the space of matter, a negative curvature necessarily implies antigravity and the same occurs for the projection of matter in the field of antimatter. **q.e.d.**

12.1.5 Identification of Gravitation and Electromagnetism

In addition to the above structural inability by Einstein's equations (13.1.10) to represent antimatter, Einstein's gravitation antimatter) is afflicted by a litany of inconsistencies for the treatment of *matter itself* studied in Section 1.4 whose resolution requires a number of structural revisions of general relativity.

It is important to show that the prediction of antigravity, not only persists, but it is actually reinforced for gravitational theories resolving the inconsistencies of Einstein's gravitation.

The first catastrophic inconsistency of Einstein's gravitation crucial for the problem of antigravity is that of Theorem 1.4.1 on the irreconcilable incompati-

bility between Einstein's lack of source in vacuum and the electromagnetic origin of mass.

As stressed in Section 1.4, this inconsistency is such that, either one assumes Einstein's gravitation as correct, in which case quantum electrodynamics must be reformulated from its foundation to prevent a first-order source in vacuum, or one assumes quantum electrodynamics to be correct, in which case Einstein's gravitation must be irreconcilably abandoned.

The second catastrophic inconsistency of Einstein's gravitation is that of Theorem 1.4.2 identifying the incompatibility of field equations (13.1.10) and the forgotten Freud identity of the Riemannian geometry,

$$R^\alpha_\beta - \frac{1}{2} \times \delta^\alpha_\beta \times R - \frac{1}{2} \times \delta^\alpha_\beta \times \Theta \ = \ U^\alpha_\beta + \partial V^{\alpha\rho}_\beta / \partial x^\rho \ = \ k \times (t^\alpha_\beta + \tau^\alpha_\beta), \quad (13.1.12)$$

where

$$\Theta \ = \ g^{\alpha\beta} g^{\gamma\delta} (\Gamma_{\rho\alpha\beta} \Gamma^\rho_{\gamma\beta} - \Gamma_{\rho\alpha\beta} \Gamma^\rho_{\gamma\delta}), \quad (13.1.13a)$$

$$U^\alpha_\beta \ = \ -\frac{1}{2} \frac{\partial \Theta}{\partial g^{\rho\alpha}_{|_\rho}} g^{\gamma\beta} \uparrow_\gamma, \quad (13.1.13b)$$

$$V^{\alpha\rho}_\beta \ = \ \frac{1}{2} [g^{\gamma\delta} (\delta^\alpha_\beta \Gamma^\rho_{\alpha\gamma\delta} - \delta^\rho_\beta \Gamma^\rho_{\alpha\delta}) +$$

$$+ (\delta^\rho_\beta g^{\alpha\gamma} - \delta^\alpha_\beta g^{\rho\gamma}) \Gamma^\delta_{\gamma\delta} + g^{\rho\gamma} \Gamma^\alpha_{\beta\gamma} - g^{\alpha\gamma} \Gamma^\rho_{\beta\gamma}]. \quad (13.1.13c)$$

The latter inconsistency requires the addition in the right-hand-side of Eqs. (13.1.10) of *two source tensors* for astrophysical bodies with null total charge.

As stressed in Section 1.4, the above two inconsistencies are deeply inter-related because complementary to each other, since the inconsistency of Theorem 1.4.2 is the dynamical counterpart of the inconsistency of Theorem 1.4.2 on geometric grounds.

A systematic study of the resolution of these inconsistencies was conducted by Santilli [18] in 1974.

The classical gravitational formulation of antimatter can be done in the *Riemannian-Santilli isodual space* $\mathcal{R}^d(x^d, g^d, R^d)$ studied in Sections 2.1.7 and 2.2.11.

To avoid catastrophic inconsistencies, the field equations of antimatter should be compatible with the basic geometric axioms of the isodual Riemannian geometry, including, most importantly, the *isodual Freud identity* [16], that can be written

$$R^{\alpha d}_\beta - \frac{1}{2}^d \times^d \delta^{\alpha d}_\beta \times^d R^d - \frac{1}{2}^d \times^d \delta^{\alpha d}_\beta \times^d \Theta^d = k^d \times^d (T^{d\alpha}_\beta + \Upsilon^{d\alpha}_\beta). \quad (13.1.14)$$

with corresponding isodualities for Eqs. (13.1.13) here assumed as known.

These studies then leads to the following:

PREDICTION 13.1.2: [18] IDENTIFICATION OF GRAVITATION AND ELECTROMAGNETISM. In the exterior problem in vacuum, gravitation coincides with the electromagnetic interactions creating the gravitational mass with field equations

$$G_{\mu\nu}^{Ext.} = R_{\mu\nu} - g_{\mu\nu} \times R/2 = k \times T_{\mu\nu}^{Elm}, \tag{13.1.15}$$

where the source tensor $T_{\mu\nu}^{Elm}$ *represents the contribution of all charged elementary constituents of matter with resulting gravitational mass*

$$m^{Grav} = \int d^3x \times T_{00}^{Elm}, \tag{13.1.16}$$

while in the interior problem gravitation coincides with electromagnetic interactions plus short range weak, strong and other interactions creating the inertial mass with field equations

$$G_{\mu\nu}^{Int.} = R_{\mu\nu} - g_{\mu\nu} \times R/2 = k \times (T_{\mu\nu}^{Elm} + \Upsilon_{\mu\nu}^{ShortRange}), \tag{13.1.17}$$

where the source tensor $\Upsilon_{\mu\nu}^{ShortRange}$ *represents all possible short range interactions in the structure of matter, with inertial mass*

$$m^{Inert} = \int d^3x \times (T_{00}^{Elm} + \Upsilon_{00}^{ShortRange}), \tag{13.1.18}$$

and general law

$$m^{Inert} > m^{Grav}. \tag{13.1.19}$$

The same identification of gravitation and electromagnetism then exists for antimatter with field equations and mass expressions given by a simple isodual form of the preceding ones.

A few comments are in order. All studies on the problem of "unification" of gravitation and electromagnetism prior to Ref. [18] known to this author[1] treated the two fields as *physically distinct*, resulting in the well known historical failures to achieve a consistent *unification* dating back to Albert Einstein (see next chapter for a detailed study). An axiomatically consistent theory emerges if gravitation and electromagnetism are instead "identified", as first done by Santilli [18] in 1974.

Also, Prediction 13.1.2 implies a *theory on the origin of the gravitational field,* rather than a theory providing its "description", as available in standard treatises such as [10]. This is due to the fact that in Prediction 13.1.2 *all* mass terms are completely eliminated and replaced with the fields originating mass.

[1]Again, the author would appreciate the indication of similar contributions prior to 1974.

In this way, the use of any mass term in any theory is an admission of our ignorance in the structure of the considered mass.

We should indicate for completeness that the identification of exterior gravitational and electromagnetic fields appears to be disproved by the assumption that quarks are physical constituents of hadrons, owing to the known large value of their "masses".

However, as indicated in Chapter 1, gravitation solely exists in our spacetime and cannot be consistently extended to mathematical unitary symmetries. Also, the only masses that can consistently create gravitation are those defined in our spacetime, thus necessarily being the eigenvalues of the second-order Casimir invariant of the Poincaré symmetry.

Since quarks cannot be defined in our spacetime, they cannot be consistently characterized by the Poincaré symmetry and their masses are not the eigenvalues of the second-order Casimir invariant of the latter symmetry, the use of quark masses has no scientific value in any gravitational profile. This is the reason why quark "masses" have been ignored in Ref. [18] as well as in this chapter.

It is well established in quantum electrodynamics that the mass of the electron is entirely of electromagnetic origin. Therefore, a gravitational theory of the electron in which the source term solely represents the charge contribution is incompatible with quantum electrodynamics. In fact, the latter requires *the entire reduction of the electron mass to electromagnetic fields* according to Eqs. (13.1.16).

Note in particular that, since the electron has a point-like charge, we have no distinction between exterior and interior problems with consequential identity

$$m^{Grav}_{Electron} \equiv m^{Inert}_{Electron}. \tag{13.1.20}$$

When considering a neutral, extended and composite particle such as the π°, the absence of a source tensor of electromagnetic nature renders gravitation, again, incompatible with quantum electrodynamics, as established in Ref. [18] and reviewed in Section 1.4.

By representing the π° as a bound state of a charged elementary particle and its antiparticle in high dynamical conditions, quantum electrodynamics establishes the existence not only of a non-null total electromagnetic tensor, but one of such a magnitude to account for the entire gravitational mass of the π° according to Eq. (13.1.16) and gravitational mass

$$m^{Grav}_{\pi^\circ} = \int d^3x \times T^{Elm}_{00\,\pi^\circ}. \tag{13.1.21}$$

Unlike the case of the electron, the π° particle has a very large charge distribution for particle standards. Moreover, the structure of the π° particle implies the additional weak and strong interactions, and their energy-momentum tensor is not traceless as it is the case for the electromagnetic energy-momentum tensor.

Therefore, for the case of the π° particle, we have a well-defined difference between exterior and interior gravitational problems, the latter characterized by Eqs. (13.1.18), i.e.,

$$m_{\pi^\circ}^{Inert} = \int d^3x \times (T_{00}^{Elm} + \Upsilon_{00}^{ShortRange}) \; > m_{\pi^\circ}^{Grav}. \tag{13.1.22}$$

The transition from the π° particle to a massive neutral star is conceptually and technically the same as that for the π°. In fact, the star itself is composed of a large number of elementary charged constituents each in highly dynamical conditions and, therefore, each implying a contribution to the total gravitational mass of the star as well as to its gravitational field.

The separation between exterior and interior problems, the presence of only one source tensor for the exterior problem and two source tensors for the interior problems, and the fact that the inertial mass is bigger than the gravitational mass is the same for both the π° and a star with null total charge.

For the case of a star we merely have an increased number of elementary charged constituents resulting in the expression [18]

$$m_{Star}^{Grav} = \Sigma_{p=1,2,3,...} \int d^3x \times T_{00}^{Elem.Constit.}. \tag{13.1.23}$$

Note that when the star has a non-null total charge there is no need to change field equations (13.1.15) since the contribution from the total charge is automatically provided by the constituents.

As it is well known, there exist numerous other theories on the identity as well as the possible differentiation of gravitational and inertial masses (see, e.g., Ref. [10]). However, these theories deal with exterior gravitational problems while the studies here considered deal with the interior problem, by keeping in mind that inertial masses are a strictly *interior* problem, the exterior problem providing at best a geometric abstraction.

Nevertheless, one should remember that all these alternative theories are crucially based on Einstein's gravitation, while the theory presented in this section is based on quantum electrodynamics. Therefore, *none of the existing arguments on the differences between gravitational and inertial masses is applicable to the theory here considered.*

Note finally that conventional electromagnetism is represented by a *first-order tensor*, the electromagnetic tensor $F_{\mu\nu}$ of type (2.2.37a) and related first-order Maxwell's equations (2.2.37b) and (2.2.37c).

When electromagnetism is identified with exterior gravitation, it is represented with a *second-order tensor,* the energy-momentum tensor $T_{\mu\nu}$ of type (13.1.7) and related second-order field equations (13.1.15).

12.1.6 Prediction of Antigravity from the Identification of Gravitation and Electromagnetism

Another aspect important for this study is that *the identification of gravitation and electromagnetism in the exterior problem in vacuum implies the necessary existence of antigravity.*

In fact, the identification implies the necessary equivalence of the phenomenologies of gravitation and electromagnetism, both of them necessarily experiencing attraction and repulsion.

Note that this consequence is intrinsic in the identification of the two fields and does not depend on the order of the field equations (that is first order for electromagnetism and second order for gravitation as indicated earlier.

Alternatively, for the exterior problem of matter we have the field equations on $\mathcal{R}(x, g, R)$ over R

$$G_{\mu\nu}^{Ext.} = R_{\mu\nu} - g_{\mu\nu} \times R/2 = k \times T_{\mu\nu}^{Elm}, \tag{13.1.24}$$

in which *the curvature tensor is positive,* and for the exterior problem of antimatter we have the isodual equations on $\mathcal{R}^d(x^d, g^d, R^d)$ over R^d

$$G_{\mu\nu}^{d,Ext.} = R_{\mu\nu}^d - g_{\mu\nu}^d \times R^d/2 = k \times T_{\mu\nu}^{d,Elm}, \tag{13.1.25}$$

in which *the curvature tensor is negative.*

The prediction of antigravity, Prediction 13.1.1, follows as a trivial extension of that of the preceding sections and occurs when the gravitational field of antimatter is projected in that of matter, or vice-versa, since such a projection implies a negative curvature in a Riemannian space that, by definition, is antigravity.

The prediction of antigravity is so strong that it is possible to prove that *the lack of existence of antigravity would imply the impossibility of identifying gravitation and electromagnetism.*

In turn, the lack of such identification would necessary require the impossibility for masses to have appreciable electromagnetic origin, resulting in the need for a structural revision of the entire particle physics of the 20-th century.

12.1.7 Prediction of Gravitational Repulsion for Isodual Light Emitted by Antimatter

Another important implication of the isodual theory of antimatter is the prediction that antimatter emits a new light, the *isodual light,* that experiences repulsion when in the vicinity of the gravitational field of matter, or vice-versa [19], where the *isodual electromagnetic waves* emitted by antimatter are given by Eqs. (2.3.37), i.e.,

$$F_{\mu\nu}^d \ = \ \partial^d A_\mu^d /^d \partial^d x^{\nu d} - \partial^d A_\nu^d /^d \partial^d x^{d\mu}, \tag{13.1.26a}$$

$$\partial^d_\lambda F^d_{\mu\nu} + \partial^d_\mu F^d_{\nu\lambda} + \partial^d_\nu F^d_{\lambda\mu} = 0, \tag{13.1.26b}$$

$$\partial^d_\mu F^{d\mu\nu} = -J^{d\nu}. \tag{13.1.26c}$$

The gravitational repulsion then emerges from the negative energy of the above isodual waves when in the field of matter. Vice versa, electromagnetic waves emitted by matter are predicted to experience antigravity when in the gravitational field of antimatter because they have a positive energy.

Note that *isodual electromagnetic waves coincide with conventional waves under all known interactions except gravitation.* Alternatively, the isodual electromagnetic waves requires the existence of antigravity at a pure classical level for their proper identification.

In turn, the experimental confirmation of the gravitational repulsion of light emitted by antimatter would have momentous astrophysical and cosmological implications, since it would permit for the first time theoretical and experimental studies as to whether far away galaxies and quasars are made up of matter or of antimatter.

It is important in this connection to recall that all relativistic quantum field equations admit solutions with positive and negative energies. As it is the case for Dirac's equations, relativistic field equations are generally isoselfdual, thus admitting solutions with both positive and negative energies.

The former are used in numerical predictions, but the negative-energy states are generally discarded because they are believed to be "unphysical".

The isodual theory implies a significant revision of the interpretation of quantum field theory because *the solutions of relativistic equations with positive energy are defined in our spacetime and represent particles, while the joint solutions with negative energy are actually defined on the isodual spacetime and represent antiparticles.*

This re-interpretation cannot be presented in this chapter for brevity. In fact, a systematic study of isodual photons requires the formulation of *isodual quantum field theory* that would render prohibitive the length of this chapter.

It is hoped that interested colleagues will indeed work out the proposed isodual quantum field theory, with particular reference to the isodual re-interpretation of advanced and retarded solutions, Green distributions, Feynman diagrams, and all that, because of various implications, such as those in conjugation of trajectories or in the transition from particles to antiparticles.

In closing, the reader should keep in mind that the isodual theory of antimatter resolves all conventional inconsistencies on negative energies as well as against antigravity (see also Section 2.3.15).

12.2 EXPERIMENTAL VERIFICATION OF ANTIGRAVITY

12.2.1 Santilli's Proposed Test of Antigravity for Positrons in Horizontal Flight

By far the most fundamental experiment that can be realized by mankind with current technologies is the measure of the gravitation of truly elementary antiparticles, such as the positron, in the field of Earth.

Irrespective of whether the outcome is positive or negative, the experiment will simply have historical implications for virtually all of physics, from particle physics to cosmology for centuries to come.

If antigravity is experimentally established, the location of the experiment is predicted to become a place of scientific pilgrimage for centuries, due to the far reaching implications, such as the consequential existence of a Causal Time Machine outlined later on in this chapter.

An inspection of the literature soon reveals that the problem of the *gravity of antiparticles in the field of Earth is fundamentally unsettled at this writing, thus requiring an experimental resolution.*

On theoretical grounds, all arguments based on the weak equivalence principle [10] are dismissed as inconclusive by the isodual theory of antimatter, since the latter predicts that bound states of particles and their isoduals experience *attraction* in the gravitational field of Earth.

At any rate, no argument against antigravity based on general relativity can be considered scientifically valid without first the resolution of the catastrophic inconsistencies of gravitation, such as those expressed by the various inconsistency theorems of Section 1.4.

Similarly, all experiments conducted to date on the test of the *gravity of antiparticles not bounded to matter* are equally inconclusive, to the author's best knowledge.[2] A direct measurement of the gravity of positrons was considered in 1967 by Fairbanks and Witteborn [6] via electrons and positrons in a *vertical* vacuum tube.

However, the test could not be conducted because preliminary tests with electrons discouraged the use of positrons due to excessive disturbances caused by stray fields, impossibility of ascertaining the maximal height of the electrons, and other problems.

Neutron interferometric measurements of the *gravity of antiprotons* have been studied by Testera [8], Poggiani [9] and others. However, these experiments are highly sophisticated, thus implying difficulties, such as those for securing

[2]The author would appreciate being kept informed by experimentalist in the field.

antiprotons with the desired *low energies,* magnetic trapping of the antiprotons, highly sensitive interferometric measurements of displacements, and others.

A number of important proposals to text the gravity of antimatter have been submitted to CERN and at other laboratories by T. Goldman, R. J. Hughes, M. M. Nieto, et al. [22–25], although no resolutory measurement has been conducted to date to the author best knowledge, perhaps in view of the excessive ambiguities for an accurate detection of the trajectories of antiparticles under Earth-s gravitational field in existing particle accelerators (see in this respect Figure 13.2).

Additional important references are those studying the connection between antigravity and quantum gravity [26–29], although the latter should be studied by keeping in mind Theorem 1.5.2 on the catastrophic inconsistencies of quantum gravity when realized via nonunitary structures defined on conventional Hilbert spaces and fields.[3]

In view of these unsettled aspects, an experiment that can be *resolutory* with existing technologies, that is, establishing in a final form either the existence of the lack of existence of antigravity, has been proposed by Santilli in Ref. [12] of 1994.

The experiment essentially requires a *horizontal* vacuum tube ranging from 100 meters in length and 0.5 meter in diameter to 10 m in length and 1 m in diameter depending on used energies, with axial collimators at one end and a scintillator at the other end as in Figure 13.1. The proposed test then consists in:

1) Measuring the location in the scintillator of lack of gravitational displacement via a collimated photon beam (since the gravitational displacement on photons at the considered distances is ignorable);

2) Measuring on the same scintillator the downward displacement due to Earth's gravity on an electron beam passing through the same collimators, which downward displacement is visible to the naked eyes for sufficiently small electron energies (for instance, we can have a downward displacement due to gravity of 5 mm, that is visible to the naked eye, for electron kinetic energies of 25 μeV along 100 m horizontal flight, or for electrons with 2 μeV along a 10 m horizontal flight); and

3) Measuring on the same scintillator the displacement due to Earth's gravity on a positron beam passing through the same collimators, which displacement is also visible to the naked eye for positron energies of the order of a few μeV.

If the displacement due to gravity of the positrons is downward, the test would establish the lack of existence of antigravity. On the contrary, the detection of an upward displacement of the positrons would establish the existence of antigravity.

[3]The author would like to express his sincere appreciation to T. Goldman for the courtesy of bringing to his attention the important references [22–29] that could not be reviewed here for brevity, but whose study is recommended as a necessary complement of the presentation of this monograph.

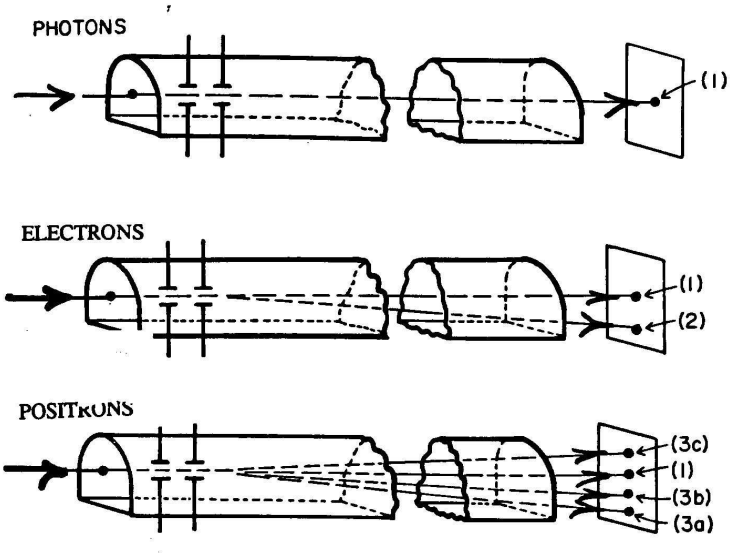

Figure 12.1. A schematic view of the proposal to test the gravity of positrons suggested by Santilli [12] in 1994 via a horizontal vacuum tube with a scintillator at the end in which a collimated beam of photons is used to identify the point in the scintillator of no displacement due to gravity, and collimated beams of very low energy electrons and, separately, positrons are used to measure displacements due to gravity. The latter are indeed visible to the naked eye for sufficiently low kinetic energy of the order of a few μeV. Santilli's proposal [12] was studied by the experimentalist J. P. Mills, jr. [13], as reviewed in the next section.

An alternative proposal was submitted by Santilli [20] via the use of the so-called *particle decelerator* in the shape of a doughnut of a diameter of about 10 m and 50 cm in sectional diameter (Figure 13.2). The main idea is that low energy beams of electrons and positrons could be *decelerated* via the use of magnetic fields down to the energy needed to achieve a displacement due to gravity sufficiently larger than the dispersion to be visible to naked eye, at which point the particles are released into a scintillator.

We have stressed throughout this presentation that the only experimental verification of the theoretical prediction of antigravity recommendable at this writing, is that for *truly elementary antiparticles in the gravitational field of matter without any bound to other particles,* such as an isolated beam of positrons under the gravitation field of Earth.

Other tests of antigravity, if conducted before the above tests with positrons and used for general claims on antigravity, can likely lead to ambiguities or a proliferations of unnecessary controversies.

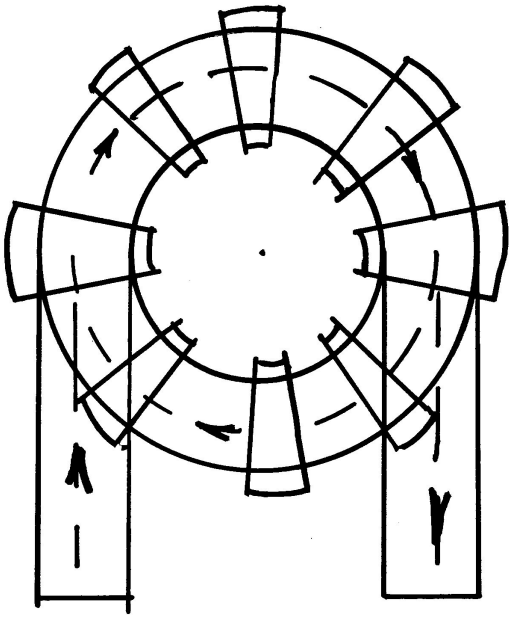

Figure 12.2. A schematic view of the alternative proposal submitted for study by the author [20] at the National High Magnetic Field Laboratory, Tallahassee, Florida, in December 1995. The main idea is to use the established techniques for "particle accelerators" for the construction of a "particle decelerator" that would slow down the initial energy of electron and positron beams down to the amounts needed to produce displacement due to gravity sufficiently bigger than the spread due to stray fields to produce a definite-resolutory answer visible to the naked eye. Suggested dimensions of the "particle decelerator" are 10 m in diameter with a sectional diameter of 0.5 m and two entrances-exits, one used for the entrance-exit of the electron beam and the other for the positron beam. The study conducted by Mills [13] for the horizontal tube indicates that the "particle decelerator" here considered is also feasible and will produce a resolutory answer.

The reasons for this restriction are numerous. Firstly, the study of the gravity of particle-antiparticle systems, such as a bound state of one electron and one positron at large mutual distances according to quantum mechanics (QM),

$$Positronium \ = \ (e^-, \ e^+)_{QM}, \tag{13.2.1}$$

is *strongly discouraged* for a first "test of antigravity", because all theories, including the isodual theory, predict attraction of the positronium in the field of matter. Therefore, under no condition can any possible experimental verification of this prediction be used as a credible claim on the lack of existence of antigravity at large.

Second, the above restriction eliminates the use of muons for a first test of antigravity, because, in view of their instability and decay modes, and as studied in detail in the next chapter, hadronic mechanics (HM) predicts that muons are a bound state of electrons and positrons in conditions of total mutual penetrations of their wavepackets at very short mutual distances,

$$\mu^{\pm} \ = \ (e^{-}, \ e^{\pm}, \ e^{+})_{HM}, \tag{13.2.2}$$

with consequential highly nonlocal effects structurally beyond any credible treatment by quantum mechanics. Under this structure, *both muons and antimuons are predicted to experience gravitational attraction only* because the possible antigravity of the positron is expected to be less than the gravity of basic electron-positron system.

A similar restriction applies against the use of mesons for first tests of antigravity because they are bound states of particles and antiparticles that, as such, are predicted not to experience antigravity in the field of matter. This is particularly the case for pions. Similarly, a first use of kaons for experiments on antigravity can only result in unnecessary controversies in view of their unsettled structure.

Serious reservation also exist for the first use of antiprotons and antineutrons due to their basically unsettled structure. As stressed earlier, the use of current quark conjecture prevents antiprotons and antineutrons to have any gravity at all, let alone antigravity, as rigorously proved by the fact indicated earlier that gravity can only be defined in our physical spacetime while quarks can only be defined in their internal mathematical unitary space, as well as by the lack of credibly defines "quark masses" as inertial eigenvalues of the second order Casimir invariant of the Poincaré group (see the Appendix of Ref. [8]).

Equally equivocal can be at this stage of our knowledge the conduction of first gravitational measurements via the sole use of the antihydrogen atom for intended general results on antigravity, evidently because its nucleus, the antiproton, is believed to be a bound state of quarks for which no gravity at all can be consistently defined. Any study of antigravity under these unsettled structural conditions can only lead to un-necessary controversies, again, if used for general results on antigravity.

It is evident that, *until baryons theories are afflicted by such fundamental problematic aspects, as the inability even to define gravity in a credible way, no gravitational measurement based on antiprotons and antineutrons can be credibly used as conclusive for all of antimatter.*

After the resolution of the gravitational behavior of unbounded positrons in the field of matter, the tests for the gravitational behavior of positronium, muons, muonium, pions, pionium, antiprotons, antineutrons, antihydrogen atom, etc. become essential to acquire an experimental background sufficiently diversified for serious advances on antimatter beyond the level of personal beliefs one way or the other.

The fundamental test of the gravity of positrons here considered was proposed by the author to the following institutions:

1) Stanford Linear Acceleration Center, Stanford, USA, during and following the Seventh Marcel Grossmann Meeting on General Relativity held at Stanford University in July 1994;

2) The Joint Institute for Nuclear Research in Dubna, Russia, during the International Conference on Selected Topics in Nuclear Physics held there in August 1994;

3) The National High Magnetic Field Laboratory in Tallahassee, Florida, during a meeting there in 1996 on magnetic levitation;

4) CERN, Geneva, Switzerland, during a presentation there of hadronic mechanics;;

5) Brookhaven National Laboratories, following the participation at the Sepino meeting on antimatter of 1996 [5];

and to other laboratories as well to universities in various countries.

It is regrettable for mankind that none of these laboratories or universities expressed interest in even considering to date such a fundamental experiment, by preferring to spend much bigger public funds for esoteric experiments manifestly lesser important than that of antigravity.

12.2.2 Santilli's Proposed Tests of Antigravity for Isodual Light

Additionally, in 1997 Santilli [19] predicted that *antimatter emits a new light, the isodual light, that is predicted to be repelled by the gravitational field of matter,* and proposed its experimental verification as the only known (or even conceivable) possibility of ascertaining whether far-away galaxies and quasars are made up of matter or of antimatter.

Measurements as to whether light emitted by the antihydrogen atoms now produced at CERN are attracted or repelled by matter is predictably more delicate than the test of the gravity of the positron, evidently because gravitational displacements for photons in horizontal flight are extremely small, as well know, thus requiring very sensitive interferometric and other measurements.

The experimental detection as to whether far-away galaxies and quasars are made up of matter or of antimatter is predictably more complex and requiring longer periods of time, but with immense scientific implications whatever the outcome.

The test can be done in a variety of ways, one of which consists of measuring the deflection of light originating from far away astrophysical objects when passing near one of our planets. Comparative measurements of a sufficiently large number of galaxies and quasars should permit the detection of possible repulsions, in the event it exists.

Another test has been privately suggested by to the author by an astrophysicist and consists in reinspecting all existing astrophysical data on the deflection of light from far away galaxies and quasars when passing near-by astrophysical bodies.

In the opinion of this astrophysicist, it appears that evidence for the repulsion of light already exists in these data. Such a possible evidence has been ignored so far, and, if found, could not be admitted publicly at the moment, simply because Einstein's gravitation does not allow for any prediction of gravitational repulsion of light.

An understand is that, for these astrophysical measurements to be credible, astrophysicists must conduct the study of a vary large number of galaxies and quasars (of the order of several thousands), and the considered galaxies and quasars must be sufficiently far away to render plausible their possible antimatter structure.

12.2.3 Mills' Studies of Santilli's Proposed Tests of Antigravity

The experimentalist J. P. Mills, jr., [13] conducted a survey of all significant experiments on the gravity of antiparticles in the field of Earth, including indirect tests based on the weak equivalence principle and direct experiments with antiparticles, by concluding that the problem is basically unsettled on theoretical and experimental grounds, thus requiring an experimental resolution.

After considering all existing possible tests, Mills' conclusion is that Santilli's proposed test [12] on the measurement of the gravitational deflection of electrons and positron beams of sufficiently low energy in horizontal flight in a vacuum tube of sufficient length and shielding, is preferable over other possible tests, experimentally feasible with current technology, and providing a resolutory answer as to whether positrons experience gravity or antigravity.

As it is well known, a main technical problem in the realization of Santilli's test is the shielding of the horizontal tube from external electric and magnetic field, and then to have a tube structure in which the internal stray fields have an ignorable impact on the gravitational deflection, or electrons and positrons have such a low energy for which the gravitational deflection is much bigger than possible contributions from internal stray fields, such as the spreading of beams.

The electric field that would cancel the Earth gravitational force on an electron is given by

$$E \ = \ m_e \times g/e = 5.6 \times 10^{-11} \ \mathrm{V/m}. \tag{13.2.3}$$

As it is well known, an effective shielding from stray fields can be obtained via Cu shells. However, our current understanding of the low temperature zero electric field effect in Cu shells does not seem sufficient at this moment to guarantee

perfect shielding from stray fields. Mills [13] then suggested the following conservative basic elements for shielding the horizontal tube.

Assuming that the diameter of the tube is d and the shielding enclosure is composed of randomly oriented grains of diameter λ, the statistical variation of the potential on the axis of the tube of a diameter d would then be [13]

$$\Delta V \;=\; \frac{\lambda}{d \times \sqrt{\pi}}. \tag{13.2.4}$$

As expected, *the effect of stray fields at the symmetry axis of the tube is inversely proportional to the tube diameter.* As we shall see, a tube diameter of 0.5 m is acceptable, although one with 1 m diameter would give better results.

Given a work function variation of 0.5 eV, 1 μm grains and $d = 30$ cm, we would have the following variation of the potential on the axis of the horizontal tube

$$\Delta V \;= 1\ \mu\text{eV}. \tag{13.2.5}$$

Differences in strain or composition could cause larger variations in stray fields. To obtain significant results without ambiguities for the shielding effect of low temperature Cu shells, Mills [13] suggests *the use of electrons and positrons with kinetic energies significantly bigger than* 1 μeV. As we shall see, this condition is met for tubes with minimal length of 10 m and the diameter of 1 m, although longer tubes would evidently allow bigger accuracies.

The realization of Santilli's horizontal vacuum tube proposed by Mills [13] is the following. As shown in Figure 13.3, the tube would be a long dewar tube, consisting of concentric shells of Al and Mu metals, with Pb and Nb superconducting shells and an inner surface coated with an evaporated Cu film.

There should be two superconducting shells so that they would go superconducting in sequence [Nb (9.25 K), Pb (7.196 K)], evidently for better expulsion of flux. Trim solenoids are also recommended for use within the inner shell and a multitude of connections to the Cu field for trimming electrostatic potentials.

As also shown in Figure 13.3, the flight tube should be configured with an electrostatic lens in its center for use of electron and positron beams in both horizontal directions, as well as to focus particles from a source at one end into a gravity deflection sensitive detector at the other end. The de Broglie wavelength of the particles results in the position resolution

$$d \;=\; 2.4 \times \pi \times \alpha_B \times \frac{c \times L}{v \times D}, \tag{13.2.6}$$

where $\alpha = 1/137$ is the fine structure constant, $a_B = 0.529\,\text{Å}$ is the Bohr radius of hydrogen, c is the velocity of light, v is the electron or positron velocity, L is the length of the horizontal path, and D is the diameter of the lens aperture in the center of the flight tube.

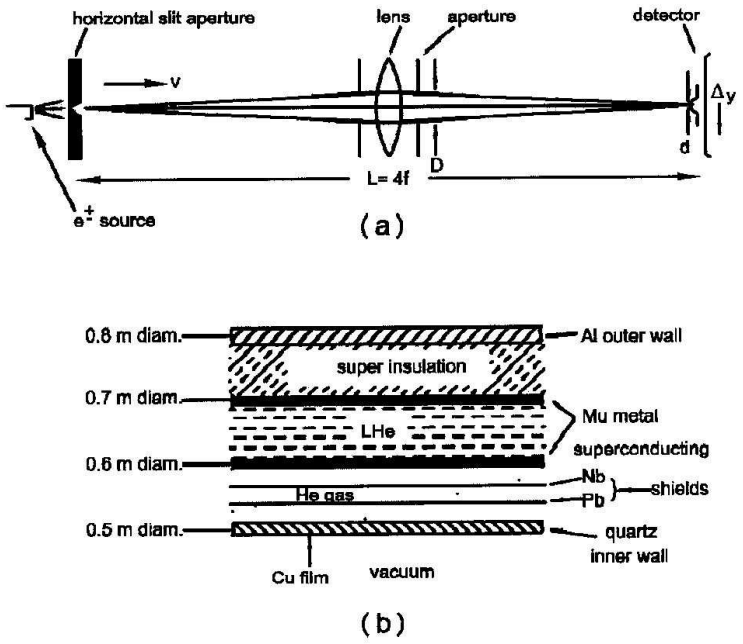

Figure 12.3. A schematic view of the realization suggested by Mills [13] of the horizontal tube proposed by Santilli [12].

The *vertical gravitational deflection* is given by

$$\Delta y \;=\; g \times \frac{L^2}{2 \times v^2}. \tag{13.2.7}$$

Given $L = 100\,\mathrm{m}$, $D = 10\,\mathrm{cm}$, $v/c = 10^{-5}$ (i.e., for 25 μeV particles), we have

$$\Delta y = 5\,\mathrm{mm}. \tag{13.2.8}$$

For 1 meV particles the resolution becomes

$$\Delta y = 125\,\mu\mathrm{m}. \tag{13.2.9}$$

Therefore, one should be able to observe a meaningful deflection using particles with kinetic energies well above the expected untrimmed fluctuation in the potential.

Mills also notes that the lens diameter should be such as to minimize the effect of lens aberration. This requirement, in turn, dictates the minimum inside diameter of the flight tube to be 0.5 m.

The *electron source* should have a cooled field emission tip. A sufficient *positron source* can be provided, for example, by 0.5 ci of ^{22}Na from which we expect (extrapolating to a source five times stronger) $3 \times 10^7\, e^+$/s in a one centimeter diameter spot, namely a positron flux sufficient for the test.

Ideal results are obtained when the positrons should be bunched into pulses of 10^4 e^+ at the rate of 10^3 bunches per second. Groups of 10^3 bunches would be collected into macrobunches containing 10^6 e^+ and 20 nsec in duration. The positrons would be removed from the magnetic field and triply brightness enhanced using a final cold Ni field remoderator to give bunches with 10^4 e^+, 10 meV energy spread, an ellipsoidal emission spot 0.1 μm high and 10 μm wide and a 1 radian divergence.

However, stray fields are notoriously weak and decrease rapidly with the distance. Therefore, there is a diameter of the vacuum tube for which stray fields are expected to have value on the axis insufficient to disrupt the test via a spreading of the beams. Consequently, the proposed tests is also expected to be resolutory via the use of very low energy positrons as available, e.g., from radioactive sources.

As a matter of fact, the detection in the scintillator of the same clear gravitational deflection due to gravity by *a few* positrons would be sufficient to achieve a final resolution, provided, of course, that these few events can be systematically reproduced.

After all, the reader should compare the above setting with the fact that new particles are nowadays claimed to be discovered at high energy laboratories via the use of extremely few events out of hundreds of millions of events on record for the same test.

The beam would then be expanded to 100 μm$\times$1 cm cross section and a 1 mrad divergence, still at 10 meV. Using a time dependent retarding potential Mills would then lower the energy spread and mean energy to 100 μeV with a 2 μs pulse width. Even assuming a factor of 1,000 loss of particles due to imperfections in this scheme, Mills' set-up would then have pulses of about 10 positrons that could be launched into the flight tube with high probability of transmissions at energy of 0 to 100 μeV.

The determination of the gravitational force would require many systematic tests. The most significant would be the measurements of the deflection as a function of the time of flight (enhance the velocity v) $\Delta v(e\pm, \pm v)$ for both positrons and elections and for both signs of the velocity relative to the lens on the axis of the tube, $v > 0$ and $v < 0$, the vertical gravitational force on a particle of charge q is

$$F_y \;=\; -m \times g + q \times E_y + q \times v_z \times B_x/c. \tag{13.2.10}$$

The deflection is then given by

$$\Delta y = \int_0^L \int_0^{z'} q \times [E(z'') + v \times B(z'')/c] \times dz'' \times dz'/(m \times v^2) - g \times z^2/2 \times v^2. \quad (13.2.11)$$

In lowest order, Mills neglects the transverse variation in E_y and B_x and writes for the average fields

$$\epsilon \; = \; \frac{1}{L^2} \int_0^L \int_0^{z'} E_y(z'') \times dz'' \times dz', \quad (13.2.12)$$

and

$$\beta \; = \; \frac{1}{L^2} \int_0^L \int_0^{z'} B_x(z'') \times dz'' \times dz'. \quad (13.2.13)$$

Note that these are not simple averages, but the averages of the running averages. They depend on the direction of the velocity. In the approximation that there are not significantly different from simple averages, the average of the four deflection Δy for both positrons and electrons and for both signs of the velocity is independent of ϵ and β and it is given by

$$< \Delta y > = \; (g^+ + g^-) \times \frac{L^2}{v^2}. \quad (13.2.14)$$

where $g^{\pm}$ refers to the gravitational acceleration of $e^{\pm}$. Since we also have the velocity dependence of the Δy's, and can manipulate E and B by means of trim adjustments, it will be possible to unravel the gravitational effect from the electromagnetic effect in this experiment.

In summary, the main features proposed by Mills [13] for Santilli's [12] horizontal vacuum tube are that:

1) The tube should be a minimum of 10 m long and 1 m in diameter, although the length of 100 m (as proposed by Santilli [12]) and 0.5 m in diameter is preferable;

2) The tube should contain shields against internal external electric and magnetic fields and internal stray fields. According to Mills [13], this can be accomplished with concentric shells made of Al, double shells of Mu metal, double shells of superconducting Nb and Pb, and a final internal evaporated layer of fine grain of Cu;

3) Use bright pulsed sources of electrons and, separately, positrons, at low temperature by means of phase space manipulation techniques including brightness enhancement;

4) Time of flight and single particle detection should be tested to determine the displacement of a trajectory from the horizontal line as a function of the particle velocity;

5) Comparison of measurements should be done using electrons and positrons traversing the flight tube in both directions.

The *use of electrons and positrons with 25 μeV kinetic energy would yield a vertical displacement of 5 mm at the end of 100 m horizontal flight, namely, a displacement that can be distinguished from displacements caused by stray fields and be visible to the naked eye,* as insisted by Santilli [12].

Mills [13] then concludes by saying that *"... an experiment to measure the gravitational deflection of electrons and positrons in horizontal flight, as suggested by R. M. Santilli, ... is indeed feasible with current technologies.... and should provide a definite resolution to the problem of the passive gravitational field of the positron".*

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Chapter 13

APPLICATION TO CAUSAL SPACETIME MACHINES

13.0.4 Introduction

In preceding sections of this monograph we have indicated the far reaching implications of a possible experimental verification of antigravity predicted for antimatter in the field of matter and vice versa, such as a necessary revision of the very theory of antimatter from its classical foundations, a structural revision of any consistent theory of gravitation, a structural revision of any operator formulation of gravitation, and others.

In this section we show that another far reaching implications of the experimental detection of antigravity is the consequential existence of a *Causal Time Machine* [14], that is the capability of moving forward or backward in time without violating the principle of causality, although, as we shall see, this capability is restricted to isoselfdual states (bound states of particles and antiparticles) and *it is not* predicted by the isodual theory to be possible for matter or, separately, for antimatter.

It should be stressed that the Causal Time Machine here considered is a *mathematical model,* rather than an actual machine. Nevertheless, science has always surpassed predictions. Therefore, we are confident that, as it has been the cases for other predictions, one the Causal Time Machine is theoretically predicted, science may indeed permits its actual construction, of course, in due time.

As we shall see, once a Causal Time Machine has been identified, the transition to a causal SpaceTime Machine with the addition of motion in space is direct and immediate.

13.0.5 Causal Time Machine

As clear from the preceding analysis, *antigravity is only possible if antiparticles in general and the gravitational field of antimatter, in particular, evolve backward in time.* A time machine is then a mere consequence.

Causality is readily verified by the isodual theory of antimatter for various reasons. Firstly, *backward time evolution measured with a negative unit of time is as causal as forward time evolution measured with a positive unit of time.* Moreover, *isoselfdual states evolve according to the time of the gravitational field in which they are immersed.* As a result, no violation of causality is conceivably possible for isoselfdual states.

Needless to say, none of these causality conditions are possible for conventional treatments of antimatter.

The reader should be aware that we are referring here to a "Time Machine," that is, to motion forward and backward in time without space displacement (Figure 13.4). The "Space-Time Machine" (that is, including motion in space as well as in time), requires the isodualities as well as isotopies of conventional geometries studied in Chapter 3 and it will be studied in the next section.

The inability to have motion backward in time can be traced back to the very foundations of special relativity, in particular, to the basic time-like interval between two points 1 and 2 in Minkowski space as a condition to verify causality

$$(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2 - (t_1 - t_2)^2 \times c^2 < 0. \tag{13.3.1}$$

defined on the field of real numbers $R(n, \times, I)$, $I = Diag.(1, 1, 1, 1)$.

The inability to achieve motion backward in time then prevents the achievement of a *closed loop* in the forward light cone, thus including motion in space and time, since said loop would necessarily require motion backward in time.

Consider now an isoselfdual state, such as the positronium or the π° meson (Section 2.3.14). Its characteristics have the sign of the unit of the observer, that is, positive time and energy for matter observers and negative times and negative energies for antimatter observers. Then a closed loop can be achieved as follows [14]:

1) With reference to Figure 13.4, expose first the isoselfdual state to a field of matter, in which case it evolved forward in time from a point at time t_1 to a point at a later time t_2 where the spacetime coordinates verify the time-like invariant (13.3.1) with $t_2 > t_1$;

2) Subsequently, expose the same isoselfdual state to a field of antimatter in which case, with the appropriate intensity of the field and the duration of the exposure, the state moves backward in time from time t_2 to the original time t_1, where the spacetime coordinates still verify invariant (13.3.1) with $t_2 < t_1$ although in its isodual form.

We, therefore, have the following:

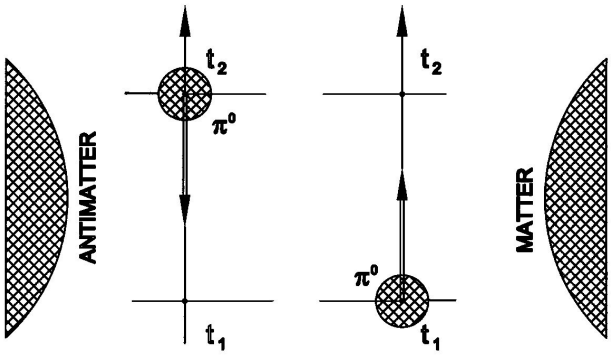

Figure 13.1. A schematic view of the simplest possible version of the "Time Machine" proposed in Ref. [14] via an isoselfdual state such as the positronium or the π° meson that are predicted to move forward (backward) in time when immersed in the gravitational field of matter (antimatter). The Time Machine then follows by a judicious immersion of the same isoselfdual state first in the fields of matter and then in that of antimatter. No causality violation is possible because of the time evolution for isoselfdual states is that of the field in which they are immersed in.

PREDICTION 13.3.1 [14]: Isoselfdual states can have causal motions forward and backward in time, thus performing causal closed loops in the forward light cone.

Note that the above causal Time Machine implies gravitational *attraction* for both fields of matter and antimatter, owing to the use of an isoselfdual test particle, in which case we only have the reversal of the sign of time and related unit.

Note also that the use of a particle or, separately, of an antiparticle would violate causality.

Numerous time machines exist in the literature. However, none of them appears to verify causality and, as such, they are ignored.

Other time machines are based on exiting our spacetime, entering into a mathematical space (e.g., of complex unitary character), and then returning into our spacetime to complete the loop.

Other attempts have been based on quantum tunnelling effects and other means.

By comparison, the Causal Time Machine proposed in Ref. [14] achieves a closed loop at the classical level without exiting the forward light cone and verifying causality.[1]

13.0.6 Isogeometric Propulsion

All means of locomotion developed by mankind to date, from prehistoric times all the way to current interplanetary missions, have been based on *Newtonian propulsions*, that is, propulsions all based on *Newton's principle of action and reaction.*

As an example, human walking is permitted by the action generated by leg muscles and the reaction caused by the resistance of the feet on the grounds. The same action and reaction is also the origin of *all* other available locomotions, including contemporary automobiles or rockets used for interplanetary missions.

Following the identification of the principle of propulsion, the next central issue is the displacement that is evidently characterized by the *Euclidean distance.* We are here referring to the conventional Euclidean space $E(r,\, \delta,\, R)$ over the reals R with familiar coordinates $r = (x,\, y,\, z) \times I$, metric $\delta = Diag.(1,\, 1,\, 1)$, units for the three axes $I = I_{3\times 3} = Diag(1\ \text{cm},\ 1\ \text{cm},\ 1\ \text{cm})$ hereon used in their dimensionless form $I = Diag.(1,\, 1,\, 1)$, and Euclidean distance that we write in the isoinvariant form

$$D^2 = r^2 \times I = (x^2 + y^2 + z^2) \times I \in R. \tag{13.3.2}$$

The *geometric locomotion* can be defined as the *covering of distances via the alteration (also called deformation) of the Euclidean geometry without any use of action and reaction* . The *only* possible realization of such a geometric locomotion that avoid the theorems of catastrophic inconsistencies of Section 1.5, as well as achieves compatibility with our sensory perception (see below), is the *isogeometric locomotion* [15b] namely, that permitted by the *Euclid-Santilli isogeometry* and relative *isodistance.*

We are here referring to the Euclid-Santilli isospace (Section 3.2) $\hat{E}(\hat{r}, \hat{\delta}, \hat{R})$ over the isoreals $\hat{R}$ with isocoordinates $\hat{r} = (x, y, z) \times \hat{I}$, metric $\hat{\delta} = \hat{T}_{3\times 3} \times \delta$, isounits for the three isoaxes

$$\hat{I} = \hat{I}_{3\times 3} = Diag(n_1^2\,\text{cm},\ n_2^2\,\text{cm},\ n_3^2\,\text{cm}) = 1/\hat{T}_{3\times 3} > 0 \tag{13.3.3}$$

that will also be used hereon in the dimensionless form

$$\hat{I} = Diag.(n_1^2,\ n_2^2,\ n_3^2), \tag{13.3.4}$$

[1]The indication by colleagues of other versions of the spacetime machine with a proved verification of causality without existing from our spacetime would be appreciated.

and *isodistance* that we write in the isoinvariant form[2]

$$\hat{D}^{\hat{2}} = \hat{r}^{\hat{2}} = (x^2/n_1^2 + y^2/n_2^2 + z^2/n_3^2) \times \hat{I} \in \hat{R}, \tag{13.3.5}$$

in which case the deformation of the geometry is called *geometric mutation.*[3]

It is evident that $\hat{D}$ can be bigger equal or smaller than D. Consequently, the isogeometric locomotion occurs when $\hat{D} < D$, as in the example below

$$\hat{I} = Diag.(n_1^2, 1, 1) \ll I = Diag.(1, 1, 1), \quad \hat{T} \gg I, \tag{13.3.6a}$$

$$\hat{D}^{\hat{2}} = (x^2/n_1^2 + y^2 + z^2) \ll D^2 = (x^2 + y^2 + z^2). \tag{13.3.6b}$$

The understanding of the above locomotion requires a knowledge of the *isobox* of Section 3.2. Consider such an isobox and assume that it is equipped with isogeometric locomotion. In this case, there is no displacement at all that can be detected by the internal observer. However, the external observer detects a displacement of the isobox the amount $x^2 - x^2/n_1^2$.

This type of locomotion is new because it is causal, invariant and occurs without any use of the principle of action and reaction and it is geometric because it occurs via the sole local mutation of the geometry.

The extension to the *Causal Spacetime Machine,* or *spacetime isogeometric locomotion* is intriguing, and can be formulated via the *Minkowski-Santilli isospace* of Section 3.2 with four-isodistance

$$\hat{D}^{\hat{2}} = (x^2/n_1^2 + y^2/n_2^2 + z^2/n_3^2 - c^2 \times t^2/n_4^2) \times \hat{I} \in \hat{R}, \tag{13.3.7}$$

where $n_4 > 0$.

The main implications in this case is the emergence of the additional *time mutation* as expected to occur jointly with any *space mutation.* In turn, this implies that the *isotime* $\hat{t} = t/n_4$ (that is, the internal time) can be bigger equal or smaller than the time t (that of the external observer).

More specifically, from the preservation of the original trace of the metric, *isorelativity predicts that the mutations of space and time are inversely promotional to each others.* Therefore, jointly with the motion ahead in space there is a motion backward in time and vice versa.

Consequently, the external observer sees the object moving with his naked eye, and believes that the object evolves in his own time, while in reality the object

[2]By "isoinvariance" we means invariance under conventional space or spacetime symmetries plus the isotopic invariance.

[3]According to the contemporary terminology, "deformations" are alterations of the original structure although referred to the original field. As such they are afflicted by the catastrophic inconsistencies of Section 1.5. The term "mutation", first introduced by Santilli in Ref. [21] of 1967, is today referred to an alteration of the original structure under the condition of preserving the original axioms, thus requiring the formulation on isospaces over isofields that avoid said theorems of catastrophic inconsistency.

Figure 13.2. An artistic rendering of the "Space Time Machine", namely, the "mathematical" prediction of traveling in space and time permitted by the isodual theory of antimatter. The main assumption is that the aether (empty space) is a universal medium characterized by a very high density of positive and negative energies that can coexist because existing in distinct, mutually isodual spacetimes. Virtually arbitrary trajectories and speeds for isoselfdual states (only) are then predicted from the capability of extracting from the aether very high densities of positive and negative energies in the needed sequence. Discontinuous trajectories do not violate the law of inertia, speeds much bigger than the speed of light in vacuum, and similarly apparently anomalous events, do not violate special relativity because the locomotion is caused by the change of the local geometry and not by conventional Newtonian motions.

could evolve far in the past. Alternatively, we can say that the inspection of an astrophysical object with a telescope, by no means, implies that said object evolves with our own time because it could evolve with a time dramatically different than that after adjustments due to the travel time of light because, again, light cannot carry any information on the actual time of its source.

To further clarify this important point, *light cannot possibly carry information on the time of its source because light propagates at the speed c at which there is no time evolution.*

As a concrete example, one of the consequences of interior gravitational problems treated via Santilli's isorelativity (see Section 3.5) is that *the time of interior gravitational problems, $\hat{t} = t/n_4$, depends on the interior density n_4^2, rather than the inertial mass, thus varying for astrophysical bodies with different densities.*

This implies that if two identical watches are originally synchronized with each other on Earth, and then placed in the interior gravitational field of astrophysical bodies with different densities, they will no longer be synchronized, thus evolving with different times, even though light may continue to provide the information needed for their intercommunication.

In particular, *the time evolution of astrophysical bodies slows down with the increase of the density*,

$$\hat{t}_1 < \hat{t}_2, \quad n_{41}^2 > n_{42}^2. \tag{13.3.8}$$

It should also be noted that the above effect has no connection with similar Riemannian predictions because it is structurally dependent on the *change of the units,* rather than geometric features.

A prediction of isospecial relativity is that the bigger the density, the slower the time evolution. Thus, a watch in the interior of Jupiter is predicted to move *slower* than its twin on Earth under the assumption that the density of Jupiter (being a gaseous body) is significantly smaller than that of Earth (that can be assumed to be solid for these aspects).

As stressed in Section 13.3.1, *the above spacetime machine is a purely mathematical model*. To render it a reality, there is the need to identify the *isogeometric propulsion*, namely a source for the geometric mutations of type (13.3.5).

Needless to say, the above problem cannot be quantitatively treated on grounds of available scientific knowledge. However, to stimulate the imagination of readers with young minds of any age, a speculation on the possible mechanism of propulsion should be here voiced.

The only source of geometric mutation conceivable today is the availability of very large energies concentrated in very small regions of space, such as energies of the order of 10^{30} ergs/cm^3. Under these conditions, isorelativity does indeed predict isogeometric locomotion because these values of energy density generate very large values of isounits $\hat{I}$, with very small values of the isotopic element $\hat{T}$, resulting in isogeometric locomotions precisely of type (13.3.5).

The only possible source of energy densities of such extreme value is empty space. In fact, according to current views, space is a superposition of positive and negative energies in equal amounts each having extreme densities precisely of the magnitude needed for isogeometric locomotion.

The speculation that should not be omitted in this section is therefore that, one day in the future, the advancement of science will indeed allow to extract from space at will all needed amounts of both positive and negative energy densities.

In the event such an extraction becomes possible in a directional way, a spaceship would be able to perform all desired types of trajectories, including trajectories with sharp discontinuities (instantaneous 90 degrees turns), instantaneous accelerations, and the like without any violation of the law of inertia because, as indicated earlier, the spaceship perceives no motion at all. It is the geometry in its surroundings that has changed.

Moreover, such a spaceship would be able to cover interstellar distances in a few of our minutes, although arriving at destination way back in the time evolution of the reached system.

Science has always surpassed science fiction and always will, because there is no limit to the advancement of scientific knowledge. On this ground it is, therefore, easy to predict that, yes, one day mankind will indeed be able to reach far away stars in minutes.

It is only hoped that, when that giant step for mankind is achieved, the theory that first achieved its quantitative and invariant prediction, Santilli isorelativity, will be remembered.

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Chapter 14

ISO-, GENO-, AND HYPER-GRAND-UNIFICATIONS AND ISO-, GENO-, HYPER-COSMOLOGIES

14.1 ISO-, GENO-, AND HYPER-GRAND-UNIFICATION

14.1.1 The Role of Antimatter in Grand Unifications

As indicated earlier, no conclusive study on antimatter can be conducted without its consistent inclusion in *grand unifications* of gravitational [1–3] and electroweak interactions [4–7]. Vice versa, no grand unification can be considered scientifically valuable without the correct inclusion of antimatter because the latter has a profound impact in the very structure of a consistent grand unification.

All studies on grand unifications conducted until now have been essentially restricted to matter. When antimatter is included, the studies have to be enlarged to *two grand unifications,* one for matter and the other for antimatter with a correct anti-automorphic (or anti-isomorphic) interconnecting map.

Consequently, the inclusion of antimatter in grand unifications introduces severe restrictions on the admissible models, which restrictions are generally absent when antimatter is ignored and grand unifications are restricted to matter alone.

We shall, therefore, avoid the review of the very large number of structurally inconsistent grand unifications published since Einstein's times and leave to the interested reader their re-examination in light of the new advances of this volume.

An in depth study of grand unifications soon reveals the need of formulating antimatter at the purely classical level, the need for abandoning curvature, and the need for a geometric unification of special and general relativities as presented in preceding chapters. It is only at the level of these broader views on grand unifications that the isodual theory of antimatter emerges as inevitable.

Even though presented at the end of this monograph, the author initiated his studies on grand unification, constructed the needed broadening or modifications

of pre-existing methods, and then achieved an invariant, axiomatically consistent grand unification.

This process requires it two decades of research before the publication of the first paper on grand unification, a lapse of time illustrating the complexity of the problem, as known in any case by the failure of the large number of preceding attempts.

The reader should be aware that, in this section, we shall exclusively study *closed-isolated systems of electroweak and gravitational interactions in vacuum* that are treatable via the Lie-isotopic branch of hadronic mechanics and its isodual. Interior problems, such as those inclusive of the origin of gravitation, require the broader Lie-admissible branch of hadronic mechanics and their treatment will be merely indicated at the end of this section for development by interested readers.

14.1.2 Axiomatic Incompatibilities of General Relativity and Electroweak Interactions

The preceding efforts for a grand unification of gauge theories of electroweak interactions and gravitation as described by general relativity are afflicted by the following axiomatic incompatibilities, first presented in Ref. [9] of 1997 (see also the related papers [10,11]):

(1) **Incompatibilities due to antimatter:** electroweak theories are *bona fide* relativistic field theories, thus characterizing antimatter via *negative-energy* solutions, while general relativity characterizes antimatter via *positive-definite* energy-momentum tensors. This first incompatibility renders manifestly inconsistent all attempts at grand unification known to this author.[1]

(2) **Incompatibilities due to curvature:** electroweak theories are essentially flat theories since they are formulated via *Minkowskian* axioms, while general relativity is centrally dependent on curvature since it is based on *Riemannian* axioms. This second incompatibility is another, independent, primary origin of the failure of the vast number of attempts at grand unification existing in the literature and carries profound implications, such as the extension to grand unification of the theorems of catastrophic inconsistencies of Section 1.4.

(3) **Incompatibilities due to spacetime symmetries:** electroweak interactions are based on the axioms of special relativity, thus verifying the fundamental *Poincaré symmetry* $P(3.1)$, while such a basic symmetry is absent in general relativity and is replaced by a generic covariance. This third incompatibility has additional profound implications for any consistent grand unification because ei-

[1]The indication of grand unifications inclusive of antimatter would be greatly appreciated.

ther one abandons the basic symmetries of electroweak interactions in favor of an unknown covariance, or one abandons general relativity for a new theory admitting a universal symmetry.

(4) **Incompatibilities due to the lack of a Minkowskian limit of general relativity:** as it is well known [1–3], general relativity admits a well defined *Euclidean* limit under PPN approximation, but one century of studies have failed to identify a corresponding well defined *Minkowskian* limit. On the other side, electroweak interactions [4–7] are formulated on a Minkowski spacetime. This fourth incompatibility of the two interactions then emerges in a number of aspects, such as irreconcilable ambiguities in the identification of total conservation laws of grand unifications when inclusive of gravitational interactions.

(5) **Incompatibilities due to the nonunitary character of quantum gravity:** as it is also well known, electroweak theories are *operator* field theories with a *unitary* structure, thus having invariant prediction of numerical values permitting meaningful experimental verifications. By comparison, all quantum formulations of general relativity (see, e.g. Ref. [8] and references quoted therein) have a *nonunitary* structure. Besides evident, additional, independent inconsistencies in attempting to combine unitary and nonunitary theories, any attempt of grand unification along contemporary views in general relativity and quantum gravity is afflicted by the theorems of catastrophic inconsistencies of Section 1.4.

It is evident that no significant advance can be achieved in grand unifications without, firstly, a serious addressing of these inconsistencies and, secondly, without their resolution.

Recall that the theory of electromagnetic interactions, when (and only when) restricted to the *vacuum*[2], has a majestic mathematical and physical consistency that eventually propagated to unified theories of electromagnetic and weak interactions.

The view adopted in this monograph, identifiable in more details only now, is that, rather than abandoning the majestic beauty of electroweak theories, we abandon instead the popular views on gravitation of the 20-th century due to their catastrophic inconsistencies and, as a condition to achieve a consistent grand unification, we reconstruct gravitational theories in such a way to have *the same abstract axioms* of electroweak theories.

[2]It is well known by expert, but rarely spoken, that Maxwell's equations have no real physical value for the treatment of electromagnetism within physical media for countless reasons, some of which have been treated in Chapter 1. As an illustration, only to locally varying character of electromagnetic waves within physical media requires a radical revision of electromagnetism in the arena considered as a condition to pass from academic politics to real science.

14.1.3 Resolution of the Incompatibilities via Isotopies and Isodualities

In this chapter we present a resolution of the above incompatibilities first achieved by Santilli in Refs. [9] of 1997 (see also Refs. [10,11] following a number of rather complex and diversified scientific journeys that can be outlined as follows:

(A) Isotopies. The scientific journey to achieve a consistent grand unification started in 1978 with memoirs [12,13] for the classical and operator isotopies. A baffling aspect in the inclusion of gravity in unified gauge theories is their geometric incompatibility.

The view that motivated Refs. [12,13] is that the difficulties experienced in achieving a consistent grand unification are primarily due to *insufficiencies in their mathematical treatment*.

Stated in plain language, the view here considered is that, due to the complexity of the problem, the achievement of an axiomatic compatibility between gravitation and electroweak interactions requires a basically new mathematics, that is, basically new numbers, new spaces, new symmetries, etc.

Following first the verification of the lack of existence in the literature of a mathematics permitting the desired consistent grand unification, and following numerous attempts, the *only* possible new mathematics resulted to be that permitted by the *isotopies* as first proposed in Refs. [12,13], namely, a generalization of the conventional trivial unit $+1$ of electroweak theories into the most general possible, positive-definite unit with an unrestricted functional dependence on local variables, called *Santilli's isounit*,

$$I = +1 > 0 \quad \rightarrow \quad \hat{I} = \hat{I}^\dagger = I(x, v, \psi, \partial\psi, \ldots) > 0, \tag{14.1.1}$$

and consequential compatible reconstruction of all main branches of mathematics.

The uniqueness of the isotopies is due to the fact that, *whether conventional or generalized, the unit is the basic invariant of any theory.* Therefore, the use of the unit for the generalization of pre-existing methods guarantees the preservation of the invariance so crucial for physical consistency (Sections 1.5.2 and 1.5.3).

Another aspect that illustrates the uniqueness of the isotopies for grand unifications is that *the positive-definiteness of the isounit guarantees the preservation of the abstract axioms of electroweak theories,* thus assuring axiomatic consistency of grand unification from the very beginning.

The general lines on isotopies presented in memoirs [12,13] of 1978 were then followed by laborious studies that reached mathematical and physical maturity only in memoir [14] of 1996, as outlined in Chapter 3 (see monographs [15] for a comprehensive presentation).

(B) Isodualities. The achievement of an axiomatically consistent grand unification for *matter* constitutes only *half* of the solution because, as stressed in Section 14.1.1, no grand unification can be considered physically significant without the consistent inclusion of antimatter.

The incompatibility of electroweak theories and general relativity for antimatter identified in Section 14.1.2 is only the symptom of deeper compatibility problems. As now familiar from the studies presented in this monograph, matter is treated at *all* levels, from Newtonian to electroweak theories, while antimatter is treated only at the level of *second quantization.*

Since there are serious indications that half of the universe could well be made up of antimatter (see Section 14.2), it is evident that a more effective theory of antimatter must apply at *all* levels.

Until such a scientific imbalance is resolved, any attempt at a grand unification can well prove to be futile.

Recall that charge conjugation in quantum mechanics is an *anti-automorphic map.* As a result, no classical theory of antimatter can possibly be axiomatically consistent via the mere change of the sign of the charge, because it must be an anti-automorphic (or, more generally, anti-isomorphic) image of that of matter in *all* aspects, including numbers, spaces, symmetries, etc.

The resolution of the above imbalance required a second laborious scientific journey that initiated with the proposal of the *isodual map* in memoirs [16] of 1985, here expressed for an arbitrary quantity

$$Q(x, v, \psi, \ldots) \ \rightarrow Q^d = -Q^\dagger(-x^\dagger, -v^\dagger, -\psi^\dagger, -\partial\psi^\dagger, \ldots), \tag{14.1.2}$$

proposal that was followed by various studies whose mathematical and physical maturity was only reached years later in memoir [14] of 1996, as reported in Chapters 2 and 3 (see also monographs [15] for a more general presentation).

To illustrate the difficulties, it is appropriate here to note that, following the presentation in papers [16] of 1985 of the main mathematical ideas, it took the author *nine years* before publishing their application to antimatter in paper [17] of 1994.

We are here referring to the original proposal of Refs. [16,17] of mapping isounit (14.1.1) for matter into an *negative-definite* nonsingular arbitrary unit, known today as *Santilli's isodual isounits*,

$$\hat{I}(x, \psi, \partial\psi, \ldots) > 0 \quad \rightarrow \quad \hat{I}^d = -\hat{I}^\dagger(-x^\dagger, -\psi^\dagger, -\partial\psi^\dagger, \ldots) < 0 \tag{14.1.3}$$

and its use for the characterization of antimatter at all levels, from Newtonian mechanics to second quantization.

The uniqueness of the isodual representation is given by the fact that isodualities are the *only* known liftings permitting the construction of a mathematic that is anti-isomorphic to the conventional (or isotopic) mathematics, as necessary for

a consistent representation of antimatter at all levels, while preserving the crucial invariance needed to avoid catastrophic inconsistencies.

(C) Poincaré-Santilli isosymmetry and its isoduals. The scientific journeys on isotopies and isodualities were only intended as pre-requisites for the construction of the *universal symmetry of gravitation for matter and, separately, for antimatter* in such a way to be locally isomorphic to the spacetime symmetry of electroweak interactions, the latter being an evident condition of consistency.

It is easy to see that, without the prior achievement of a new gravitation possessing an invariance, rather than the covariance of general relativity, any attempt at constructing a grand unification will prove to be futile in due time.

The complexity of the problem is illustrated by the fact that, not only gravitation for matter had to be reformulated in a form admitting a symmetry, but that symmetry had to be compatible with the basic Poincaré symmetry of electroweak theories [4–7]. Moreover, a dual compatible symmetry had to be achieved for the gravity of antimatter.

The latter problems called for a third laborious scientific journey on the *isotopies and isodualities of the Poincaré symmetry* $\hat{P}(3.1)$, today called the *Poincaré-Santilli isosymmetry and its isodual* outlined in Section 3.5 (see monographs [15] for comprehensive studies). These studies included:

1) The isotopies and isodualities of the Lorentz symmetry initiated with paper [18] of 1983 on the classical isotopies with the operator counterpart presented in paper [19] of the same year;

2) The isotopies and isodualities of the rotational symmetry first presented in papers [16][3];

3) The isotopies and isodualities of the $SU(2)$-spin symmetry, first presented in paper [20] of 1993, and related implications for local realist, hidden variables and Bell's inequalities published in Ref. [21] of 1998;

4) The isotopies and isodualities of the Poincaré symmetry including the universal invariance of gravitation, first presented in paper [22] of 1993; and

5) The isotopies and isodualities of the spinorial covering of the Poincaré symmetry first presented in papers [23,24] of 1996.[4]

[3]Papers [16] on the lifting of the rotational symmetry were evidently written before paper [19] on the lifting of the Lorentz symmetry, but appeared in print only two years following the latter due to rather unreasonable editorial processing by various journals reported in Ref. [16], which processing perhaps illustrates the conduct of some (but not all) editors when facing true scientific novelty.

[4]Ref. [24], which is the most important reference of this entire monograph (because admitting all topics as particular cases), was rejected for years by all journals of Western Physical Societies because the paper included an *industrial* application currently receiving large investments by the industry — although not by academia, — consisting in the achievement of a numerical, exact and invariant representation of *all* characteristics of the neutron as a bound state of a proton and an electron according to Rutherford. In fact, the resolution of the historical difficulties of Rutherford's conception of the neutron permits the utilization of the large clean energy contained in the neutron's structure, via its stimulated decay

We are referring here to the reconstruction of the conventional symmetries with respect to an arbitrary nonsingular positive-definite unit (14.1.1) for the isotopies, and with respect to an arbitrary nonsingular negative-definite unit (14.1.3) for the isodualities.

This reconstruction yields the most general known nonlinear, nonlocal and noncanonical or nonunitary liftings of conventional symmetries, while the locally isomorphism for isotopies) (anti-isomorphism for isodualities) with the original symmetries is guaranteed by the positive-definiteness (negative-definiteness) of the generalized units.

One should be aware that the above structures required the prior step-by-step isotopies and isodualities of Lie's theory (enveloping associative algebras, Lie algebras, Lie groups, transformation and representation theories, etc.), originally proposed by Santilli in 1978 [12], studied in numerous subsequent works and today called the *Lie-Santilli isotheory and its isodual* (see Section 3.2 for an outline and Refs. [15] for comprehensive studies).

It is evident that the Poincaré-Santilli isosymmetry and its isodual have fundamental character for these studies. One of their primary applications has been the achievement of the universal *symmetry* (rather than covariance) of all possible Riemannian line elements in their iso-Minkowskian representation [22]

$$ds'^2 = dx'^{\mu} \times g(x')_{\mu\nu} \times dx'^{\nu} \equiv dx^{\mu} \times g(x)_{\mu\nu} \times dx^{\nu} = ds^2, \tag{14.1.4}$$

Once the unit of gauge theories is lifted to represent gravitation, electroweak interactions will also obey the Poincaré-Santilli isosymmetry for matter and its isodual for antimatter, thus offering realistic hopes for the resolution of the most difficult problem of compatibility between gravitation and electroweak interactions, that for spacetime symmetries.

Perhaps unexpectedly, the fundamental spacetime symmetry of the grand unified theory of Refs. [9–11] is based on the *total symmetry of Dirac's equation*, here written with related spacetime and underlying unit (see Chapter 2 for details)

$$S_{tot} = \{SL(2.C) \times T(3.1) \times \mathcal{I}(1)\} \times \{SL^d(2.C^d) \times^d T^d(3.1) \times^d \mathcal{I}^d(1)\}, \tag{14.1.5a}$$

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caused by a hard photon with a resonating frequency (numerically predicted by hadronic mechanics) that expels Rutherford's electron (the *isoelectron* with an isorenormalized mass generated by the nonlocal and non-Lagrangian interactions in the hyperdense medium inside the proton, see Chapter 6 and references quoted therein),

$$\gamma_{reson.} + n \to p^+ + e^- + \bar{\nu}.$$

Despite the undeniable mathematical consistency clear plausibility and evident large societal implications due to the need for new clean energies, Ref. [24] was rejected by all Western Physical Society without any credible scientific motivation because not aligned with organized interests in quantum mechanics and special relativity. Paper [24] was finally published in China in 1996. As a gesture of appreciation for this scientific democracy, the author organized in Beijing the 1997 International Workshop on Hadronic Mechanics (see the Proceedings of the Wiorkshops on Hadronic Mechanics listed in the General Bibliography).

$$M_{tot} = \{M(x,\eta,R) \times S_{spin}\} \times \{M^d(x^d,\eta^d,R^d) \times^d S^d_{spin}\}, \tag{14.1.5b}$$

$$I_{tot} = \{I_{orb} \times I_{spin}\} \times \{I^d_{orb} \times^d I^d_{spin}\}. \tag{14.1.5c}$$

To understand the above occurrence, the reader should be aware that isodualities imply a new symmetry called *isoselfduality* (Section 2.1), given by the invariance under the isodual map (14.1.2).

Dirac's gamma matrices verify indeed this new symmetry (from which the symmetry itself was derived in the first place), i.e.,

$$\gamma_\mu \to \gamma^d_\mu = -\gamma^\dagger_\mu = \gamma_\mu. \tag{14.1.6}$$

Consequently, contrary to a popular belief throughout the 20-th century, the Poincaré symmetry *cannot* be the total symmetry of Dirac's equations, evidently because it is not isoselfdual.

For evident reasons of consistency, the total symmetry of Dirac's equation must also be isoselfdual as the gamma matrices are. This condition identifies the total symmetry (14.1.5a) because that symmetry is indeed isoselfdual.

To understand the dimensionality of symmetry (14.1.5a) one must first recall that isodual spaces are independent from conventional spaces. The doubling of the conventionally believed ten-dimensions of the Poincaré symmetry then yields *twenty* dimensions.

But relativistic invariants possess the novel *isotopic invariance* (3.5.27), i.e.,

$$\begin{aligned}(x^\nu \times \eta_{\mu\nu} \times x^\nu) \times I &\equiv [x^\nu \times (w^{-2} \times \eta)_{\mu\nu} \times x^\nu) \times (w^2 \times I) \\ &= (x^\nu \times \hat{\eta}_{\mu\nu} \times x^\nu) \times \hat{I},\end{aligned} \tag{14.1.7}$$

with corresponding isotopic invariance of Hilbert's inner product

$$\begin{aligned}< \psi| \times |\psi > \times I &\equiv < w^{-1} \times \psi| \times |w^{-1} \times \psi > \times (w^2 \times I) \\ &= < \psi|\hat{\times}|\psi > \times \hat{I}.\end{aligned} \tag{14.1.8}$$

Consequently, the conventional Poincaré symmetry has emerged as being *eleven dimensional* at both the classical and operator levels, as first presented by Santilli in Ref. [22] of 1993 and studied in Section 3.5.3. It then follows that *the total symmetry* (14.1.5a) *of Dirac's equations is twenty-two dimensional.*

The grand unification proposed in Refs. [9–11] is based on the axiomatic structure of the conventional Dirac's equations, not as believed throughout the 20-th century, but as characterized by isotopies and isodualities.

In particular, the grand unification here studied is permitted by the new isotopic invariances (14.1.7) and (14.1.8) that are hidden in relativistic invariants [21], thus assuring the operator compatibility of the grand unification, as we shall see.

The reader should not be surprised that the two new invariances (14.1.7) and (14.1.8) remained undetected throughout the 20-th century because their identification required the prior discovery of *new numbers*, first the numbers with arbitrary positive units, and then the additional new numbers with arbitrary negative units for invariances [25].

(D) Classical and operator isogravitation. After a number of (unpublished) attempts, the resolution of numerous inconsistencies of general relativity studied in Section 1.4, plus the inconsistencies for grand unifications, requested the *isotopic reformulation of gravitation,* today known as *Santilli's isogravitation*, first presented at the VII M. Grossman Meeting on General Relativity of 1996 [26], as reviewed in Section 3.5, essentially consisting in the factorization of any given (nonsingular and symmetric) Riemannian metric $g(x)$ into the Minkowskian metric η multiplied by a 4×4-matrix $\hat{T}$,

$$g(x) = \hat{T}_{Grav}(x) \times \eta, \tag{14.1.9}$$

and the reconstruction of gravitation with respect to the isounit

$$\hat{I}_{Grav}(x) = 1/\hat{T}_{Grav}(x), \tag{14.1.10}$$

thus requiring the isotopic reformulation of the totality of the mathematical and physical methods of general relativity.

Despite its simplicity, the implications of isogravitation are far reaching, such as:

1) The isotopic reformulation permits the achievement of the universal Poincaré-Santilli isoinvariance for all possible gravitational models;

2) The isotopic reformulation eliminates curvature for the characterization of gravity, and replaces it with *isoflatness,* thus achieving compatibility with the flatness of electroweak interactions;

3) The isotopic reformulation reconstructs unitarity on iso-Hilbert spaces over isofields via the identical reformulation of nonunitary transform at the foundations of hadronic mechanics (Chapter 3)

$$U \times U^\dagger \neq I \to \hat{U} \hat{\times} \hat{U}^\dagger = \hat{U}^\dagger \hat{\times} \hat{U} = \hat{I}_{Grav}, \tag{14.1.11}$$

where

$$U \times U^\dagger = \hat{I}, \quad \hat{U} = U \times \hat{T}^{1/2}_{Grav}, \tag{14.1.12}$$

thus providing the *only* known resolution of the catastrophic inconsistencies of Theorems 1.5.1 and 1.5.2.

Above all, isogravitation achieved the first and only known, axiomatically consistent operator formulation of gravitation provided by relativistic hadronic mechanics of Section 3.5, as first presented in Ref. [27] of 1997.

In fact, gravity is merely imbedded in the *unit* of relativistic operator theories. Since the gravitational isounit is positive-definite from the nonsingular and symmetric character of the metric $g(x)$ in factorization (14.1.9), the abstract axioms of operator isogravity are the conventional axioms of relativistic quantum mechanics, only subjected to a broader realization.

The preservation of conventional relativistic axioms then assures the achievement, for the first time as known by the author, of a consistent operator formulation of gravitation.[5]

(E) Geometric unification of special and general relativities. The resolution of the problems caused by lack of any Minkowskian limit of general relativity requested additional studies. After a number of (unpublished) attempts, the only possible solution resulted to be a geometric unification of special and general relativities, first presented in Ref. [28], in which the two relativities are characterized

by the same abstract axioms and are differentiated only by their realization of the basic unit. The trivial realization $I = Diag.(1, 1, 1, 1)$ characterizes special relativity, and broader realization (14.1.10) characterizes general relativity.

The latter final efforts requested the construction *ab initio* of a new geometry, today known as *Minkowski-Santilli isogeometry* [28] in which the abstract axioms are those of the Minkowskian geometry, including the abstract axiom of flatness necessary to resolve the catastrophic inconsistencies of Section 1.4, yet the new geometry admits the entire mathematical formalist of the Riemannian geometry, including covariant derivatives, Christoffel's symbols, etc. (see Section 3.2 for an outline and monographs [15] for comprehensive studies).

The important point is that at the limit

$$\lim \hat{I}_{Grav}(x) \to I, \tag{14.1.13}$$

the Minkowskian geometry and conventional special relativity are recovered identically and uniquely.

The reader should be aware that the grand unification presented in this section is centrally dependent on the Minkowski-Santilli isogeometry, the Poincaré-Santilli isosymmetry, and the isotopic formulation of gravitation. Their knowl-

[5]Note that the use of the words "quantum gravity" for operator formulation of gravitation, whether conventional or characterized by the isotopies, would be merely political. This is due to the fact that, on serious scientific grounds, the term "quantum" can only be referred to physical conditions admitting a quantized emission and absorption of energy as occurring in the structure of the hydrogen atom. By comparison, no such quantized orbits are possible for operator theories of gravity, thus rendering nonscientific its characterization as "quantum gravity". Ironically, the editor of a distinguished physics journal expressed interest in publishing a paper on "operator isogravity" under the condition of being called "quantum gravity", resulting in the necessary withdrawal of the paper by the author so as not to reduce fundamental physical inquiries to political compromises.

edge is a necessary pre-requisite for the technical understanding of the following sections.

14.1.4 Isotopic Gauge Theories

The isotopies of gauge theories were first studied in the 1980's by Gasperini [29], followed by Nishioka [30], Karajannis and Jannussis [31] and others, and ignored thereafter for over a decade.

These studies were defined on conventional spaces over conventional fields and were expressed via the conventional differential calculus. As such, they are not invariant, as it became shown in memoirs [32], thus suffering of the catastrophic inconsistencies of Theorem 1.5.2.

Refs. [9–11] presented, apparently for the first time, the *invariant isotopies of gauge theories*, or *isogauge theories* for short, and their isoduals, those formulated on isospaces over isofields and characterized by the isodifferential calculus of memoir [14]. For completeness, let us recall that the latter theories are characterized by the following methods:

(1) Isofields [25] of isoreal numbers $\hat{R}(\hat{n}, \hat{+}, \hat{\times})$ and isocomplex numbers $\hat{C}(\hat{c}, \hat{+}, \hat{\times})$ with: additive isounit $\hat{0} = 0$; generalized multiplicative isounit $\hat{I}$ given by Eq. (14.1.9); elements, isosum, isoproduct and related generalized operations,

$$\hat{a} = a \times \hat{I}, \;\; \hat{a}\hat{+}\hat{b} = (a + b) \times \hat{I}, \tag{14.1.14a}$$

$$\hat{a}\hat{\times}\hat{b} = \hat{a} \times \hat{T} \times \hat{b} = (a \times b) \times \hat{I}, \tag{14.1.14b}$$

$$\hat{a}^{\hat{n}} = \hat{a}\hat{\times}\hat{a}\hat{\times}...\hat{\times}\hat{a}, \tag{14.1.14c}$$

$$\hat{a}^{\hat{1/2}} = a^{1/2} \times \hat{I}^{1/2}, \;\; \hat{a}\hat{/}\hat{b} = (\hat{a}/\hat{b}) \times \hat{I}, \text{ etc.} \tag{14.1.14d}$$

(2) Isominkowski spaces [18] $\hat{M} = \hat{M}(\hat{x}, \hat{\eta}, \hat{R})$ with isocoordinates $\hat{x} = x \times \hat{I} = \{x^\mu\} \times \hat{I}$, isometric $\hat{N} = \hat{\eta} \times \hat{I} = [\hat{T}(x, \dots) \times \eta] \times \hat{I}$, and *isointerval* over the isoreals $\hat{R}$

$$\begin{aligned}(\hat{x} - \hat{y})^{\hat{2}} &= [(\hat{x} - \hat{y})^\mu \hat{\times} \hat{N}_{\mu\nu} \hat{\times} (\hat{x} - \hat{y})^\nu] \\ &= [(x - y)^\mu \times \hat{\eta}_{\mu\nu} \times (x - y)^\nu] \times \hat{I},\end{aligned} \tag{14.1.15}$$

equipped with *Kadeisvili isocontinuity* [33] and the *isotopology* developed by G. T. Tsagas and D. S. Sourlas [34], R. M. Santilli [14], R. M. Falcón Ganfornina and J. Núñez Valdés [35,36] (see also Aslander and Keles [37]). A more technical formulation of the isogauge theory can be done via the isobundle formalism on isogeometries.

(3) Isodifferential calculus [14] characterized by the following isodifferentials

$$\hat{d}\hat{x}^\mu = \hat{I}^\mu_\nu \times d\hat{x}^\nu, \tag{14.1.16a}$$

$$\hat{d}\hat{x}_\mu = \hat{T}_\mu^\nu \times d\hat{x}_\nu, \tag{14.1.16b}$$

and isoderivatives

$$\hat{\partial}_\mu \hat{f} = \hat{\partial}\hat{f}\hat{/}\hat{\partial}\hat{x}^\mu = (\hat{T}_\mu^\nu \times \partial_\nu f) \times \hat{I}, \tag{14.1.17a}$$

$$\hat{\partial}^\mu \hat{f} = (\hat{I}_\nu^\mu \times \partial_\nu f) \times \hat{I}, \;\; \hat{\partial}\hat{x}^\mu\hat{/}\hat{\partial}\hat{x}^\nu = \hat{\delta}_\nu^\mu = \delta_\nu^\mu \times \hat{I}, \text{ etc.} \tag{14.1.17b}$$

where one should note the inverted use of the isounit and isotopic element with respect to preceding formulations.

(4) Isofunctional isoanalysis [15], including the reconstruction of all conventional and special functions and transforms into a form admitting of $\hat{I}_{Grav}$ as the left and right unit. Since the iso-Minkowskian geometry preserves the Minkowskian axioms, it allows the preservation of the notions of straight and intersecting lines, thus permitting the reconstruction of trigonometric and hyperbolic functions for the Riemannian metric $g(x) = \hat{T}(x) \times \eta$.

(5) Iso-Minkowskian geometry [28], i.e., the geometry of isomanifolds $\hat{M}$ over the isoreals $\hat{R}$, that satisfies all abstract Minkowskian axioms because of the joint liftings

$$\eta \to \hat{\eta} = T(x, \ldots) \times \eta, \tag{14.1.18a}$$

$$I \to \hat{I} = T^{-1}, \tag{14.1.18b}$$

while preserving the machinery of Riemannian spaces as indicated earlier, although expressed in terms of the isodifferential calculus.

In this new geometry *Riemannian* line elements are turned into identical *Minkowskian* forms via the embedding of gravity in the deferentials, e.g., for the Schwarzschild exterior metric we have the iso-Minkowskian reformulation (Ref. [28], Eqs. (2.57)), where the spacetime coordinates are assumed to be covariant,

$$\hat{d}\hat{s} = \hat{d}\hat{r}^{\hat{2}} \hat{+} \hat{r}^{\hat{2}} \hat{\times} (\hat{d}\hat{\theta}^{\hat{2}} \hat{+} isosin^{\hat{2}}\hat{\theta}) \hat{-} \hat{d}\hat{t}^{\hat{2}}, \tag{14.1.19a}$$

$$\hat{d}\hat{r} = \hat{T}_r \times d\hat{r}, \hat{d}\hat{t} = \hat{T}_t \times d\hat{t}, \tag{14.1.19b}$$

$$\hat{T}_r = (1 - 2 \times M/r)^{-1}, \;\; \hat{T}_t = 1 - 2 \times M/r. \tag{14.1.19c}$$

(6) Relativistic hadronic mechanics [15] characterized by the *iso-Hilbert space* $\hat{\mathcal{H}}$ with *isoinner product and isonormalization* over $\hat{C}$

$$< \hat{\phi}|\hat{\times}|\hat{\psi} > \times \hat{I}, \quad < \hat{\psi}|\hat{\times}|\hat{\psi} >= \hat{I}. \tag{14.1.20}$$

Among various properties, we recall that: the *iso-Hermiticity* on $\hat{\mathcal{H}}$ coincides with the conventional Hermiticity (thus, all conventional observables remain observables under isotopies); the isoeigenvalues of iso-Hermitean operators are real and conventional (because of the identities

$$\hat{H}\hat{\times}|\hat{\psi} >= \hat{E}\hat{\times}|\hat{\psi} >= E \times |\hat{\psi} >; \tag{14.1.21}$$

the condition of *isounitarity* on $\hat{\mathcal{H}}$, over $\hat{C}$ is given by

$$\hat{U}\hat{\times}\hat{U}^{\dagger} = \hat{U}^{\dagger}\hat{\times}\hat{U} = \hat{I}, \tag{14.1.22}$$

(see memoir [27] for details).

(7) The Lie-Santilli isotheory [12] with: conventional (ordered) basis of generators $X = (X_k)$, and parameters $w = (w_k)$, $k = 1, 2, \ldots, n$, only formulated in isospaces over isofields with a common isounit; universal enveloping isoassociative algebras $\hat{\xi}$ with infinite-dimensional basis characterized by the isotopic Poincare'-Birkhoff-Witt theorem [12]

$$\hat{I},\ \hat{X}_i\hat{\times}\hat{X}_j,\ (i \leq j),\quad \hat{X}_i\hat{\times}\hat{X}_j \times \hat{X}_k,\ (i \leq j \leq k, ...) \tag{14.1.23}$$

Lie-Santilli subalgebras [12]

$$[\hat{X}_i,\hat{X}_j] = \hat{X}_i\hat{\times}\hat{X}_j - \hat{X}_j\hat{\times}\hat{X}_i = \hat{C}_{ij}^{k}(x, \ldots)\hat{\times}\hat{X}_k, \tag{14.1.24}$$

where the $\hat{C}$'s are the structure disfunctions; and isogroups characterized by isoexponentiation on $\hat{\xi}$ with structure [12]

$$\hat{e}^{\hat{X}} = \hat{I}\hat{+}\hat{X}\hat{/}\hat{1}!\hat{+}\hat{X}\hat{\times}\hat{X}\hat{/}\hat{2}!\hat{+}... = (e^{\hat{X}\times\hat{T}}) \times \hat{I} = \hat{I} \times (e^{\hat{T}\times\hat{X}}). \tag{14.1.25}$$

Despite the isomorphism between isotopic and conventional structures, the lifting of Lie's theory is nontrivial because of the appearance of the matrix $\hat{T}$ with nonlinear integrodifferential elements in the very *exponent* of the group structure, Eqs. (14.1.25).

To avoid misrepresentations, one should keep in mind that the isotopies of Lie's theory *were not* proposed to identify "new Lie algebras" (an impossible task since all simple Lie algebras are known from Cartan's classification), but to construct instead the most general possible nonlinear, nonlocal and noncanonical or nonunitary "realizations" of known Lie algebras.

(8) Isolinearity, isolocality and isocanonicity or isounitarity. Recall from lifting (14.1.25) that isosymmetries have the most general possible nonlinear, nonlocal and noncanonical or nonunitary structure. A main function of the isotopies is that of reconstructing linearity, locality and canonicity or unitarity on isospaces over isofields, properties called *isolinearity, isolocality and isocanonicity or isounitarity.* These are the properties that permit the bypassing of the theorems of catastrophic inconsistencies of Section 1.5.

As a result, the use of the conventional *linear* transformations on M over R, $X' = A(w) \times x$ violates *isolinearity* on $\hat{M}$ over $\hat{R}$.

In general, *any* use of conventional mathematics for isotopic theories leads to a number of inconsistencies which generally remain undetected by nonexperts in the field.[6]

(9) Isogauge theories [9–11]. They are characterized by an n-dimensional connected and non-isoabelian isosymmetry $\hat{G}$ with: basic n-dimensional isounit (4.1.9); iso-Hermitean generators $\hat{X}$ on an iso-Hilbert space $\hat{\mathcal{H}}$ over the isofield $\hat{C}(\hat{c}, \hat{+}, \hat{\times})$; universal enveloping associative algebra $\hat{\xi}$ with infinite isobasis (14.1.23); isocommutation rules (14.1.24); isogroup structure

$$\hat{U} = \hat{e}^{-i\times X_k\times\theta(x)_k} = (e^{-i\times X_k\times\hat{T}\times\theta(x)_k})\times\hat{I}, \quad \hat{U}^\dagger\hat{\times}\hat{U} = \hat{I}, \tag{14.1.26}$$

where one should note the appearance of the gravitational isotopic elements in the *exponent* of the isogroup, and the parameters $\theta(x)_k$ now depend on the iso-Minkowski space; isotransforms of the isostates on $\hat{\mathcal{H}}$

$$\hat{\psi}' = \hat{U}\hat{\times}\hat{\psi} = \left(e^{-i\times X_k\times\hat{T}(x,...)\times\theta(x)_k}\right)\times\hat{\psi}; \tag{14.1.27}$$

isocovariant derivatives [28]

$$\hat{D}_\mu\hat{\psi} = (\hat{\partial}_\mu - i\hat{\times}\hat{g}\hat{\times}\hat{A}(\hat{x})^k_\mu\hat{\times}\hat{X}_k)\hat{\times}\hat{\psi}; \tag{14.1.28}$$

iso-Jacobi identity

$$[\hat{D}_\alpha\hat{,}[\hat{D}_\beta\hat{,}\hat{D}_\gamma]]\,\hat{+}\,[\hat{D}_\beta\hat{,}[\hat{D}_\gamma\hat{,}\hat{D}_\alpha]]\,\hat{+}\,[\hat{D}_\gamma\hat{,}[\hat{D}_\alpha\hat{,}\hat{D}_\beta]] = 0, \tag{14.1.29}$$

where g and $\hat{g} = g\times\hat{I}$ are the conventional and isotopic coupling constants, $A(x)^k_\mu\times X_k$ and $\hat{A}(\hat{x})^k_\mu\hat{\times}\hat{X}_k = [A(x)^k_\mu\times X_k]\times\hat{I}$ are the gauge and isogauge potentials; isocovariance

$$(\hat{D}_\mu\hat{\psi})' = (\hat{\partial}_\mu\hat{U})\hat{\times}\hat{\psi}\hat{+}\hat{U}\hat{\times}(\hat{\partial}_\mu\hat{\psi})\hat{-}\hat{i}\hat{\times}\hat{g}\hat{\times}\hat{A}'(\hat{x})_\mu\hat{\times}\hat{\psi} = \hat{U}\hat{\times}\hat{D}_\mu\hat{\psi}, \tag{14.1.30a}$$

$$\hat{A}(\hat{x})'_\mu = -\hat{g}^{-\hat{1}}\hat{\times}[\hat{\partial}_\mu\hat{U}(\hat{x})]\hat{\times}\hat{U}(\hat{x})^{-\hat{1}}, \tag{14.1.30b}$$

$$\hat{\delta}\hat{A}(\hat{x})^k_\mu = -\hat{g}^{-\hat{1}}\,\hat{\times}\,\hat{\partial}_\mu\hat{\theta}(\hat{x})^k\,\hat{+}\,\hat{C}^k_{ij}\,\hat{\times}\,\hat{\theta}(\hat{x})^i\,\hat{\times}\,\hat{A}(\hat{x})^j_\mu, \tag{14.1.30c}$$

$$\hat{\delta}\hat{\psi} = -\hat{i}\hat{\times}\hat{g}\hat{\times}\hat{\theta}(\hat{x})^k\hat{\times}\hat{X}_k\hat{\times}\hat{\psi}; \tag{14.1.30d}$$

non-isoabelian iso-Yang-Mills fields

$$\hat{F}_{\mu\nu} = \hat{i}\hat{\times}\hat{g}^{-\hat{1}}\hat{\times}[\hat{D}_{\hat{\mu}}, \hat{D}_\nu]\hat{\psi}, \tag{14.1.31a}$$

[6]The use of conventional mathematics for isotheories would be the same as elaborating Balmer's quantum spectral lines in the hydrogen atoms with isofunctional analysis, resulting in evident major inconsistencies.

$$\hat{F}^k_{\mu\nu} = \hat{\partial}_\mu \hat{A}^k_\nu \hat{-} \hat{\partial}_\nu \hat{A}^k_\mu \hat{+} \hat{g} \hat{\times} \hat{C}^k_{ij} \hat{\times} \hat{A}^i_\mu \hat{\times} \hat{A}^j_\nu; \tag{14.1.31b}$$

related isocovariance properties

$$\hat{F}_{\mu\nu} \to \hat{F}'_{\mu\nu} = \hat{U} \hat{\times} \hat{F}_{\mu\nu} \hat{\times} \hat{U}^{-1}, \tag{14.1.32a}$$

$$Isotrace(\hat{F}_{\mu\nu'} \hat{\times} \hat{F}^{\mu\nu'}) = Isotrace(\hat{F}_{\mu\nu} \hat{\times} \hat{F}^{\mu\nu}), \tag{14.1.32b}$$

$$[\hat{D}_\alpha \hat{,} \hat{F}_{\beta\gamma}] \hat{+} [\hat{D}_\beta \hat{,} \hat{F}_{\gamma\alpha}] \hat{+} [\hat{D}_\gamma \hat{,} \hat{F}_{\alpha'\beta}] \equiv 0; \tag{14.1.32c}$$

derivability from the isoaction

$$\hat{S} = \hat{\int} \hat{d}^{\hat{4}} \hat{x} (-\hat{F}_{\mu\nu} \hat{\times} \hat{F}^{\mu\nu} \hat{/} \hat{4}) = \hat{\int} \hat{d}^{\hat{4}} \hat{x} (-\hat{F}^k_{\mu\nu} \hat{\times} \hat{F}^{\mu\nu}_k \hat{/} \hat{4}), \tag{14.1.33}$$

where $\hat{\int} = \int \times \hat{I}$, plus all other familiar properties in isotopic formulation.

The *isodual isogauge theory*, first proposed in Refs. [9–11], is the image of the preceding theory under the isodual map (14.1.2) when applied to the totality of quantities and their operations.

The latter theory is characterized by the isodual isogroup $\hat{G}^d$ with isodual isounit

$$\hat{I}^d_{Grav} = -\hat{I}^\dagger_{Grav} = -\hat{I}_{Grav} = -1/\hat{T}_{Grav} < 0. \tag{14.1.34}$$

The elements of the base fields

$$\hat{R}^d(\hat{n}^d, \hat{+}^d, \hat{\times}^d), \tag{14.1.35}$$

are given by the isodual isoreal numbers

$$\hat{n}^d = -\hat{n} = -n \times \hat{I}, \tag{14.1.36}$$

and those of the field

$$\hat{C}^d(\hat{c}^d, \hat{+}^d, \hat{\times}^d), \tag{14.1.37}$$

are the isodual isocomplex numbers

$$\hat{c}^d = -(c \times \hat{I})^\dagger = (n_1 - i \times n_2) \times \hat{I}^d = (-n_1 + i \times n_2) \times \hat{I}. \tag{14.1.38}$$

The carrier spaces are the isodual iso-Minkowski spaces $\hat{M}^d(\hat{x}^d, -\hat{\eta}^d, \hat{R}^d)$ on $\hat{R}^d$ and the isodual iso-Hilbert space $\mathcal{H}^d$ on $\hat{C}^d$ with isodual isostates and isodual isoinner product

$$|\hat{\psi}>^d = -|\hat{\psi}>^\dagger = - <\psi|, \tag{14.1.39a}$$

$$<\hat{\phi}|^d \times \hat{T}^d \times |\hat{\psi}>^d \times \hat{I}^d. \tag{14.1.39b}$$

It is instructive to verify that all eigenvalues of isodual iso-Hermitean operators are *negative − definite* (when projected in our space-time),

$$\hat{H}^d \hat{\times}^d |\hat{\psi} >^d = < \psi| \times (-E). \tag{14.1.40}$$

$\hat{G}^d$ is characterized by the isodual Lie-Santilli isotheory with isodual generators $\hat{X}^d = -\hat{X}$, isodual isoassociative product

$$\hat{A}^d \hat{\times}^d \hat{B}^d = \hat{A}^d \times \hat{T}^d \times \hat{B}^d, \;\; \hat{T}^d = -\hat{T}, \tag{14.1.41}$$

and related isodual isoenveloping and Lie-Santilli isoalgebra.

The elements of $\hat{G}^d$ are the isodual isounitary isooperators

$$\hat{U}^d(\hat{\theta}^d(\hat{x}^d)) = -\hat{U}^\dagger(-\hat{\theta}(-\hat{x})). \tag{14.1.42}$$

In this way, the isodual isogauge theory is seen to be an anti-isomorphic image of the preceding theory, as desired.

It is an instructive exercise for the reader interested in learning the new techniques to study first the isodualities of the *conventional* gauge theory (rather than of their isotopies), and show that they essentially provide a mere reinterpretation of the usually discarded, advanced solutions as characterizing antiparticles.

Therefore, in the isoselfdual theory with total gauge symmetry $\hat{G} \times \hat{G}^d$, isotopic retarded solutions are associated with particles and advanced isodual solutions are associated with antiparticles.

No numerical difference is expected in the above reformulation because, as shown in Chapter 3, isotopies preserve not only the original axioms but also the original numerical value (when constructed properly).

It is also recommendable for the interested reader to verify that the isotopies are indeed equivalent to charge conjugation for all massive particles, with the exception of the photon (see Section 2.3). In fact, isodual theories predict that the antihydrogen atom emits a new photon, tentatively called by this author the *isodual photon* [38], that coincides with the conventional photon for all possible interactions, thus including electroweak interactions, *except gravitation.* This indicates that the isodual map is inclusive of charge conjugation for massive particles, but it is broader than the latter.

Isodual theories in general, thus including the proposed grand unification, predict that all *stable* isodual particles, such as the isodual photon, the isodual electron (positron), the isodual proton (antiproton) and their bound states (such as the antihydrogen atom), experience *antigravity* in the field of the Earth (defined as the reversal of the sign of the curvature tensor).

If confirmed, the prediction may offer the possibility in the future to ascertain whether far away galaxies and quasars are made-up of matter or of antimatter.

We finally note that isomathematics is a particular case of the broader *genomathematics*, also introduced for the first time in Refs. [12] of 1978 (see Chapter

4), which occurs for non-Hermitean generalized units and is used for an axiomatization of irreversibility.

In turn, genomathematics is a particular case of the *hypermathematics*, that occurs when the generalized units are given by ordered *sets* of non-Hermitean quantities and is used for the representation of multivalued complex systems (e.g. biological entities) in irreversible conditions.

Evidently both the genomathematics and hypermathematics admit an anti-isomorphic image under isoduality (see also Chapter 4).

In conclusion the methods outlined in this note permit the study of *seven* liftings of conventional gauge theories [9–11]:

(1) The *isodual gauge theories* for the treatment of antimatter without gravitation in vacuum;

(2,3) The *isogauge theories and their isoduals*, for the inclusion of gravity for matter and antimatter in reversible conditions in vacuum (exterior gravitational problem);

(4,5) The *genogauge theories and their isoduals*, for the inclusion of gravity for matter and antimatter in irreversible interior conditions (interior gravitational problems); and

(6,7) the *hypergauge theories and their isoduals*, for multivalued and irreversible generalizations.

For brevity this section is restricted to theories of type (1), (2), (3). The development of the remaining genotopies of gauge theories is left to interested readers.

14.1.5 Iso-, Geno- and Hyper-Grand-Unifications

In this section we review the *Iso-Grand-Unification* (IGU) with the inclusion of electroweak and gravitational interactions, first submitted in Refs. [9–11] via the 22-dimensional total isoselfdual isosymmetry given by isosymmetry (3.5.28) and its isodual

$$\hat{S}_{tot} = (\hat{\mathcal{P}}(3.1)\hat{\times}\hat{G}) \times (\hat{\mathcal{P}}(3.1)^{d}\hat{\times}^{d}\hat{G}^{d}) =$$

$$= [\hat{SL}(2,\hat{C})\hat{\times}\hat{T}(3.1)\hat{\times}\hat{\mathcal{I}}(1)] \times [\hat{SL}^{d}(2,\hat{C}^{d})\hat{\times}^{d}\hat{T}^{d}(3.1)\hat{\times}^{d}\hat{\mathcal{I}}^{d}(1)], \qquad (14.1.43)$$

where $\hat{\mathcal{P}}$ is the Poincaré-Santilli isosymmetry [22] in its isospinorial realization [24], $\hat{G}$ is the isogauge symmetry of the preceding section and the remaining structures are the corresponding isoduals.

Without any claim of a final solution, it appears that the proposed IGU does indeed offer realistic possibilities of resolving the axiomatic incompatibilities (1)–(5) of Section 14.1.2 between gravitational and electroweak interactions.

In fact, IGU represents gravitation in a form geometrically compatible with that of the electroweak interactions, represents antimatter at all levels via negative-

energy solutions, and characterizes both gravitation as well as electroweak interactions via the universal Poincaré-Santilli isosymmetry.

It should be indicated that we are referring here to the *axiomatic* consistency of IGU. In regard to the *physical* consistency we recall that isotopic liftings preserve not only the original axioms, but also the original numerical values [15].

As an example, the image in iso-Minkowskian space over the isoreals of the light cone, the isolight cone, not only is a perfect cone, but a cone with the original characteristic angle, thus preserving the speed of light in vacuum as the maximal causal speed in iso-Minkowskian space.

This peculiar property of the isotopies implies the expectation that the proposed Iso-Grand-Unification preserves the numerical results of electroweak interactions.

The reader should be aware that the methods of the recent memoir [27] permit a truly elementary, explicit construction of the proposed IGU.

As well known, the transition from the Minkowskian metric η to Riemannian metrics $g(x)$ is a *noncanonical transform* at the classical level, and, therefore, a at the operator level.

The method herein considered for turning a gauge theory into an IGU consists in the following representation of the selected gravitational model, e.g., Schwarzschild's model:

$$g(x) = T(x) \times \eta, \tag{14.1.44a}$$

$$I(x) = U \times U^\dagger = 1/\hat{T} =$$

$$Diag.[(1 - 2 \times M/r) \times Diag.(1, 1, 1),\ (1 - 2 \times M/r)^{-1}], \tag{14.1.44b}$$

and then subjecting the *totality* of the gauge theory to the nonunitary transform $U \times U^\dagger$.

The method then yields: the isounit

$$I \to \hat{I} = U \times I \times U^\dagger; \tag{14.1.45}$$

the isonumbers

$$a \to \hat{a} = U \times a \times U^\dagger = a \times (U \times U^\dagger) = a \times \hat{I},\ a = n, c; \tag{14.1.46}$$

the isoproduct with the correct expression and Hermiticity of the isotopic element,

$$A \times B \to U \times (A \times B) \times U^\dagger =$$

$$= (U \times A \times U^\dagger) \times (U \times U^\dagger)^{-1} \times (U \times B \times U^\dagger) =$$

$$= \hat{A} \times \hat{T} \times \hat{B} = \hat{A} \hat{\times} \hat{B}; \tag{14.1.47}$$

the correct form of the iso-Hilbert product on $\hat{C}$,

$$< \phi| \times |\psi > \to U \times < \phi| \times |\psi > \times U^\dagger =$$

$$= (< \psi| \times U^\dagger) \times (U \times U^\dagger)^{-1} \times (U \times |\psi >) \times (U \times U^\dagger) =$$
$$=< \hat{\phi}| \times \hat{T} \times |\hat{\psi} > \times \hat{I}; \tag{14.1.48}$$

the correct Lie-Santilli isoalgebra

$$A \times B - B \times A \to \hat{A}\hat{\times}\hat{B} - \hat{B}\hat{\times}\hat{A}; \tag{14.1.49}$$

the correct isogroup

$$U \times (e^X) \times U^\dagger = (e^{X \times \hat{T}}) \times \hat{I}, \tag{14.1.50}$$

the Poincaré-Santilli isosymmetry $\mathcal{P} \to \hat{\mathcal{P}}$, and the isogauge group $G \to \hat{G}$.

It is then easy to verify that the emerging IGU is indeed invariant under all possible additional nonunitary transforms, provided that, for evident reasons of consistency, they are written in their identical isounitary form,

$$W \times W^\dagger = \hat{I}, \tag{14.1.51a}$$

$$W = \hat{W} \times \hat{T}^{1/2}, W \times W^\dagger = \hat{W}\hat{\times}\hat{W}^\dagger = \hat{W}^\dagger\hat{\times}\hat{W} = \hat{I}. \tag{14.1.51b}$$

In fact, we have the invariance of the isounit

$$\hat{I} \to \hat{I}' = \hat{W}\hat{\times}\hat{I}\hat{\times}\hat{W}^\dagger = \hat{I}, \tag{14.1.52}$$

the invariance of the isoproduct

$$\hat{A}\hat{\times}\hat{B} \to \hat{W}\hat{\times}(\hat{A}\hat{\times}\hat{B})\hat{\times}\hat{W}^\dagger = \hat{A}'\hat{\times}\hat{B}', \text{ etc.} \tag{14.1.53}$$

Note that the isounit is *numerically* preserved under isounitary transforms, as it is the case for the conventional unit I under unitary transform, and that the selection of a nonunitary transform $W \times W^\dagger = \hat{I}'$ with value different from $\hat{I}$ evidently implies the transition to a different gravitational model.

Note that the lack of implementation of the above nonunitary-isounitary lifting to only *one* aspect of the original gauge theory (e.g., the preservation of the old numbers or of the old differential calculus) implies the loss of the invariance of the theory [32].

The assumption of the negative-definite isounit $\hat{I}^d = -(U \times U^\dagger)$ then yields the isodual component of the IGU.

Note finally that diagonal realization (14.1.44) has been assumed mainly for simplicity. In general, the isounit is positive-definite but *nondiagonal* 4×4-dimensional matrix. The Schwarzschild metric can then be more effectively represented in its isotropic coordinates as studied, e.g. in Ref. [39], pp. 196–199).

In closing, the most significant meaning of IGU is that *gravitation has always been present in unified gauge theories. It did creep-in un-noticed because embedded where nobody looked for, in the "unit" of gauge theories.*

In fact, the isogauge theory of Section 14.1.4 coincides with the conventional theory at the abstract level to such an extent that we could have presented IGU with exactly the same symbols of the conventional gauge theories without the "hats", and merely subjecting the same symbols to a more general realization.

Also, the isounit representing gravitation as per rule (14.1.9) verifies all the properties of the conventional unit I of gauge theories,

$$\hat{I}^{\hat{n}} = \hat{I}, \quad \hat{I}^{\hat{1/2}} = \hat{I}, \tag{14.1.54a}$$

$$d\hat{I}/dt = \hat{I}\hat{\times}\hat{H} - \hat{H}\hat{\times}\hat{I} = \hat{H} - \hat{H} = 0, \text{ etc.} \tag{14.1.54b}$$

The "hidden" character of gravitation in conventional gauge theories is then confirmed by the isoexpectation value of the isounit recovering the conventional unit I of gauge theories,

$$\hat{<}\hat{I}\hat{>} =< \hat{\psi}| \times \hat{T} \times \hat{I} \times \hat{T} \times |\hat{\psi} > / < \hat{\psi}| \times \hat{T} \times |\hat{\psi} >= I. \tag{14.1.55}$$

It then follows that *IGU constitutes an explicit and concrete realization of the theory of "hidden variables"* [40]

$$\lambda = T(x) = g(x)/\eta, \hat{H}\hat{\times}|\hat{\psi} >= \hat{H} \times \lambda \times |\hat{\psi} >= E_\lambda \times |\hat{\psi} >, \tag{14.1.56}$$

and the theory is correctly reconstructed with respect to the new unit

$$\hat{I} = \lambda^{-1}, \tag{14.1.57}$$

in which von Neumann's Theorem [41] and Bell's inequalities [42] do not apply, evidently because of the nonunitary character of the theory (see Ref. [21] and Vol. II of Refs. [15] for details).

In summary, the proposed inclusion of gravitation in unified gauge theories is essentially along the teaching of Einstein, Podolsky, and Rosen [43] on the "lack of completion" of quantum mechanics, only applied to gauge theories.

14.2 ISO-, GENO-, AND HYPER-SELF-DUAL COSMOLOGIES

A rather popular belief of the 20-th century was that the universe is solely composed of matter. This belief was primarily due to the scientific imbalance pertaining to antimatter as being solely studied at the level of second quantization, without any theoretical, let alone experimental, mean available for the study of antimatter.

In reality, there exists rather strong evidence that the universe is indeed composed of matter as well as antimatter and, more particularly, that some of the galaxies are made up of matter and others of antimatter.

To begin, not only the expansion of the universe, but more particularly the recently detected increase of the expansion itself, can be readily explained via an equal distribution of matter and antimatter galaxies.

In fact, antigravity experienced by matter and antimatter galaxies (studied in the preceding chapter) explains the expansion of the universe, while the continuous presence of antigravity explains the increase of the expansion.

The assumption that the universe originated from a primordial explosion, the "big bang", could have explained at least conceptually the expansion of the universe. However, the "big bang" conjecture is eliminated as scientifically possible by the increase of the expansion itself.

The "big bang" conjecture is also eliminated by the inability to explain a possible large presence of antimatter in the universe, trivially, because it would have been annihilated at the time of the "big bang" because produced jointly with matter, as well as for other reasons.

By comparison, the only plausible interpretation at the current state of our knowledge is precisely the assumption that the universe is made up half of *matter galaxies* and half of *antimatter galaxies* due to the joint explanation of the expansion of the universe and its increase.

Independently from the above, there exists significant evidence that our Earth is indeed bombarded by antimatter particles and asteroids.

Astronauts orbiting Earth in spaceship have systematically reported that, when passing over the dark side, they see numerous flashes in the upper atmosphere that can be only interpreted as *antimatter cosmic rays*, primarily given by high energy antiprotons and/or positrons[7] originating from far away antimatter galaxies, which antiparticles, when in contact with the upper layers of our atmosphere, annihilate themselves producing the flashes seen by astronauts.

Note that the conventional *cosmic rays* detected in our atmosphere are *matter cosmic rays,* that is, high energy *particles*, such as protons and electrons, originating from a matter supernova or other matter astrophysical event.

In any case, it is evident that matter cosmic rays with sufficient energy can indeed penetrate deep into our atmosphere, while antimatter cosmic rays will be stopped by the upper layers of our atmosphere irrespective of their energy.

In addition, there exists evidence that our Earth has been hit by *antimatter meteorites* that, as such, can only originate from an astrophysical body made up of antimatter.

The best case is the very large devastation re corded in 1908 in Tunguska, Siberia, in which over one million acres of forest were completely flattened in a radial direction originating from a common center without any crater whatever, not even at the center.

[7]Evidently only *stable antiparticles can travel intergalactic distances without decaying.*

The lack of a crater combined with the dimension of the devastation, exclude the origination from the explosion of a *matter asteroid*, firstly, because in this case debris would have been detected by the various expeditions in the area and, secondly, because there is no credible possibility that the mere explosion of a matter asteroid could have caused a devastation over such a large area requiring energies computed at about 100 times the atomic bomb exploded over Hiroshima, Japan.

The only plausible interpretation of the *Tunguska explosion* is that it was due to an antimatter asteroid that eventually annihilated after contact deep into our matter atmosphere.

The important point is that the numerical understanding of the Tunguska explosion requires an antimatter mass of the order of a ton, namely, an antimatter asteroid that, as such, can only originate from the supernova explosion of an antimatter star.

Consequently, the evidence on the existence of even one antimatter asteroid confirms the existence in the universe of antimatter stars. Since it is highly improbable that antimatter stars can exist within a matter galaxy, antimatter asteroids constitute significant evidence on the existence in the universe of antimatter galaxies.

But again, the expansion of the universe as well as the increase of the expansion itself are the strongest evidence for an essentially equal distribution of matter and antimatter galaxies in the universe, as well as for the existence of antigravity between matter and antimatter.

In any case, there exist no alternative hypothesis at all known to this author, let alone a credible hypothesis, that could explain quantitatively both the expansion of the universe and the increase of the expansion itself.

In view of the above occurrences, as well as to avoid discontinuities at creation, Santilli [44] proposed the new *Iso-Self-Dual Cosmology*, namely, a cosmology in which the universe has an exactly equal amount of matter and antimatter, much along the isoselfdual re-interpretation of Dirac's equation of Section 2.3.6.

Needless to say, such a conception of the universe dates back to the very birth of cosmology, although it was abandoned due to various reasons, including the lack of a consistent classical theory of antimatter, inconsistencies for negative energies, and other problems.

The above conception of the universe was then replaced with the "big bang" conjecture implying a huge discontinuity at creation, in which a possible antimatter component in the universe is essentially left untreated.

All the above problems are resolved by the isodual theory of antimatter, and quantitative astrophysical studies on antimatter galaxies and quasars can now be initiated at the purely classical level.

Moreover, the prediction that the *isodual light* emitted by antimatter experiences a repulsion in the gravitational field of matter [38], permits the initiation of actual measurements on the novel *antimatter astrophysics.*

Noticeably, there already exist reports that certain astrophysical events can only be explained via the repulsion experiences by light emitted by certain galaxies or quasars, although such reports could not be subjected to due scientific process since the mere existence of such a repulsion would invalidate Einstein's gravitation, as studied in Section 1.4.

Even though the assumption of an equal distribution of matter and antimatter in the universe dates back to the discovery of antimatter itself in the early 1930s, the Iso-Self-Dual Cosmology is structurally new because it is the first cosmology in scientific records based on a *symmetry,* let alone an *isoselfdual symmetry,* that of Dirac's equation subjected to isotopies, Eqs. (14.1.43), i.e.,

$$\hat{S}_{Tot} = (\hat{\mathcal{P}}(3.1)\,\hat{\times}\,\hat{G}) \times (\hat{\mathcal{P}}(3.1)^d\,\hat{\times}^d\,\hat{G}^d) =$$

$$= [\hat{SL}(2,\hat{C})\hat{\times}\hat{T}(3.1)\hat{\times}\hat{\mathcal{I}}(1)] \times [\hat{SL}^d(2,\hat{C}^d)\hat{\times}^d\hat{T}^d(3.1)\hat{\times}^d\hat{\mathcal{I}}^d(1)]. \qquad (14.2.1)$$

In fact, virtually all pre-existing cosmologies are based on Einstein's gravitation, thus eliminating a universal symmetry *ab initio.*

Other novelties of the Iso-Self-Dual Cosmology are given by the implications, that are impossible without the isotopies and isodualities, such as:

1) The direct interpretation of the expansion of the universe, as well as the increase of the expansion itself, since antigravity is permitted by the isodualities but not in general by other theories;

2) The prediction that the universe has absolutely null total characteristics, that is, an absolutely null total time, null total mass, null total energy, null total entropy, etc., as inherent in all isoselfdual states[8];

3) The creation of the universe without any discontinuity at all, but via the joint creation of equal amounts of matter and antimatter, since all total characteristics of the universe would remain the same before and after creation.

We also mention that the isoselfdual cosmology was proposed by Santilli [44] to initiate mathematical and theoretical studies on the creation of the universe, studies that are evidently prohibited by theories with huge discontinuities at creation.

After all, we should not forget that the Bible states the creation first of light and then of the universe, while it is now known that photons can create a pair of a particle and its antiparticle.

[8]We are here referring to intrinsic characteristic of isoselfdual states, and not to the same characteristics when inspected from a matter or an antimatter observer that would be evidently impossible for the universe.

Also, there is a mounting evidence that space (the *aether* or the *universal substratum*) is composed of a superposition of positive and negative energies, thus having all pre-requisites needed for the creation of matter and antimatter galaxies.

As one can see, a very simple property of the new number theory, the invariance under isoduality as it is the case for the imaginary unit (Section 2.1.1),

$$i \equiv i^d = -i^\dagger = -\bar{i}, \tag{14.2.2}$$

acquires a fundamental physical character for a deeper understanding of Dirac's gamma matrices (Chapter 2),

$$\gamma_\mu \equiv \gamma_\mu^d = -\gamma_\mu^\dagger, \tag{14.2.3}$$

and then another fundamental character for the entire universe.

To understand the power of isodualities despite their simplicity, one should meditate a moment on the fact that the assumed main characteristics of the universe as having an equal amount of matter and antimatter, can be reduced to a primitive abstract axiom as simple as that of the new invariance (14.2.2).

Needless to say, the condition of exactly equal amounts of matter and antimatter in the universe is a *limit case,* since in reality there may exist deviations, with consequential *breaking of the isoselfdual symmetry* (14.2.1). This aspect cannot be meaningfully discussed at this time due to the abyssal lack of knowledge we now have on the antimatter component in our universe.

It should be finally indicated that, in view of the topological features assumed for the basic isounit

$$\hat{I} = \hat{I}^\dagger > 0, \tag{14.2.4}$$

the Iso-Self-Dual Cosmology outlined above can only represent a closed and reversible universe, thus requiring suitable broadening for more realistic theories.

Recall that, from its Greek meaning, "cosmology" denotes the entire universe. Consequently, no theory formulated until now, including the Iso-Self-Dual Theory, can be called, strictly speaking, a "cosmology" since the universe is far from being entirely composed of closed and reversible constituents.

To begin, there is first the need to represent irreversibility, since the behavior in time of all stars, galaxies and quasars in the universe is indeed irreversible.

This first need can be fulfilled with the Iso-Self-Dual Cosmology realized via isounits that are positive-definite, but explicitly time dependent,

$$\hat{I}(t, \ldots) = \hat{I}^\dagger(t, \ldots) \neq \hat{I}(-t, \ldots), \tag{14.2.5}$$

which feature assures irreversibility, although the universe remains closed due to the conservation of the total energy of matter and that of antimatter.

The latter model has evident limitations, e.g., in view of the possible continuous creation of matter and antimatter advocated by various researchers as an alternative to the "big bang".

The latter condition, when joint with the necessary representation of irreversibility, requires the broader *Geno-Self-Dual Cosmology*, namely, a cosmology based on the Lie-admissible lifting of symmetry (14.2.1), via the further generalization of generalized units (14.3.4) and (14.2.5) into four genounits, one per each of the four possible directions of time

$$\hat{I}^{>}, \quad -\hat{I}^{>}, \quad (\hat{I}^{>})^{d} = -^{<}\hat{I}, \quad -(\hat{I}^{>})^{d} = ^{<}\hat{I}, \tag{14.2.6}$$

whose explicit construction is left to the interested reader for brevity (see Chapter 5).

Nevertheless, the latter genotopic lifting itself cannot be considered, strictly speaking, a "cosmology" because a basic component of the universe is life, for which genotopic theories are insufficient, as indicated in Section 3.7, due to their single-valuedness.

The latter need inevitably requires the formulation of cosmologies via the most general possible methods studied in this monograph, the multivalued hyperstructure of Chapter 5, resulting in the *Hyper-Self-Dual Cosmology,* namely, a cosmology based on the hyperlifting of symmetry (14.2.1) characterized by the ordered multivalued hyperunits

$$\hat{I}^{>} = \{\hat{I}_1^{>}, \hat{I}_2^{>}, \hat{I}_3^{>}, \ldots\}, \quad -\hat{I}^{>} = \{-\hat{I}_1^{>}, -\hat{I}_2^{>}, -\hat{I}_3^{>}, \ldots\}, \tag{14.2.7a}$$

$$(\hat{I}^{>})^{d} = \{-^{<}\hat{I}_1, -^{<}\hat{I}_2, -^{<}\hat{I}_3, \ldots\}, \quad -(\hat{I}^{>})^{d} = \{^{<}\hat{I}_1, ^{<}\hat{I}_2, ^{<}\hat{I}_3, \ldots\}. \tag{14.2.7b}$$

However, at this point we should remember the limitations of our mind and admit that the foundations of the Hyper-Self-Dual Cosmology, such as the multivalued hypertime encompassing all four directions of time, is simply beyond our human comprehension.

After all, we have to admit that a final scientific understanding of life will likely require thousands of years of studies.

14.3 CONCLUDING REMARKS

The analysis conducted in this monograph establishes that the isodual theory of antimatter does indeed resolve the scientific imbalance of the 20-th century caused by the treatment of matter at all levels of study, and the treatment of antimatter at the sole level of second quantization.

In fact, the isodual theory of antimatter achieves an absolute democracy of treatment of both matter and antimatter at all levels, from Newton to second quantization.

In particular, the analysis presented in this monograph establishes that the isodual theory of antimatter is verified by all known experimental data on antimatter, since the isodual theory trivially represents all available classical experimental data (Section 2.2.3), while resulting in being equivalent to charge conjugation at the operator level (Section 2.3.7), as a result of which the entire currently available experimental knowledge on antiparticles is verified by the isodual theory.

Despite its simplicity, the isodual theory of antimatter has deep implications for all quantitative sciences, including classical mechanics, particle physics, superconductivity, chemistry, biology, astrophysics and cosmology.

The most salient consequence of the isodual theory is the prediction of antigravity experienced by *elementary* antiparticles in the field of matter and vice-versa.

This prediction is a direct consequence of the very existence of a consistent classical formulation of antimatter, the electromagnetic origin of the gravitational mass with consequential phenomenological equivalence of electromagnetism and gravitation for both attraction and repulsion, the forgotten Freud identity of the Riemannian geometry, and other aspects.

In reality, the prediction of antigravity for truly elementary antiparticles in the field of matter is rooted in so many diversified aspects that the possible experimental disproof of antigravity would likely require the reconstruction of theoretical physics from its foundations.

To minimize controversies, it should be stressed that the prediction of antigravity has been solely and specifically presented for *elementary* antiparticles, that is, for the *positron,* with the careful exclusion for first tests of any unstable or composite particles whose constituents are not seriously established as being all antiparticles.

As an illustration, we have discouraged the use in possible experiments on the gravity of the positronium as claim for final knowledge on the gravity of antimatter, because the positronium is predicted by the isodual theory to be attracted in both fields of matter and antimatter. Similarly we have discouraged the use of leptons because they may eventually result to be composite of particles and antiparticles.

Finally, we have strongly discouraged to assume experimental data on the gravity of antiprotons as final knowledge on the gravity of antiparticles, because antiprotons are today fabricated in high energy laboratories from matter components and are believed to be bound states of quarks for which no gravity at all can be consistently defined [38].

It then follows that, while all experimental data are indeed useful and should be supported, including experimental data on the gravity of antiprotons, their use for general claims on the gravity of antimatter could be deceptive.

Moreover, none of the numerous arguments against antigravity could even be properly formulated for the isodual theory, let alone have any value. As a result, the prediction of antigravity for elementary antiparticles in the field of matter is fundamentally unchallenged at this writing on theoretical grounds.

A test of the gravity of positrons in horizontal flight in a vacuum tube, that is resolutory via gravitational deflections visible to the naked eye, has been proposed by Santilli [45] and proved by the experimentalist Mills [46] to be feasible with current technology and be indeed resolutory (Section 4.2).

A comparative study of other tests has revealed that they are too delicate and require too sensitive measurements to be as resolutory as proposal [45] with current technologies.

It is hoped that the experimental community finally comes to its senses, and conducts fundamental test [45,46], rather than continuing to conduct tests of transparently less relevance at bigger public costs, because in the absence of a final experimental resolution of the problem of antigravity, the entire theoretical physics remains essentially in a state of suspended animation.

In turn, the possible experimental verification of antigravity (as above identified) would have implications so advanced as to be at the edge of our imagination.

One of these implications has been presented in Section 13.3 with the Causal Time Machine, the novel, non-Newtonian *isolocomotion* (propulsion to unlimited speeds without any action and reaction as requested by all currently available propulsions), and other far reaching possibilities.

The experimental resolution of the existence of antigravity for *truly elementary* antiparticles is also crucial to fulfil the original scope for which the isodual theory was built, namely, to conduct quantitative studies as to whether far-away galaxies and quasars are made up of matter or antimatter.

This main scope has been achieved via the *isodual photon,* namely, the discovery that, according to the isodual theory, photons emitted by antimatter appear to have a number of physical differences with the photons emitted by matter. In particular, *the simplest possible isodual electromagnetic waves have negative energy, thus experiencing antigravity in the field of matter.*

The above prediction requires the experimental resolution as to whether light emitted by antimatter is attracted or repelled by the gravitational field of matter.

Needless to say, the current availability at CERN of the antihydrogen atom is an ideal source for such a study, with the understanding that gravitational deflections of light at short distances (as attainable in a laboratory on Earth) are extremely small, thus implying extremely sensitive measurements.

More promising is the re-inspection of available astrophysical data privately suggested to the author because said data could already include evidence of light from far-away galaxies and quasars that is repelled by astrophysical objects closer to us.

Such a repulsion could not be publicly disclosed at this time because of known opposition by organized academic interests on Einsteinian doctrines since, as well known, Einstein's gravitation prohibits the existence of antigravity (Section 4.1).

It is hoped that such organized academic interests come to their senses too, if nothing else, to avoid an easily predictable serious condemnation by posterity, in view of the well known catastrophic inconsistencies of Einstein gravitation outlined in Section 1.4.

After all, we should not forget that antiparticles were first experimentally detected in cosmic rays, thus confirming their possible origin from supernova explosions of stars made up of antimatter.

Also, there are reports of huge explosions in Earth's atmosphere before the advent of atomic bombs without any crater on the ground, such as the 1908 Tunguska explosion in Siberia, which explosions can be best interpreted as antimatter asteroids from far away antimatter galaxies or quasars penetrating in our atmosphere.

Therefore, it should not be surprising if light experiencing gravitational repulsion from matter is discovered first in astrophysics.

Additional tests on the possible gravitational repulsion of light emitted by antimatter can be done via the direct measurement of the deflection of light from far away galaxies and quasars when passing near one of the planets of our Solar system.

Under the assumption of using light originating from far away galaxies and quasars (to render plausible their possible antimatter nature), and for the use of a sufficient number of galaxies and quasars (to have a sufficient probability that at least one of them is made up of antimatter), these astrophysical measurements are potentially historical, and will signal the birth of the new science proposed in this monograph under the name of *antimatter astrophysics.*

The reader should be aware that, while the prediction of antigravity for *truly elementary* antiparticles is an absolute necessity for the validity of the isodual theory, the gravitational behavior of light emitted by antimatter is not that simple.

Recall from Section 13.2 that the prediction of antigravity for light emitted by antimatter is based on the negative value of its energy for the selected solution of the electromagnetic wave.

However, the photons is invariant under charge conjugation and travel at the maximal causal speed in vacuum, c. Therefore, the photon could well result to be a superposition of positive and negative energies, perhaps as a condition to travel at the speed c, in which case the photon would be an isoselfdual state, thus experiencing attraction in both fields of matter and antimatter.

As a consequence, the possible disproof of antigravity for light emitted by antimatter stars in the field of matter *would not* invalidate the isodual theory of

antimatter, but merely tell us that our conception of light remains excessively simplistic to this day, since it could well be in reality a composite state of photons and their isoduals.

The issue is further complicated by the fact indicated during the analysis of this monograph that *antigravity is predicted between masses with opposite time evolutions,* as it is the case for a positron in the field of Earth. However, the photon travels at the speed of light at which speed time has no meaningful evolution.

As a result, it is not entirely clear to this author whether the sole value of negative energy for the isodual light is sufficient for the existence of a gravitational repulsion, and the issue is suggested for study by interested colleagues.

To express a personal view, it would be distressing if light solely experience gravitational attraction irrespective of whether in the field of matter or antimatter and whether originating from matter or antimatter, because this would imply the impossibility for experimental studies as to whether far-away galaxies and quasars are made up of matter or antimatter, since all other aspects, including thermodynamics, are not detectable at large distances, thus implying the perennial inability for mankind to reach any in depth knowledge of the universe.

The author does not believe so. Advances in human knowledge have no limit, and often go beyond the most vivid imagination, as established by scientific realities that resulted in being beyond the science fiction of preceding generations.

In closing, the author hopes that the studies presented in this monograph have stimulated young minds of any age and confirmed that science will never admit final theories. No matter how precious, beloved and valid a given theory may appear to be at a given time, its surpassing with broader theories more adequate for new scientific knowledge is only a matter of time.

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Chapter 15

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