APPENDIX 1

THE GRAVITATIONAL FIELD OF AN OBJECT MOVING WITH CONSTANT VELOCITY AND THE GEM EQUATIONS

In fig. A-1 we consider the gravitational field of a particle with rest mass m_0 that is moving with constant velocity $\vec{v} = v.\vec{e}_z$ along the *Z*-axis of an inertial reference frame ***O***. At the moment when the particle passes at the origin *O*, we set $t = 0$.

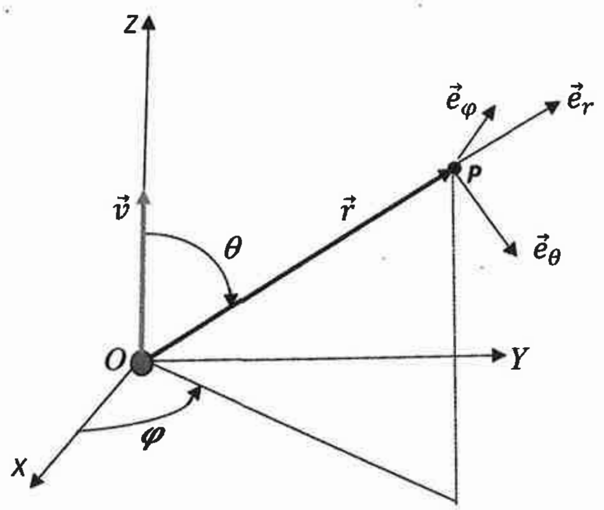

Fig. A-1

According to §4.5 the gravitational field of that particle at *P* is completely defined, in spherical coordinates (r, θ, φ), by:

$$\vec{E}_g = N.\vec{s}_g = -\frac{m_0}{4\pi\eta_0 r^2}.\frac{1-\beta^2}{(1-\beta^2.sin^2\theta)^{\frac{3}{2}}}.\vec{e}_r$$

$$\vec{B}_g = n.\vec{s}_\beta = -\frac{\nu_0.m_0}{4\pi r^2}.\frac{1-\beta^2}{(1-\beta^2.sin^2\theta)^{\frac{3}{2}}}.v.\sin\theta.\vec{e}_\varphi$$

We will verify that $(\vec{E}_g, \vec{B}_g)$ satisfy the Maxwell-Heaviside equations at an arbitrary point *P*:

1. $div\vec{E}_g = 0$ 2. $div\vec{B}_g = 0$

3. $rot\vec{E}_g = -\frac{\partial \vec{B}_g}{\partial t}$ 4. $rot\vec{B}_g = \frac{1}{c^2}.\frac{\partial \vec{E}_g}{\partial t}$

1. $div\vec{E}_g = 0$

From mathematics we know that:

$$div\vec{E}_g = \frac{1}{r^2}.\frac{\partial}{\partial r}(r^2.E_{gr}) + \frac{1}{r.\sin\theta}.\frac{\partial}{\partial\theta}(\sin\theta\,.E_{g\theta}) + \frac{1}{r.\sin\theta}.\frac{\partial E_{g\varphi}}{\partial\varphi}$$

With:

$$E_{gr} = -\frac{m_0}{4\pi\eta_0 r^2}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}} \quad \text{and} \quad E_{g\theta} = E_{g\varphi} = 0$$

We find: $div\vec{E}_g = 0$

2. $div\vec{B}_g = 0$

One can prove this in the same way as *1*.

3. $rot\vec{E}_g = -\frac{\partial \vec{B}_g}{\partial t}$

From mathematics we know that:

$$rot\vec{E}_g = \frac{1}{r.\sin\theta}.\left[\frac{\partial}{\partial\theta}(E_{g\varphi}.\sin\theta) - \frac{\partial E_{g\theta}}{\partial\varphi}\right].\vec{e}_r$$

$$+\frac{1}{r}.\left[\frac{1}{\sin\theta}.\frac{\partial E_{gr}}{\partial\varphi} - \frac{\partial}{\partial r}(r.E_{g\varphi})\right].\vec{e}_\theta$$

$$+\frac{1}{r}.\left[\frac{\partial}{\partial r}(r.E_{g\theta}) - \frac{\partial E_{gr}}{\partial\theta}\right].\vec{e}_\varphi$$

With:

$$E_{gr} = -\frac{m_0}{4\pi\eta_0 r^2}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}};\ E_{g\theta} = E_{g\varphi} = 0 \text{ and } \beta^2 = \frac{v^2}{c^2}\eta_0.\nu_0.v^2$$

We find:

$$rot\vec{E}_g = 3\frac{\nu_0 m_0}{4\pi r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{5}{2}}}.v^2.\sin\theta.\cos\theta.\vec{e}_\varphi \qquad (1)$$

Next we calculate $\frac{\partial \vec{B}_g}{\partial t}$.

Taking into account that from the kinematics of the particle along the Z-axis, it follows that:

$$\frac{\partial r}{\partial t} = -v.\cos\theta \qquad and \qquad \frac{\partial\theta}{\partial t} = \frac{v.\sin\theta}{r}$$

We find:

$$\frac{\partial \vec{B}_g}{\partial t} = -3\frac{\nu_0 m_0}{4\pi r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{5}{2}}}.v^2.\sin\theta.\cos\theta.\vec{e}_\varphi \qquad (2)$$

From (1) and (2) it follows:

$$rot\vec{E}_g = -\frac{\partial \vec{B}_g}{\partial t}$$

4. $\boldsymbol{rot\vec{B}_g = \frac{1}{c^2}.\frac{\partial \vec{E}_g}{\partial t}}$

One can prove this in the same way as *3*.

APPENDIX 2

THE GEM EQUATIONS ARE MATHEMATICALLY CONSISTENT

At a point *P* of a gravitational field - where ρ_G is the mass density and $\vec{J}_G$ is the density of the mass flow - $\vec{E}_g$ and $\vec{B}_g$ must obey the GEM equations (the Maxwell-Heaviside equations):

1. $div\vec{E}_g = -\frac{\rho_G}{\eta_0}$

2. $div\vec{B}_g = 0$

3. $rot\vec{E}_g = -\frac{\partial\vec{B}_g}{\partial t}$

4. $rot\vec{B}_g = \frac{1}{c^2}\frac{\partial\vec{E}_g}{\partial t} - \nu_0.\vec{J}_G$

And: $\eta_0.\nu_0 = \frac{1}{c^2}$

We will prove that these equations are mathematically consistent.

1 THE CASE OF AN OBJECT WITH INVARIABLE REST MASS

Because $div(rot\vec{F}) = 0$, it follows from (4) that:

$$\frac{1}{c^2}\frac{\partial}{\partial t}\left(div\vec{E}_g\right) - \nu_0.div\vec{J}_G = 0 \quad (4')$$

Substituting (1) in (4') gives:

$$-\frac{1}{c^2\eta_0}.\frac{\partial\rho_G}{\partial t} - \nu_0.div\vec{J}_G = 0$$

And with $\frac{1}{c^2\eta_0} = \nu_0$, we obtain from (4'):

$$\frac{\partial \rho_G}{\partial t} + div\vec{J}_G = 0 \qquad (4")$$

(4") is nothing else but the expression of the law of mass conservation. Indeed:

- The rate at which mass is flowing out form a closed surface S is:

$$\oiint_S \vec{J}_G.\overrightarrow{dS} \qquad (A)$$

- The rate of the decrease of the mass enclosed by S is (V is the volume enclosed by S):

$$-\frac{\partial}{\partial t}\iiint_V \rho_G.dV = \iiint_V \left(-\frac{\partial \rho_G}{\partial t}\right).dV \qquad (B)$$

Because of the law of mass conservation (A) = (B), so

$$\oiint_S \vec{J}_G.\overrightarrow{dS} = \iiint_V \left(-\frac{\partial \rho_G}{\partial t}\right).dV \qquad (5)$$

Ostrogradsky's theorem (divergence theorem) states that

$$\oiint_S \vec{F}.\overrightarrow{dS} = \iiint_V div\vec{F}.dV$$

Substituting in (5) gives:

$$\iiint_V div\vec{J}_G.dV = \iiint_V \left(-\frac{\partial \rho_G}{\partial t}\right).dV$$

It follows:

$$div\vec{J}_G = -\frac{\partial \rho_G}{\partial t}$$

Or:

$$\frac{\partial \rho_G}{\partial t} + div\vec{J}_G = 0$$

We conclude that - in a system with invariable rest mass - the GEM equations of the gravitational field are in line with the law of mass conservation.

2. THE CASE OF AN OBJECT WITH VARIABLE REST MASS

Let us consider - relative to an inertial reference frame - an object with rest mass m_0 that - due to intern instability - during the period $(0, \Delta t)$ emits EM radiation. This implies that that object during that time interval is emitting electromagnetic energy U_{EM} carried by photons (+ gravitomagnetic energy• U_{GEM} carried by gravitons) that propagate with the speed of light. Because of that event, from the moment $t = \Delta t$ the rest mass of the particle is decreased with an amount $\frac{U_{EM}+(U_{GEM})}{c^2}$ to the value m_0'.

Consider the surface S enclosing the object in whole or in part (V is the volume enclosed by S). At a moment $0 < t < \Delta t$:

- The rate of the decrease of the enclosed mass is:

$$-\frac{\partial}{\partial t}\iiint_V \rho_G dV = \iiint_V \left(-\frac{\partial \rho_G}{\partial t}\right).dV \quad \text{(A)}$$

- $\vec{J}_G$, the density of the mass flow out from the enclosed volume at a point P of S has two components:

  1. $\vec{J}_{G1}$ describing the outflow of massive mass;
  2. $\vec{J}_{G2}$ describing the outflow of mass in the form of energy. If we represent the density of that energy flow by $\vec{S}$: $\vec{J}_{G2} = \frac{\vec{S}}{c^2}$

So:

$$\vec{J}_G = \vec{J}_{G1} + \vec{J}_{G2} = \vec{J}_{G1} + \frac{\vec{S}}{c^2}$$

and the rate at which mass-energy is flowing out from the closed surface S is:

$$\oiint_S \vec{J}_G.\overrightarrow{dS} \quad \text{(B)}$$

(A) = (B) because of the law of mass-energy conservation, so

$$\oiint_S \vec{J}_G.\overrightarrow{dS} = \iiint_V \left(-\frac{\partial \rho_G}{\partial t}\right).dV$$

and

• negligible in first approximation

$$div\vec{J}_G = -\frac{\partial \rho_G}{\partial t} \qquad or \qquad \frac{\partial \rho_G}{\partial t} + div\vec{J}_G = 0$$

We conclude that in the case of a system with variable rest mass, the GEM equations of the gravitational field are in line with the law of mass-energy conservation.

APPENDIX 3

THE THEORY OF INFORMATONS AND ELECTROMAGNETISM

The theory of informatons unifies gravitation with electromagnetism. Indeed, with the theory of informatons it is also possible to explain the phenomena and the laws of electromagnetism[1],...,[6]. It is sufficient to add the following rule to the postulate of the emission of informatons:

C. *Informatons emitted by an electrically charged particle (a "point charge" q) at rest in an inertial reference frame, carry an attribute referring to the charge of the emitter, namely the e-index. e-indices are represented as $\vec{s}_e$ and defined by:*

1. *The e-indices are radial relative to the position of the emitter. They are centrifugal when the emitter carries a positive charge (q = +Q) and centripetal when the charge of the emitter is negative (q = -Q).*

2. *s_e, the magnitude of an e-index depends on Q/m, the charge per unit of mass of the emitter. It is defined by:*

$$s_e = \frac{1}{K.\varepsilon_0}.\frac{Q}{m} = 8{,}32.10^{-40}.\frac{Q}{m} N.m^2.s.C^{-1}$$

where $\varepsilon_0 = 8{,}85.10^{-12} F/m$ is the permittivity constant.

Consequently, the informatons emitted by a moving point charge q have at the fixed point P - defined by the time dependant position vector $\vec{r}$ (see fig 5) - two attributes that are in relation with the fact that q is a *moving* point *charge*, namely their e-index $\vec{s}_e$ and their b-index $\vec{s}_b$:

$$\vec{s}_e = \frac{q}{m}.\frac{1}{K.\varepsilon_0}.\vec{e}_r = \frac{q}{m}.\frac{1}{K.\varepsilon_0}.\frac{\vec{r}}{r} \quad \text{and} \quad \vec{s}_b = \frac{\vec{c} \times \vec{s}_e}{c} = \frac{\vec{v} \times \vec{s}_e}{c}$$

Macroscopically, these attributes manifest themselves at P as, respectively the *electric field strength* (the *e-field*) $\vec{E}$ and the *magnetic induction* (the *b-induction*) $\vec{B}$.

References

1.**Acke, Antoine.** *De Beginselen van de Informatonentheorie*. Gent: Uitgeverij Nevelland, 1990.

2.**Acke, Antoine.** *Gravitatie en Elektromagnetisme*. Gent: Uitgeverij Nevelland, 2008.

3.**Acke, Antoine.** *Theoretical Foundation of Electromagnetism*. Prespacetime Journal, Vol. 1, Issue 1, December 2010.

4.**Acke, Antoine.** *Physical Foundation of the Theory of Fields: The theory of Informatons*. Prespacetime Journal, Vol. 2, Issue 4, April 201.

5.**Acke, Antoine.** *Electromagnetism explained by the Theory of informatons*. Hadronic Journal, Vol. 36, Number 6, December 2013.

6.**Acke, Antoine.** *Fundamentals of the Theory of Informatons*. Hadronic Journal, Vol. 38, Number 2, December 2015.

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ELECTROMAGNETISM EXPLAINED BY THE THEORY OF INFORMATONS

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Abstract

To describe the diverse aspects of the gravitational and the electromagnetic "actions-at-a-distance", classical physics has introduced the *field concept*: the gravitational and electromagnetic vector fields are defined as the entities that mediate in respectively the gravitational and the electromagnetic interactions.

The *theory of informatons* develops the hypothesis that the substance of these fields is *information* carried by mass and energy less grains, called "*informatons*". It is assumed that any material object manifests itself in space by the continuous emission - at a rate proportional to its rest mass - of *informatons*: mass and energy less granular entities rushing away with the speed of light and carrying information regarding the position, the velocity and the electric charge of their emitter. This implies that any material object is at the center of an expanding cloud of informatons that manifests itself as the gravitational and, in the case of an electrically charged object also as the electromagnetic field of that object.

In this article we focus on the electromagnetic field. It will be shown that it is a dual entity always having a field- and an induction- component simultaneously created by their common sources: time-variable charges and charge flows, that the Maxwell equations are the expressions at the macroscopic level of the kinematics of the informatons, that the electromagnetic interaction is the effect of the fact that an electrically charged object in an electromagnetic field tends to become "blind" for that field by accelerating according to Lorentz law, and that an accelerated object is the source of electromagnetic radiation. In that context photons are identified as informatons carrying a quantum of energy, what explains the dual nature of light.

Key words: electromagnetism, electromagnetic field, informaton.

1 INTRODUCTION

This article is an appendix to the book "Gravito-electromagnetism explained by the theory of informatons". In that book the gravito-electromagnetic (GEM) description of the gravitational phenomena is explained by the hypothesis that "*information*" is the substance of gravitational fields. The constituent element of that substance is called an "*informaton*". It is assumed that any material object manifests itself in space by the emission - at a rate proportional to its rest mass - of informatons: granular mass and energy less entities rushing away with the speed of light and carrying *g-* and *β-information,* that is information about the position and about the velocity of their emitter relative to the reference frame of the observer. The informatons surround their emitter with an expanding cloud of g-and β-information that can be identified as its gravitational field. In the quoted book it is shown that the gravitational phenomena and laws can be explained as the macroscopic manifestation of the kinematics of the informatons.

In what follows we will show that this is also the case for the phenomena and the laws that are studied under the heading "Electromagnetism" (EM). To this end we have to assume that informatons emitted by an electrically charged object carry - in addition to g-and β-information - *e*-and *b-information*, this is information about the position and the electric charge of their emitter (more specifically about the sign and about the quantity of charge on it) and about its velocity. It follows that the informatons emitted by an electrically charged object surround that object not only with an expanding cloud of g-information but also with an expanding cloud of e-information that can be identified as its electromagnetic field. Just like a gravitational field, an electromagnetic field macroscopically can be characterized by two vectoral quantities: the *e-field* $\vec{E}$ and the *magnetic induction* $\vec{B}$. It will be shown that $\vec{E}$ and $\vec{B}$ play in EM the role that is played by the g-field $\vec{E}_g$ and by the g-induction $\vec{B}_g$ in GEM. It will turn out that gravitational and electromagnetic fields are isomorphic.

Introducing "*information carried by informatons*" as the substance• of gravitational and electromagnetic fields offers a new view on gravitation and on electromagnetism. By explaining the phenomena and the laws of GEM and EM as the macroscopic manifestations of the physics of informatons, the "*theory of informatons*" unifies gravito-electromagnetism with electromagnetism.

• When we say that it is the *substance* of gravitational and electromagnetic fields, we mean that "information carried by informatons" makes these fields what they are: not just mathematical constructions but elements of the natural world.

2 THE POSTULATE OF THE EMISSION OF INFORMATONS

In this chapter the mechanism of the emission of informatons by a particle at rest, described in "Gravitoelectromagnetism explained by the Theory of Informatons", will be expanded to the case of an electrically charged particle.

2.1 Preliminary definitions

A material object occupies space, its surface encloses matter. The amount of matter within its contours is called its *mass*. The mass of an object is the source of its gravitational field that mathematically can be described by GEM and explained by the theory of informatons[1], ..., [4]. An object can be a carrier of *electric charge*. The electric charge of an object is the source of its electromagnetic field that mathematically can be described by Maxwell's electromagnetism (EM).

An object reduced to a material point is known as a "particle". When we focus on a particle as the source of gravitation we call it a "*point mass*", when we focus on it as a source of electromagnetism we call it a "*point charge*". A point charge will graphically be represented by a little sphere in which a plus- or a minus sign.

The phenomena that are the subject of this article are situated in spacetime: they are located in "space" and dated in "time".
- *Space* is conceived as a three-dimensional, homogeneous, isotropic, unlimited and empty continuum. This continuum is called the "Euclidean space" because that what there geometrically is possible is determined by the Euclidean geometry. By anchoring a standardized Cartesian coordinate system to a reference body, an observer can - relative to that reference body - localize each point by three coordinates x, y, z.
- We identify *time* with the monotonically increasing quantity t that is generated by a standard clock•. In a Cartesian coordinate system a standard clock links to each event a "moment" - this is a specific value of t - and to each duration a "period" or "time interval" - this is a specific increase of t. The introduction of time makes it possible for the observer to express, in an objective manner, the chronological order of events in a Cartesian coordinate system.

A Cartesian coordinate system together with a standard clock is called a "*reference frame*". We represent a reference frame as $OXYZ(T)$ or, shortly as $\boldsymbol{O}$. A reference frame is called an "*inertial reference frame*" (*IRF*) if light propagates rectilinear (in the sense of the Euclidean geometry) with constant speed

• The operation of a standard clock is based on the counting of the successive cycles of a periodic process that is generated by a device inside the clock.

everywhere in the empty space linked to that frame. This definition implies that the space linked to an IRF is an homogeneous, isotropic, unlimited and empty continuum in which the Euclidean geometry is valid. A reference frame ***O'*** moving relative to an IRF ***O*** is itself also an IRF. The coordinates of an event linked to the inertial frames ***O*** and ***O'*** are related by the Lorentz transformation.

2.2 The concept of electric information

Two point charges at rest relative to an IRF exert an electric force on one another. *Between charges of like sign these force is repulsive and between charges of unlike sign it is attractive.* The precise value of the electric force that one charged particle exerts on another is given by Coulomb's law [5].

The magnitude of the electric force $\vec{F}_E$ that a particle with charge q_1 exerts on another particle with charge q_2 is directly proportional to the product of their charges and inversely proportional to the square of the distance R between them. The direction of the force is along the line joining the particles:

$$F_E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{|q_1| . |q_2|}{R^2}$$

where $\varepsilon_0 = 8{,}85.10^{-12} F/m$ is the permittivity constant.

Coulomb's law expresses the basic fact of electrostatics, namely that two point charges are interacting "at-a-distance".

According to Coulomb's law $\vec{F}_{EB}$, the electric force exerted by a particle *A* - with charge q_1 - on a particle *B* - with charge *q* - is pointing to the position of *A* if the signs of the charges are unlike and in the opposite direction if they are like. The magnitude of that force is:

$$F_B = \left(\frac{1}{4\pi\varepsilon_0} \cdot \frac{|q_1|}{r^2}\right) . |q|$$

The orientation of this force and the fact that it is directly proportional to the charge of *A* and inversely proportional to the square of the distance from *B* to *A*, implies that particle *B* must receive *information* about particle *A*. Point charge *A* must send information to *B* about its position and about the magnitude and the sign of its charge. So, we can posit that *a point charge manifests itself in space by emitting information about its charge and about its position*. We consider that type of information as a substantial element of nature and call it "electric information" or "*e-information*".

We assume that electric information emitted by an electrically charged particle is transported by the informatons emitted by that particle. That implies that we have to complete the formulation* of "the postulate of the emission of informatons" with a section C defining the attribute that characterizes an informaton as a carrier of a quantum of e-information.

2.3 The postulate of the emission of informatons

The emission of informatons by a particle with rest mass m carrying a charge q, that is anchored in an IRF O, is governed by the *postulate of the emission of informatons*:

A. *The emission* of informatons by a particle at rest is governed by the following rules:

1. The emission is uniform in all directions of space, and the informatons diverge with the speed of light (c = 3.10^8 m/s*) along radial trajectories relative to the position of the emitter.*

2. $\dot{N} = \frac{dN}{dt}$, *the rate at which a particle emits informatons*•, *is time independent and proportional to the rest mass m of the emitter. So there is a constant K so that:*

$$\dot{N} = K.m$$

3. The constant K is equal to the ratio of the square of the speed of light (c) to the Planck constant (h):

$$K = \frac{c^2}{h} = 1{,}36.10^{50} kg^{-1}.s^{-1}$$

B. We call the essential attribute of an informaton its *g-index*. The g-index of an informaton refers to information about the position of its emitter and equals *the elementary quantity of g-information*. It is represented by a vectoral quantity $\vec{s}_g$:

1. $\vec{s}_g$ *points to the position of the emitter.*

2. The elementary quantity of g-information is:

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* GRAVITOELECTROMAGNETISM EXPLAINED BY THE THEORY OF INFORMATONS - §2.3

• We neglect the possible stochastic nature of the emission, that is responsible for noise on the quantities that characterize the electric field. So, $\dot{N}$ is the average emission rate.

$$s_g = \frac{1}{K.\eta_0} = 6{,}18.10^{-60} m^3.s^{-1}$$

where $\eta_0 = \frac{1}{4.\pi.G} = 1{,}19.10^9 kg.s^2.m^{-3}$, G being the gravitational constant.

C. Informatons emitted by an electrically charged particle with rest mass *m* that is carrying an electric charge *q* have a second attribute, namely the *e-index*. The e-index of an informaton refers to the position and to the electric status of its emitter and is represented by the vectoral quantity $\vec{s}_e$:

1. $\vec{s}_e$ is radial relative to the position of the emitter. It is centrifugal if the emitter carries a positive charge (q = +Q) and centripetal if the charge of the emitter is negative (q = -Q).

2. s_e, the magnitude of the e-index depends on Q/m, the charge per unit of mass of the emitter of the informaton. s_e is defined by:

$$s_e = \frac{1}{K.\varepsilon_0}.\frac{Q}{m} = 8{,}32.10^{-40}.\frac{Q}{m} N.m^2.s.C^{-1}$$

where $\varepsilon_0 = 8{,}85.10^{-12} F/m$ is the permittivity constant).

So, according to *the postulate of the emission of informatons*, a particle that is anchored in an IRF ***O*** is an emitter of informatons, that move with the speed of light relative to ***O***. The emission rate only depends on the rest mass *m* of the particle and is defined in section *A* of the postulate.
Each emitted informaton transports the elementary quantity of g-information that is represented by the g-index $\vec{s}_g$ (defined in section B). The orientation of $\vec{s}_g$ refers to the position of the emitter.
If the particle is electrically charged, each emitted informaton transports, together with the elementary quantity of g-information, an elementary quantity of e-information that is represented by the e-index $\vec{s}_e$ (defined in section C). The magnitude of $\vec{s}_e$ depends on the charge per unit mass of the particle and its orientation refers to the position of the emitter.
The g-index and the e-index have the same orientation if the informaton is emitted by a negative point charge. If it is emitted by a positive point charge, they are opposite to each other.

In what follows, we study the electromagnetic phenomena. We will show that they perfectly can be deduced from the physics of the informatons.

3. THE ELECTRIC FIELD OF ELECTRICALLY CHARGED OBJECTS AT REST

3.1 The electric field of a point charge at rest

In fig 1 we consider a point charge, with rest mass m and (algebraic) charge q, that is anchored at the origin of an IRF $\boldsymbol{O}$.

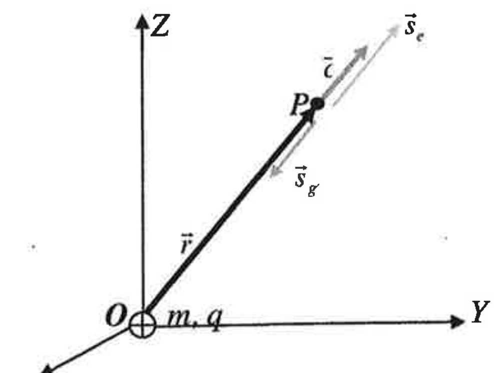

Fig 1

According to rule A of the postulate of the emission of informatons, that point charge emits informatons at a rate:

$$\dot{N} = \frac{dN}{dt} = K.m$$

It are carriers of both g- and e-information. The informatons passing - with velocity $\vec{c} = c.\frac{\vec{r}}{r} = c.\vec{e}_r$ - near the fixed point P - defined by the position vector $\vec{r}$ - have two attributes: their g-index $\vec{s}_g$ and their e-index $\vec{s}_e$:

$$\vec{s}_g = -\frac{1}{K.\eta_0}.\frac{\vec{r}}{r} = -\frac{1}{K.\eta_0}.\vec{e}_r \qquad \vec{s}_e = \frac{q}{m}.\frac{1}{K.\varepsilon_0}.\frac{\vec{r}}{r} = \frac{q}{m}.\frac{1}{K.\varepsilon_0}.\vec{e}_r$$

The gravitational field of the point charge is the macroscopic manifestation of the g-indices. At an arbitrary point P, it is characterized by the vectoral quantity $\vec{E}_g$, the density of *the g-information flow* or *the g-field*♦.

The electric field of the point charge is the macroscopic manifestation of the e-indices. At an arbitrary point P, it is characterized by the vectoral quantity $\vec{E}$, the density of the *e-information flow* or the *e-field*.

♦ GRAVITATIOELECTROMAGNETISM EXPLAINED BY THE THEORY OF INFORMATONS – Chapter 3

Indeed. The rate at which the point charge q emits e-information is the product of the rate at which it emits informatons with the elementary e-information quantity carried by the emitted informatons:

$$\dot{N}.s_e = K.m.\frac{1}{K.\varepsilon_0}.\frac{Q}{m} = \frac{Q}{\varepsilon_0}$$

Of course, this is also the rate at which it sends e-information through any closed surface that spans q.

The emission of informatons fills the space around q with an expanding cloud of e-information. This cloud has the shape of a sphere whose surface moves away with the speed of light from the centre O, the position of the point charge.

1. Within that cloud there is a *stationary state*. Because for each spatial region, the inflow of informations equals the outflow, each spatial region contains an unchanging number of informatons and thus a constant quantity of e-information. Moreover, the orientation of the e-indices of the informatons passing near a fixed point is always the same.

2. That cloud can be identified with a *continuum*. Each spatial region contains a very large number of informatons: the e-information is like continuously spread over the volume of the region.

The cloud of e-information surrounding O constitutes the electric field or the e-field of the point charge q.

Without interruption "countless" informatons are rushing through any - even very small - surface in the electric field: we can describe the motion of e-information through a surface as a *continuous flow* of e-information.

We know already that the intensity of the flow of e-information through a closed surface that spans O is expressed as:

$$\dot{N}.s_e = \frac{Q}{\varepsilon_0}$$

If the closed surface is a sphere with radius r, the *intensity of the flow per unit area* is given by:

$$\frac{Q}{4.\pi.r^2.\varepsilon_0}$$

This is the *density* of the flow of e-information at any point P at a distance r from q (fig 1). This quantity is, together with the orientation of the e-indices of the informatons that are passing near P, characteristic for the electric field at that point. Consequently, at a point P, the electric field of the point charge q is characterized by the vectoral quantity $\vec{E}$:

$$\vec{E} = \frac{\dot{N}}{4.\pi.r^2}.\vec{s}_e = \frac{q}{4.\pi.\varepsilon_0.r^2}.\vec{e}_r = \frac{q}{4.\pi.\varepsilon_0.r^3}.\vec{r}$$

This quantity is the *electric field strength* or the *e-field strength* or the *e-field*. At any point of the electric field of the point charge q, the orientation of $\vec{E}$ corresponds to the orientation of the e-indices of the informatons that are passing near that point. If the emitter is positively charged this is also the direction in which the informatons are moving. And the magnitude of $\vec{E}$ is the *density of the e-information flow* at that point.

Let us notice that the role played by the factor $(-\frac{m}{\eta_0})$ *in the definition of* $\vec{E}_g$ *is taken over by the factor* $(\frac{q}{\varepsilon_0})$ *in het definition of* $\vec{E}$ •

Next, let us consider a surface-element dS at P (fig 2,a). Its orientation and magnitude are completely determined by the surface-vector $\overrightarrow{dS}$ (fig 2,b). We define $d\Phi_E$, the *elementary e-flux through dS* as:

$$d\Phi_E = \vec{E}.\overrightarrow{dS} = E.dS.\cos\alpha$$

The magnitude of this scalar quantity equals the rate at which e-information flows through dS in the sense of the positive normal. The sign is related to the direction of the e-indices of the informatons passing near P: in the case of a positive emitter this is also the direction in which the informatons are moving.

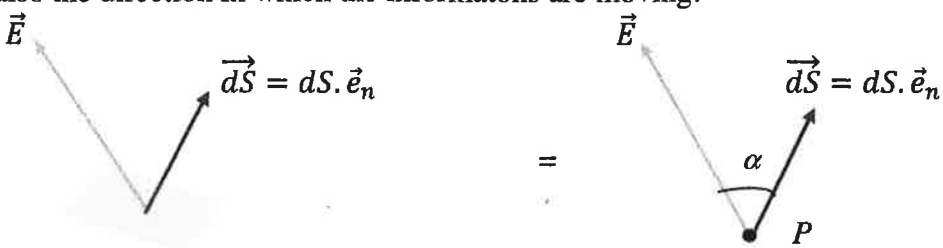

Fig 2,a Fig 2,b

For an arbitrary closed surface S that spans q, the outward flux (which we obtain by integrating the elementary contributions $d\Phi_E$ over S) must be equal to the rate at which the charge emits e-information. Thus:

$$\Phi_E = \oiint \vec{E}.\overrightarrow{dS} = \frac{q}{\varepsilon_0}$$

• GRAVITOELCTROMAGNETISM EXPLAINED BY THE THEORY OF INFORMATONS - §3.1

This relation is the expression of *the conservation of e-information* in the case of a point charge at rest.

3.2 The electric field of a set of point charges at rest.

We consider a set of point charges $q_1,\dots,q_i,\dots q_n$ that are anchored in an IRF $\boldsymbol{O}$. At an arbitrary point P, the flows of e-information that are emitted by the distinct charges are defined by the electric fields $\vec{E}_1,\dots,\vec{E}_i,\dots,\vec{E}_n$.

$d\Phi_E$, the rate at which e-information flows through a surface-element dS at P in the sense of the positive normal, is the sum of the contributions of the distinct charges:

$$d\Phi_E = \sum_{i=1}^{n}(\vec{E}_i.\overrightarrow{dS}) = (\sum_{i=1}^{n}\vec{E}_i).\overrightarrow{dS} = \vec{E}.\overrightarrow{dS}$$

So, the *effective density of the flow of e-information at P* (the effective e-field) is completely defined by:

$$\vec{E} = \sum_{i=1}^{n}\vec{E}_i$$

We conclude: *The e-field of a set of point charges at rest is at any point of space completely defined by the vectoral sum of the e-fields caused by the distinct charges.*

3.3 The electric field of a charge continuum at rest

We call an object in which the charge is spread over the occupied volume in a time independent manner, a *charge continuum*. At each point M of such a continuum, the accumulation of charge is defined by the *charge-density* ρ_E. To define this scalar quantity one considers a volume element dV that contains M, and one determines the enclosed charge dq. The accumulation of charge near M is defined by:

$$\rho_E = \frac{dq}{dV}$$

A charge continuum - anchored in an IRF - is equivalent to a set of infinitely many infinitesimal charge elements dq. The contribution of each of them to the electric field at an arbitrary point P is $d\vec{E}$. $\vec{E}$, the effective electric field at P, is the result of the integration over the volume of the continuum of all these contributions.

It is evident that the outward e-flux through a closed surface *S* only depends on the charge enclosed by the surface (the enclosed volume is *V*):

$$\oiint_S \vec{E}.\overrightarrow{dS} = \frac{1}{\varepsilon_0}.\iiint_V \rho_E.dV$$

According to the theorem of Ostrogradsky [6], this is equivalent to

$$div\vec{E} = \frac{\rho_E}{\varepsilon_0}$$

Let us notice that the role played by the factor $(-\frac{\rho_G}{\eta_0})$ *in the case of a mass continuum is played by the factor* $(\frac{\rho_E}{\varepsilon_0})$ *in the case of a charge continuum*•.

Furthermore, it can be shown[2] that: $rot\vec{E} = 0$, what implies the existence of *an electric potential function V* for which: $\vec{E} = -gradV$.

4. THE ELECTROMAGNETIC FIELD OF A CHARGED OBJECT MOVING WITH CONSTANT VELOCITY

4.1 The electric field caused by a uniform rectilinear moving point charge

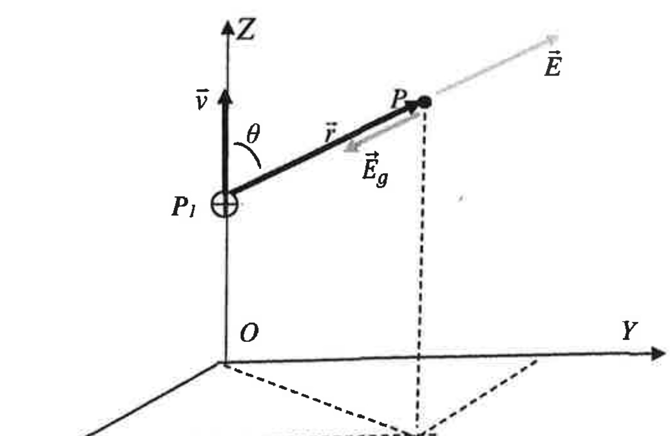

Fig. 3

• GRAVITOELECTROMAGNETISM EXPLAINED BY THE THEORY OF INFORMATONS - §3.3

In fig 3, we consider a charged particle with rest mass m_0 that is moving with constant velocity $\vec{v} = v.\vec{e}_z$ along the Z-axis of an IRF $\boldsymbol{O}$ and that is carrying an electric charge q. At the moment $t = 0$ it passes through the origin O and at the moment $t = t$ through the point P_1.

The particle continuously emits informatons that, with the speed of light, rush away relative to the position of the mass at the moment of emission. We wish to determine the density of the flow of e-information - this is the e-field - at a fixed point P. The position of P relative to the reference frame $\boldsymbol{O}$ is determined by the time independent Cartesian coordinates (x, y, z), or by the time dependent position vector $\vec{r} = \overrightarrow{P_1 P}$. θ is the angle between $\vec{r}$ and the Z-axis.

In §4.2 of "Gravitoelectromagnetism explained by the theory of informatons", the gravitational field $\vec{E}_g$ that at P is generated by the moving particle is deduced. Because the role played by the factor $(-\frac{m}{\eta_0})$ in the definition of $\vec{E}_g$ is taken over by the factor $(\frac{q}{\varepsilon_0})$ in the definition of $\vec{E}$, we conclude that the e-field caused at P by the moving particle is:

$$\vec{E} = \frac{q}{4\pi\varepsilon_0 r^3} \cdot \frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}} . \vec{r} = \frac{q}{4\pi\varepsilon_0 r^2} \cdot \frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}} . \vec{e}_r$$

We conclude: A point charge describing - relative to an IRF $\boldsymbol{O}$ - a uniform rectilinear movement creates in the space linked to $\boldsymbol{O}$ a time dependent electric field. $\vec{E}$, the e-field at an arbitrary point P, is at any time on the line connecting P to the position of the charge at that moment; and its magnitude is:

$$E = \frac{Q}{4\pi\varepsilon_0 r^2} \cdot \frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}$$

It is important to notice that the orientation of $\vec{E}$ implies that the e-indices of the informatons that at a certain moment pass near P, point to the position of the emitting mass *at that moment*. That means that the movement of the source of the field manifests itself in a deviation of $\vec{s}_e$ - the e-index of the informatons at P - relative to their velocity $\vec{c}$.

If the speed of the charge is much smaller than the speed of light, the expression for $\vec{E}$ reduces itself to that valid in the case of a charge at rest. This non-relativistic result directly could be obtained if one assumes that the displacement of the point charge during the time interval that the informatons need to move from the emitter to P can be neglected compared to the distance they travel during that period.

4.2 The emission of informatons by a uniform rectilinear moving point charge

In fig 4 we consider a point charge q moving with constant velocity $\vec{v}$ along the Z-axis of an inertial reference frame. Its instantaneous position (at the arbitrary moment t) is P_1. The position of P, an arbitrary fixed point in space, is defined by the vector $\vec{r} = \overrightarrow{P_1P}$. The position vector $\vec{r}$ - just like the distance r and the angle θ - is time dependent because the position of P_1 is constantly changing.

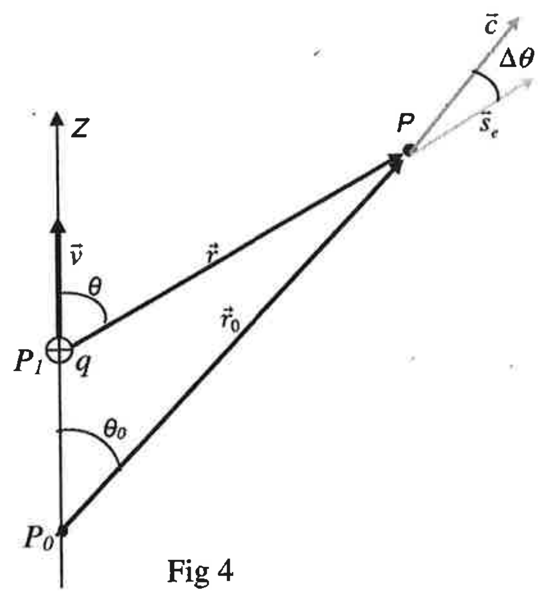

Fig 4

The informatons that - with the speed of light - at the moment t are passing near P, are emitted when q was at P_0. Bridging the distance $P_0P = r_0$ took the time interval $\Delta t = \frac{r_0}{c}$. During their rush from P_0 to P, the particle was moving from P_0 to P_1:

$$P_0P_1 = v.\Delta t$$

- $\vec{c}$, the velocity of the informatons, points in the direction of their movement, thus along the radius P_0P, where P_0 is the position of q at the moment $(t - \Delta t)$.
- $\vec{s}_e$, their e-index, is along the line P_1P, where P_1 is the position of q at the moment t. This is an implication of rule B.1 of the postulate of the emission of informatons and confirmed by the conclusion of §3.1.

The lines carrying $\vec{s}_e$ and $\vec{c}$ form an angle $\Delta\theta$, that we call• the "*characteristic angle*" or the "*characteristic deviation*" because it is characteristic for the speed of the point charge. The quantity $s_b = s_e.sin(\Delta\theta)$ is called the "*characteristic e-information*" or the "*magnetic information*" or the "*b-information*" of an informaton. It refers to the speed of the emitter of the informaton and plays the role that is played by $s_\beta = s_g.\sin(\Delta\theta)$ in gravitoelectromagnetism.

We conclude that an informaton emitted by a moving point charge, is transporting information referring to the velocity of that charge. This information is represented by its "*electric characteristic vector*" or its "*b-index*" $\vec{s}_b$ that is defined by:

$$\vec{s}_b = \frac{\vec{c} \times \vec{s}_e}{c}$$

- The b-index is perpendicular to the plane formed by the path of the informaton and the straight line that carries the e-index, thus perpendicular to the plane formed by the point *P* and the path of the emitter.
- Its orientation relative to that plane is defined by the "rule of the corkscrew": in the case of fig 4 (positive charge) the orientation of the b-indices is opposite to the orientation of the positive *X*-axis.
- Its magnitude is: $s_b = s_e.sin(\Delta\theta)$, the *b-information* of the informaton.

From the sine rule applied to the triangle P_0P_1P, it follows:

$$s_b = s_e.\frac{v}{c}.sin\,\theta = s_e.\beta.sin\,\theta = s_e.\beta_\perp$$

$\beta_\perp$ is the component of the dimensionless velocity $\vec{\beta} = \frac{\vec{v}}{c}$ perpendicular to $\vec{s}_e$.
And taking into account the orientation of the different vectors, the b-index of an informaton emitted by a point charge moving with constant velocity, can also be expressed as:

$$\vec{s}_b = \frac{\vec{v} \times \vec{s}_e}{c}$$

Let us still notice that $\vec{s}_b$ has the same orientation as $\vec{s}_\beta$ if the particle is carrier of a negative charge, and that the orientations of $\vec{s}_b$ and $\vec{s}_\beta$ are opposite in the case of a positive particle.

4.3 The magnetic induction of a point charge describing a uniform rectilinear motion

We consider the situation of fig 4. All informatons in dV - the volume element at P - carry both e-information and b-information. The b-information refers to the velocity of the emitting particle and is represented by the b-indices $\vec{s}_b$:

$$\vec{s}_b = \frac{\vec{c} \times \vec{s}_e}{c} = \frac{\vec{v} \times \vec{s}_e}{c}$$

If n is the density at P of the cloud of informatons (number of informatons per unit volume) at the moment t, the amount of b-information in dV is determined by the magnitude of the vector:

$$n.dV.\vec{s}_b = n.\frac{\vec{c} \times \vec{s}_e}{c}.dV = n.\frac{\vec{v} \times \vec{s}_e}{c}.dV$$

And the density of the b-information cloud (b-information per unit volume) at P is:

$$n.\vec{s}_b = n.\frac{\vec{c} \times \vec{s}_e}{c} = n.\frac{\vec{v} \times \vec{s}_e}{c}$$

We call this (time dependent) vectoral quantity - that will be represented by $\vec{B}$ - the "*magnetic induction*" or the "*b-induction*" at *P:*

- Its magnitude - B - determines the density of the b-information at P.
- Its orientation determines the orientation of the b-indices $\vec{s}_b$ of the informatons passing near that point.

So, the magnetic induction caused at P by the moving point charge q (fig 4) is:

$$\vec{B} = n.\frac{\vec{v} \times \vec{s}_e}{c} = \frac{\vec{v}}{c} \times (n.\vec{s}_e)$$

N - the density of the flow of informatons at P (the rate per unit area at which the informatons cross an elementary surface perpendicular to the direction of movement) - and n - the density of the cloud of informatons at P - are connected by the relation:

$$n = \frac{N}{c}$$

With $\vec{E} = N.\vec{s}_e$, we can express the magnetic induction at P as:

$$\vec{B} = \frac{\vec{v}}{c^2} \times (N.\vec{s}_e) = \frac{\vec{v} \times \vec{E}}{c^2}$$

And taking into account §4.1:

$$\vec{B} = \frac{q}{4\pi\varepsilon_0 c^2.r^3}.\frac{1-\beta^2}{(1-\beta^2.sin^2\,\theta)^{\frac{3}{2}}}.(\vec{v} \times \vec{r})$$

We define the constant $\mu_0 = 1{,}26.10^{-6}H/m$ as: $\mu_0 = \frac{1}{\varepsilon_0.c^2}$

And finally, we obtain:

$$\vec{B} = \frac{\mu_0.q}{4\pi r^3}.\frac{1-\beta^2}{(1-\beta^2.sin^2\,\theta)^{\frac{3}{2}}}.(\vec{v} \times \vec{r})$$

$\vec{B}$ at *P* is perpendicular to the plane formed by *P* and the path of the point charge; its orientation is defined by the rule of the corkscrew; and its magnitude is:

$$B = \frac{\mu_0.q}{4\pi r^2}.\frac{1-\beta^2}{(1-\beta^2.sin^2\,\theta)^{\frac{3}{2}}}.v.sin\,\theta$$

If the speed of the charge is much smaller than the speed of light, this expression reduces itself to:

$$\vec{B} = \frac{\mu_0.q}{4\pi r^3}.(\vec{v} \times \vec{r})$$

This non-relativistic result could directly be obtained if one assumes that the displacement of the point charge during the time interval that the informatons need to move from the emitter to *P* can be neglected compared to the distance they travel during that period.

Let us notice that the role played by the factor $(-v_0.m_0)$ in the definition of $\vec{B}_g$ is taken over by the factor $(\mu_0.q)$ in het definition of $\vec{B}$.

4.4 The electromagnetic field of a point charge describing a uniform rectilinear motion

A point charge q, moving with constant velocity $\vec{v}$ along the Z-axis of an IRF $\boldsymbol{O}$, creates and maintains a cloud of informatons that (in addition to g- and β-information) are carrying e- and b-information. That cloud can be described as a time dependent continuum. That continuum is called the *electromagnetic field* (EM-field) of the point charge. Relative to $\boldsymbol{O}$ it is characterized by two time dependent vectoral quantities: the electric field (short: *e-field*) $\vec{E}$ and the magnetic induction (short: *b-induction*) $\vec{B}$.

1.With *N* the density of the flow of informatons at *P*, the e-field at that point is:

$$\vec{E} = N.\vec{s}_e = \frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.\vec{r}$$

2.With *n*, the density of the cloud of informatons at *P*, the magnetic induction at that point is:

$$\vec{B} = n.\vec{s}_b = \frac{\mu_0.q}{4\pi r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(\vec{v}\times\vec{r})$$

One can verify that•:

1. $div\vec{E} = 0$ 3. $rot\vec{E} = -\frac{\partial\vec{B}}{\partial t}$

2. $div\vec{B} = 0$ 4. $rot\vec{B} = \frac{1}{c^2}.\frac{\partial\vec{E}}{\partial t}$

These relations are Maxwell's laws in the case of the electromagnetic field of a point charge describing a uniform rectilinear motion.

If $v \ll c$, the expressions for the electric field and for the magnetic induction reduce to:

$$\vec{E} = -\frac{q}{4\pi\varepsilon_0 r^3}.\vec{r}$$

$$\vec{B} = \frac{\mu_0.q}{4\pi r^3}.(\vec{v}\times\vec{r})$$

• GRAVITOELECTROMAGNETISM EXPLAINED BY THE THEORY OF INFORMATONS – Appendix 1

4.5 The electromagnetic field of a set of point charges describing uniform rectilinear motions

We consider a set of point charges $q_1,\ldots,q_i,\ldots q_n$ that move with constant velocities $\vec{v}_1,\ldots,\vec{v}_i,\ldots,\vec{v}_n$ with respect to an IRF $\boldsymbol{O}$. This set creates and maintains an electromagnetic field that at each point of the space linked to $\boldsymbol{O}$, is characterised by the vector pair $(\vec{E},\vec{B})$.

1.Each charge q_i continuously emits e-information and contributes to the e-field at an arbitrary point P with an amount $\vec{E}_i$. As in 3.2 we conclude that the effective e-field $\vec{E}$ at P is defined as: $\vec{E} = \sum \vec{E}_i$

2.If it is moving, each charge q_i emits also b-information, contributing to the magnetic induction at P with an amount $\vec{B}_i$. It is evident that the b-information in the volume element dV at P at each moment t is expressed by:

$$\sum(\vec{B}_i.dV) = (\sum \vec{B}_i).dV$$

So, the effective magnetic induction $\vec{B}$ at P is: $\vec{B} = \sum \vec{B}_i$

By superposition one can prove that Maxwell's laws mentioned in the previous section remain valid for the effective electric field and the effective magnetic induction in the case of the electromagnetic field of a set of point charges describing uniform rectilinear motions.

4.6 The electromagnetic field of a stationary charge flow

4.6.1 The magnetic induction of a line current

With the term "line current", we refer to a stationary charge flow through a - whether or not straight - conductor. If dq is the elementary quantity of charge that during the elementary time interval dt flows through ΔS - an arbitrary section of the conductor - the rate at which charge is transported through the conductor, is

$$i = \frac{dq}{dt}$$

This - time and position independent - algebraic• quantity is called the *electric current through the conductor*.

• $i > 0$ if the current is transporting positive charge in the sense of an a priori chosen reference direction.

In the case of a cylindrical conductor, the charge elements dq that constitute the current are moving parallel to the axis with speed $\vec{v}$. We can identify a cylindrical conductor with a string through which a current i flows. Each moving charge element is contained in a line element $\vec{dl}$ of the string♦. The quantities that are relevant for the electric current in the string are related by[2]:

$$\vec{v}.dq = i.\vec{dl}$$

$i.\vec{dl}$ is called a *current element*. The magnetic induction $d\vec{B}$, caused at a point P by a current element is found by substituting $\vec{v}.dq$ by $i.\vec{dl}$ in the formula that we derived in §4.4 for a moving point charge. ($\vec{r}$ defines the position of P relative to the current element). So:

$$d\vec{B} = \frac{\mu_0.i}{4\pi r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(\vec{dl}\times\vec{r})$$

The fact that the speed of the charge carriers that constitute the current i is very small relative to the speed of light, implies that $\beta << 1$, and explains *Laplace's law:*

$$d\vec{B} = \frac{\mu_0.i}{4.\pi.r^3}.(\vec{dl}\times\vec{r})$$

We can describe the current in a conductor as the drift movement of fictive positive charge carriers through a lattice of immobile negative charged entities. *A conductor in which an electric current flows causes a magnetic field, but not an electric one.* Indeed, the current is a stationary charge flow and thus the cause of a stationary magnetic field composed by contributions defined by Laplace's law. A current carrying conductor doesn't cause an electric field, because the e-field caused by the moving charge carriers is neutralized by the e-field caused by the fixed lattice.

> *Unlike a β -field - that never exists without a g-field - a magnetic field can exist without an electric field, what implies that a magnetic field is not necessarily masked in everyday circumstances.*

One can show[2] that $\oint_L \vec{B}.\vec{dl}$ calculated along a closed path L only depends on the electric current ($\sum i_{in}$) encircled by that path (*Ampère's law*):

$$\oint_L B.\vec{dl} = \mu_0.\sum i_{in}$$

♦ The reference direction is identified with the orientation of the vector $\vec{dl}$

4.6.2 The magnetic induction of a charge flow

The term "stationary charge flow" refers to the movement of an homogeneous and incompressible charged fluid that, in an invariable way, flows relative to an IRF. The intensity of the charge flow at an arbitrary point *P* is characterised by the flow density $\vec{J}_E$. The magnitude of this vectoral quantity equals the rate per unit area at which the charge flows through a surface element that is perpendicular to the flow at *P*. The orientation of $\vec{J}_E$ corresponds to the direction of the movement of positive charge. If $\vec{v}$ is the velocity of the charge element $\rho_E.dV$ that at the moment *t* flows through *P*, then[2]: $\vec{J}_E = \rho_E.\vec{v}$. And the rate at which the flow transports charge - in the positive sense - through an arbitrary surface ΔS, is:

$$i = \iint_{\Delta S} \vec{J}_E.\overrightarrow{dS}$$

i, the electric current through ΔS, is the *intensity of the charge flow through ΔS.*

Since a stationary charge flow is the macroscopic manifestation of moving charge elements $\rho_E.dV$, it creates and maintains an electromagnetic field. And since the velocity $\vec{v}$ of the charge element at each point is time independent, *the electromagnetic field of a stationary charge flow is time independent.*

It is evident that the rules of §2.3 also apply for the time independent e-field:

1.$div\vec{E} = \frac{\rho_E}{\varepsilon_0}$ and 2.$rot\vec{E} = 0$, what implies: $\vec{E} = -gradV$

And for the time independent magnetic induction, the following rules apply:

3.$div\vec{B} = 0$, what implies $\vec{B} = rot\vec{A}$ and 4.$rot\vec{B} = \mu_0.\vec{J}_E$

Indeed, from the fact that the b-index of an informaton is always perpendicular to its velocity it follows that for any closed surface S: $\oiint_S \vec{B}.\overrightarrow{dS} = 0$, what according to Ostrogradsky theorem[6] implies: $div\vec{B} = 0$. And from Ampère's law one can conclude that the following relation exists between $\oint_L \vec{B}.\overrightarrow{dl}$ calculated for a closed line *L* and $\iint_{\Delta S} \vec{J}_E.\overrightarrow{dS}$ calculated over a surface ΔS bounded by that line: $\oint_L \vec{B}.\overrightarrow{dl} = \mu_0.\iint_{\Delta S} \vec{J}_E.\overrightarrow{dS}$, what according to Stokes theorem[6] implies: $rot\vec{B} = \mu_0.\vec{J}_E$.

Let us notice that the role played by the factor ($-\nu_0.\vec{J}_G$) in the case of a mass flow is taken over by the factor ($\mu_0.\vec{J}_E$), in the case of a charge flow.

We can conclude that time-variable charges and charge flows are the common sources of the electromagnetic field in an IRF $\boldsymbol{O}$. An electromagnetic field is a dual entity always having a field- ($\vec{E}$) and an induction- component ($\vec{B}$). Its constituent elements are the informatons emitted by its sources.

5 MAXWELL'S LAWS

The electromagnetic field is set up by a given distribution of - whether or not moving - charges and it is defined by a vector field with two components: the "*e-field*" characterized by the vector $\vec{E}$ and the "*magnetic induction*" or "*b-induction*" characterized by the vector $\vec{B}$. These components each have a value defined at every point of space and time and are thus, relative to an IRF $\boldsymbol{O}$, regarded as functions of the space and time coordinates.

Let us focus on the contribution to an electromagnetic field of one of its sources: a certain point charge q. We focus, more specifically, on the contribution of q to the flow of e-information at an arbitrary point P. That flow is made up of informatons that pass near P in a specific direction with velocity $\vec{c}$ and it is characterized by N, the rate per unit area at which these informatons cross an elementary surface perpendicular to the direction in which they move. The cloud of these informatons in the vicinity of P is characterized by its density n: n is the number of informatons per unit volume. N and n are linked by the relationship:

$$n = \frac{N}{c} \qquad (1)$$

The definition in chapter 2 of an informaton implies that every informaton that passes near P is characterized by two attributes that refer to the electric state of its emitter, its e-index $\vec{s}_e$ and its b-index $\vec{s}_b$ linked by the relation:

$$\vec{s}_b = \frac{\vec{c} \times \vec{s}_e}{c} \qquad (2)$$

The informatons emitted by q that pass near P with velocity $\vec{c}$ contribute there to the *density of the e-information flow* with an amount $(N.\vec{s}_e)$. It is the contribution of q to the e-field at P. We put: $N.\vec{s}_e = \vec{E}$

And the same informatons contribute there to the *density of the e-information cloud* with an amount $(n.\vec{s}_b)$. It is the contribution of q to the b-induction at P. We put: $n.\vec{s}_b = \vec{B}$

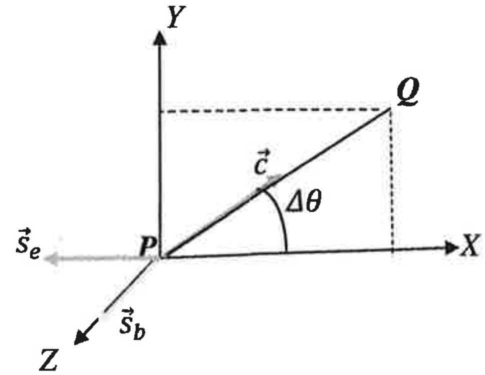

Fig 5

In fig 5, we consider the flow of informatons that - at the moment t - pass near P with velocity $\vec{c}$. These informatons are completely defined by their attributes $\vec{s}_e$ and $\vec{s}_b$. $\Delta\theta$ is their characteristic angle: the angle between the lines carrying $\vec{s}_e$ and $\vec{c}$ that is characteristic for the movement of the emitter.

The infinitesimal change of the attributes of an informaton at P between the moments t and $(t + dt)$, is governed by the kinematics of that informaton. An informaton that at the moment t passes at P is at the moment $(t + dt)$ at Q, with $PQ = c.dt$. This implies that the spatial variation of the attributes of an informaton between P and Q at the moment t equals the change in time of those attributes at P between the moment $(t - dt)$ and the moment t.

On the macroscopic level, this implies that there must be a relationship between the change in time of the electromagnetic field $(\vec{E},\vec{B})$ at a point P and the spatial variation of that field in the vicinity of P.

The intensity of the spatial variation of the components of the gravitational field at P is characterized by $div\vec{E}$, $div\vec{B}$, $rot\vec{E}$ and $rot\vec{B}$, and the rate at which these components change in time by $\frac{\partial \vec{E}}{\partial t}$ and by $\frac{\partial \vec{B}}{\partial t}$.

Starting from what applies in the corresponding situation in the case of gravitation, we find the following relations in vacuum•:

1. $div\vec{E} = 0$ 2. $div\vec{B} = 0$

3. $rot\vec{E} = -\frac{\partial \vec{B}}{\partial t}$ 4. $rot\vec{B} = \frac{1}{c^2}\frac{\partial \vec{E}}{\partial t}$

• GRAVITOELECTROMAGNETISME EXPLAINDED BY THE THEORY OF INFORMATONS – Chapter 5

And substituting the factor $(-\frac{\rho_G}{\eta_0})$ by the factor $(\frac{\rho_E}{\varepsilon_0})$, and the factor $(-\nu_0.\vec{J}_G)$ by $(\mu_0.\vec{J}_E)$, in the Maxwell-Heaviside equations♦, we find the following relations in a point of a charge continuum:

$$1.\ div\vec{E} = \frac{\rho_E}{\varepsilon_0} \qquad 2.\ div\vec{B} = 0$$

$$3.\ rot\vec{E} = -\frac{\partial\vec{B}}{\partial t} \qquad 4.\ rot\vec{B} = \frac{1}{c^2}\frac{\partial\vec{E}}{\partial t} + \mu_0.J_E$$

The mathematical deductions of Maxwell's equations indicate that there is no causal link between $\vec{E}$ and $\vec{B}$. Therefore, *we must conclude that an EM field is a dual entity always having a "field-" and an "induction-" component simultaneously created by their common sources: time-variable masses and mass flows*♣.

Maxwell's equations are consistent with special relativity[7]. Thus, *they are invariant under a Lorentz transformation* and EM is consistent with SR.

5 THE INTERACTION BETWEEN CHARGES

5.1 The virtual gravitational field

The informatons emitted by a charged particle (with rest mass m_0 and electric charge q) at rest at the origin of an IRF O pass near any fixed point P (defined by the position vector $\vec{r}$) with velocity $\vec{c} = c.\frac{\vec{r}}{r} = c.\vec{e}_r$. They are characterized by two attributes: their g-index: $\vec{s}_g = -\frac{1}{K.\eta_0}.\frac{\vec{r}}{r} = -\frac{1}{K.\eta_0}.\vec{e}_r$ and their e-index: $\vec{s}_e = \frac{q}{m_0}.\frac{1}{K.\varepsilon_0}.\frac{\vec{r}}{r} = \frac{q}{m_0}.\frac{1}{K.\varepsilon_0}.\vec{e}_r$

These informatons are the constituent elements of the gravitational and of the electric field of the particle. At P the gravitational field is characterized by $\vec{E}_g$, the density of the flow of g-information, and the electric field is characterized by $\vec{E}$, the density of the flow of e-nformation at P.

We notice that the vector

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♣ On the understanding that the induction-component equals zero if the source of the field is time independent.

$$\frac{q}{m_0}\vec{s}_e = (\frac{q}{m_0})^2.\frac{1}{K.\varepsilon_0}.\frac{\vec{r}}{r} = (\frac{q}{m_0})^2.\frac{1}{K.\varepsilon_0}.\vec{e}_r = \vec{s}_g^*$$

has the same dimension ($m^3.s^{-1}$) as the g-index $\vec{s}_g$, and that it is radial (centrifugal). So, we can interpret $\vec{s}_g^*$ as the constituent element of a *virtual gravitational field* $\vec{E}_g^* = \frac{q}{m_0}.\vec{E}$.

5.2 The interaction between charges at rest

The action of an electric field $\vec{E}$ on a point charge (m_0, q) at rest relative to an IRF O can be explained as the reaction of that point charge on the disturbance of its virtual gravitational field by an external virtual gravitational field ($\frac{q}{m_0}.\vec{E}$), thus as a *virtual gravitational interaction*.

The reasoning of §7.1 of "Gravitoelectromagnetism explained by the Theory of Informatons" leads to the conclusion:

> *A point charge, carried by a particle with rest mass m_0, anchored in a point of an electric field is subjected to a tendency to move in the direction defined by $\vec{E}$, the e-field at that point. Once the anchorage is broken, the charge acquires a vectoral acceleration $\vec{a}$ that equals ($\frac{q}{m_0}.\vec{E}$).*

Because the cause of an acceleration is defined as a "force", an electric field exerts a force - more specifically an "electric force" $\vec{F}_E$ - on a point charge. The relation between that force and its effect, the acceleration $\vec{a}$, is: $\vec{F}_E = m_0.\vec{a}$. So, the relation between the electric field at P and the force it exerts on a point charge at rest at that point, is:

$$\vec{F}_E = q.\vec{E}$$

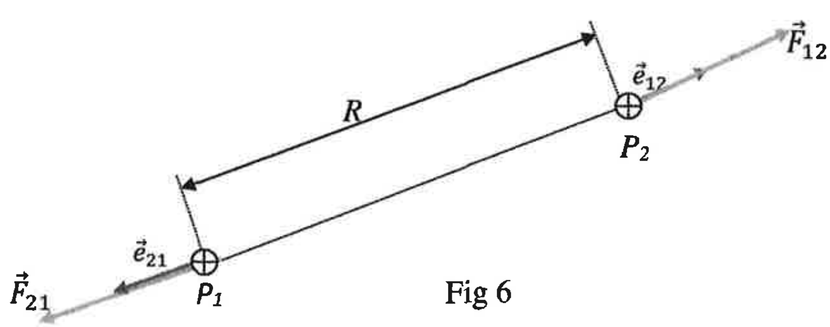

Fig 6

In fig 6 we consider the special cast of two point charges q_1 and q_2 anchored at the points P_1 and P_2 of an IRF. q_1 creates and maintains an electric field that at P_2 is defined by:

$$\vec{E}_2 = \frac{q_1}{4.\pi.\varepsilon_0.R^2}.\vec{e}_{12}$$

This field exerts an electric force on q_2:

$$\vec{F}_{12} = q_2.\vec{E}_2 = \frac{q_1.q_2}{4.\pi.\varepsilon_0.R^2}.\vec{e}_{12}$$

In a similar manner we find $\vec{F}_{21}$:

$$\vec{F}_{21} = \frac{q_1.q_2}{4.\pi.\varepsilon_0.R^2}.\vec{e}_{21} = -\vec{F}_{12}$$

This is the mathematical formulation of *Coulomb's law.*

5.4 The interaction between moving charges

In the same way, the action of an electromagnetic field $(\vec{E}, \vec{B})$ on a point charge (m_0, q) that moves with velocity $\vec{v}$ relative to an IRF $\boldsymbol{O}$ can be explained as the reaction of that point charge on the disturbance of its virtual gravitational field by an extern virtual gravitational field $\frac{q}{m_0}.[\vec{E} + (\vec{v} \times \vec{B})]$, thus as a virtual gravitational interaction. The reasoning of §7.4 of "Gravitoelectromagnetism explained by the Theory of Informatons" leads to the conclusion:

> *A point charge q carried by a particle with rest mass m_0 that is - relative to an IRF **O** - moving in an electromagnetic field ($\vec{E}$,$\vec{B}$) with velocity $\vec{v}$, tends to become blind for the influence of that field on the characteristic symmetry of its "proper" EM-field. If it is free to move, it will accelerate relative to its "eigen" IRF* with an amount $\vec{a}'$:*

$$\vec{a}' = \frac{q}{m_0}.[\vec{E} + (\vec{v} \times \vec{B})]$$

* The proper or eigen-IRF frame $\boldsymbol{O'}$ of the particle is the reference frame that at each moment t moves relative to $\boldsymbol{O}$ with the same velocity as that particle.

Because a charged particle (m_0, q), moving in an electromagnetic field ($\vec{E},\vec{B}$) experiences an acceleration because of that field, the field must exert a force on it•. The relation between that force $\vec{F}_{EM}$ and $\vec{a}'$, the acceleration of the particle relative to the reference frame that moves with the same velocity $\vec{v}$ as the particle, is:

$$\vec{F}_{EM} = m_0.\vec{a}'$$

And with $\vec{a}' = \frac{q}{m_0}.[\vec{E} + (\vec{v} \times \vec{B})]$:

$$\vec{F}_{EM} = q.(\vec{v} \times \vec{B})$$

This force is called the *Lorentz force*. It is the superposition of the *electric force* $\vec{F}_E = q.\vec{E}$ and the *magnetic force* $\vec{F}_B = q.(\vec{v} \times \vec{B})$.

One can show that* :

$$\vec{F}_{EM} = \frac{d\vec{p}}{dt}$$

$\vec{p}$ is the linear momentum of the particle relative to the inertial reference frame ***O***:

$$\vec{p} = \frac{m_0}{\sqrt{1-\beta^2}}.\vec{v}$$

6 ELECTROMAGNETIC WAVES

The existence of electromagnetic waves is embedded in EM: in vacuum EM waves are solutions of Maxwell's equations•. In the framework of the theory of informatons, an electromagnetic wave is understood as the macroscopic manifestation of the fact that the "train" of informatons emitted by an oscillating source and travelling with the speed of light in a certain direction is a spatial sequence of informatons whose characteristic angle is harmonically fluctuating along the "train" what implies that the component of their e-index perpendicular to their velocity $\vec{c}$ and their b-index harmonically fluctuate along the "train". Electromagnetic waves transport electromagnetic energy because some of the informatons that constitute the "train" are carriers of energy. Informatons carrying energy are called "photons". In what follows, we limit our

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* GRAVITOELECTROMAGNETISME EXPLAINDED BY THE THEORY OF INFORMATONS – §7.4

• GRAVITOELECTROMAGNETISM EXPLAINED BY THE THEORY OF INFORMATONS - §8.1

considerations to the electromagnetic wave emitted by an harmonically oscillating point charge.

6.1 EM wave of an harmonically oscillating point charge

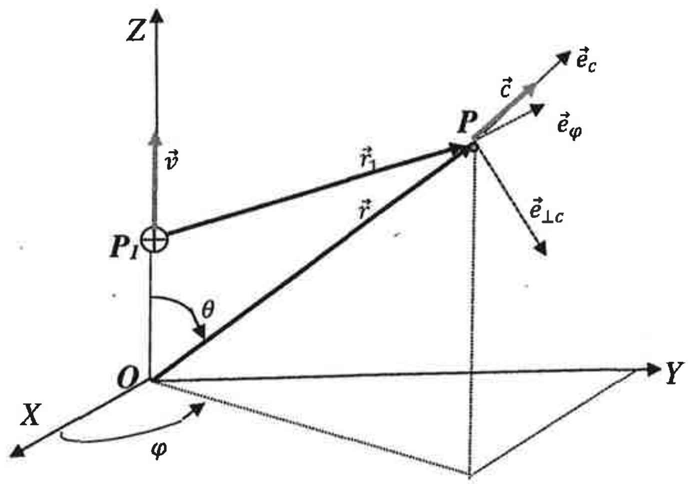

Fig 7

In fig 7 we consider a point charge q that harmonically oscillates around the origin of the IRF O with frequency $\nu = \frac{\omega}{2.\pi}$. At the moment t it passes at P_1. We suppose that $v(t)$, the speed of the particle, is always much smaller than the speed of light.

$$v(t) = V.\cos\omega\, t$$

The elongation $z(t)$ and the acceleration $a(t)$ are then:

$$z(t) = \frac{V}{\omega}.\cos(\omega t - \frac{\pi}{2}) \qquad \text{and} \qquad a(t) = \omega.V.\cos(\omega t + \frac{\pi}{2})$$

We restrict our considerations about the EM field of q to points P that are sufficiently far away from the origin O. Under that condition we can posit that the fluctuation of the length of the vector $\overrightarrow{P_1P} = \vec{r}_1$ is very small relative to the length of the time-independent position vector $\vec{r}$, that defines the position of P relative to the origin O. In other words: we assume that the amplitude of the oscillation is very small relative to the distances between the origin and the points P on which we focus.

Substitution of $(-\frac{m}{\eta_0})$ by $(\frac{q}{\varepsilon_0})$ and of $(-\nu_0.m)$ by $(\mu_0.q)$ in the expressions that describe the time dependent gravitational field of an harmonically oscillating point c• relative to $\boldsymbol{O}$ gives:

$$B_\varphi(r,\theta;t) = \frac{E_{\perp c}(r,\theta;t)}{c} = \frac{\mu_0.q.V.\sin\theta.\sqrt{1+k^2r^2}}{4\pi r^2}.\cos(\omega t - kr + \Phi)$$

with $tg\Phi = kr$ and $k = \frac{\omega}{c}$ the phase constant

So, an harmonically oscillating point charge is the source of a transversal "electromagnetic" wave that propagates out of the charge with the speed of light:

In points at a great distance from the oscillating particle, specifically there where $r >> \frac{1}{k} = \frac{c}{\omega}$, this expression asymptotically equals:

$$B_\varphi = \frac{E_{\perp c}}{c} = -\frac{\mu_0.k.q.V.\sin\theta}{4\pi r}.\sin(\omega t - kr)$$

$$= \frac{\mu_0.q.\omega.V.\sin\theta}{4\pi cr}.\sin(\omega t - kr) = -\frac{\mu_0.q.a\left(t-\frac{r}{c}\right).\sin\theta}{4\pi cr}$$

The intensity of the "far EM field" is inversely proportional to r, and is determined by the component of the acceleration of the particle, that is perpendicular to the direction of $\vec{e}_c$.

6.3 The energy radiated by an harmonically oscillating point charge.

An EM wave (just as a gravitational wave•) transports energy. The density of the EM energy flow at a point P, this is the rate of flow of energy per unit frontal area, is given by the "Poynting vector":

$$\vec{P} = \frac{\vec{E}\times\vec{B}}{\mu_0}$$

• GRAVITATIOELECTROMAGNETISM EXPLAINED BY THE THEORY OF INFORMATONS - §8.2.1

• GRAVITOELCTROMAGNETISM EXPLAINED BY THE THEORY OF INFORMATONS - §8.5.1

In the case of an EM wave generated by an harmonically oscillating point charge, the instantaneous value of Poynting's vector at a far point P, is:

$$\vec{P} = \frac{E_{\perp c}.B_{\varphi}}{\mu_0} = \frac{\mu_0.q^2.\omega^2.V^2.sin^2\,\theta}{16.\pi^2.c.r^2}.sin^2(\omega t - kr).\vec{e}_c$$

The amount of energy that, during one period T, flows through the surface element dS that at P is perpendicular to the direction of motion of the train of informatons, is:

$$dU = \int_0^T P.dt.dS = \frac{\mu_0.q^2.\omega^2.V^2.sin^2\,\theta}{16.\pi^2.c.r^2}.\frac{T}{2}.dS$$

And with $\omega = \frac{2.\pi}{T} = 2.\pi.\nu$:

$$dU = \frac{\mu_0.q^2.V^2.sin^2\,\theta}{8c}.\nu.\frac{dS}{r^2}$$

$\frac{dS}{r^2} = d\Omega$ is the solid angle under which dS is "seen" from the origin.

So, the oscillating charge radiates, per period, an amount of energy per unit of solid angle in the direction θ:

$$u_\Omega = \frac{\mu_0.q^2.V^2.sin^2\,\theta}{8c}.\nu$$

The density of the flow of energy is greatest in the direction defined by $\theta = 90°$, thus in the direction perpendicular to the movement of the charge. The radiated energy is proportional to the frequency of the wave, thus proportional to the frequency at which the charge oscillates.

We posit that an oscillating charge q loads some of the informatons that it emits with a discrete energy packet hν (where $h = 6{,}63 \times 10^{-34}$ J.s, *Planck's constant). Informatons carrying an energy packet are called " photons".*

This implies that photons rush through space with the speed of light.

Consequently, the number of photons emitted by an oscillating point charge q per period and per unit of solid angle in the direction θ is:

$$N_{f\Omega} = \frac{\mu_0.q^2.V^2.sin^2\,\theta}{8hc}$$

It follows that the total number of photons that it emits per period is:

$$N_f = \frac{\mu_0 . q^2 . V^2}{8hc} . 2\pi . \int_0^\pi sin^3 \theta . d\theta = \frac{\pi}{3} . \frac{\mu_0}{h.c} . q^2 . V^2$$

The hypothesis that photons are nothing else than informatons carrying a packet of energy allows us to understand the dual nature of light. Indeed, the *wave character* of light can be understood as the macroscopic manifestation of the kinematics of the informatons (the "train" of informatons) emitted by an oscillating point charge; and the *corpuscular character* as the manifestation of the fact that some of those informatons are carriers of a quantum of energy.

References

1.Acke, Antoine. *De Beginselen van de Informatonentheorie*. Gent: Uitgeverij Nevelland, 1990.

2.Acke, Antoine. *Gravitatie en Elektromagnetisme*. Gent: Uitgeverij Nevelland, 2008.

3.Acke, Antoine. *Theoretical Foundation of Electromagnetism*. Prespacetime Journal, Vol. 1, Issue 10, December 2010.

4.Acke, Antoine. *Electromagnetism explained by the theory of informatons*. Hadronic Journal, Vol. 36, Number 6, August 2013.

5.Ohanian, Hans C. *Physics*. New York - London : W.W. Norton & Company Inc, 1985.

6.Angot, André. *Compléments de Mathematiques*. Paris : Editions de la Revue d'Optique, 1957.

7. Resnick, Robert. *Introduction to special Relativity*. New York, London, Sydney : John Wiley & Sons, Inc, 1968.