CHAPTER 5

THE GRAVITATIONAL FIELD OF AN ACCELERATED OBJECT

An accelerated object is the source of a gravitational field that, at a sufficient great distance *r* from that object, is characterized by a transverse g-field and g-induction that are both inversely proportional to *r*.

5.1. THE g-INDEX OF AN INFORMATON EMITTED BY AN ACCELERATED PARTICLE

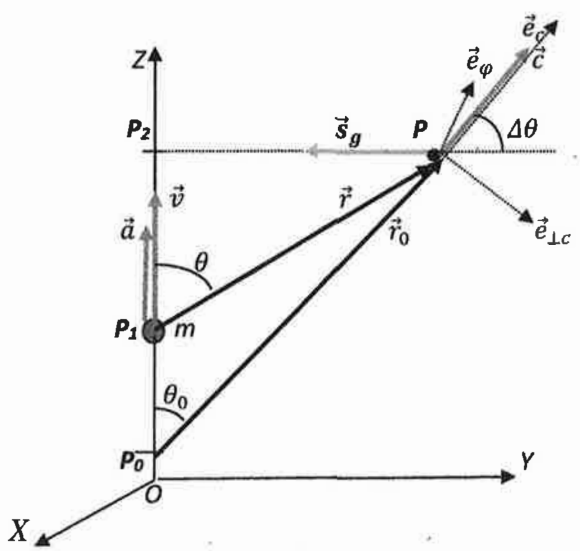

Fig 6

In fig 6 we consider a point mass m that, during a finite time interval, moves with constant acceleration $\vec{a} = a.\vec{e}_z$ relative to the inertial reference frame *OXYZ*. At the moment $t = 0$, m starts from rest at the origin O, and at $t = t$ it passes at the point P_1. Its velocity is there defined by $\vec{v} = v.\vec{e}_z = a.t.\vec{e}_z$, and its position by

$$z = \frac{1}{2}.a.t^2 = \frac{1}{2}.v.t.$$

We suppose that the speed v remains much smaller than the speed of light: $\frac{v}{c} \ll 1$.

The informatons that during the infinitesimal time interval $(t, t+dt)$ pass near the fixed point P (whose position relative to the moving mass m is defined by the time dependent position vector $\vec{r}$) have been emitted at the moment $t_0 = t - \Delta t$, when m – with velocity $\vec{v}_0 = v_0.\vec{e}_z = v(t - \Delta t).\vec{e}_z$ – passed at P_0 (the position of P relative to P_0 is defined by the time dependent position vector $\vec{r}_0 = \vec{r}(t - \Delta t)$). Δt, the time interval during which m moves from P_0 to P_1 is the time that the informatons need to move – with the speed of light – from P_0 to P. We can conclude that $\Delta t = \frac{r_0}{c}$, and that

$$v_0 = v(t - \Delta t) = v(t - \frac{r_0}{c}) = v - a.\frac{r_0}{c}$$

Between the moments $t = t_0$ and $t = t_0 + \Delta t$, m moves from P_0 to P_1. That movement can be considered as the resultant (the superposition) of

1. a uniform movement with constant speed $v_0 = v(t - \Delta t)$ and
2. a uniformly accelerated movement with constant acceleration a.

1.

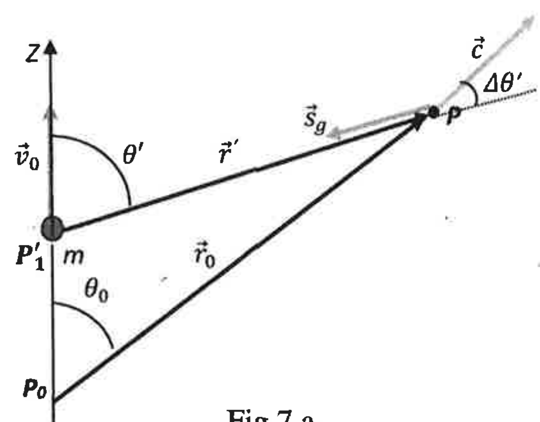

Fig 7,a

In fig. 7,a, we consider the case of the point mass m moving with constant speed v_0 along the Z-axis. At the moment $t_0 = t - \Delta t$ m passes at P_0 and at the moment t at P_1': $P_0P_1' = v_0.\Delta t$. The informatons that, during the infinitesimal time interval $(t, t + dt)$, pass near the point P - whose position relative to the uniformly moving mass m at the moment t is defined by the position vector $\vec{r}'$ -

have been emitted at the moment t_0 when m passed at P_0. Their velocity vector $\vec{c}$ is on the line P_0P, their g-index $\vec{s}_g$ points to P_1':

$$P_0P_1' = v_0.\Delta t = v_0\frac{r_0}{c}$$

2. In fig 7,b we consider the case of the point mass m starting at rest at P_0 and moving with constant acceleration a along the Z-axis.

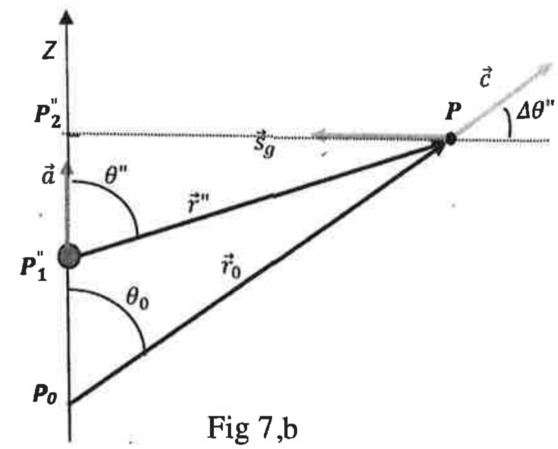

Fig 7,b

At the moment $t_0 = t - \Delta t$ it is at P_0 and at the moment t at P_1'':

$$P_0P_1'' = \frac{1}{2}.a.(\Delta t)^2$$

The informatons that during the infinitesimal time interval $(t, t + dt)$ pass near the point P (whose position relative to the uniformly accelerated mass m is at t defined by the position vector $\vec{r}''$) have been emitted at t_0 when m was at P_0. Their velocity vector $\vec{c}$ points away from P_0, their g-index $\vec{s}_g$ to P_2''.

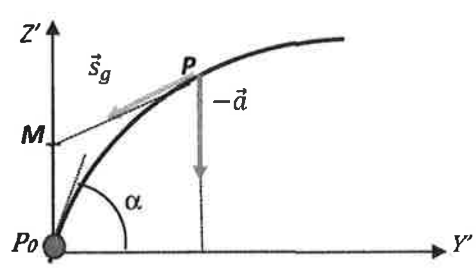

Fig. 7,c

To determine the position of $P_2^{"}$, we consider the trajectory of the informatons that at t_0 are emitted in the direction of P relative to the accelerated reference frame $OX'Y'Z'$ that is anchored to m (fig 7,c; $\alpha = \frac{\pi}{2} - \theta_0$).

Relative to $OX'Y'Z'$ these informatons are accelerated with an amount $-\vec{a}$: they follow a parabolic trajectory described by the equation:

$$z' = tg\alpha . y' - \frac{1}{2} . \frac{a}{c^2 . cos^2 \alpha} . y'^2$$

At the moment $t = t_0 + \Delta t$, when they pass at P, the tangent line to that trajectory cuts the Z'-axis at the point M, that is defined by:

$$z'_M = \frac{1}{2} . a . (\Delta t)^2 = \frac{1}{2} . a . \frac{r_0^2}{c^2}$$

That means that the g-indices of the informatons that at the moment t pass at P, point to a point M on the Z-axis that has a lead of

$$P_1^{"} P_2^{"} = P_0 M = \frac{1}{2} . a . (\Delta t)^2 = \frac{1}{2} . a . \frac{r_0^2}{c^2}$$

on $P_1^{"}$, the actual position of the mass m. And since $P_0 P_1^{"} = P_0 P_1^{"} + P_1^{"} P_2^{"}$, we conclude that:

$$P_0 P_2^{"} = a . \frac{r_0^2}{c^2}$$

In the inertial reference frame $OXYZ$ (fig 6), $\vec{s}_g$ points to the point P_2 on the Z-axis determined by the superposition of the effect of the velocity (*1*) and the effect of the acceleration (2):

$$P_0 P_2 = P_0 P_1' + P_0 P_2^{"} = \frac{v_0}{c} . r_0 + \frac{a}{c^2} . r_0^2$$

The carrier line of the g-index $\vec{s}_g$ of an informaton that - relative to the inertial frame $OXYZ$ - at the moment t passes near P forms a "characteristic angle" $\Delta\theta$ with the carrier line of its velocity vector $\vec{c}$, that can be deduced by application of the sine-rule in triangle $P_0 P_2 P$ (fig 6):

$$\frac{sin(\Delta\theta)}{P_0P_2} = \frac{sin(\theta_0 + \Delta\theta)}{r_0}$$

We conclude:

$$sin(\Delta\theta) = \frac{v_0}{c}.sin(\theta_0 + \Delta\theta) + \frac{a}{c^2}.r_0.sin(\theta_0 + \Delta\theta)$$

From the fact that P_0P_1 - the distance travelled by m during the time interval Δt - can be neglected relative to P_0P - the distance travelled by light during the same period - it follows that $\theta_0 \approx \theta_0 + \Delta\theta \approx \theta$ and that $r_0 \approx r$. So:

$$sin(\Delta\theta) \approx \frac{v_0}{c}.sin\,\theta + \frac{a}{c^2}.r.sin\,\theta$$

We can conclude that the g-index $\vec{s}_g$ of an informaton that at the moment t passes near P, has a longitudinal component, this is a component in the direction of $\vec{c}$ (its velocity vector) and a transversal component, this is a component perpendicular to that direction. It is evident that:

$$\vec{s}_g = -s_g.cos(\Delta\theta).\vec{e}_c - s_g.sin(\Delta\theta).\vec{e}_{\perp c}$$

$$\approx -s_g.\vec{e}_c - s_g.\left(\frac{v_0}{c}.sin\,\theta + \frac{a}{c^2}.r.sin\,\theta\right).\vec{e}_{\perp c}$$

5.2 THE GRAVITATIONAL FIELD OF AN ACCELERATED PARTICLE

The informatons that, at the moment t, are passing near the fixed point P - defined by the time dependent position vector $\vec{r}$ - are emitted when m was at P_0 (fig 6). Their velocity $\vec{c}$ is on the same carrier line as $\vec{r}_0 = \overrightarrow{P_0P}$. Their g-index is on the carrier line P_2P. According to §5.1, the characteristic angle $\Delta\theta$ - this is the angle between the carrier lines of $\vec{s}_g$ and $\vec{c}$ - has two components:

1. a component $\Delta\theta'$ related to the velocity of m at the moment $(t - \frac{r_0}{c})$ when the considered informatons were emitted. In the framework of our assumptions, this component is determined by:

$$sin(\Delta\theta') = \frac{v(t - \frac{r}{c})}{c}.sin\,\theta$$

2. a component $\Delta\theta''$ related to the acceleration of m at the moment when they were emitted. This component is, in the framework of our assumptions, determined by:

$$sin(\Delta\theta") = \frac{a(t-\frac{r}{c}).r}{c^2}.sin\,\theta$$

The macroscopic effect of the emission of g-information by the accelerated mass m is a gravitational field $(\vec{E}_g, \vec{B}_g)$. We introduce the reference system $(\vec{e}_c, \vec{e}_{\perp c}, \vec{e}_\varphi)$ (fig 6).

1. $\vec{E}_g$, the g-field at P, is defined as the density of the flow of g-information at that point. That density is the rate at which g-information crosses per unit area the elementary surface perpendicular to the direction of movement of the informatons. So $\vec{E}_g$ is the product of N, the density of the flow of informatons at P, with $\vec{s}_g$ their g-index:

$$\vec{E}_g = N.\vec{s}_g$$

According to the postulate of the emission of informatons, the magnitude of $\vec{s}_g$ is the elementary g-information quantity:

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

and the density of the flow of informatons at P is:

$$N = \frac{\dot{N}}{4\pi.r_0^2} \approx \frac{\dot{N}}{4.\pi.r^2} = \frac{K.m}{4\pi.r^2}$$

Taking into account that $\frac{1}{\eta_0.c^2} = \nu_0$, we obtain:

$$\vec{E}_g = -\frac{m}{4\pi.\eta_0.r^2}.\vec{e}_c$$
$$-\{\frac{m}{4\pi.\eta_0.c.r^2}.v(t-\frac{r}{c}).sin\,\theta + \frac{\nu_0.m}{4\pi.r}.a(t-\frac{r}{c}).sin\,\theta\}.\vec{e}_{\perp c}$$

2. $\vec{B}_g$, the g-induction at P, is defined as the density of the cloud of β - information at that point. That density is the product of n, the density of the cloud of informations at P (number per unit volume) with $\vec{s}_\beta$, their β-index:

$$\vec{B}_g = n.\vec{s}_\beta$$

The β-index of an informaton refers to the information it carries about the state of motion of its emitter; it is defined as:

$$\vec{s}_\beta = \frac{\vec{c} \times \vec{s}_g}{c}$$

And the density of the cloud of informatons at P is related to N, the density of the flow of informatons at that point by: $n = \frac{N}{c}$.

So:

$$\vec{B}_g = n.\vec{s}_\beta = \frac{N}{c}.\frac{\vec{c} \times \vec{s}_g}{c} = \frac{\vec{c} \times (N.\vec{s}_g)}{c^2} = \frac{\vec{c} \times \vec{E}_g}{c^2}$$

And with the expression of that we have derived above under *1* we finally obtain:

$$\vec{B}_g = -\{\frac{v_0.m}{4.\pi.r^2}.v(t-\frac{r}{c}).\sin\theta + \frac{v_0.m}{4.\pi.c.r}.a(t-\frac{r}{c}).\sin\theta\}.\vec{e}_\varphi$$

From this it can be concluded that at a point P, sufficient far from the accelerated particle m, the components of its gravitational field are both transverse to the velocity of the informatons and they are proportional to $\frac{1}{r}$.