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GRAVITATION EXPLAINED BY THE THEORY OF INFORMATONS

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ABSTRACT

The *"theory of informatons"* explains the gravitational interactions by the hypothesis that "*information*" is the substance of gravitational fields. The constituent element of that substance is called an "*informaton*".

The theory starts from the idea that any material object manifests itself in space by the emission of informatons: granular mass and energy less entities rushing away with the speed of light and carrying information about the position ("*g-information*") and about the velocity ("*β-information*") of the emitter. In this article the gravitational field is characterised; the laws of gravito-electromagnetism are mathematically deduced from the dynamics of the informatons; the gravitational interactions are explained as the effect of the trend of a material object to become blind for flows of information generated by other masses; and gravitons are identified as informatons carrying a quantum of energy.

INTRODUCTION

Daily contact with the things on hand confronts us with their *substantiality*. An object is not just form, it is also matter. It takes space, it eliminates emptiness. The amount of matter within the contours of a physical body is called its *mass.*

The mass of an object manifests itself when it interacts with other objects. A fundamental form of interaction is "*gravitation*". Material objects (masses) action "at a distance" on each other: they attract each other and if they are free, they move to each other along the straight line that connects them.

According to the classical theory of fields, the gravitational interactions can be described by introducing the "*gravitational field*": each material object manifests its substantiality in space by creating and maintaining a vector field and each object in that field experiences a tendency to change its state of motion. The "*field theory*" considers the gravitational field as the mathematical entity that mediates in the gravitational interaction.

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This is further developed by Oliver Heaviside [1] and Oleg Jefimenko [2]. In "the *theory of gravito-electromagnetism*" *(G.E.M.)* they describe the gravitational field starting from the idea that it must be isomorphic with the electromagnetic field. This implies that it should be characterized by two vectorial quantities that are analogue to respectively the electric field $\vec{E}$ and the magnetic induction $\vec{B}$, and that the relations governing these quantities should be analogue to Maxwell's laws.
Within the framework of general relativity, G.E.M. has been discussed by a number of authors [3]. It is shown that the gravitational analogues to Maxwell's equations (the G.E.M. equations) can be derived from the Einstein field equation.

Although G.E.M. describes the gravitational phenomena in a correct and coherent manner, it doesn't create clarity about the true nature of the "action at a distance". In the context of G.E.M., the gravitational field is a purely mathematical construction that doesn't provide insight in the mechanisms that are at the base of the physical laws.

In this paper we develop the idea that, if masses can influence each other "at a distance", they must in one way or another exchange data. We assume that each mass emits information relative to its magnitude and its position, and is able to "interpret" the information emitted by its neighbours. In this way we propose a physical foundation of G.E.M. by introducing "*information*" as the substance of the gravitational field.

Explicitly, we start from the idea that the gravitational field of a material object can be explained as the macroscopic manifestation of the emission by that object of mass-, energy- and granular entities rushing away with the speed of light and carrying information about the position ("*g-information*") and the velocity ("*β-information*") of the emitter. Because they transport nothing else than information, we call these entities "*informatons*". In the "*postulate of the emission of informatons*", we define an informaton by its attributes and determine the rules that govern the emission of informatons by a point mass that is anchored in an inertial reference frame.

The first consequence of that postulate is that a point mass at rest - and by extension any material object at rest - can be considered as the source of an expanding spherical cloud of informatons, that - in an arbitrary point *P* - is characterised by the vectorial quantity $\vec{E}_g$. $\vec{E}_g$ is *the density of the flow of g-information* in that point. That cloud of informatons can be identified with the gravitational field and the quantity $\vec{E}_g$ with the gravitational field strength in *P*. A second consequence is that the informatons emitted by a moving point mass, constitute a gravitational field that is characterised by two vectorial quantities: $\vec{E}_g$, the density of the g-information flow, and $\vec{B}_g$, *the density of the β-information cloud*. We show that the relations - arising from the dynamics of the informatons - between these two quantities (the laws of G.E.M.) are the gravitational analogues of the laws of Maxwell-Heaviside.

Next we explain the gravitational interaction between masses as the reaction of a point mass on the disturbance of the symmetry of its "own" gravitational field by the field that, in its direct vicinity, is created and maintained by other masses. And finally we examine the emission of energy by an accelerating mass.

I. The Postulate of the Emission of Informatons

With the aim to understand and to describe the mechanism of the gravitational interaction, we introduce a new quantity in the arsenal of physical concepts: *information.* We suppose that information is transported by mass and energy less granular entities that rush through space with the speed of light (*c*). We call these information carriers *informatons*. Each material object continuously emits informatons. An informaton always carries *g-information*, that is at the root of gravitation.

The emission of informatons by a point mass (*m*) anchored in an inertial reference frame ***O***, is governed by the *postulate of the emission of informatons*:

A. *The emission* 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 location of the emitter.*

2. $\dot{N} = \dfrac{dN}{dt}$*, the rate at which a point-mass emits informatons•, is time independent and proportional to its mass m. 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-spin.* The g-spin 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 vectorial quantity $\vec{s}_g$, the "*g-spin vector*":

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

2. *All g-spin vectors have the same magnitude, namely:*

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

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

($\eta_0 = \dfrac{1}{4.\pi.G} = 1{,}19.10^9\, kg.s^2.m^{-3}$ with *G* the gravitational constant)

s_g, the magnitude of the g-spin-vector, is the *elementary g-information quantity.*

II. The gravitational Field of Masses at Rest

2.1. The gravitational field of a point mass at rest

In fig 1 we consider a point mass that is anchored in the origin of an inertial reference frame ***O***. It continuously emits informatons in all directions of space.

The informatons that pass near a fixed point *P* - defined by the position vector $\vec{r}$ - have two attributes: their velocity $\vec{c}$ and their g-spin vector $\vec{s}_g$:

$$\vec{c} = c.\frac{\vec{r}}{r} = c.\vec{e}_r \qquad \text{and} \qquad \vec{s}_g = -\frac{1}{K.\eta_0}.\frac{\vec{r}}{r} = -\frac{1}{K.\eta_0}.\vec{e}_r$$

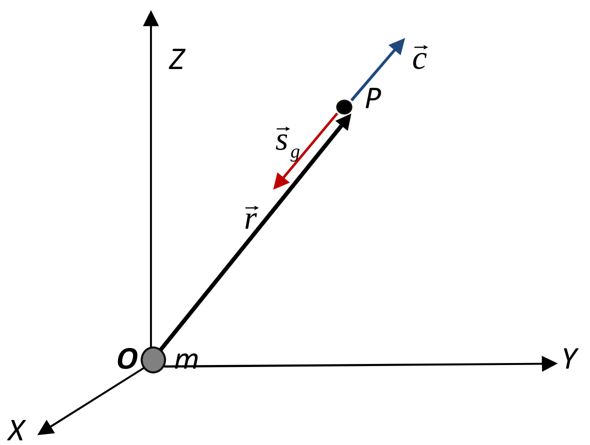

Fig 1

The rate at which the point mass emits g-information is the product of the rate at which it emits informatons with the elementary g-information quantity:

$$\dot{N}.s_g = \frac{m}{\eta_0}$$

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

The emission of informatons fills the space around *m* with an expanding cloud of g-information. This cloud has the shape of a sphere whose surface goes away - with the speed of light - from the centre *O*, the position of the point mass.

- Within the cloud is a *stationary state*: because the inflow equals the outflow, each spatial region contains an unchanging number of informatons and thus a constant quantity of g-information. Moreover, the orientation of the g-spin vectors of the informatons passing through a fixed point is always the same.

- The cloud can be identified with a *continuum*: each spatial region contains a very large number of informatons: the g-information is like continuously spread over the volume of the region.

That cloud of g-information surrounding O constitutes the *gravitational field* * or the *g-field* of the point mass *m.*

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

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

$$\dot{N}.s_g = \frac{m}{\eta_0}$$

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

$$\frac{m}{4.\pi.r^2.\eta_0}$$

This is the *density* of the flow of g-information in each point P at a distance r from m (fig 1). This quantity is, together with the orientation of the g-spin vectors of the informatons that are passing near P, characteristic for het gravitational field in that point.

Thus, in a point P, the gravitational field of the point mass m is defined by the vectorial quantity $\vec{E}_g$:

$$\boxed{\vec{E}_g = \frac{\dot{N}}{4.\pi.r^2}.\vec{s}_g = -\frac{m}{4.\pi.\eta_0.r^2}.\vec{e}_r = -\frac{m}{4.\pi.\eta_0.r^3}.\vec{r}}$$

This quantity is the *gravitational field strength* or the *g-field strength* or the *g-field*. In any point of the gravitational field of the point mass m, the orientation of $\vec{E}_g$ corresponds to the orientation of the g-spin-vectors of the informatons who are passing near that point. And

* The time T elapsed since the emergence of a point-mass (this is the time elapsed since the emergence of the universe) and the radius R of its field of gravitation are linked by the relation $R = c.T$. Assuming that the universe - since its beginning ($1{,}8.10^{10}$ years ago) - uniformly expands, a point at a distance r from m runs away with speed v: $v = \frac{r}{R}.c = \frac{1}{T}.r = H_0.r$. H_0 is the Hubble constant:

$$H_0 = \frac{1}{T} = 1{,}7.10^4 \, \frac{m/s}{millionlight - years}$$

the magnitude of $\vec{E}_g$ is the *density of the g-information flow* in that point. Let us note that $\vec{E}_g$ is opposite to the sense of movement of the informatons.

Let us consider a surface-element *dS* in *P* (fig 2,a). Its orientation and magnitude are completely determined by the surface-vector $\overrightarrow{dS}$ (fig 2,b)

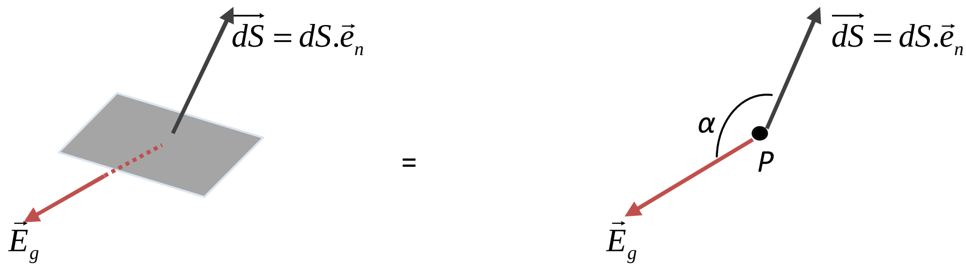

Fig 2,a

Fig 2,b

By $d\Phi_g$, we represent the rate at which g-information flows through *dS* in the sense of the positive normal and we call this scalar quantity the *elementary g-flux through dS*:

$$d\Phi_g = -\vec{E}_g.\overrightarrow{dS} = -E_g.dS.\cos\alpha$$

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

$$\Phi_g = -\oiint \vec{E}_g.\overrightarrow{dS} = \frac{m}{\eta_0}$$

This relation expresses *the conservation of g-information* in the case of a point mass at rest.

2.2. The gravitational field of a set of point-masses at rest

We consider a set of point-masses $m_1,\dots,m_i,\dots m_n$ that are anchored in an inertial frame ***O***.

In an arbitrary point *P*, the flows of g-information who are emitted by the distinct masses are defined by the gravitational fields $\vec{E}_{g1},\dots,\vec{E}_{gi},\dots,\vec{E}_{gn}$.

$d\Phi_g$, the rate at which g-information flows through a surface-element *dS* in *P* in the sense of the positive normal, is the sum of the contributions of the distinct masses:

$$d\Phi_g = \sum_{i=1}^{n} -(\vec{E}_{gi}.\overrightarrow{dS}) = -(\sum_{i=1}^{n}\vec{E}_{gi}).\overrightarrow{dS} = -\vec{E}_g.\overrightarrow{dS}$$

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

$$\boxed{\vec{E}_g = \sum_{i=1}^{n} \vec{E}_{gi}}$$

We conclude: *The g-field of a set of point masses at rest is in any point of space completely defined by the vectorial sum of the g-fields caused by the distinct masses.*

Let us note that the orientation of the effective g-field has no longer a relation with the direction in which the passing informatons are moving.

One shows easily that the outward g-flux through a closed surface in the g-field of a set of anchored point masses only depends on the spanned masses m_{in}:

$$\Phi_g = -\oint\!\!\!\oint \vec{E}_g.\overrightarrow{dS} = \frac{m_{in}}{\eta_0}$$

This relation expresses *the conservation of g-information* in the case of a set of point masses at rest.

2.3. The gravitational field of a mass continuum at rest

We call an object in which the matter in a time independent manner is spread over the occupied volume, a *mass continuum*.

In each point Q of such a continuum, the accumulation of mass is defined by the (*mass*) *density* ρ_G. To define this scalar quantity one considers a volume element dV that contains Q, and one determines the enclosed mass dm. The accumulation of mass in the vicinity of Q is defined by:

$$\rho_G = \frac{dm}{dV}$$

A mass continuum - anchored in an inertial frame - is equivalent to a set of infinitely many infinitesimal mass elements *dm.* The contribution of each of them to the field strength in an arbitrary point P is $d\vec{E}_g$. $\vec{E}_g$, the effective field strength in P, is the result of the integration over the volume of the continuum of all these contributions.

It is evident that the outward g-flux through a closed surface S only depends on the mass enclosed by the surface (the enclosed volume is V).

$$-\oint\!\!\!\oint_S \vec{E}_g.\overrightarrow{dS} = \frac{1}{\eta_0}.\iiint_V \rho_G.dV$$

That is equivalent with (theorem of Ostrogradsky) [4]:

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

This relation expresses *the conservation of g-information* in the case of a mass contiuum at rest.

Furthermore, one can show that: $rot\vec{E}_g = 0$, what implies the existence of *a gravitational potential function* V_g for which: $\vec{E}_g = -gradV_g$.

III. The gravitational Field of moving Masses

3.1. Rest mass and relativistic mass

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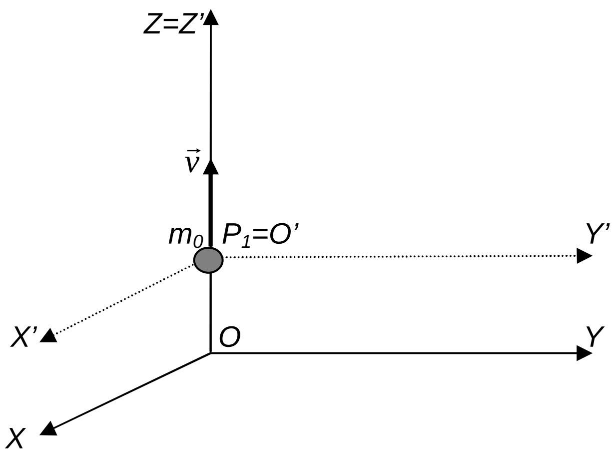

Fig 3

In fig 3, we consider a point mass that moves with constant velocity $\vec{v} = v.\vec{e}_z$ along the *Z*-axis of an inertial reference frame ***O*** . At the moment *t = 0***,** it passes through the origin *O* and at the moment *t = t* through the point P_1.

> *We posit that* $\dot{N}$ *- the rate at which a point mass emits informatons in the space connected to* ***O*** *- is determined by its rest mass* m_0 *and is independent of its motion:*
>
> $$\dot{N} = \frac{dN}{dt} = K.m_0$$

That implies that, if the time is read on a standard clock anchored in ***O***, *dN* - the number of informatons that during the interval *dt* by a - whether or not moving - point mass is emitted in the space connected to ***O***, is:

$$dN = K.m_0.dt$$

We can the space-time also connect to an inertial reference frame ***O'*** (fig 3) whose origin is anchored to the point mass and that is running away relative to ***O*** with the velocity $\vec{v} = v.\vec{e}_z$.

We assume that *t = t′ = 0* when the mass passes through ***O*** (*t* is the time read on a standard clock in ***O*** and *t′* the time read on a standard clock in ***O′***).

We determine the time that expires while the moving point mass emits *dN* informatons.

1. An observer in ***O*** uses therefore a standard clock that is linked to that reference frame. The emission of *dN* informatons takes *dt* seconds. The relationship between *dN* and *dt* is:

$$dN = K.m_0.dt$$

2. To determine the duration of the same phenomenon, the observer in ***O*** can also read the time on the moving clock, that is the standard clock linked to the inertial reference frame ***O′***. According to that clock, the emission of *dN* informatons takes *dt′* seconds.

(*x, y, z; t*) - the coordinates of an event connected to ***O*** - and (*x′, y′, z′; t′*) - the coordinates of the same event connected to ***O′*** - are related by the Lorentz-transformation [5]:

$x' = x$	$x = x'$
$y' = y$	$y = y'$
$z' = \dfrac{z - vt}{\sqrt{1-\beta^2}}$	$z = \dfrac{z' + vt'}{\sqrt{1-\beta^2}}$
$t' = \dfrac{t - \dfrac{v}{c^2} z}{\sqrt{1-\beta^2}}$	$t = \dfrac{t' + \dfrac{v}{c^2} z'}{\sqrt{1-\beta^2}}$

The relationship between *dt* and *dt′* is:

$$dt = \frac{dt'}{\sqrt{1-\beta^2}} \quad \text{with} \quad \beta = \frac{v}{c}$$

So:

$$dN = K.m_0.dt = K.m_0.\frac{dt'}{\sqrt{1-\beta^2}} = K.\frac{m_0}{\sqrt{1-\beta^2}}.dt' = \frac{\dot{N}}{\sqrt{1-\beta^2}}.dt'$$

and:

$$\frac{dN}{dt'} = \frac{\dot{N}}{\sqrt{1-\beta^2}} = K.\frac{m_0}{\sqrt{1-\beta^2}} = K.m \quad \text{with} \quad m = \frac{m_0}{\sqrt{1-\beta^2}}\text{, the “relativistic mass”}$$

Conclusion: *The rate at which a point mass, moving with constant velocity relative to an inertial reference frame **O**, emits informatons in the space linked to **O**, is determined by its relativistic mass if the time is read on a standard clock that is anchored to that mass.*

3.2. The field caused by a uniform rectilinear moving point mass

In fig 4,a, we consider again a point mass with rest mass m_0 that, with constant velocity $\vec{v} = v.\vec{e}_z$, moves along the *Z*-axis of an inertial reference frame ***O***. At the moment $t = 0$**,** it passes through the origin *O* and at the moment $t = t$ through the point P_1. It is evident that:

$$OP_1 = z_{P_1} = v.t$$

m_0 continuously emits informatons that, with the speed of light, rush away with respect to the point where the mass is at the moment of emission. We wish to determine the density of the flow of g-information - this is the g-field - in a fixed point *P*. The position of P relative to the reference frame ***O*** is determined by the time independent Cartesian coordinates (*x, y, z*), or by the time dependent position vector $\vec{r} = \overrightarrow{P_1P}$. θ is the angle between $\vec{r}$ and the *Z*-axis.

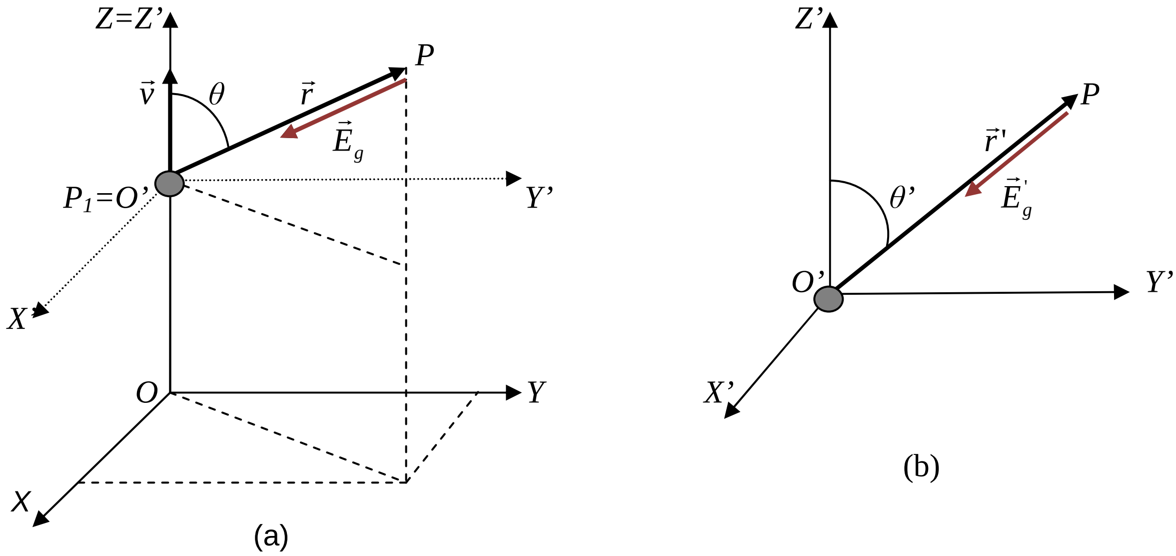

Fig. 4

Relative to the inertial reference frame ***O'***, that is anchored to the moving mass and that at the moment $t = t' = 0$, coincides with ***O*** (fig 4,b), the instantaneous value of the density of the flow of g-information in *P* is determined by:

$$\vec{E}_g^{'} = -\frac{m_0}{4\pi\eta_0 r'^3}.\vec{r}'$$

Indeed, relative to ***O'*** the point mass is at rest and he position of *P* is determined by the time dependant position vector $\vec{r}'$ or by the Cartesian coordinates (*x', y', z'*). So, the g-field generated by the mass is determined by 2.1.

The components of $\vec{E}_g^{'}$ in *O'X'Y'Z'*, namely:

$$E_{gx'}^{'} = -\frac{m_0}{4\pi\eta_0 r'^3}.x' \qquad E_{gy'}^{'} = -\frac{m_0}{4\pi\eta_0 r'^3}.y' \qquad E_{gz'}^{'} = -\frac{m_0}{4\pi\eta_0 r'^3}.z'$$

determine in *P* the densities of the flows of g-information respectively through a surface element *dy'.dz'* perpendicular to the *X'*-axis, through a surface element *dz'.dx'* perpendicular to the *Y'*-axis and through a surface element *dx'.dy'* perpendicular to the *Z'*-axis.

The g-fluxes through these different surface elements in *P*, or the rates at which g-information flows through it are:

$$E'_{gx'}.dy'.dz' = -\frac{m_0.x'}{4\pi\eta_0 r'^3}.dy'.dz'$$

$$E'_{gy'}.dz'.dx' = -\frac{m_0.y'}{4\pi\eta_0 r'^3}.dz'.dx'$$

$$E'_{gz'}.dx'.dy' = -\frac{m_0.z'}{4\pi\eta_0 r'^3}.dx'.dy'$$

The Cartesian coordinates of *P* in the frames ***O*** and ***O'*** are connected by [(5)]:

$$x' = x \qquad y' = y \qquad z' = \frac{z - v.t}{\sqrt{1-\beta^2}} = \frac{z - z_{P_1}}{\sqrt{1-\beta^2}}$$

And the line elements by: $dx' = dx$ $\qquad$ $dy' = dy$ $\qquad$ $dz' = \dfrac{dz}{\sqrt{1-\beta^2}}$

Further•: $r' = r.\dfrac{\sqrt{1-\beta^2.\sin^2\theta}}{\sqrt{1-\beta^2}}$

So relative to ***O***, the g-information fluxes that the moving mass sends - in the positive direction - through the surface elements *dy.dz*, *dz.dx* and *dx.dy* in *P* are:

• In ***O***: $r = \sqrt{x^2 + y^2 + (z - z_{P_1})^2}$, $\sin\theta = \dfrac{\sqrt{x^2+y^2}}{r}$ and $\cos\theta = \dfrac{z - z_{P_1}}{r}$.

And in ***O'***: $r' = \sqrt{x'^2 + y'^2 + z'^2}$ and $\sin\theta' = \dfrac{\sqrt{x'^2+y'^2}}{r'}$.

We express *r'* in function of *x, y* and *z*:

$$r' = \sqrt{x^2 + y^2 + \frac{(z - z_{P1})^2}{(1-\beta^2)}} = \sqrt{r^2.\sin^2\theta + \frac{(z-z_{P1})^2}{1-\beta^2}} = \frac{\sqrt{r^2.\sin^2\theta.(1-\beta^2) + r^2.\cos^2\theta}}{\sqrt{1-\beta^2}} = r\frac{\sqrt{1-\beta^2.\sin^2\theta}}{\sqrt{1-\beta^2}}$$

$$-\frac{m_0}{4\pi\eta_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.x.dy.dz$$
$$-\frac{m_0}{4\pi\eta_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.y.dz.dx$$
$$-\frac{m_0}{4\pi\eta_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(z-z_{P_1}).dx.dy$$

Since the densities in *P* of the flows of g-information in the direction of the *X*-, the *Y*- and the *Z*-axis are the components of the g-field caused by the moving point mass m_0 in *P*, we find:

$$E_{gx}=-\frac{m_0}{4\pi\eta_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.x$$
$$E_{gy}=-\frac{m_0}{4\pi\eta_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.y$$
$$E_{gz}=-\frac{m_0}{4\pi\eta_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(z-z_{P_1})$$

So, the g-field caused by the moving point mass in the fixed point *P* is:

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

We conclude: *A point mass describing - relative to an inertial reference frame* ***O*** *- a uniform rectilinear movement creates in the space linked to that frame a time dependent gravitational field.* $\vec{E}_g$*, the g-field in an arbitrary point P, points at any time to the position of the mass at that moment*[•] *and its magnitude is:*

$$E_g=\frac{m_0}{4\pi\eta_0 r^2}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}$$

If the speed of the mass is much smaller than the speed of light, this expression reduces itself to that valid in the case of a mass at rest. This non-relativistic result could also been obtained if one assumes that the displacement of the point mass during the time interval

[•] From this conclusion on the direction of the g-field, one can deduce that the movement of an object in a gravitational field is determined by the present position of the source of the field and not by its light-speed delayed position.

that the informatons need to move from the emitter to *P* can be neglected compared to the distance they travel during that period.

The orientation of the field strength implies that the spin vectors of the informatons that at a certain moment pass through P, point to the position of the emitting mass at that moment.

3.3. The emission of informatons by a point mass describing a uniform rectilinear motion

In fig 5 we consider a point mass m_0 that moves with a constant velocity $\vec{v}$ along the *Z*-axis of an inertial reference frame. Its instantaneous position (at the arbitrary moment *t*) is P_1.

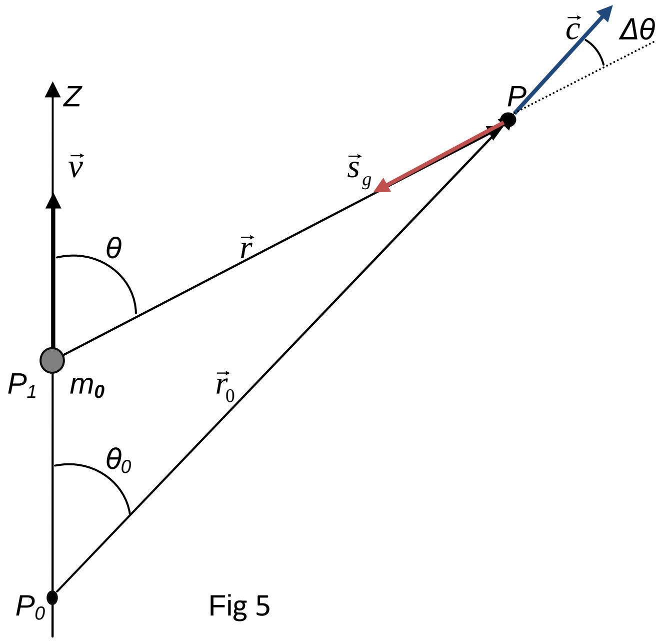

Fig 5

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.

The informatons that - with the speed of light - at the moment *t* are passing near *P*, are emitted when m_0 was at P_0. Bridging the distance $P_0P = r_0$ took the time interval Δt:

$$\Delta t = \frac{r_0}{c}$$

During their rush from P_0 to *P*, the mass moved 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.

- $\vec{s}_g$, their g-spin vector, points to P_1, the position of m_0 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 §3.2.

The lines carrying $\vec{s}_g$ and $\vec{c}$ form an angle $\Delta\theta$. We call this angle, that is characteristic for the speed of the point mass, the "*characteristic angle*" or the "*characteristic deviation*".
The quantity $s_\beta = s_g.\sin(\Delta\theta)$ - referring to the speed of its emitter - is called the "*characteristic g-information*" or the "*β-information*" of an informaton.

We note that an informaton emitted by a moving point mass, transports information referring to the velocity of that mass. This information is represented by its "*gravitational characteristic vector*" or "*β-index*" $\vec{s}_\beta$ that is defined by:

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

- The β-index is perpendicular to the plane formed by the path of the informaton and the straight line that carries the g-spin vector, 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 5, the β-indices have the orientation of the positive *X*-axis.

- Its magnitude is: $s_\beta = s_g.\sin(\Delta\theta)$, the *β-information* of the informaton.

We apply the sine rule to the triangle P_0P_1P: $\frac{\sin(\Delta\theta)}{v.\Delta t} = \frac{\sin\theta}{c.\Delta t}$

It follows:

$$s_\beta = s_g.\frac{v}{c}.\sin\theta = s_g.\beta.\sin\theta = s_g.\beta_\perp$$

$\beta_\perp$ is the component of the dimensionless velocity $\vec{\beta} = \frac{\vec{v}}{c}$ perpendicular to $\vec{s}_g$.

Taking into account the orientation of the different vectors, the β-index of an informaton emitted by a point mass moving with constant velocity, can also be expressed as:

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

3.4. The gravitational induction of a point mass describing a uniform rectilinear motion

We consider again the situation of fig 5. All informatons in *dV* - the volume element in *P* - carry both g-information and β-information. The β-information refers to the velocity of the emitting mass and is represented by the β-indices $\vec{s}_\beta$:

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

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

$$n.\vec{s}_\beta.dV = n.\frac{\vec{c}\times\vec{s}_g}{c}.dV = n.\frac{\vec{v}\times\vec{s}_g}{c}.dV$$

And the density of the the β-information (characteristic information per unit volume) in *P* is determined by:

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

We call this (time dependent) vectorial quantity - that will be represented by $\vec{B}_g$ - the "*gravitational induction*" or the "*g-induction*"• in *P:*

- Its magnitude B_g determines the density of the β-information in *P.*
- Its orientation determines the orientation of the β-vectors $\vec{s}_\beta$ of the informatons passing near that point.

So, the g-induction caused in *P* by the moving mass m_0 (fig 5) is:

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

N - the density of the flow of informatons in *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 in *P* (number of informatons per unit volume) - are connected by the relation:

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

With $\vec{E}_g = N.\vec{s}_g$, we can express the gravitational induction in *P* as:

• This quantity is also called the "cogravitational field", represented as $\vec{K}$ or the "gyrotation", represented as $\vec{\Omega}$.

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

Taking into account (3.2): $\vec{E}_g = -\frac{m_0}{4\pi\eta_0 r^3} . \frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}} . \vec{r}$

We find:

$$\vec{B}_g = -\frac{m_0}{4\pi\eta_0 c^2 . r^3} . \frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}} . (\vec{v} \times \vec{r})$$

We define the constant ν_0 *= 9,34.10^-27^ m.kg^-1^* as: $\nu_0 = \frac{1}{c^2 . \eta_0}$

And finally, we obtain:

$$\boxed{\vec{B}_g = \frac{\nu_0 . m_0}{4\pi r^3} . \frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}} . (\vec{r} \times \vec{v})}$$

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

$$B_g = \frac{\nu_0 . m_0}{4\pi r^2} . \frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}} . v . \sin\theta$$

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

$$\vec{B}_g = \frac{\nu_0 . m}{4\pi r^3} . (\vec{r} \times \vec{v})$$

This non-relativistic result could also be obtained if one assumes that the displacement of the point mass 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.

3.5. The gravitational field of a point mass describing a uniform rectilinear motion

A point mass *m₀*, moving with constant velocity $\vec{v} = v.\vec{e}_z$ along the *Z*-axis of an inertial frame, creates and maintains a cloud of informatons that are carrying both g- and β-information. That cloud can be identified with a time dependent continuum. That continuum is called the *gravitational field*• of the point mass. It is characterized by two time dependent vectorial

• Also called: “gravito-electromagnetic” (GEM field) or “gravito-magnetic” field (GM field) quantities: the gravitational field (short: *g-field*) $\vec{E}_g$ and the gravitational induction (short*: g-induction*) $\vec{B}_g$.

- With *N* the density of the flow of informatons in *P* (the rate per unit area at which the informatons cross an elementary surface perpendicular to the direction of movement), the g-field in that point is:

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

The orientation of $\vec{E}_g$ learns that the direction of the flow of g-information in *P* is not the same as the direction of the flow of informatons.

- With *n,* the density of the cloud of informatons in *P* (number of informatons per unit volume), the g-induction in that point is:

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

One can verify that:

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

These relations are the laws of G.E.M. in the case of the gravitational field of a point mass describing a uniform rectilinear motion.

If $v << c$, the expressions for the g-field and the g-induction reduce to:

$$\vec{E}_g = -\frac{m_0}{4\pi\eta_0 r^3}.\vec{r} \qquad \text{and} \qquad \vec{B}_g = \frac{\nu_0.m_0}{4\pi r^3}.(\vec{r}\times\vec{v})$$

3.6. The gravitational field of a set of point masses describing uniform rectilinear motions

We consider a set of point masses *m_1,...,m_i,...m_n* that move with constant velocities $\vec{v}_1,...,\vec{v}_i,...,\vec{v}_n$ in an inertial reference frame ***O***. This set creates and maintains a gravitational field that in each point of the space linked to ***O***, is characterised by the vector pair ($\vec{E}_g$, $\vec{B}_g$) .

- Each mass m_i continuously emits g-information and contributes with an amount $\vec{E}_{gi}$ to the g-field at an arbitrary point *P*. As in 2.2 we conclude that the effective g-field $\vec{E}_g$ in *P* is defined as:

$$\boxed{\vec{E}_g = \sum \vec{E}_{gi}}$$

- If it is moving, each mass m_i emits also β-information, contributing to the g-induction in *P* with an amount $\vec{B}_{gi}$. It is evident that the β-information in the volume element *dV* in *P* at each moment *t* is expressed by:

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

Thus, the effective g-induction $\vec{B}_g$ in *P* is:

$$\boxed{\vec{B}_g = \sum \vec{B}_{gi}}$$

The laws of G.E.M. mentioned in the previous section remain valid for the effective g-field and g-induction in the case of the gravitational field of a set op point masses describing a uniform rectilinear motion.

3.7. The gravitational field of a stationary mass flow

The term "stationary mass flow" indicates the movement of an homogeneous and incompressible fluid that, in an invariable way, flows relative to an inertial reference frame.

The intensity of the flow in an arbitrary point *P* is characterised by the flow density $\vec{J}_G$. The magnitude of this vectorial quantity equals the rate per unit area at which the mass flows through a surface element that is perpendicular to the flow in *P*. The orientation of $\vec{J}_G$ corresponds to the direction of that flow. If $\vec{v}$ is the velocity of the mass element $\rho_G.dV$ that at the moment *t* flows through *P*, then: $\vec{J}_G = \rho_G.\vec{v}$

So, the rate at which the flow transports - in the positive sense (defined by the orientation of the surface vectors $\overrightarrow{dS}$) - mass through an arbitrary surface *ΔS,* is: $i_G = \iint\limits_{\Delta S} \vec{J}_G.\overrightarrow{dS}$

We call i_G the *intensity of the mass flow through ΔS.*

Since a stationary mass flow is the macroscopic manifestation of moving mass elements $\rho_G.dV$, it creates and maintains a gravitational field. And since the velocity $\vec{v}$ of the mass element in each point is time independent, *the gravitational field of a stationary mass flow will be time independent*. It is evident that the rules of 2.3 also apply for this time independent g-field:

$$div\vec{E}_g = -\frac{\rho_G}{\eta_0} \qquad \text{and} \qquad rot\vec{E}_g = 0 \text{ what implies: } \vec{E}_g = -gradV_g$$

One can prove [(6)] that the rules for the time independent g-induction are:

$$div\vec{B}_g = 0 \text{ what implies } \vec{B}_g = rot\vec{A}_g \qquad \text{and} \qquad rot\vec{B}_g = -\nu_0.\vec{J}_G$$

This are the laws of G.E.M. in the case of the gravitational field of a stationary mass flow.

3.8. The gravitational field of an accelerated point mass.

3.8.1. The g-spinvector of an informaton emitted by an accelerated point mass

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 - in the origin *O*, and at the moment *t = t* it passes in 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: $\frac{v}{c} << 1$.

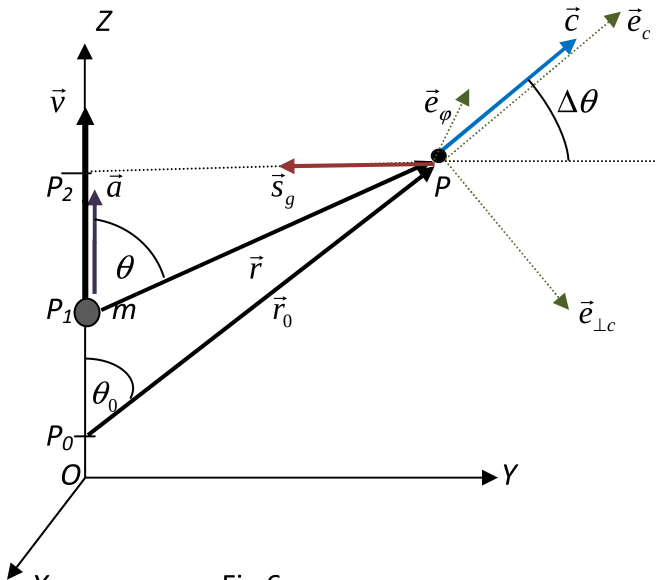

Fig 6

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 dependant 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 through P_0 (whose position is defined by the time dependant 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 (c) - 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 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. In fig. 6,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 in P_0 and at the moment t in P_1': $P_0P_1' = v_0.\Delta t$

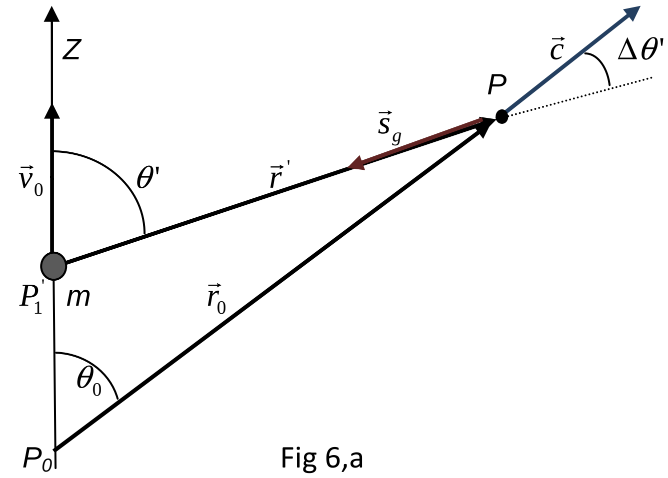

Fig 6,a

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 in P_0. Their velocity vector $\vec{c}$ is on the line P_0P, their spin vector $\vec{s}_g$ points to P_1': $P_0P_1' = v_0.\Delta t = v_0\frac{r_0}{c}$

2.

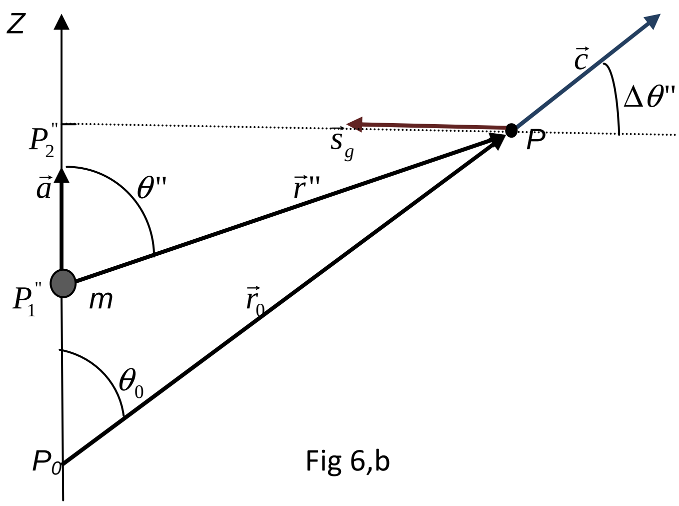

Fig 6,b

In fig 6,b we consider the case of the point mass *m* starting at rest in P_0 and moving with constant acceleration a along the *Z*-axis. At the moment $t_0 = t - \Delta t$ it is in P_0 and at the moment t in 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 the moment *t* - defined by the position vector $\vec{r}''$) have been emitted at the moment t_0 when *m* was in P_0. Their velocity vector $\vec{c}$ points to P_0, their spinvector $\vec{s}_g$ to P_2''.

To determine the position of P_2'', we consider the trajectories of the informatons that at the moment t_0 are emitted in the direction of *P*, relative to the accelerated reference frame *OX'Y'Z'* that is anchored to *m*. (fig 6,c; $\alpha = \frac{\pi}{2} - \theta_0$)

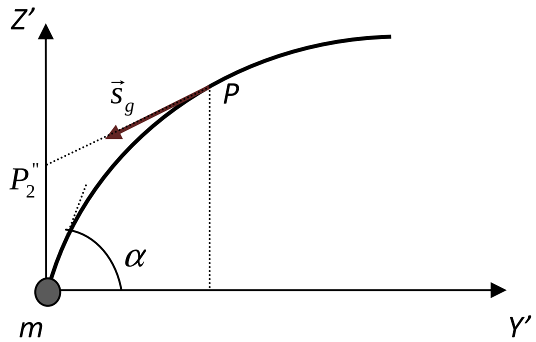

Fig. 6,c

Relative to *OX'Y'Z'* these informatons are accelerated with an amount $-\vec{a}$: they follow a parabolic trajectory defined 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 in *P*, the tangent line to that trajectory cuts the *Z'*-axis in the point P_2'', that is defined by:

$$z'_{P_2''} = \frac{1}{2}.a.(\Delta t)^2 = \frac{1}{2}.a.\frac{r_0^2}{c^2}$$

That means that the spinvectors of the informatons that at the moment *t* pass in *P*, point to a point P_2'' on the *Z*-axis that has a lead of

$$P_1''P_2'' = \frac{1}{2}.a.(\Delta t)^2 = \frac{1}{2}.a.\frac{r_0^2}{c^2}$$

on P_1'', the actual position of the mass *m.*

And since $P_0P_1'' = P_0P_1'' + P_1''P_2''$, we conclude that: $P_0P_2'' = a.\frac{r_0^2}{c^2}$

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):

$$P_0P_2 = P_0P_1^{'} + P_0P_2^{''} = \frac{v_0}{c}.r_0 + \frac{a}{c^2}.r_0^2$$

The carrier line of the spinvector $\vec{s}_g$ of an informaton that - relative to het 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_0P_2P (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 in the same interval - it follows that $\theta_0 \approx \theta_0 + \Delta\theta \approx \theta$ and that $r_0 \approx r$. So:

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

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

$$\vec{s}_g = -s_g.\cos(\Delta\theta).\vec{e}_c - s_g.\sin(\Delta\theta).\vec{e}_{\perp c} \approx -s_g.\vec{e}_c - s_g.(\frac{v_0}{c}.\sin\theta + \frac{a}{c^2}.r.\sin\theta).\vec{e}_{\perp c}$$

3.8.2. The gravitational field of an accelerated point mass

The informatons that, at the moment *t,* are rushing near the fixed point *P* - defined by the time dependent position vector $\vec{r}$ - are emitted when *m* was in P_0 (fig 6). Their velocity $\vec{c}$ is on the same carrier line as $\vec{r}_0 = \overrightarrow{P_0P}$. Their g-spin vector is on the carrier line P_2P. According to 3.8.1, the characteristic angle $\Delta\theta$ - this is the angle between the carrying lines of $\vec{s}_g$ and $\vec{c}$ - has two components:

- 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:

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

- 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:

$$\sin(\Delta\theta'') = \frac{a(t-\frac{r}{c}).r}{c^2}.\sin\theta$$

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 field in *P*, is defined as the density of the flow of g-information in that point. That density is the rate at which g-information per unit area crosses in *P* 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 in *P*, with $\vec{s}_g$, their spinvector:

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

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

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

and the density of the flow of informatons in *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 this into account and knowing that $\frac{1}{\eta_0.c^2} = \nu_0$, we obtain:

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

2. $\vec{B}_g$, the gravitational induction in *P*, is defined as the density of the cloud of *β*-information in that point. That density is the product of *n*, the density of the cloud of informations in *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 characterizes 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 in *P* is related to *N*, the density of the flow of informatons in 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: $\vec{E}_g = -\frac{m}{4.\pi.\eta_0.r^2}.\vec{e}_c - \{\frac{m}{4.\pi.\eta_0.c.r^2}.v(t-\frac{r}{c}).\sin\theta + \frac{\nu_0.m}{4.\pi.r}.a(t-\frac{r}{c}).\sin\theta\}.\vec{e}_{\perp c}$,

we obtain:

$$\boxed{\vec{B}_g = -\{\frac{\nu_0.m}{4.\pi.r^2}.v(t-\frac{r}{c}).\sin\theta + \frac{\nu_0.m}{4.\pi.c.r}.a(t-\frac{r}{c}).\sin\theta\}.\vec{e}_\varphi}$$

IV. The Laws of the gravitational Field - The Laws of G.E.M.

In the space linked to an inertial reference frame ***O***, the gravitational field is characterised by two time dependent vectors: the (effective) g-field $\vec{E}_g$ and the (effective) g-induction $\vec{B}_g$. In an arbitrary point *P*, these vectors are the results of the superposition of the contributions of the various sources of informatons (the masses) to respectively the density of the flow of g-information and to the cloud of β-information in *P*:

$$\vec{E}_g = \sum N.\vec{s}_g \qquad \text{and} \qquad \vec{B}_g = \sum n.\vec{s}_\beta$$

The informatons that - at the moment *t* - pass near *P* with velocity $\vec{c}$ contribute with an amount ($N.\vec{s}_g$) to the instantaneous value of the g-field and with an amount ($n.\vec{s}_\beta$) to the instantaneous value of the g-induction in that point.

- $\vec{s}_g$ and $\vec{s}_\beta$ respectively are their g-spin and their β-index. They are linked by the relationship:

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

- *N* is the instantaneous value of the density of the flow of informatons with velocity $\vec{c}$ at *P* and *n* is the instantaneous value of the density of the cloud of those informatons in that point. *N* *a*nd *n* are linked by the relationschip:

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

4.1. Relations between $\vec{E}_g$ and $\vec{B}_g$ in a matter free point of a gravitational Field

In each point where no matter is located - where *ρ*$\rho_G(x, y,z;t) = \vec{J}_G(x,y,z;t) = 0$ - the following statements are valid.

1. In a matter free point *P* of a gravitational field, the spatial variation of $\vec{E}_g$ obeys the law:

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

This statement is the expression of the law of conservation of g-information. The fact that the rate at which g-information flows inside a closed empty space must be equal to the rate at which it flows out, can be expressed as:

$$\boxed{\oiint_S \vec{E}_g.\overrightarrow{dS} = 0}$$

So (theorem of Ostrogradsky) [(4)]:

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

2. In a matter free point *P* of a gravitational field, the spatial variation of $\vec{B}_g$ obeys the law:

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

This statement is the expression of the fact that the β-index of an informaton is always perpendicular to its g-spin vector $\vec{s}_g$ and to its velocity $\vec{c}$.

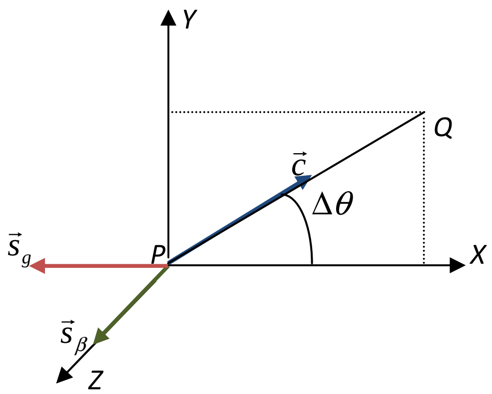

Fig 7

In fig 7, we consider the flow of informatons that - at the moment *t* - pass with velocity $\vec{c}$ in the vicinity of the point *P*. An informaton that at the moment *t* passes in *P* is at the moment (*t + dt*) in *Q*: *PQ = c.dt*

In *P*, the instantaneous value of the density of the considered flow of informatons is represented by *N*, the instantaneous value of the density of the cloud that they constitute by *n*, and the instantaneous value of their characteristic angle by $\Delta\theta$. We introduce the coordinate system *PXYZ*:

$$\vec{s}_g = -s_g.\vec{e}_x \qquad \text{and} \qquad \vec{s}_\beta = \frac{\vec{c}\times\vec{s}_g}{c} = s_g.\sin(\Delta\theta).\vec{e}_z$$

The contribution of the considered informatons to the g-induction in *P* is: $\vec{B}_g = n.\vec{s}_\beta$

From mathematics [4] we know:

$$div\vec{B}_g = div(n.\vec{s}_\beta) = grad(n).\vec{s}_\beta + n.div(\vec{s}_\beta)$$

- $grad(n).\vec{s}_\beta = 0$ because *grad(n)* is perpendicular to $\vec{s}_\beta$. Indeed *n* changes only in the direction of the flow of informatons, so *grad(n)* has the same orientation as $\vec{c}$:

$$grad(n) = \frac{n_Q - n_P}{PQ}.\frac{\vec{c}}{c}$$

- $n.div(\vec{s}_\beta) = 0$. According to the definition: $div(\vec{s}_\beta) = \dfrac{\oiint \vec{s}_\beta.\overrightarrow{dS}}{dV}$. We calculate the double integral over the closed surface *S* formed by the infinitesimal surfaces *dS = dz.dy* which are in *P* and in *Q* perpendicular to the *X*-axis and by the tube which connects the edges of these surfaces. *dV* is the infinitesimal volume enclosed by *S*. It is obvious that:

$$div(\vec{s}_\beta) = \frac{\oiint \vec{s}_\beta.\overrightarrow{dS}}{dV} = 0$$

Both terms of the expression of $div\vec{B}_g$ are zero, so $div\vec{B}_g = 0$, what implies (theorem of Ostrogradsky) that for every closed surface *S* in a gravitational field:

$$\boxed{\oiint_S \vec{B}_g.\overrightarrow{dS} = 0}$$

3. In a matter free point *P* of a gravitational field, the spatial variation of $\vec{E}_g$ and the rate at which $\vec{B}_g$ is changing are connected by the relation:

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

This statement is the expression of the fact that any change of the product $n.\vec{s}_\beta$ in a point of a gravitational field is related to a variation of the product $N.\vec{s}_g$ in the vicinity of that point.

We consider again $\vec{E}_g$ and $\vec{B}_g$, the contributions to the g-field and to the g-induction in the point *P* of the informatons which - at the moment t - pass with velocity $\vec{c}$ in the vicinity of that point (fig 7).

$$\vec{E}_g = N.\vec{s}_g = -N.s_g.\vec{e}_x \qquad \text{and} \qquad \vec{B}_g = n.\vec{s}_\beta = n.\frac{\vec{c}\times\vec{s}_g}{c} = n.s_g.\sin(\Delta\theta).\vec{e}_z$$

We investigate the relationship between

$$rot\vec{E}_g = \{grad(N)\times\vec{s}_g\} + N.rot(\vec{s}_g) \qquad \text{and} \qquad \frac{\partial\vec{B}_g}{\partial t} = \frac{\partial n}{\partial t}.\vec{s}_\beta + n.\frac{\partial\vec{s}_\beta}{\partial t}$$

- The term $\{grad(N)\times\vec{s}_g\}$ describes the component of $rot\vec{E}_g$ caused by the spatial variation of *N* in the vicinity of *P* when $\Delta\theta$ remains constant.

  N has the same value in all points of the infinitesimal surface that, in *P*, is perpendicular to the flow of informatons. So *grad(N)* is parallel to $\vec{c}$ and its magnitude is the increase of the magnitude of *N* per unit length.

  With $N_P = N$, $N_Q = N + dN$ and $PQ = c.dt$, *grad(N)* is determined by:

$$grad(N) = \frac{N_Q - N_P}{PQ}\frac{\vec{c}}{c} = \frac{dN}{c.dt}.\frac{\vec{c}}{c}$$

  It follows:

$$grad(N)\times\vec{s}_g = \frac{dN}{c.dt}.\frac{\vec{c}}{c}\times\vec{s}_g = \frac{dN}{c.dt}.\vec{s}_\beta$$

  From the fact that the density of the flow of informatons in *Q* at the moment *t* is equal to the density of that flow in *P* at the moment (*t - dt*), it follows:

  If $N_P(t) = N$, then $N_P(t - dt) = N_Q(t) = N + dN$

  The rate at which N_P changes at the moment *t* is:

$$\frac{\partial N}{\partial t} = \frac{N_P(t) - N_P(t-dt)}{dt} = -\frac{dN}{dt}$$

  And since: $\frac{N}{c} = n$: $\qquad \frac{1}{c}\frac{dN}{dt} = -\frac{1}{c}\frac{\partial N}{\partial t} = -\frac{\partial n}{\partial t}$

  We conclude (*I*):

$$grad(N)\times\vec{s}_g = -\frac{\partial n}{\partial t}.\vec{s}_\beta$$

- The term $\{N.rot(\vec{s}_g)\}$ describes the component of $rot\vec{E}_g$ caused by the spatial variation of $\Delta\theta$ - the orientation of the g-spinvector in the vicinity of *P* - when *N* remains constant. At the moment *t*, $(\Delta\theta)_P$ - the characteristic angle of the informatons that pass in *P* - differs from $(\Delta\theta)_Q$ - the characteristic angle of the informatons that pass in *Q*. If $(\Delta\theta)_P = \Delta\theta$, than $(\Delta\theta)_Q = \Delta\theta + d(\Delta\theta)$ (fig 8).

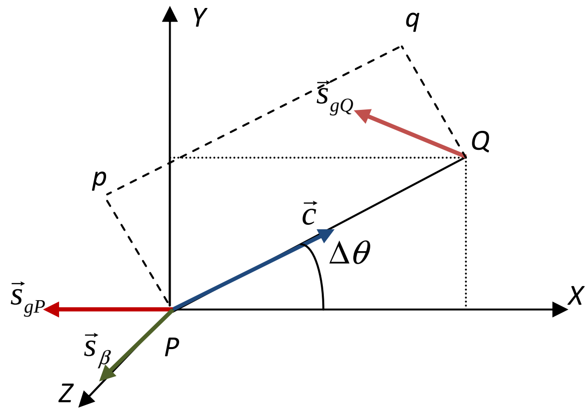

Fig 8

For the calculation of $rot(\vec{s}_g)$, we calculate $\oint \vec{s}_g.\overrightarrow{dl}$ along the closed path *PQqpP* that encircles the area *dS = PQ.Pp = c.dt.Pp*. (*PQ* and *qp* are parallel to the flow of the informatons, *Qq* and *pP* are perpendicular to it.

$$N.rot(\vec{s}_g) = N.\frac{\oint \vec{s}_g.\overrightarrow{dl}}{dS}.\vec{e}_z = N.\frac{s_{g.}\sin\{\Delta\theta + d(\Delta\theta)\}.Qq - s_g.\sin(\Delta\theta).Pp}{c.dt.Pp}.\vec{e}_z$$

From the fact that the characteristic angle of the informatons in *Q* at the moment *t* is equal to the characteristic angle of the informatons in *P* at the moment (*t* - *dt*), it follows:

If $(\Delta\theta)_P(t) = \Delta\theta$, then $(\Delta\theta)_P(t - dt) = (\Delta\theta)_Q(t) = \Delta\theta + d(\Delta\theta)$

The rate at which sin($\Delta\theta$) in *P* changes at the moment *t*, is:

$$\frac{\partial\{\sin(\Delta\theta)\}}{\partial t} = \frac{\sin(\Delta\theta) - \sin\{\Delta\theta + d(\Delta\theta)\}}{dt} = -\frac{d\{\sin(\Delta\theta)\}}{dt}$$

And since *N = c.n* , we obtain (*II*):

$$N.rot(\vec{s}_g) = N.s_g.\frac{\sin\{\Delta\theta + d(\Delta\theta)\} - \sin(\Delta\theta)}{c.dt} = \frac{\partial}{\partial t}\{n.s_g.\sin(\Delta\theta).\vec{e}_z\} = -n.\frac{\partial\vec{s}_\beta}{\partial t}$$

Combining the results (*I*) and (*II*), we obtain:

$$rot\vec{E}_g = grad(N_g)\times\vec{s}_g + N_g.rot(\vec{s}_g) = -(\frac{\partial n_g}{\partial t}.\vec{s}_\beta + n_g.\frac{\partial\vec{s}_\beta}{\partial t}) = -\frac{\partial\vec{B}_g}{\partial t}$$

The relation $rot\vec{E}_g = -\frac{\partial\vec{B}_g}{\partial t}$ implies (theorem of Stokes [4]): *In a gravitational field, the rate at which the surface integral of* $\vec{B}_g$ *over a surface S changes is equal and opposite to the line integral of* $\vec{E}_g$ *over its boundery L:*

$$\boxed{\oint \vec{E}_g.\overrightarrow{dl} = -\iint_S \frac{\partial \vec{B}_g}{\partial t}.\overrightarrow{dS} = -\frac{\partial}{\partial t}\iint_S \vec{B}_g.\overrightarrow{dS} = -\frac{\partial \Phi_b}{\partial t}}$$

The orientation of the surface vector $\overrightarrow{dS}$ is linked to the orientation of the path on *L* by the "rule of the corkscrew". $\Phi_b = \iint_S \vec{B}_g.\overrightarrow{dS}$ is called the "b-flux through *S*".

4. In a matter free point *P* of a gravitational field, the spatial variation of $\vec{B}_g$ and the rate at which $\vec{E}_g$ is changing are connected by the relation:

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

This statement is the expression of the fact that any change of the product $N.\vec{s}_g$ in a point of a gravitational field is related to a variation of the product $n.\vec{s}_g$ in the vicinity of that point.

We consider again $\vec{E}_g$ and $\vec{B}_g$, the contributions to the g-field and to the g-induction in a point *P,* of the informatons that - at the moment t - pass near *P* with velocity $\vec{c}$ (fig 8).

$$\vec{E}_g = N.\vec{s}_g = -N.s_g.\vec{e}_x \quad \text{and} \quad \vec{B}_g = n.\vec{s}_\beta = n.\frac{\vec{c}\times\vec{s}_g}{c} = n.s_g.\sin(\Delta\theta).\vec{e}_z$$

And we note first that $\vec{s}_g = -s_g.\vec{e}_x$ and that $\frac{\partial \vec{s}_g}{\partial t} = s_g.\frac{\partial(\Delta\theta)}{\partial t}.\vec{e}_y$

We investigate the relationship between

$$rot\vec{B}_g = \{grad(n)\times\vec{s}_\beta\} + n.rot(\vec{s}_\beta) \quad \text{and} \quad \frac{\partial \vec{E}_g}{\partial t} = \frac{\partial N}{\partial t}.\vec{s}_g + N.\frac{\partial \vec{s}_g}{\partial t}$$

1°. First we calculate $rot\vec{B}_g$ **:**

$$rot\vec{B}_g = \{grad(n)\times\vec{s}_\beta\} + n.rot(\vec{s}_\beta)$$

- The term $\{grad(n)\times\vec{s}_\beta\}$ describes the component of $rot\vec{B}_g$ caused by the spatial variation of *n* in the vicinity of *P* when $\Delta\theta$ remains constant.

  n has the same value in all points of the infinitesimal surface that, in *P*, is perpendicular to the flow of informatons. So *grad(n)* is parallel to $\vec{c}$ and its magnitude is the increase of the magnitude of *n* per unit length.

  With $n_P = n$, $n_Q = n + dn$ and $PQ = c.dt$, *grad(n)* is determined by:

$$grad(n) = \frac{n_Q - n_P}{PQ} \frac{\vec{c}}{c} = \frac{dn}{c.dt} \cdot \frac{\vec{c}}{c}$$

The vector $\{grad(n) \times \vec{s}_\beta\}$ is perpendicular to het plane determined by $\vec{c}$ and $\vec{s}_\beta$. So, it lies in the *XY*-plane and is there perpendicular to $\vec{c}$. Taking into account the definition of vectorial product, we obtain (fig 8):

$$grad(n) \times \vec{s}_\beta = -\frac{dn}{c.dt} . s_\beta . \vec{e}_{\perp c} = -\frac{dn}{c.dt} . s_g . \sin(\Delta\theta) . \vec{e}_{\perp c}$$

From the fact that the density of the cloud of informatons in *Q* at the moment *t* is equal to the density of that cloud in *P* at the moment (*t* - *dt*), it follows:

If $n_P(t) = n$, then $n_P(t - dt) = n_Q(t) = n + dn$

The rate at which n_P changes at the moment *t* is:

$$\frac{\partial n}{\partial t} = \frac{1}{c} \cdot \frac{\partial N}{\partial t} = \frac{n_P(t) - n_P(t - dt)}{dt} = \frac{n_P(t) - n_Q(t)}{dt} = -\frac{dn}{dt}$$

And, taking into account that $n = \dfrac{N}{c}$, we obtain (*I*)

$$grad(n) \times \vec{s}_\beta = \frac{1}{c} \cdot \frac{\partial n}{\partial t} . s_g . \sin(\Delta\theta) . \vec{e}_{\perp c} = \frac{1}{c^2} \cdot \frac{\partial N}{\partial t} . s_g . \sin(\Delta\theta) . \vec{e}_{\perp c}$$

- The term $\{n.rot(\vec{s}_\beta)\}$ is the component of $rot\vec{B}_g$ caused by the spatial variation of $\vec{s}_\beta$ in the vicinity of *P* when *n* remains constant. The fact that $\vec{s}_{\beta Q} \neq \vec{s}_{\beta P}$ at the moment *t,* follows from the fact that, at that moment, $(\Delta\theta)_P$ - the characteristic angle of the informatons that pass in *P* - differs from $(\Delta\theta)_Q$ - the characteristic angle of the informatons that pass in *Q*. If $(\Delta\theta)_P = \Delta\theta$, than $(\Delta\theta)_Q = \Delta\theta + d(\Delta\theta)$.

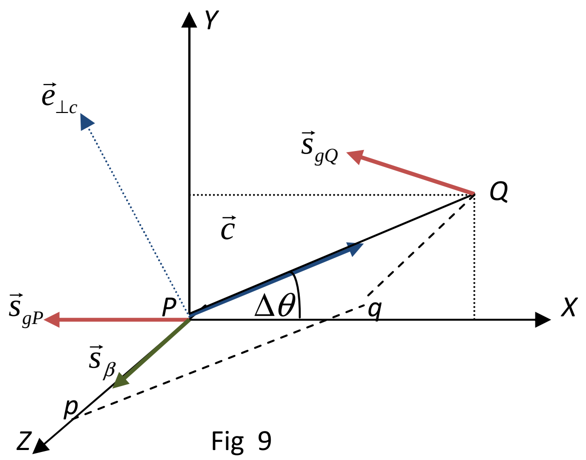

Fig 9

From the definition of $rot\vec{F}$ (4), it follows (fig 9):

$$rot(\vec{s}_\beta) = \frac{\oint \vec{s}_\beta.\overrightarrow{dl}}{dS}.\vec{e}_{\perp c} = \frac{s_g.\sin(\Delta\theta).Pp - s_g.\sin\{(\Delta\theta)+d(\Delta\theta)\}.qQ}{c.dt.Pp}.\vec{e}_{\perp c} = -s_g \frac{d\sin(\Delta\theta)}{c.dt}.\vec{e}_{\perp c}$$

From the fact that the characteristic angle of the informatons in *Q* at the moment *t* is equal to the characteristic angle of the informatons in *P* at the moment (*t* - *dt*), it follows that if $(\Delta\theta)_P(t) = \Delta\theta$, then $(\Delta\theta)_P(t - dt) = (\Delta\theta)_Q(t) = \Delta\theta + d(\Delta\theta)$

The rate at which $\sin(\Delta\theta)$ in *P* changes at the moment *t*, is:

$$\frac{\partial\{\sin(\Delta\theta)\}}{\partial t} = \frac{\sin(\Delta\theta) - \sin\{\Delta\theta + d(\Delta\theta)\}}{dt} = -\frac{d\{\sin(\Delta\theta)\}}{dt}$$

Further : $\frac{\partial}{\partial t}\{\sin(\Delta\theta)\} = \cos(\Delta\theta).\frac{\partial(\Delta\theta)}{\partial t}$ and $n = \frac{N}{c}$

Finally, we obtain (*II*): $n.rot(\vec{s}_\beta) = \frac{1}{c^2}.N.s_g.\cos(\Delta\theta).\frac{\partial(\Delta\theta)}{\partial t}.\vec{e}_{\perp c}$

Combining the results (*I*) and (*II*), we obtain:

$$rot\vec{B}_g = \frac{1}{c^2}.\{\frac{\partial N_g}{\partial t}s_g.\sin(\Delta\theta) + N_g.s_g.\cos(\Delta\theta).\frac{\partial(\Delta\theta)}{\partial t}\}.\vec{e}_{\perp c}$$

2°. Next we calculate $\frac{\partial\vec{E}_g}{\partial t}$ **:**

$$\frac{\partial\vec{E}_g}{\partial t} = \frac{\partial N}{\partial t}.\vec{s}_g + N.\frac{\partial\vec{s}_g}{\partial t} = -\frac{\partial N}{\partial t}.s_g.\vec{e}_x + N.s_g.\frac{\partial(\Delta\theta)}{\partial t}.\vec{e}_y$$

Taking into account:

$$\vec{e}_x = \cos(\Delta\theta).\vec{e}_c - \sin(\Delta\theta).\vec{e}_{\perp c} \quad \text{and} \quad \vec{e}_y = \sin(\Delta\theta).\vec{e}_c + \cos(\Delta\theta).\vec{e}_{\perp c}$$

we obtain:

$$\frac{\partial\vec{E}_g}{\partial t} = \left[-\frac{\partial N}{\partial t}.s_g.\cos(\Delta\theta) + N.s_g.\frac{\partial(\Delta\theta)}{\partial t}.\sin(\Delta\theta)\right].\vec{e}_c + \left[\frac{\partial N}{\partial t}.s_g.\sin(\Delta\theta) + N.s_g.\frac{\partial(\Delta\theta)}{\partial t}.\cos(\Delta\theta)\right].\vec{e}_{\perp c}$$

From the first law of the gravitational field, it follows that the component in the direction of $\vec{e}_c$ of $\frac{\partial\vec{E}_g}{\partial t}$ is zero. Indeed.

- We know (4.1.3): $grad(N) = -\frac{1}{c^2}.\frac{\partial N}{\partial t}.\vec{c}$, so:

$$grad(N).\vec{s}_g = \frac{1}{c}.\frac{\partial N}{\partial t} s_g.\cos(\Delta\theta) \quad (III)$$

- We determine $div(\vec{s}_g) = \frac{\oiint \vec{s}_g.\overrightarrow{dS}}{dV}$ (*IV*). For that purpose, we calculate the double integral over the closed surface *S* formed by the infinitesimal surfaces *dS* which are in *P* and *Q* perpendicular to the flow of informatons (perpendicular to $\vec{c}$) and by the tube which connects the edges of these surfaces (and that is parallel to $\vec{c}$).
  dV =c.dt.dS is the infinitesimal volume enclosed by *S*:

$$\frac{\oiint \vec{s}_g.\overrightarrow{dS}}{dV} = \frac{s_g.dS.\cos(\Delta\theta) - s_g.dS.\cos\{\Delta\theta + d(\Delta\theta)\}}{dS.c.dt} = -\frac{1}{c}.s_g.\frac{d\{\cos(\Delta\theta)\}}{dt} = -\frac{1}{c}.s_g.\sin(\Delta\theta).\frac{\partial(\Delta\theta)}{\partial t}$$

So (*IV*):

$$N.div(\vec{s}_g) = -\frac{1}{c}.N.s_g.\sin(\Delta\theta).\frac{\partial(\Delta\theta)}{\partial t}$$

According to the first law of the gravitational field (*V*):

$$-div\vec{E}_g = -div(N.\vec{s}_g) = -grad(N).\vec{s}_g - N.div(\vec{s}_g) = 0$$

Substitution of (*III*) and (*IV*) in (*V*):

$$-div\vec{E}_g = -\frac{1}{c}.\frac{\partial N}{\partial t}.s_g.\cos(\Delta\theta) + \frac{1}{c}.N.s_g.\sin(\Delta\theta).\frac{\partial(\Delta\theta)}{\partial t} = 0$$

So, the component of $\frac{\partial \vec{E}_g}{\partial t}$ In the direction of $\vec{e}_{\perp c}$ is zero, and:

$$\frac{\partial \vec{E}_g}{\partial t} = \{\frac{\partial N}{\partial t}.s_g.\sin(\Delta\theta) + N.s_g.\frac{\partial(\Delta\theta)}{\partial t}.\cos(\Delta\theta)\}.\vec{e}_{\perp c}$$

3°. Conclusion: From 1° en 2° follows:

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

This relation implies (theorem of Stokes): In a gravitational field, the rate at which the surface integral of $\vec{E}_g$ over a surface *S* changes is proportional to the line integral of $\vec{B}_g$ over its boundery *L:*

$$\boxed{\oint \vec{B}_g.\overrightarrow{dl} = \frac{1}{c^2}\iint_S \frac{\partial \vec{E}_g}{\partial t}.\overrightarrow{dS} = \frac{1}{c^2}\frac{\partial}{\partial t}\iint_S \vec{E}_g.\overrightarrow{dS} = \frac{1}{c^2}\frac{\partial \Phi_e}{\partial t}}$$

The orientation of the surface vector $\overrightarrow{dS}$ is linked to the orientation of the path on *L* by the "rule of the corkscrew". $\Phi_e = \iint_S \vec{E}_g.\overrightarrow{dS}$ is called the "e-flux through *S*".

4.2. Relations between $\vec{E}_g$ and $\vec{B}_g$ in a point of a gravitational field

The volume-element in a point *P* inside a mass continuum is in any case an emitter of g-information and, if the mass is in motion, also a source of β-information. According to 2.3 , the instantenuous value of ρ_G - the mass density in *P* - contributes to the instantaneous value of $div\vec{E}_g$ in that point with an amount $-\frac{\rho_G}{\eta_0}$; and according to 3.7 the instantaneous value of $\vec{J}_G$ - the mass flow density - contributes to the instantaneous value of $rot\vec{B}_g$ in *P* with an amount $-\nu_0.\vec{J}_G$ (3.7).

Generally, in a point of a gravitational field - linked to an inertial reference frame ***O*** - one must take into account the contributions of the local values of $\rho_G(x,y,z;t)$ and of $\vec{J}_G(x,y,z;t)$. This results in the generalization and expansion of the laws in a mass free point. By superposition we obtain:

1. In a point *P* of a gravitational field, the spatial variation of $\vec{E}_g$ obeys the law:

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

In integral form: $\Phi_g = \oiint_S \vec{E}_g.\overrightarrow{dS} = -\frac{1}{\eta_0}.\iiint_G \rho_G.dV$

2. In a point *P* of a gravitational field, the spatial variation of $\vec{B}_g$ obeys the law:

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

In integral form: $\Phi_b = \oiint_S \vec{B}_g.\overrightarrow{dS} = 0$

3. In a point *P* of a gravitational field, the spatial variation of $\vec{E}_g$ and the rate at which $\vec{B}_g$ is changing are connected by the relation:

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

In integral form: $$\oint \vec{E}_g.\overrightarrow{dl} = -\iint_S \frac{\partial \vec{B}_g}{\partial t}.\overrightarrow{dS} = -\frac{\partial}{\partial t}\iint_S \vec{B}_g.\overrightarrow{dS} = -\frac{\partial \Phi_b}{\partial t}$$

4. In a point *P* of a gravitational field, the spatial variation of $\vec{B}_g$ and the rate at which $\vec{E}_g$ is changing are connected by the relation:

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

In integral form:

$$\oint \vec{B}_g.\overrightarrow{dl} = \frac{1}{c^2}\iint_S \frac{\partial \vec{E}_g}{\partial t}.\overrightarrow{dS} - \nu_0.\iint_S \vec{J}_g.\overrightarrow{dS} = \frac{1}{c^2}.\frac{\partial}{\partial t}\iint_S \vec{E}_g.\overrightarrow{dS} - \nu_0.\iint_S \vec{J}_G.\overrightarrow{dS} = \frac{1}{c^2}.\frac{\partial \Phi_E}{\partial t} - \nu_0.i_g$$

These are the laws of Heaviside-Maxwell or the laws of gravitoelectromagnetism.

V. The interaction between masses

5.1. The interaction between masses at rest

We consider a set of point masses anchored in an inertial reference frame ***O***. They create and maintain a gravitational field that is completely determined by the vector $\vec{E}_g$ in each point of the space linked to ***O.*** Each mass is "immersed" in a cloud of g-information. In every point, except its own anchorage, each mass contributes to the construction of that cloud.

Let us consider the mass *m* anchored in *P*. If the other masses were not there, then *m* would be at the centre of a perfectly spherical cloud of g-information. In reality this is not the case: the emission of g-information by the other masses is responsible for the disturbance of that "*characteristic symmetry*". Because $\vec{E}_g$ in *P* represents the intensity of the flow of g-information send to *P* by the other masses, the extent of disturbance of that characteristic symmetry in the direct vicinity of *m* is determined by $\vec{E}_g$ in *P*.

If it was free to move, the point mass *m* could restore the characteristic symmetry of the g-information cloud in his direct vicinity: it would suffice to accelerate with an amount $\vec{a} = \vec{E}_g$. Accelerating in this way has the effect that the extern field disappears in the origin of the reference frame anchored to *m*. If it accelerates that way, the mass becomes "blind" for the g-information send to *P* by the other masses, it "sees" only its own spherical g-information cloud.

These insights are expressed in the following postulate.

5.1.1. The postulate of the gravitational action

A free point mass *m* in a point of a gravitational field acquires an acceleration $\vec{a} = \vec{E}_g$ so that the characteristic symmetry of the g-information cloud in its direct vicinity is conserved. A point mass who is anchored in a gravitational field cannot accelerate. In that case it *tends* to move. We can conclude that:

A point mass anchored in a point of a gravitational field is subjected to a tendency to move in the direction defined by $\vec{E}_g$, the g-field in that point. Once the anchorage is broken, the mass acquires a vectorial acceleration $\vec{a}$ that equals $\vec{E}_g$.

5.1.2. The concept force - the gravitational force

Any disturbance of the characteristic symmetry of the cloud of g-information around a point mass gives rise to an action aimed at the destruction of that disturbance.

A point mass *m*, anchored in a point *P* of a gravitational field, experiences an action because of that field, an action that is compensated by the anchorage.

- That action is proportional to the extent to which the characteristic symmetry of the own gravitational field of *m* in the vicinity of *P* is disturbed by the extern g-field, thus to the value of $\vec{E}_g$ in *P*.
- It depends also on the magnitude of *m*. Indeed, the g-information cloud created and maintained by *m* is more compact if *m* is greater. That implies that the disturbing effect on the spherical symmetry around *m* by the extern g-field $\vec{E}_g$ is smaller when *m* is greater. Thus, to impose the acceleration $\vec{a} = \vec{E}_g$, the action of the gravitational field on *m* must be greater when *m* is greater.

We conclude: *The action that tend to accelerate a point mass m in a gravitational field must be proportional to $\vec{E}_g$, the g-field to which the mass is exposed; and to m, the magnitude of the mass.*

We represent that action by $\vec{F}_g$ and we call this vectorial quantity "the force developed by the g-field on the mass" or the *gravitational force* on *m*. We define it by the relation:

$$\vec{F}_g = m.\vec{E}_g$$

A mass anchored in a point *P* cannot accelerate, what implies that the effect of the anchorage must compensate the gravitational force. This means that the disturbance of the characteristic symmetry around *P* by $\vec{E}_g$ must be cancelled by the g-information flow created and maintained by the anchorage. The density of that flow in *P* must be equal and opposite to $\vec{E}_g$. It cannot be otherwise than that the anchorage exerts an action on *m* that is exactly equal and opposite to the gravitational force. That action is called a *reaction force*.

This discussion leads to the following insight: *Each phenomenon that disturbs the characteristic symmetry of the cloud of g-information around a point mass, exerts a force on that mass.*
Between the gravitational force on a mass *m* and the local field strength exists the following relationship:

$$\vec{E}_g = \frac{\vec{F}_g}{m}$$

So, the acceleration imposed to the mass by the gravitational force is: $\vec{a} = \frac{\vec{F}_g}{m}$

Considering that the effect of the gravitational force is actually the same as that of each other force we can conclude that the relation between a force $\vec{F}$ and the acceleration $\vec{a}$ that it imposes to a free mass *m* is: $\vec{F} = m.\vec{a}$

5.1.3. Newtons universal law of gravitation

In fig 10 we consider two point masses m_1 and m_2 anchored in the points P_1 and P_2 of an inertial frame.

m_1 creates and maintains a gravitational field that in P_2 is defined by the g-field:

$$\vec{E}_{g2} = -\frac{m_1}{4.\pi.\eta_0}.\vec{e}_{12}$$

This field exerts a gravitational force on m_2:

$$\vec{F}_{12} = m_2.\vec{E}_{g2} = -\frac{m_1.m_2}{4.\pi.\eta_0}.\vec{e}_{12}$$

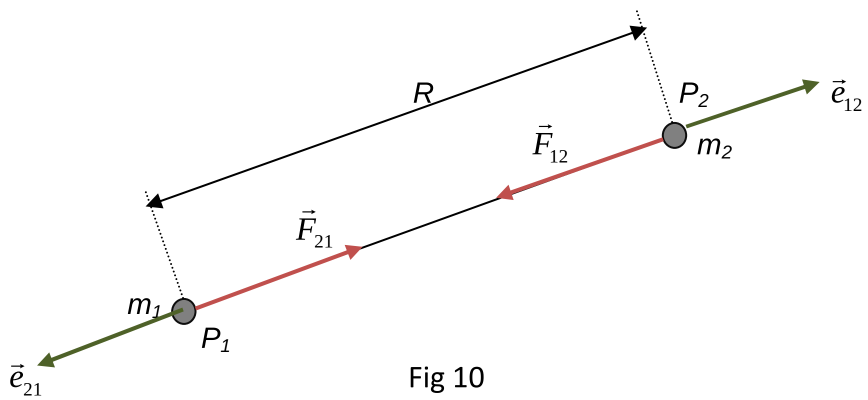

Fig 10

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

$$\boxed{\vec{F}_{21} = -\frac{m_1.m_2}{4.\pi.\eta_0}.\vec{e}_{21} = -\vec{F}_{12}}$$

This is the mathematical formulation of *Newtons universal law of gravitation.*

5.2. The interaction between moving masses

We consider a number of point masses moving relative to an inertial reference frame ***O***. They create and maintain a gravitational field that in each point of the space linked to ***O*** is defined by the vectors $\vec{E}_g$ and $\vec{B}_g$. Each mass is "immersed" in a cloud of informatons carrying both g- and β-information. In each point, except its own position, each mass contributes to the construction of that cloud. Let us consider the mass *m* that, at the moment *t*, goes through the point *P* with velocity $\vec{v}$.

- If the other masses were not there, the g-field in the vicinity of *m* (the "eigen" g-field of *m*) should be symmetric relative to the carrier line of the vector $\vec{v}$. Indeed, the g-spin vectors of the informatons emitted by *m* during the interval ($t - \Delta t$, $t + \Delta t$) are all directed to that line. In reality that symmetry is disturbed by the g-information that the other masses send to *P*. $\vec{E}_g$, the instantaneous value of the g-field in *P,* defines the extent to which this occurs.

- If the other masses were not there, the β-field in the vicinity of *m* (the "eigen" β-field of *m*) should "rotate" around the carrier line of the vector $\vec{v}$. The vectors of the vector field defined by the vector product of $\vec{v}$ with the g-induction that characterizes the "eigen" β-field of *m,* should - as $\vec{E}_g$ - be symmetric relative to the carrier line of the vector $\vec{v}$. In reality this symmetry is disturbed by the β-information send to *P* by the other masses. The vector product $(\vec{v}\times\vec{B}_g)$ of the instantaneous values of the velocity of *m* and of the g-induction in *P*, defines the extent to which this occurs.

So, the *characteristic symmetry* of the cloud of information around a moving mass (the "eigen" gravitational field) is disturbed by $\vec{E}_g$ regarding the "eigen" g-field; and by ($\vec{v}\times B_g$) regarding the "eigen" β-field. If it was free to move, the point mass *m* could restore the characteristic symmetry in its direct vicinity by accelerating with an amount $\vec{a}' = \vec{E}_g + (\vec{v}\times\vec{B}_g)$ relative to its "eigen" inertial reference frame* ***O'***. In that manner it would become "blind" for the disturbance of symmetry of the gravitational field in its direct vicinity.

These insights form the basis of the following postulate.

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* The "eigen" inertial reference frame ***O'*** of the point mass *m* is the reference frame that at the moment *t* moves relative to ***O*** with the same velocity as *m*.

5.2.1. The postulate of the gravitational action

A point mass m, moving with velocity $\vec{v}$ in a gravitational field ($\vec{E}_g, \vec{B}_g$), tends to become blind for the influence of that field on the symmetry of its "eigen" field. If it is free to move, it will accelerate relative to its eigen inertial reference frame with an amount $\vec{a}'$:

$$\vec{a}' = \vec{E}_g + (\vec{v} \times \vec{B}_g)$$

5.2.2. The gravitational force

The action of the gravitational field ($\vec{E}_g, \vec{B}_g$) on a point mass that is moving with velocity $\vec{v}$ relative to the inertial reference frame ***O***, is called the *gravitational force* $\vec{F}_G$ on that mass. In extension of 5.1.2 we define $\vec{F}_G$ as:

$$\boxed{\vec{F}_G = m_0.\left[\vec{E}_g + (\vec{v} \times \vec{B}_g)\right]}$$

m_0 is the rest mass of the point mass: it is the mass that determines the rate at which it emits informatons in the space linked to ***O***.

The acceleration $\vec{a}'$ of the point mass relative to the eigen inertial reference frame ***O'*** can be decomposed in a tangential ($\vec{a}_T'$) and a normal component ($\vec{a}_N'$).

$$\vec{a}_T' = a_T'.\vec{e}_T \qquad \text{and} \qquad \vec{a}_N' = a_N'.\vec{e}_N$$

$\vec{e}_T$ and $\vec{e}_N$ are the unit vectors, respectively along the tangent and along the normal to the path of the point mass in ***O'*** (and in ***O***).

We express a_T' en a_N' in function of the characteristics of the motion in the reference system ***O***:

$$a_T' = \frac{1}{(1-\beta^2)^{\frac{3}{2}}}.\frac{dv}{dt} \qquad \text{and} \qquad a_N' = \frac{v^2}{R.\sqrt{1-\beta^2}}$$

(If *R* is the curvature of the path in ***O***, the curvature in ***O'*** is $R\sqrt{1-\beta^2}$.)

The gravitational force is:

$$\vec{F}_G = m_0.\vec{a}' = m_0.(a_T'.\vec{e}_T + a_N'.\vec{e}_N) = m_0.\left[\frac{1}{(1-\beta^2)^{\frac{3}{2}}}.\frac{dv}{dt}.\vec{e}_T + \frac{1}{(1-\beta^2)^{\frac{1}{2}}}.\frac{v^2}{R}.\vec{e}_N\right] = \frac{d}{dt}\left[\frac{m_0}{\sqrt{1-\beta^2}}.\vec{v}\right]$$

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

We obtain: $$\vec{F}_G = \frac{d\vec{p}}{dt}$$

$\vec{p}$ is the linear momentum of the point mass relative to the inertial reference frame ***O***. It is the product of its relativistic mass $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$ with its velocity $\vec{v}$ in ***O***.

The linear momentum of a moving point mass is a measure for its inertia, for its ability to persist in its dynamic state.

5.2.3. The equivalence mass-energy

The instantaneous value of the linear momentum $\vec{p} = m.\vec{v}$ of the point mass m_0, that freely moves relative to the inertial reference frame ***O***, and the instantaneous value of the force $\vec{F}$ that acts on it, are related by:

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

The elementary vectorial displacement $d\vec{r}$ of m_0 during the elementary time interval *dt* is:

$$d\vec{r} = \vec{v}.dt$$

And the elementary work done by $\vec{F}$ during *dt* is [(7)]:

$$dW = \vec{F}.\overrightarrow{dr} = \vec{F}.\vec{v}.dt = \vec{v}.d\vec{p}$$

With $\vec{p} = m.\vec{v} = \frac{m_0}{\sqrt{1-(\frac{v}{c})^2}}.\vec{v}$, this becomes:

$$dW = \frac{m_0.v.dv}{\left[1-(\frac{v}{c})^2\right]^{\frac{3}{2}}} = d\left[\frac{m_0}{\sqrt{1-(\frac{v}{c})^2}}.c^2\right] = d(m.c^2)$$

The work done on the moving point mass equals, by definition, the increase of the energy of the mass. So, $d(m.c^2)$ is the increase of the energy of the mass and $m.c^2$ is the energy represented by the mass.

We conclude: *A point mass with relativistic mass m is equivalent to an amount of energy of* $m.c^2$.

5.2.4. The interaction between two uniform linear moving point masses

5.2.4.1. The interaction between two moving point masses according to S.R.T.

Two material points with rest masses m_1 and m_2 (fig 11) are anchored in the inertial frame ***O'*** that is moving relative to the inertial frame ***O*** with constant velocity $\vec{v} = v.\vec{e}_z$. The distance between the masses is *R.*

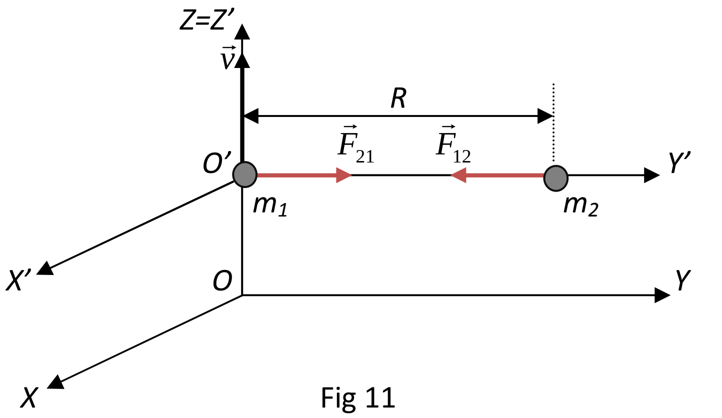

Fig 11

In ***O'*** the masses are at rest, they don't move. According to Newton's law of universal gravitation, they exert on each other equal but opposite forces:

$$F' = F_{12}^{'} = F_{21}^{'} = G.\frac{m_{.1}.m_2}{R^2} = \frac{1}{4.\pi.\eta_0}.\frac{m_1.m_2}{R^2}$$

In ***O*** both masses are moving with constant speed v in the direction of the *Z*-axis. From the transformation equations between an inertial frame ***O*** and another inertial frame ***O'***, in which a point mass experiencing a force *F'* is instantaneously at rest(5), we can immediately deduce the force *F* that the point masses exert on each other in ***O***:

$$F = F_{12} = F_{21} = F'.\sqrt{1-(\frac{v}{c})^2} = F'.\sqrt{1-\beta^2}$$

5.2.4.2. The interaction between two moving point masses according to G.E.M.

In 3.5, it is shown that the gravitational field ($\vec{E}_g, \vec{B}_g$) 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 frame ***O*** (fig 11) is determined by:

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

$$\vec{B}_g = -\frac{m_0}{4\pi\eta_0 c^2.r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(\vec{v}\times\vec{r})$$

with $\beta = \frac{v}{c}$, the dimensionless speed of m_0. One can verify that these expressions satisfy the laws of G.E.M.

In the inertial frame ***O***, the masses m_1 and m_2 are moving in the direction of the *Z*-axis with speed v. m_2 moves through the G.E.M. field generated by m_1, and m_1 moves through that generated by m_2.

According the above formulas, the magnitude of the G.E.M. field created and maintained by m_1 at the position of m_2 is determined by:

$$E_{g2} = \frac{m_1}{4\pi\eta_0 R^2}.\frac{1}{\sqrt{1-\beta^2}} \qquad \text{and} \qquad B_{g2} = \frac{m_1}{4\pi\eta_0 R^2}.\frac{1}{\sqrt{1-\beta^2}}.\frac{v}{c^2}$$

And according to the force law $\vec{F}_G = m_0.[\vec{E}_g + (\vec{v}\times\vec{B}_g)]$, F_{12}, the magnitude of the force exerted by the gravitaltional field ($\vec{E}_{g2}, \vec{B}_{g2}$) on *$m_2$* - this is the attraction force of *m_1* on *m_2* - is:

$$F_{12} = m_2.(E_{g2} - v.B_{g2})$$

After substitution: $$F_{12} = \frac{1}{4\pi\eta_0}.\frac{m_1 m_2}{R^2}.\sqrt{1-\beta^2} = F_{21}^{'}.\sqrt{1-\beta^2}$$

In the same way we find: $$F_{21} = \frac{1}{4\pi\eta_0}.\frac{m_1 m_2}{R^2}.\sqrt{1-\beta^2} = F_{12}^{'}.\sqrt{1-\beta^2}$$

We conclude that the moving masses attract each other with a force:

$$F = F_{12} = F_{21} = F'.\sqrt{1-\beta^2}$$

This result perfectly agrees with that based on S.R.T. (§5.2.4.1).

We can also conclude that the component of the gravitational force due to the g-induction is β^2 times smaller than that due to the g-field. *This implies that, for speeds much smaller than the speed of light, the effects of het β-information are masked.*

The β-information emitted by the rotating sun is not taken into account when the classical theory of gravitation describes the planetary orbits. It can be shown that this is responsible for deviations (as the advance of Mercury Perihelion) of the real orbits with respect to these predicted by that theory [(8)].

5.2.4.3. The interaction between two moving point masses according to linearized G.R.T.

For weak gravitational fields, the linearized form of G.R.T. turns out to be very similar to G.E.M.[(3)(8)]. The laws of the G.E.M field derived from the linear approximation of G.R.T. are the same as those derived from the dynamics of the informatons. However this does not apply to the force law. Indeed if one accepts that gravitational phenomena propagate with the speed *c*, according to linearized G.R.T. the gravitational force $\vec{F}_G$ must be expressed as:

$$\vec{F}_G = m_0.[\vec{E} + 2.(\vec{v}\times\vec{B})].$$

Starting from this force law, we become an expression for the interaction between the moving masses that is not consistent with S.R.T.

VI. The gravitational field of an harmonically oscillating point mass *m* Gravito-magnetic waves

In fig 12 we consider a point mass *m* that harmonically oscillates, with frequency $\nu = \frac{\omega}{2.\pi}$, around the origin of the inertial reference frame ***O***. At the moment *t* it passes in P_1. We suppose that the speed of the charge is always much smaller than the speed of light and that it is described by:

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

The elongation *z(t)* and the acceleration *a(t)* are than expressed as:

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

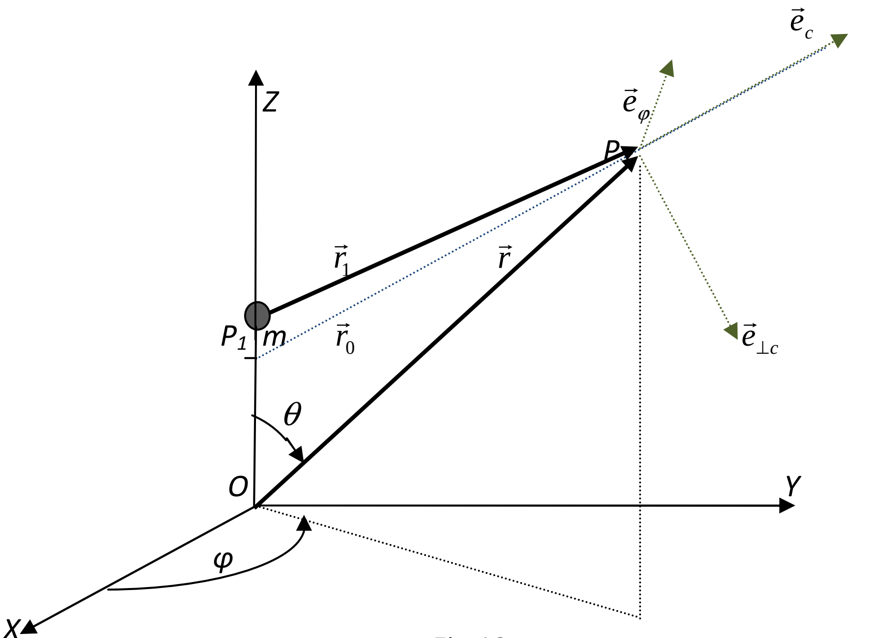

Fig 12

We restrict our considerations about the gravitational field of *m* to points *P* that are sufficiently far away from the origin *O*. Under this 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 accept that the amplitude of the oscillation is very small relative to the distances between the origin and the points *P* on which we focus.

6.3.1. The transversal gravitational field of an harmonically oscillating point mass

Starting from $\overline{V} = V.e^{j.0}$ - the complex quantity representing $v(t)$ - the complex representation $\overline{E}_{g\perp c}$ of the time dependant part of the transversal component of $\vec{E}_g$ and the complex representation $\overline{B}_{g\varphi}$ of the time dependant part of $\vec{B}_g$ in *P* follow immediately from 3.8.2.

$\overline{E}_{g\perp c} = -\frac{m.\overline{V}}{4.\pi}.e^{-j.k.r}.(\frac{1}{\eta_0.c.r^2} + \frac{j.\omega.\nu_0}{r}).\sin\theta$ and $\overline{B}_{g\varphi} = -\frac{\nu_0.m.\overline{V}}{4.\pi}.e^{-j.k.r}.(\frac{1}{r^2} + \frac{j.k}{r}).\sin\theta$

Where $k = \frac{\omega}{c}$ the phase constant. Note that $\overline{B}_{g\varphi} = \frac{\overline{E}_{g\perp c}}{c}$.

So, an harmonically oscillating point mass emits a transversal "gravitomagnetic" wave that - relative to the position of the mass - expands with the speed of light:

$$B_{g\varphi}(r,\theta;t) = \frac{E_{g\perp c}(r,\theta;t)}{c} = \frac{\nu_0.m.V.\sin\theta.\sqrt{1+k^2r^2}}{4\pi r^2}.\cos(\omega t - kr + \Phi + \pi) \quad \text{with} \quad tg\Phi = kr$$

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

$$B_{g\varphi} = \frac{E_{\perp c}}{c} = \frac{\nu_0.k.m.V.\sin\theta}{4\pi r}.\sin(\omega t - kr) = \frac{\nu_0.m.\omega.V.\sin\theta}{4\pi c r}.\sin(\omega t - kr) = -\frac{\nu_0.m.a(t-\frac{r}{c}).\sin\theta}{4\pi c r}$$

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

6.3.2. The longitudinal gravitational field of an harmonically oscillating point mass

The oscillation of the point mass *m* along the *Z*-axis is responsible for the existence of a fluctuation of $r_0 = P_1P$ (fig 2), the distance travelled by the informatons that at the moment *t* pass near *P*. Within the framework of our approximations:

$$r_0(t) \approx r - z(t-\frac{r}{c}).\cos\theta = r.\left\{1 - \frac{z(t-\frac{r}{c})}{r}.\cos\theta\right\} \quad \text{and} \quad (\frac{1}{r_0})^2 \approx \frac{1}{r^2}.(1+2.\frac{z(t-\frac{r}{c})}{r}.\cos\theta)$$

From 6.2, it follows: $E_{gc} = -\frac{m}{4.\pi.\eta_0.r^2} - \frac{m}{4.\pi.\eta_{.0}.r^3}.2.z(t-\frac{r}{c}).\cos\theta$

So $\overline{E}_{gc}$, the complex representation of the time dependant part of the longitudinal gravitationel field is: $\overline{E}_{gc} = -\frac{m.\overline{V}}{4\pi}.e^{-jkr}.\frac{2}{j.\omega.\eta_0.r^3}.\cos\theta$

We conclude that an harmonically oscillating point mass emits a longitudinal gravitational wave that - relative to the position of the mass - expands with the speed of light:

$$E_{gc}(r,\theta;t) = \frac{m.V}{4.\pi.\eta_0.c.k}.\frac{2}{r^3}.\sin(\omega t - kr)$$

6.3.3. The energy radiated by an harmonically oscillating point mass

6.3.3.1. Poynting's theorem

In empty space a gravitomagnetic field is completely defined by the vectorial functions $\vec{E}_g(x,y,z;t)$ and $\vec{B}_g(x,y,z;t)$. It can be shown that the spatial area *G* enclosed by the surface *S* contains - at the moment *t* - an amount of energy given by the expression:

$$U = \iiint_G \left(\frac{\eta_0 . E_g^2}{2} + \frac{B_g^2}{2\nu_0}\right).dV$$

The rate at which the energy escapes from *G* is: $-\frac{\partial U}{\partial t} = -\iiint_V \left(\eta_0 .\vec{E}_g . \frac{\partial \vec{E}_g}{\partial t} + \frac{1}{\nu_0}.\vec{B}_g . \frac{\partial \vec{B}_g}{\partial t}\right).dV$

According to the third law of gravitoelectromagnetism: $rot\vec{E}_g = -\frac{\partial \vec{B}_g}{\partial t}$, and according to the fourth law: $rot\frac{\vec{B}_g}{\nu_0} = \eta_0 . \frac{\partial \vec{E}_g}{\partial t}$. So:

$$-\frac{\partial U}{\partial t} = \iiint_G \left(\frac{\vec{B}_g}{\nu_0}.rot\vec{E}_g - \vec{E}_g .rot\frac{\vec{B}_g}{\nu_0}\right).dV = \iiint_G div\left(\frac{\vec{E}_g \times \vec{B}_g}{\nu_0}\right).dV$$

By application of the theorem of Ostrogradsky[4]: $\iiint_G div\vec{F}.dV = \oiint_S \vec{F}.\overrightarrow{dS}$, one can rewrite this as: $-\frac{\partial U}{\partial t} = \oiint_S \frac{\vec{E}_g \times \vec{B}_g}{\nu_0}.\overrightarrow{dS}$

One can conclude that the expression $\frac{\vec{E}_g \times \vec{B}_g}{\nu_0}.\overrightarrow{dS}$ defines the rate at which energy flows through the surface element *dS* in *P* in the sense of the positive normal. So, the density of the energy flow in *P* is: $\frac{\vec{E}_g \times \vec{B}_g}{\nu_0}$. This vectorial quantity is called the "Poynting's vector". It is represented by $\vec{P}$:

$$\vec{P} = \frac{\vec{E}_g \times \vec{B}_g}{\nu_0}$$

The amount of energy transported through the surface element *dS* in the sense of the positive normal during the time interval *dt* is:

$$dU = \frac{\vec{E}_g \times \vec{B}_g}{\nu_0}.\overrightarrow{dS}.dt$$

6.3.3.2. The energy radiated by an harmonically oscillating point mass - gravitons

Under 6.3.1 we have shown that an harmonically oscillating point mass *m* radiates a gravitomagnetic wave that in a far point *P* is defined by (see fig 12):

$$\vec{E} = E_{\perp c}.\vec{e}_{\perp c} = \frac{\nu_0.m.\omega.V.\sin\theta}{4\pi r}.\sin(\omega t - kr).\vec{e}_{\perp c}$$

$$\vec{B} = B_{\varphi}.\vec{e}_{\varphi} = \frac{\nu_0.m.\omega.V.\sin\theta}{4\pi c r}.\sin(\omega t - kr).\vec{e}_{\varphi}$$

The instantaneous value of Poynting's vector in *P* is:

$$\vec{P} = \frac{\nu_0.m^2.\omega^2.V^2.\sin^2\theta}{16.\pi^2.c.r^2}.\sin^2(\omega t - kr).\vec{e}_c$$

The amount of energy that, during one period *T* , flows through the surface element *dS* that in *P* is perpendicular on the direction of the movement of the informatons, is:

$$dU = \int_0^T P.dt.dS = \frac{\nu_0.m^2.\omega^2.V^2.\sin^2\theta}{16.\pi^2.c.r^2}.\frac{T}{2}.dS$$

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

$$dU = \frac{\nu_0.m^2.V^2.\sin^2\theta}{8c}.\nu.\frac{dS}{r^2}$$

$\frac{dS}{r^2} = d\Omega$ is the solid angle under which *dS* is "seen" from the origin. So, the oscillating mass radiates, per period, an amount of energy u_Ω per unit of solid angle in the direction θ :

$$u_\Omega = \frac{\nu_0.m^2.V^2.\sin^2\theta}{8c}.\nu$$

The density of the flux of energy is greatest in the direction defined by θ *= 90°*, thus in the direction perpendicular to the movement of the mass. The radiated energy is proportional to the frequency of the wave, thus proportional to the frequency at which the mass oscillates.
We posit that an oscillating mass *m* loads some of the informatons that it emits with a discrete energy packet (*h'.*ν). *h'* plays the role of Planck's constant in electromagnetism, but his value depends on the nature of the emitter. Informatons carrying an energy packet are called "gravitons". In other words, we postulate that the gravitomagnetic energy radiated by an oscillating point mass is transported by informatons. This implies that gravitons rush through space with the speed of light.

6.3.3.3. Estimate of the value of *h'*

The number of gravitons emitted by an oscillating point mass *m* per period and per unit of solid angle in the direction θ is:

$$N_{g\Omega} = \frac{u_\Omega}{h'.\nu} = \frac{\nu_0.m^2.V^2.\sin^2\theta}{8.h'.c}$$

It follows that the total number of gravitons that are emitted per period is:

$$N_g = \frac{\nu_0.m^2.V^2}{8.h'.c}.2\pi.\int_0^\pi \sin^3\theta.d\theta = \frac{\pi}{3}.\frac{\nu_0}{h'.c}.m^2.V^2$$

If the oscillating point mass is an electron:

$$N_g = 2{,}71.10^{-95}\frac{V^2}{h_e^{'}}$$

An oscillating electron also emits photons. The number of photons it emits per period is[(10)]:

$$N_f = 1{,}70.10^{-19}.V^2$$

If we assume that the number of emitted gravitions equals the number of emitted photons:

$$N_f = 1{,}70.10^{-19}.V^2 = 2{,}71.10^{-95}.\frac{V^2}{h_e^{'}} = N_g$$

From which follows:

$$\boxed{h_e^{'} = 1{,}60.10^{-76}\,J.s}$$

For an oscillating proton, an analogue reasoning leads to:

$$\boxed{h_p^{'} = 5{,}35.10^{-70}\,J.s}$$

VII. CONSLUSION: THE NATURE OF THE GRAVITATIONAL FIELD

According to the postulate of the emission of informatons, the gravitational field of a mass at rest is characterized by the following statements.

1. Gravitational phenomena propagate with the speed of light.

2. The gravitational field is granular.

3. The gravitational field continuously regenerates.

4. The gravitational field shows fluctuations.

5. The gravitational field expands with the speed of light.

6. In a gravitational field, there is conservation of g-information, what mathematically can be expressed as a relation between the spatial variation of the g-field $\vec{E}_g$ and the mass density ρ_G in any point of the field: $div\vec{E}_g = -\frac{\rho_G}{\eta_0}$.

Complementary, the following statements are valid for the gravitational field of a uniformly moving mass:

7. The g-field $\vec{E}_g$ of a point mass that is moving with constant velocity always points to the actual position of that mass.

8. The g-induction $\vec{B}_g$ shows fluctuations.

9. From the definition of the β-index, it follows: $div\vec{B}_g = 0$.

10.The spatial variation of the g-induction in a point of a gravitational field depends on the densitity of the mass flow $\vec{J}_G$ in that point: $rot\vec{B}_g = -\nu_0.\vec{J}_G$ *with* $\nu_0 = \frac{1}{\eta_0.c^2}$.

The definitions of $\vec{E}_g$ and of $\vec{B}_g$ can be extended to the situation where the gravitational field is generated by a set of whether or not - uniformly or not uniformly - moving point masses or by a whether or not moving mass continuum. In that general case, the statements 1 - 10 stay valid. In addition:

11.From the dynamics of an informaton, it follows that in empty space:

- *11,a.* $rot\vec{E}_g = -\frac{\partial\vec{B}_g}{\partial t}$
- *11,b.* $rot\vec{B}_g = \frac{1}{c^2}.\frac{\partial\vec{E}_g}{\partial t}$

12.There is a perfect isomorphism between the gravitational field and the electromagnetic field: in a point P situated in a mass continuum that is characterized by the mass density ρ_G and the mass flow density $\vec{J}_G$, $\vec{E}_g$ and $\vec{B}_g$ satisfy the following equations:

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

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

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

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

In an inertial reference system, the gravitational interaction between masses is determined by the force law of G.E.M. that is analogue to the force law of E.M. It is the expression of the fact that a point mass tends to become blind for the flow of information generated by other point masses.

13. A point mass with rest mass m_0 that moves with velocity $\vec{v}$ through a gravitational field ($\vec{E}_g, \vec{B}_g$) experiences a force $\vec{F}_G = m_0.\left[\vec{E}_g + (\vec{v} \times \vec{B}_g)\right]$.
An accelerated mass is the source of a gravito-magnetic wave.

14. An oscillating point mass radiates a gravito-magnetic wave, transporting energy in the form of granular energy packets called "gravitons".

EPILOGUE

1. The theory of informatons is also able to explain the phenomena and the laws of electromagnetism [(6), (9)]. It is sufficient to add the following rule at the postulate of the emission of informatons:

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

1. *The e-spin vectors 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-spin vector depends on Q/m, the charge per unit of mass of the emitter. It is defined by:*

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

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

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

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

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

2. The assumption that a photon is nothing else than an informaton transporting an energy package can explain the duality of light [6], [9] [10].

3. The fact that the "theory of informatons" permits to understand the nature of gravitation and to deduce the laws that govern the gravitational phenomena justifies the hypothesis that "information" is the substance of the gravitational field and it supports the idea that informatons really exist.

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