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The Gravitational Interaction between Moving Mass Particles Explained by the Theory of Informatons

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Abstract

In the article "*Newtons Law of Universal Gravitation Explained by the Theory of Informatons*" the gravitational interaction between mass particles at rest has been explained by the hypothesis that *g-information carried by informatons is* the substance of the medium that the interaction in question makes possible. It has been showed that, on the macroscopic level, that medium—the "gravitational field"—manifests itself as the vector field $\boldsymbol{E}_g$. In this article we will deduce from *the postulate of the emission of informatons*, that the informatons emitted by a moving mass particle carry not only information about the position (g-information) but also about the velocity ("*β-information*") of their emitter. It follows that the gravitational field of a moving mass particle is a dual entity always having a field- and an induction-component ($\boldsymbol{E}_g$ and $\boldsymbol{B}_g$) simultaneously created by their common sources: time-variable masses and mass flows and that the gravitational interaction is the effect of the fact that an object in a gravitational field always tends to become "blind" for that field by accelerating according to a Lorentz-like law.

Keywords

Gravity, Gravitational Field, Gravitational Interaction, Informatons

1. Introduction

The theory of informatons [1]-[3] starts from the hypothesis that a material object at rest manifests its presence in space by continuously emitting "informatons", granular entities carrying "information" about the position of the emitter. The emission of informatons by a material object anchored in an inertial reference frame (IRF) $\boldsymbol{O}$, is governed by the "*postulate of the emission of informa-*

tons":

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

1. *The emission is uniform in all directions of space*, *and the informatons diverge with the speed of light* ($c = 3 \times 10^8$ m/s) *along radial trajectories relative to the position of the emitter.*

2. $\dot{N} = \frac{\mathrm{d}N}{\mathrm{d}t}$, *the rate at which a particle emits informatons*[1], *is time independent and proportional to the rest mass m_0 of the emitter. So there is a constant K so that*:

$$\dot{N} = K \cdot m_0$$

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

$$K = \frac{c^2}{h} = 1.36 \times 10^{50}\ \mathrm{kg}^{-1} \cdot \mathrm{s}^{-1}$$

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

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

2. *The elementary quantity of g-information is*:

$$s_g = \frac{1}{K \cdot \eta_0} = \frac{h}{\eta_0 \cdot c^2} = 6.18 \times 10^{-60}\ \mathrm{m}^3 \cdot \mathrm{s}^{-1}$$

where $\eta_0 = \frac{1}{4 \cdot \pi \cdot G} = 1.19 \times 10^9\ \mathrm{kg} \cdot \mathrm{s}^2 \cdot \mathrm{m}^{-3}$, G being the gravitational constant.

In the article "*Newtons law of universal gravitation explained by the theory of informatons*" [1] it is shown that this postulate leads to the conclusion that the gravitational field—the medium that the gravitational interaction between objects makes possible—is a cloud of "g-information", *i.e.* information carried by informatons. At the macroscopic level it is, in the case of an object at rest, completely defined by the vector field $\boldsymbol{E}_g$. E_g, the magnitude of $\boldsymbol{E}_g$ at any point P, is the density of the flow of g-information at that point (the rate per unit area at which g-information at P flows through an elementary surface perpendicular to the direction of $\boldsymbol{E}_g$).

In this article (the follow-up article of [1]) we will deduce from the *postulate of the emission of informatons* that the gravitational field of a moving mass particle is a dual entity always having a field- and an induction-component ($\boldsymbol{E}_g$ and $\boldsymbol{B}_g$) simultaneously created by their common sources: time-variable masses and mass flows. At an arbitrary point P the magnitude of $\boldsymbol{E}_g$ is the density of the flow of g-information at that point and the magnitude of $\boldsymbol{B}_g$ is the density of the cloud of *β-information* at *P*. *β*-information is the information that infor-

[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.

matons carry regarding the velocity of their source. This implies that the gravitational field of a moving object besides g-information, *i.e.* this is information about the position of the emitter, contains also information about its velocity.

We will also show that the gravitational interaction is the effect of the fact that an object in a gravitational field always tends to become "blind" for that field by accelerating according to a Lorentz-like law.

2. Rest Mass and Relativistic Mass

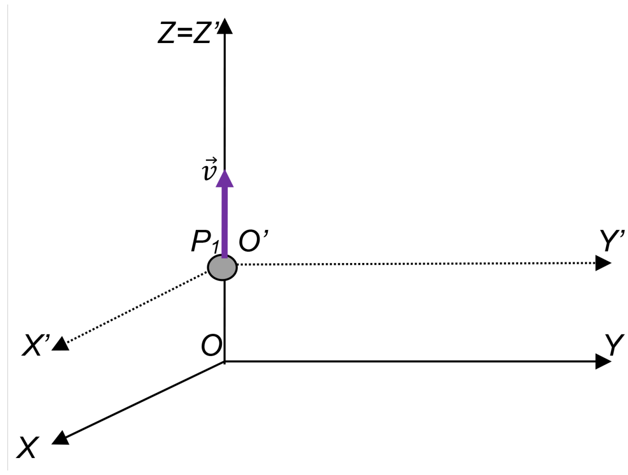

Figure 1. A mass particle m_0 moving with constant velocity relative to an IRF ***O***.

In **Figure 1**, we consider a mass point with rest mass m_0 that moves with constant velocity $\boldsymbol{v} = v \cdot \boldsymbol{e}_z$ along the *Z*-axis of an IRF ***O***. At the moment $t = 0$, it passes through the origin *O* and at the moment $t = t$ through the point P_1.

We extend rule A.1 of the postulate of the emission of information to a mass point that is moving relative to an IRF ***O***:

$\dot{N} = \frac{\mathrm{d}N}{\mathrm{d}t}$, *the rate at which a particle emits informatons, is independent of the motion of the emitter and proportional to its rest mass* m_0. *So there is a constant K so that*:

$$\dot{N} = K \cdot m_0$$

That implies that, if the time is read on a standard clock anchored in ***O***, d*N*, the number of informatons that during the time interval d*t* is emitted by a—whether or not moving—point mass, is:

$$\mathrm{d}N = K \cdot m_0 \cdot \mathrm{d}t$$

To emit d*N* informatons relative to ***O'***—the "*proper IRF*" of the mass particle (*i.e.* the IRF anchored to the moving particle)—it takes a time interval d*t'*. The Lorentz transformation relation between d*t* and d*t'* is [4]:

$$\mathrm{d}t = \frac{\mathrm{d}t'}{\sqrt{1-\beta^2}}$$

where $\beta = \frac{v}{c}$ is the dimensionless speed of the particle.

So:

$$\mathrm{d}N = K \cdot m_0 \cdot \mathrm{d}t = K \cdot m_0 \cdot \frac{\mathrm{d}t'}{\sqrt{1-\beta^2}} = K \cdot \frac{m_0}{\sqrt{1-\beta^2}} \cdot \mathrm{d}t' = \frac{\dot{N}}{\sqrt{1-\beta^2}} \cdot \mathrm{d}t'$$

and:

$$\frac{\mathrm{d}N}{\mathrm{d}t'} = \frac{\dot{N}}{\sqrt{1-\beta^2}} = K \cdot \frac{m_0}{\sqrt{1-\beta^2}} = K \cdot m$$

with

$$m = \frac{m_0}{\sqrt{1-\beta^2}}$$

the "relativistic mass" of the particle.

We conclude:

*The rate at which a mass particle moving with constant velocity relative to an IRF **O** emits informatons is determined by its "rest mass". Relative to its proper IRF **O'** it is determined by its "relativistic mass". In other words: the rest mass of a particle is representative for the rate at which it emits informatons relative to the IRF of the observer and its relative mass for the emission rate relative to its proper IRF.*

3. The g-Field of a Mass Particle Moving with Constant Velocity

In Figure 2(a), we consider a particle with rest mass m_0 that is moving with constant velocity $\boldsymbol{v} = v \cdot \boldsymbol{e}_z$ along the Z-axis of an IRF $\boldsymbol{O}$. 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:

$$OP_1 = z_{P_1} = v \cdot t$$

P is an arbitrary fixed point in $\boldsymbol{O}$ with space coordinates (x, y, z). Its position relative to the moving particle is determined by the time dependent position vector $\boldsymbol{r} = \boldsymbol{P_1P}$.

We introduce the IRF $\boldsymbol{O'}$ (Figure 2(b)), the proper IRF of the particle, whose origin is anchored to the moving particle and we assume that $t = t' = 0$ when it passes through O.

Relative to $\boldsymbol{O'}$ (Figure 1(b)), the position of P is determined by the time dependent position vector $\boldsymbol{r}' = \boldsymbol{O'P}$ and in $\boldsymbol{O'}$ the space coordinates of P are (x', y', z').

The particle is at rest in $\boldsymbol{O'}$. So $\boldsymbol{E}'_g$, its g-field relative to $\boldsymbol{O'}$, is completely defined by the vectoral quantity [1]:

$$\boldsymbol{E}'_g = -\frac{\frac{\mathrm{d}N}{\mathrm{d}t'} \cdot s_g}{4 \cdot \pi \cdot r'^2} \cdot \boldsymbol{e}_{r'}$$

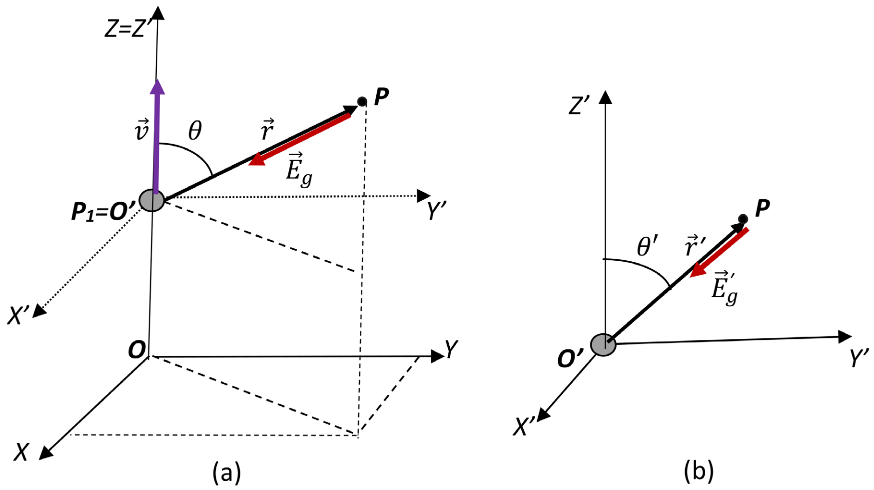

Figure 2. The g-field of a mass particle moving with constant velocity relative to an IRF $\boldsymbol{O}$.

$\mathrm{d}N$ is the number of informatons that during the time interval $\mathrm{d}t'$ pass through an elementary surface $\mathrm{d}S'$ that in $\boldsymbol{O'}$ is perpendicular to $\boldsymbol{c}$, the velocity of these informatons.

Thus $\boldsymbol{E}_g'$ is—relative to $\boldsymbol{O'}$—the density of the g-information flow at P and the magnitude of $\boldsymbol{E}_g'$ is the rate per unit area at which—relative to $\boldsymbol{O'}$—g-information flows through an elementary surface $\mathrm{d}S'$ that at P is perpendicular to the velocity $\boldsymbol{c}$ of the informatons that carry that information.

The components of $\boldsymbol{E}_g'$ in O', are:

$$E'_{gx'} = -\frac{\frac{\mathrm{d}N}{\mathrm{d}t'} \cdot s_g}{4 \cdot \pi \cdot r'^3} \cdot x'$$

$$E'_{gy'} = -\frac{\frac{\mathrm{d}N}{\mathrm{d}t'} \cdot s_g}{4 \cdot \pi \cdot r'^3} \cdot y'$$

$$E'_{gz'} = -\frac{\frac{\mathrm{d}N}{\mathrm{d}t'} \cdot s_g}{4 \cdot \pi \cdot r'^3} \cdot z'$$

They determine at P the densities of the flows of g-information respectively through a surface element $\mathrm{d}y' \cdot \mathrm{d}z'$ perpendicular to the X'-axis, through a surface element $\mathrm{d}z' \cdot \mathrm{d}x'$ perpendicular to the Y'-axis and through a surface element $\mathrm{d}x' \cdot \mathrm{d}y'$ perpendicular to the Z'-axis.

Thus, the amount of information that the particle during the time-interval dt' sends through the different surface elements at P are:

$$E'_{gx'} \cdot \mathrm{d}y' \cdot \mathrm{d}z' \cdot \mathrm{d}t' = -\frac{\frac{\mathrm{d}N}{\mathrm{d}t'} \cdot s_g \cdot x'}{4 \cdot \pi \cdot r'^3} \cdot \mathrm{d}y' \cdot \mathrm{d}z' \cdot \mathrm{d}t'$$

$$E'_{gy'} \cdot \mathrm{d}z' \cdot \mathrm{d}x' \cdot \mathrm{d}t' = -\frac{\frac{\mathrm{d}N}{\mathrm{d}t'} \cdot s_g \cdot y'}{4 \cdot \pi \cdot r'^3} \cdot \mathrm{d}z' \cdot \mathrm{d}x' \cdot \mathrm{d}t'$$

$$E'_{gz'} \cdot \mathrm{d}x' \cdot \mathrm{d}y' \cdot \mathrm{d}t' = -\frac{\frac{\mathrm{d}N}{\mathrm{d}t'} \cdot s_g \cdot z'}{4 \cdot \pi \cdot r'^3} \cdot \mathrm{d}x' \cdot \mathrm{d}y' \cdot \mathrm{d}t'$$

Informatons propagate at the speed of light that—in free space—has the same value in all IRFs. That implies that, by applicating the Lorenz transformation equations, the amount of g-information that during the time interval $\mathrm{d}t$ flows through the surface element $\mathrm{d}S$ that in ***O*** is perpendicular to the velocity of the informatons at P can be derived from the quantity that during the corresponding time interval $\mathrm{d}t'$ flows through the corresponding surface element $\mathrm{d}S'$ in ***O'***.

- The Cartesian coordinates of P in the frames ***O*** and ***O'*** are related to each other by [4]:

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

- The line elements by: $\mathrm{d}x' = \mathrm{d}x\,, \quad \mathrm{d}y' = \mathrm{d}y\,, \quad \mathrm{d}z' = \frac{\mathrm{d}z}{\sqrt{1-\beta^2}}$

  The elementary time intervals by: $\mathrm{d}t' = \mathrm{d}t \cdot \sqrt{1-\beta^2}$

- And further:

$$r' = r \cdot \frac{\sqrt{1-\beta^2 \cdot \sin^2\theta}}{\sqrt{1-\beta^2}}$$

So relative to ***O***, the rates at which the moving particle sends g-information in the positive direction through the surface elements $\mathrm{d}y \cdot \mathrm{d}z$, $\mathrm{d}z \cdot \mathrm{d}x$ and $\mathrm{d}x \cdot \mathrm{d}y$ at P are:

$$-\frac{\frac{\mathrm{d}N}{\mathrm{d}t} \cdot s_g}{4 \cdot \pi \cdot r^3} \cdot \frac{1-\beta^2}{\left(1-\beta^2 \cdot \sin^2\theta\right)^{\frac{3}{2}}} \cdot x \cdot \mathrm{d}y \cdot \mathrm{d}z$$

$$-\frac{\frac{\mathrm{d}N}{\mathrm{d}t} \cdot s_g}{4 \cdot \pi \cdot r^3} \cdot \frac{1-\beta^2}{\left(1-\beta^2 \cdot \sin^2\theta\right)^{\frac{3}{2}}} \cdot y \cdot \mathrm{d}x \cdot \mathrm{d}z$$

$$-\frac{\frac{\mathrm{d}N}{\mathrm{d}t} \cdot s_g}{4 \cdot \pi \cdot r^3} \cdot \frac{1-\beta^2}{\left(1-\beta^2 \cdot \sin^2\theta\right)^{\frac{3}{2}}} \cdot \left(z - z_{P_1}\right) \cdot \mathrm{d}x \cdot \mathrm{d}z$$

By definition, the densities at 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 particle m_0 at P in ***O***.

Taking into account that

$$\frac{\mathrm{d}N}{\mathrm{d}t} = \dot{N} = K \cdot m_0\,, \quad s_g = \frac{1}{K \cdot \eta_0}$$

We obtain:

$$E_{gx} = -\frac{m_0}{4\pi\eta_0 r^3} \cdot \frac{1-\beta^2}{\left(1-\beta^2 \cdot \sin^2\theta\right)^{\frac{3}{2}}} \cdot x$$

$$E_{gy} = -\frac{m_0}{4\pi\eta_0 r^3} \cdot \frac{1-\beta^2}{\left(1-\beta^2 \cdot \sin^2\theta\right)^{\frac{3}{2}}} \cdot y$$

$$E_{gz} = -\frac{m_0}{4\pi\eta_0 r^3} \cdot \frac{1-\beta^2}{\left(1-\beta^2 \cdot \sin^2\theta\right)^{\frac{3}{2}}} \cdot \left(z - z_{P_1}\right)$$

From which it follows that the g-field caused by the particle at the fixed point P is:

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

We conclude:

A particle describing a uniform rectilinear movement relative to an inertial reference frame ***O****, creates in the space linked to that frame a time dependent gravitational field.* $\boldsymbol{E}_g$ *, the g-field at an arbitrary point P, points at any time to the position of the mass at that moment*[2] *and its magnitude is:*

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

The magnitude of $\boldsymbol{E}_g$ at an arbitrary point P in the g-field of m_0 is the rate per unit area at which *g-information* at that point flows—relative to ***O***—through an elementary surface perpendicular to $\boldsymbol{E}_g$.

With N the density of the flow of informatons at P (the number of informatons that per unit time and per unit area crosses an elementary surface perpendicular to the direction of their movement), $\boldsymbol{E}_g$ can be expressed as:

$$\boldsymbol{E}_g = N \cdot \boldsymbol{s}_g$$

Because the rate at which g-information that escapes from an enclosed space is completely determined by the rate at which g-information is generated inside that space (*conservation of g-information*):

$$\oiint \boldsymbol{E}_g \cdot \mathrm{d}\boldsymbol{S} = -\frac{m_0}{\eta_0}$$

If the speed of the mass particle is much smaller than the speed of light, the expression (1) reduces to that valid in the case of a mass particle at rest. This non-relativistic result could directly be obtained if one assumes that the displacement of the mass particle 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.

[2]The orientation of the g-field implies that the g-indices of the informatons that at a certain moment pass near *P*, point at that moment to the position of the emitting mass and not to its light delayed position.

4. The Emission of Informatons by a Mass Particle Moving with Constant Velocity

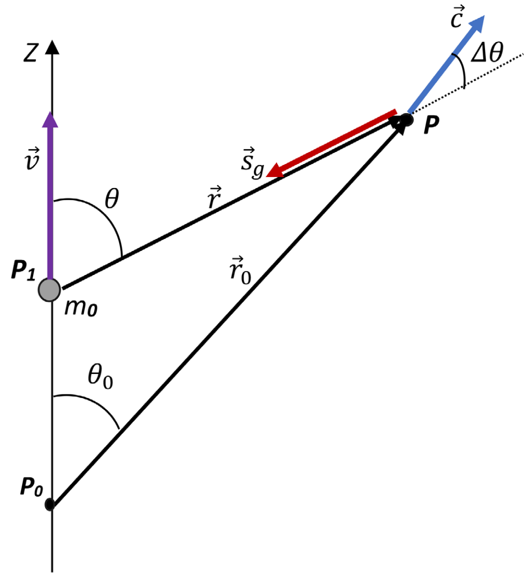

Figure 3. An informaton emitted by a mass particle moving with constant velocity.

In **Figure 3** we consider a mass particle with rest mass m_0 that is moving with constant velocity $\boldsymbol{v}$ along the Z-axis of an inertial reference frame $\boldsymbol{O}$. Its instantaneous position (at the arbitrary moment t) is P_1. The position of P, an arbitrary fixed point in space, is defined by the vector $\boldsymbol{r} = \boldsymbol{P_1 P}$. This position vector $\boldsymbol{r}$—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 $P_0 P = r_0$ took the time interval $\Delta t = \frac{r_0}{c}$.

During their rush from P_0 to P their emitter, the particle, moved from P_0 to P_1: $P_0 P_1 = v \cdot \Delta t$.

1. $\boldsymbol{c}$, the velocity of the informatons, points in the direction of their movement, thus along the radius $P_0 P$;

2. $\boldsymbol{s}_g$, their g-index, 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, confirmed by the conclusion of §3.

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

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

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

- The β-index is perpendicular to the plane formed by the path of the informaton and the straight line that carries the g-index, thus it is 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".
- Its magnitude is: $s_\beta = s_g \cdot \sin(\Delta\theta)$.

In the case of Figure 3 the β-indices have the orientation of the positive X-axis.

Applying the sine-rule to the triangle P_0P_1P, we obtain:

$$\frac{\sin(\Delta\theta)}{v \cdot \Delta t} = \frac{\sin\theta}{c \cdot \Delta t}$$

From which it follows:

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

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

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:

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

5. The Gravitational Induction (or the g-Induction) of a Mass Particle Moving with Constant Velocity

We consider again the situation of Figure 3. All informatons in dV—the volume element at P—carry both g-information and β-information. The β-information refers to the velocity of the emitting particle and is represented by the β-indices $\boldsymbol{s}_\beta$:

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

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

$$n \cdot \boldsymbol{s}_\beta \cdot \mathrm{dV} = n \cdot \frac{\boldsymbol{c} \times \boldsymbol{s}_g}{c} \cdot \mathrm{dV} = n \cdot \frac{\boldsymbol{v} \times \boldsymbol{s}_g}{c} \cdot \mathrm{dV}$$

So the density of the β-information (characteristic information per unit volume) at P is determined by:

$$n \cdot \boldsymbol{s}_\beta = n \cdot \frac{\boldsymbol{c} \times \boldsymbol{s}_g}{c} = n \cdot \frac{\boldsymbol{v} \times \boldsymbol{s}_g}{c}$$

We call this (time dependent) vectoral quantity—that will be represented by $\boldsymbol{B}_g$ (s^{-1})—the "*gravitational induction*" or the "*g-induction*" at P[3]. Its magnitude B_g determines the density of the β-information at P and its orientation determines the orientation of the β-indices $\boldsymbol{s}_\beta$ of the informatons passing near that point.

So, the g-induction caused by the moving particle with res mass m_0 (**Figure 3**) at P is:

$$\boldsymbol{B}_g = n \cdot \frac{\boldsymbol{v} \times \boldsymbol{s}_g}{c} = \frac{\boldsymbol{v}}{c} \times \left(n \cdot \boldsymbol{s}_g \right)$$

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

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

With $\boldsymbol{E}_g = N \cdot \boldsymbol{s}_g$, we can express the gravitational induction at P as:

$$\boldsymbol{B}_g = \frac{\boldsymbol{v}}{c^2} \times \left(N \cdot \boldsymbol{s}_g \right) = \frac{\boldsymbol{v} \times \boldsymbol{E}_g}{c^2}$$

Taking the result of §3 into account, we find:

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

We define the constant ν_0 as:

$$\nu_0 = \frac{1}{c^2 \cdot \eta_0} = 9.34 \times 10^{-27}\ \text{m} \cdot \text{kg}^{-1}$$

And finally, we obtain:

$$\boldsymbol{B}_g = \frac{\nu_0 \cdot m_0}{4\pi r^3} \cdot \frac{1-\beta^2}{\left(1-\beta^2 \cdot \sin^2 \theta\right)^{\frac{3}{2}}} \cdot \left(\boldsymbol{r} \times \boldsymbol{v} \right)$$

$\boldsymbol{B}_g$ at 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:

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

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

$$\boldsymbol{B}_g = \frac{\nu_0 \cdot m_0}{4\pi r^3} \cdot \left(\boldsymbol{r} \times \boldsymbol{v} \right)$$

This non-relativistic result could directly be obtained if one assumes that the

[3]also called "*gravitomagnetic induction*".

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.

So if $v \ll c$, $\boldsymbol{B}_g$ at P is perpendicular to the plane formed by P and the path of the mass particle; its orientation is defined by the rule of the corkscrew; and its magnitude is:

$$B_g = \frac{\nu_0 \cdot m_0}{4\pi r^2} \cdot v \cdot \sin\theta$$

6. The Gravitational Field of a Mass Particle Moving with Constant Velocity

A particle with rest mass m_0, moving with constant velocity $\boldsymbol{v} = v \cdot \boldsymbol{e}_z$ along the Z-axis of an IRF, creates and maintains an expanding cloud of informatons that are carriers of both g- and β-information. That cloud can be identified with a time dependent continuum. It is called the *gravitational field*[4] of the particle. It is characterized by two time dependent vectoral quantities: the gravitational field (short: *g-field*) $\boldsymbol{E}_g$ and the gravitational induction (short: *g-induction*) $\boldsymbol{B}_g$.

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

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

The magnitude of $\boldsymbol{E}_g$ is the rate per unit area at which g-information is crossing an elementary surface perpendicular to the orientation of the g-indices of the constituent informatons. It's clear that the direction of the flow of g-information at P is not the same as the direction of the flow of informatons.

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

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

The magnitude of $\boldsymbol{B}_g$ is the density of the cloud of β-information at P (amount of β-information per unit volume). The orientation of $\boldsymbol{B}_g$ is determined by the orientation of the β-indices of the constituent informatons.

One can verify that:

1. $div\, \boldsymbol{E}_g = 0$
2. $div\, \boldsymbol{B}_g = 0$
3. $rot\, \boldsymbol{E}_g = -\frac{\partial \boldsymbol{B}_g}{\partial t}$
4. $rot\, \boldsymbol{B}_g = \frac{1}{c^2} \cdot \frac{\partial \boldsymbol{E}_g}{\partial t}$

[4]Also called: "gravito-electromagnetic" (GEM field) or "gravito-magnetic" field (GM field).

These relations are the laws of Maxwell-Heaviside.

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

$$\boldsymbol{E}_g = -\frac{m_0}{4\pi\eta_0 r^3}\cdot\boldsymbol{r}, \quad \boldsymbol{B}_g = \frac{\nu_0\cdot m_0}{4\pi r^3}\cdot(\boldsymbol{r}\times\boldsymbol{v})$$

7. The Gravitational Field of a Set of Particles Moving with Constant Velocities

We consider a set of particles $m_1,\cdots,m_i,\cdots,m_n$ that move with constant velocities $\boldsymbol{v}_1,\cdots,\boldsymbol{v}_i,\cdots,\boldsymbol{v}_n$ relative to an IRF ***O***. It creates and maintains a gravitational field that in ***O*** at each point, is characterised by the vector pair ($\boldsymbol{E}_g$, $\boldsymbol{B}_g$).

1. Each mass m_i continuously emits g-information and contributes with an amount $\boldsymbol{E}_{gi}$ to the g-field at an arbitrary point *P*. As in [1] we conclude that the effective g-field $\boldsymbol{E}_g$ at *P* is defined as:

$$\boldsymbol{E}_g = \sum \boldsymbol{E}_{gi}$$

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

$$\sum\left(\boldsymbol{B}_{gi}\cdot \mathrm{d}V\right) = \left(\sum \boldsymbol{B}_{gi}\right)\cdot \mathrm{d}V$$

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

$$\boldsymbol{B}_g = \sum \boldsymbol{B}_{gi}$$

On the basis of the superposition principle we can conclude that the laws of Maxwell-Heaviside 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 of particles describing uniform rectilinear motions.

8. The Gravitational Field of a Stationary Mass Flow

The term "stationary mass flow" refers to the movement of a homogeneous and incompressible fluid that, in an invariable way, flows relative to an IRF. The intensity of the flow at an arbitrary point *P* is characterized by the flow density $\boldsymbol{J}_G$. The magnitude of this vectoral quantity at *P* equals the rate per unit area at which the mass flows through a surface element that is perpendicular to the flow at *P*. The orientation of $\boldsymbol{J}_G$ corresponds to the direction of that flow. So, the rate at which the flow transports—in the positive sense (defined by the orientation of the surface vectors $\mathrm{d}\boldsymbol{S}$)—mass through an arbitrary surface ΔS, is:

$$i_G = \iint_{\Delta S} \boldsymbol{J}_G \cdot \mathrm{d}\boldsymbol{S}$$

i_G is the *intensity of the mass flow through* ΔS.

Since a stationary mass flow is the macroscopic manifestation of moving mass elements $\rho_G\cdot \mathrm{d}V$, it creates and maintains a gravitational field. And since the velocity $\boldsymbol{v}$ of the mass element at a certain point is time independent, *the gravitational field of a stationary mass flow will be time independent*. It is evident that the rules for a static g-field [1] also apply for this time independent g-field:

1. $div\,\boldsymbol{E}_g = -\frac{\rho_G}{\eta_0}$
2. $rot\,\boldsymbol{E}_g = 0$ what implies: $\boldsymbol{E}_g = -grad\,V_g$

One can prove [2] [3] that the rules for the time independent g-induction are:

1. $div\,\boldsymbol{B}_g = 0$ what implies the existence of a vector gravitational potential function $\boldsymbol{A}_g$ for which $\boldsymbol{B}_g = rot\,\boldsymbol{A}_g$
2. $rot\,\boldsymbol{B}_g = -\nu_0 \cdot \boldsymbol{J}_G$

9. The Gravitational Interaction between Moving Objects

We consider a number of mass particles moving relative to an inertial reference frame ***O***. They create and maintain a gravitational field that at each point of the space linked to ***O*** is defined by the vectors $\boldsymbol{E}_g$ and $\boldsymbol{B}_g$. Each mass is "immersed" in a cloud of informatons carrying both g- and β-information. At each point, except at its own position, each particle contributes to the construction of that cloud.

Let us consider the particle with rest mass m_0 that, at the moment *t*, goes with velocity $\boldsymbol{v}$ through the point *P*.

1. If the other particles were not there $\boldsymbol{E}'_g$—the g-field in the immediate vicinity of m_0—would, according to §3, be symmetric relative to the carrier line of the velocity $\boldsymbol{v}$ of m_0. In reality that symmetry is disturbed by the g-information that the other particles send to *P*. $\boldsymbol{E}_g$, the instantaneous value of the g-field at *P*, defines the extent to which this occurs.

2. If the other particles were not there $\boldsymbol{B}'_g$—the g-induction near m_0—would, according to §5, "rotate" around the carrier line of the vector $\boldsymbol{v}$. The pseudo-gravitational-field $\boldsymbol{E}''_g = \boldsymbol{v} \times \boldsymbol{B}'_g$ defined by the vector product of $\boldsymbol{v}$ with the g-induction that characterizes the proper β-field of m_0, would also be symmetric relative to the carrier line of the velocity $\boldsymbol{v}$. In reality this symmetry is disturbed by the β-information send to *P* by the other particles. The vector product ($\boldsymbol{v} \times \boldsymbol{B}_g$) of the instantaneous values of the velocity of m_0 and the g-induction at *P*, characterizes the extent to which this occurs.

So, the *characteristic symmetry* of the cloud of g-information around a moving particle (the proper gravitational field) is in the immediate vicinity of that particle disturbed by $\boldsymbol{E}_g$ regarding the proper g-field and by ($\boldsymbol{v} \times \boldsymbol{B}_g$) regarding the proper β-induction.

If it is free to move, the particle m_0 could restore the characteristic symmetry in its immediate vicinity by accelerating—relative to its proper IRF ***O'***—with an amount $\boldsymbol{a}' = \boldsymbol{E}_g + \left(\boldsymbol{v} \times \boldsymbol{B}_g\right)$. In that manner it would become "blind" for the disturbance of symmetry of the gravitational field in its immediate vicinity. These insights form the basis of the following postulate.

A particle with rest mass m_0, moving with velocity $\boldsymbol{v}$ in a gravitational field ($\boldsymbol{E}_g, \boldsymbol{B}_g$), tends to become blind for the influence of that field on the symmetry of its proper gravitational field. If it is free to move, it will accelerate relative to *its proper inertial reference frame with an amount* $\boldsymbol{a}'$:

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

10. The Gravitational Force Law

The action of the gravitational field ($\boldsymbol{E}_g, \boldsymbol{B}_g$) on a particle with rest mass m_0 that is moving with velocity $\boldsymbol{v}$ relative to the IRF ***O***, is called the *gravitational force* $\boldsymbol{F}_G$ on that particle. In extension of [1] we define $\boldsymbol{F}_G$ as:

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

If it is free to move, the effect of $\overline{F}_G$ on a particle with rest mass m_0 is that this will be accelerated relative to the its proper IRF ***O'*** with an amount $\boldsymbol{a}'$:

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

This acceleration can be decomposed in a tangential ($\boldsymbol{a}'_T$) and a normal component ($\boldsymbol{a}'_N$):

$$\boldsymbol{a}'_T = a'_T \cdot \boldsymbol{e}_T \quad \text{and} \quad \boldsymbol{a}'_N = a'_N \cdot \boldsymbol{e}_N$$

where $\boldsymbol{e}_T$ and $\boldsymbol{e}_N$ 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 and a'_N in function of the characteristics of the motion relative to the IRF ***O*** [4]:

$$a'_T = \frac{1}{\left(1-\beta^2\right)^{\frac{3}{2}}} \cdot \frac{\mathrm{d}v}{\mathrm{d}t} \quad \text{and} \quad a'_N = \frac{v^2}{R \cdot \sqrt{1-\beta^2}}$$

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

The gravitational force is:

$$\boldsymbol{F}_G = m_0 \cdot \boldsymbol{a}' = m_0 \cdot \left(a'_T \cdot \boldsymbol{e}_T + a'_N \cdot \boldsymbol{e}_N\right)$$

$$= m_0 \cdot \left[\frac{1}{\left(1-\beta^2\right)^{\frac{3}{2}}} \cdot \frac{\mathrm{d}v}{\mathrm{d}t} \cdot \boldsymbol{e}_T + \frac{1}{\left(1-\beta^2\right)^{\frac{1}{2}}} \cdot \frac{v^2}{R} \cdot \boldsymbol{e}_N\right] = \frac{\mathrm{d}}{\mathrm{d}t}\left[\frac{m_0}{\sqrt{1-\beta^2}} \cdot \boldsymbol{v}\right]$$

With:

$$\frac{m_0}{\sqrt{1-\beta^2}} \cdot \boldsymbol{v} = \boldsymbol{p}$$

We finally obtain:

$$\boldsymbol{F}_G = \frac{\mathrm{d}\boldsymbol{p}}{\mathrm{d}t}$$

$\boldsymbol{p}$ is the linear momentum of the particle relative to the IRF ***O***. It depends on the relativistic mass m op the particle:

$$m = \frac{m_0}{\sqrt{1-\beta^2}}$$

In §2 it has been showed that m is the parameter of the mass particle that determines the rate at which it emits informatons relative to its proper IRF. Thus it is representative for the density of the cloud of informatons generated in that IRF and thus for the ability to persist in its dynamic state. It is a measure for its inertia.

11. The Interaction between Two Moving Particles

Two particles with rest masses m_1 and m_2 (**Figure 4**) are anchored in the IRF $\boldsymbol{O'}$ that is moving relative to the inertial reference frame $\boldsymbol{O}$ with constant velocity $\vec{\boldsymbol{v}} = \boldsymbol{v} \cdot \vec{e}_z$. The distance between the masses is *R.*

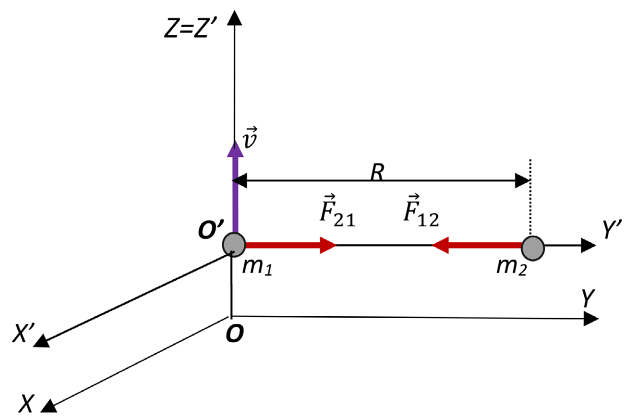

Figure 4. The gravitational interaction between moving particles.

According to §6, the components of the gravitational field created and maintained by m_1 at the position of m_2 are—in magnitude—determined by:

$$E_{g2} = \frac{m_1}{4\pi\eta_0 R^2} \cdot \frac{1}{\sqrt{1-\beta^2}}$$

$$B_{g2} = \frac{m_1}{4\pi\eta_0 R^2} \cdot \frac{1}{\sqrt{1-\beta^2}} \cdot \frac{v}{c^2}$$

$\boldsymbol{E}_{g2}$ points to the position of m_1 and $\boldsymbol{B}_{g2}$ points in the direction of the X-axis.

And according to the force law F_{12}, the magnitude of the force exerted by the gravitational field ($\boldsymbol{E}_{g2}, \boldsymbol{B}_{g2}$) on m_2—this is the attraction force of m_1 on m_2—is:

$$F_{12} = m_2 \cdot \left(E_{g2} - v \cdot B_{g2}\right)$$

After substitution:

$$F_{12} = \frac{1}{4\pi\eta_0} \cdot \frac{m_1 m_2}{R^2} \cdot \sqrt{1-\beta^2} = F'_{12} \cdot \sqrt{1-\beta^2}$$

with:

$$F'_{12} = \frac{1}{4\pi\eta_0} \cdot \frac{m_1 m_2}{R^2}$$

the magnitude of the force that m_1, according Newtons universal law of gravitation, in the IRF $\boldsymbol{O'}$—where both particles are at rest—exerts on m_2.

In the same way we find:

$$F_{21} = \frac{1}{4\pi\eta_0} \cdot \frac{m_1 m_2}{R^2} \cdot \sqrt{1-\beta^2} = F'_{12} \cdot \sqrt{1-\beta^2}$$

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

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

This result perfectly agrees with that based on S.R.T. Indeed, relative to $\boldsymbol{O'}$ the particles are at rest. According to Newton's law of universal gravitation, they exert on each other equal but opposite forces:

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

Relative to $\boldsymbol{O}$ both masses are moving with constant speed v in the direction of the Z-axis. From the transformation equations between an inertial frame $\boldsymbol{O}$ and another inertial frame $\boldsymbol{O'}$, in which a point mass experiencing a force F' is instantaneously at rest, we can immediately deduce the force F that the point masses exert on each other in $\boldsymbol{O}$ *[4]*:

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

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

It can be shown that the β-information emitted by moving gravitating objects is responsible for deviations (as the advance of Mercury Perihelion) of the real orbits of planets with respect to these predicted by the classical theory of gravitation [5].

12. Conclusions

A mass particle moving relative to an inertial IRF $\boldsymbol{O}$ is the emitter of informatons that are carriers of information regarding the positon (g-information) and regarding the velocity (β-information) of their source. As a result, the gravitational field, of a moving mass particle (and by extension of a set of moving particles, a moving material object and a mass flow) manifests itself at the macroscopic level in $\boldsymbol{O}$ as a dual entity, always having a field- and an induction component ($\boldsymbol{E}_g$ and $\boldsymbol{B}_g$) simultaneously created by their common sources.

The interaction between material objects in that field is made possible by the intermediation of the gravitational field. An object in a gravitational field tends to become blind for that field. It experiences a force described by a Lorentz like law.

Thus, it is clear that the kinematics of the gravitating objects play a role in the gravitational phenomena. This is taken into account in the framework of the gravitoelectromagnetic description of gravitation [6] [7] (GEM) where the idea is developed that the gravitational field must be isomorphic with the electromagnetic field in a vacuum.

Because the role of the kinematics of the gravitating objects is not relevant when the speed of the object is small relative to the speed of light, this phenomenon is not taken into account in the "classical" description of the gravitational phenomena and laws.

13. Epilogue

In the follow-up article "*The Maxwell-Heaviside Equations Explained by the Theory of Informatons*" we mathematically deduce the Maxwell-Heaviside equations from the kinematics of the informatons. That deduction indicates that there is no causal link between $\boldsymbol{E}_g$ and $\boldsymbol{B}_g$.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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