Article

The Nature of the Gravitational Field

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Abstract

In this article we show that the introduction of g-information as the substance of the gravitational field and the hypothesis that the constitutive elements of this substance are informatons, permits to explain the - by experiments confirmed - nature of that field.

Key words: informatons, gravitation, gravito-electromagnetism.

INTRODUCTION

In previous articles [(1), (2), (3)] published in *Prespacetime Journal*, we have shown that it is possible to explain the phenomena and to deduce the laws of gravito-electromagnetism (GEM) and of electromagnetism (EM) by introducing "information" as the substance of the gravitational and of the electromagnetic field.

We have explained all aspects of the gravitational and of the electromagnetic interactions starting from the idea that any material object manifests itself in space by continuously emitting - at a rate proportional to its rest mass - dot shaped entities. Relative to an inertial reference frame, these entities transport - at the speed of light - information about the position ("g-information"), about the electrical charge if this is the case ("e-information"), and about the velocity ("β-information", "b-information") of the emitter. Carrying nothing but information, they are called "informatons".

It has been shown that gravitational and electromagnetic fields may be interpreted as the macroscopic manifestations of the attributes of the informatons. The physical quantities - "field" ($\vec{E}_g / \vec{E}$) and "induction" ($\vec{B}_g / \vec{B}$) - that characterize a gravitational/electromagnetic field determine respectively the density of the flow of g/e-information and the density of the cloud of β/b-information in any point of that field. The mathematical relations (G.E.M.-equations/ Maxwell's equations) governing these quantities, are deduced from the dynamics of the informatons.

In this article we will show that the expansion of the arsenal of fundamental physical concepts with the concept "information", and the hypothesis that information is carried by "informatons" leads to a theory ("the theory of informations") that reveals the nature of the gravitational field and that explains the characteristics of that field.

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I. THE GRAVITATIONAL FIELD OF A POINT MASS AT REST

According to the fundamental postulate [1] of the theory of informatons a point mass that is anchored in a point (e.g. the origin *O*) of an inertial reference frame ***O***, manifests itself in space by emitting informatons at a rate $\dot{N}$ that is proportional to its rest mass *m*: $\dot{N} = \frac{c^2}{h}.m = K.m$ (*h* is Planck's constant).

These informatons are entities that propagate at the speed of light (*c*) along orbits that are radial relative to the emitter. Informatons transport the elementary g-information quantity $s_g = \frac{4.\pi.G}{K} = \frac{1}{K.\eta_0}$ (*G* is the gravitational constant) and their essential attribute is the g-spin vector $\vec{s}_g$. This vectorial quantity, with magnitude s_g, points to the position of the emitter *m*.

The expanding spherical cloud of informatons around *m* is called the "*gravitational field*" of *m*. In an arbitrary point *P* the gravitational field of *m* is macroscopically characterized by the density of the flow of g-information in the immediate vicinity and by the orientation of the g-spin vectors of the informatons passing near. So - if *N* represents 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 gravitational field of *m* is completely determined by the vectorial quantity $\vec{E}_g = N.\vec{s}_g$, that points to the position of *m* and that represents the density of the flow of g-information in *P* (the rate per unit area at which g-information flows through an elementary surface perpendicular to the direction of the flow). $\vec{E}_g$ is called the "*g-field*" in *P*. The definition of g-field can easily be extended to situations where the gravitational field is generated by a set of point masses at rest or/and by a mass continuum.

1. **Gravitational phenomena propagate with the speed of light.** This is a direct consequence of the fact that - relative to an inertial reference frame - informatons move at the speed of light.

2. **The gravitational field is granular.** This is evident, because the elementary building blocks - the informatons - are g-information grains. Macroscopically, the granular character of the field can be neglected because of the high density of the cloud of informatons.

3. **The gravitational field continuously regenerates.** The informatons that constitute the field in *ΔV* - any volume element of space - are continuously replaced: indeed, they fly through the volume element. So, *ΔV* contains g-information that is continuously regenerating.

4. **The gravitational field shows fluctuations.** Because the emission of informatons by *m* is a stochastic process ($\dot{N} = K.m$ is the average emission rate), the rate at which informatons cross an elementary surface that in *P* is perpendicular to the direction of movement, fluctuates. This implies that there is noise on the g-field $\vec{E}_g$.

5. **The gravitational field expands with the speed of light.** The surface of the spherical cloud of informatons that is generated and maintained by *m* moves away from the emitter at the speed of light.

6. **In a gravitational field, there is conservation of g-information.** The source of g-information is mass. In a point *P* of an inertial reference frame, a mass continuum is macroscopically characterized by the mass density ρ_G. The rate at which g-information flows out through a closed surface equals the rate at which g-information is generated in the space enclosed by that surface. Mathematically, this can be expressed as a relation between the spatial variation of the g-field $\vec{E}_g$ and the mass density ρ_G in *P*: $div\vec{E}_g = -\frac{\rho_G}{\eta_0}$.

II. THE GRAVITATIONAL FIELD OF A MOVING POINT MASS

An informaton emitted by a point mass *m* that - relative to an inertial reference frame ***O*** - describes a uniform rectilinear motion with velocity $\vec{v}$, follows a rectilinear path that starts at the point P_0 where *m* was at the moment of emission. Because the velocity $\vec{c}$ of that informaton coincides with its path, $\vec{c}$ points away from P_0. On the other hand, the spin vector $\vec{s}_g$ of the informaton at any time points to P_1, the actual position of its emitter. So, the line carrying $\vec{s}_g$ no longer coincides with the line carrying $\vec{c}$: they form an angle $\Delta\theta$ whose sine is characteristic for the speed of *m* [(1)]. For that reason, we call $\Delta\theta$ the "characteristic angle" of the informaton and the quantity $s_\beta = s_g.\sin(\Delta\theta)$ its "characteristic g-information" or its "β-information".

It can be concluded that an informaton emitted by a uniformly moving mass *m* transports not only information about the position of *m* ("g-information"), but also about its velocity $\vec{v}$ ("β-information"). So, it must be characterized by two attributes:

- The g-spin vector $\vec{s}_g$, that at any time, points to the actual position of the emitter *m*.
- The β-index $\vec{s}_\beta = \frac{\vec{c} \times \vec{s}_g}{c}$, that crosses the path of the emitter *m* at right angles and whose magnitude is the β-information of the informaton. It can be shown that $\vec{s}_\beta = \frac{\vec{v} \times \vec{s}_g}{c}$.

It follows that in an arbitrary point *P* of an inertial reference frame ***O***, the gravitational field of a moving point mass macroscopically is characterized by two vectorial quantities: the density of the flow of g-information and the density of the cloud of β-information.

If *N* represents 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* represents the density of the cloud of informatons in that point (number of informatons per unit volume), the gravitational field in *P* is completely determined by:

- $\vec{E}_g = N.\vec{s}_g$, the "*g-field*"
- $\vec{B}_g = n.\vec{s}_\beta$, the "gravitational induction" or the "*g-induction*"*.

Complementary to those listed in §I, 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.** This is an obvious consequence of the fact that the g-spin vector of the informatons emitted by that mass always points to the actual position of the emitter. This implies that in a point of a gravitational field generated by a moving mass *m*, the g-field does not point in the direction in which *m* is seen (that is its light-delayed position) , but in that where *m* really is.

8. **The g-induction $\vec{B}_g$ shows fluctuations**. The reason for this phenomenon is the same as that for the phenomenon mentioned under 4.

9. **From the definition of the β-index, it follows**: $div\vec{B}_g = 0$. This relation is the expression of the fact that the β-index $\vec{s}_\beta$ of an informaton is always perpendicular to its velocity $\vec{c}$.

10.**The spatial variation of the g-induction in a point of a gravitational field depends on the density 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 source of β-information is moving mass. In a point of an inertial reference frame, a continuous mass flow is macroscopically characterized by the mass flow density $\vec{J}_G$. The relation $rot\vec{B}_g = -\nu_0.\vec{J}_G$ expresses how the generation of β-information in a point is affecting the gravitational induction in that point.

III. GENERALIZATION

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

* The quantity is also called the "co-gravitation" or the "gyrotation".

$\vec{B}_g$ - the g-induction in a point *P* of a gravitational field - is the superposition of the contributions $\vec{B}_{gi}$ of the various moving masses m_i that send informatons to *P*. Taking into account the definition of g-induction, a change of $\vec{B}_{gi} = n_i.\vec{s}_{\beta i}$ in *P* is the macroscopic manifestation of a change of n_i - the density in *P* of the cloud of informatons due to m_i - and/or of a change of $\vec{s}_{\beta i}$ - the β-index in *P* of these informatons. A change of n_i implies that the density N_i of the flow of informatons into the volume element ΔV in *P* differs from the density of the outward flow; and a change of $\vec{s}_{\beta i}$ is associated with a change in the orientation of the g-spin vectors $\vec{s}_{gi}$ of the informatons emitted by m_i that pass in *P*. We conclude that a change of $\vec{B}_{gi}$ in *P* always is accompanied by a spatial variation of $\vec{E}_{gi} = N_i.\vec{s}_{gi}$ in the direct vicinity of *P*, what mathematically is expressed by the relation 11,a. An analogous argument shows that a change of $\vec{E}_{gi}$ in *P* always is accompanied by a spatial variation of $\vec{B}_{gi}$, what is expressed by the relation 11,b.

12.**There is a perfect isomorphism between the gravitational field and the electromagnetic field.** From 6, 9, 10, 11, it follows that 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. $rot\vec{B}_g = -\nu_0.\vec{J}_G + \frac{1}{c^2}.\frac{\partial \vec{E}_g}{\partial t}$

These equations - "the laws of gravito-electromagnetism" or the "laws of G.E.M." [(4), (5)] - are completely analogous to "Maxwell's laws" [(2), (3)] or Maxwell's equations for the electromagnetic field. The isomorphism between a gravitational and an electromagnetic field is a direct consequence of the fact that, according to the theory of informatons, "information" is the substance of both: the laws of G.E.M. as well as the laws of Maxwell are deduced from the behavior of the informatons, that are the elementary constituents of both types of fields.

III. THE GRAVITATIONAL INTERACTION (6)

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

The gravitational field generated by a mass *m* anchored in a point *P* of an inertial reference frame ***O*** shows spherical symmetry relative to *P*: in all points of a spherical surface with centre *P* the g-field has the same magnitude and points to *m*. When, together with *m*, there are other masses in ***O*** this “characteristic symmetry” get lost and the extent to which this happens in the direct vicinity of *m* is all the greater as $\vec{E}_g$ - the “extern” g-field in *P*, this is the g-field caused by the other masses in ***O*** - is stronger. If *m* was free to move, it could restore the characteristic symmetry of the g-information cloud in its direct vicinity by accelerating relative to ***O*** with an amount $\vec{a} = \vec{E}_g$. Indeed, by reacting in this way the extern field disappears in the origin of the accelerating reference frame anchored to *m*, and *m* becomes blind for the disturbance of the spherical symmetry of its “eigen” field by the flow of g-information caused by the other masses in ***O***.

The gravitational field generated by a mass *m*, that at the moment *t*, passes with velocity $\vec{v}$ in the point *P* of an inertial reference frame ***O*** has two components: the g-field $\vec{E}_g^{'}$ and the g-induction $\vec{B}_g^{'}$. In the direct vicinity of *P*, the quantity $[\vec{E}_g^{'} + (\vec{v} \times \vec{B}_g^{'})]$ shows circular symmetry relative to the line that carries $\vec{v}$: $[\vec{E}_g^{'} + (\vec{v} \times \vec{B}_g^{'})]$ has the same magnitude and points to $\vec{v}$ in all points of a circle in a plane that is perpendicular to $\vec{v}$ and whose centre is on the carrier of $\vec{v}$. When, together with *m*, there are other moving masses in ***O*** this “characteristic symmetry” - due to the influence of the extern gravitational field $(\vec{E}_g, \vec{B}_g)$ - get lost and the extent to which this happens in the direct vicinity of *m* is all the greater as $[\vec{E}_g + (\vec{v} \times \vec{B}_g)]$ is stronger. *m* can restore the characteristic symmetry in its direct vicinity by accelerating relative to the eigen inertial reference frame - that is the reference frame ***O’*** that relative to ***O*** moves with velocity $\vec{v}$ - with an amount $\vec{a}' = \vec{E}_g + (\vec{v} \times \vec{B}_g)$.

We conclude: a gravitational field ($\vec{E}_g, \vec{B}_g$) exerts an action on a, whether or not moving, point mass *m.* If it is free to move, that action forces *m* to accelerate and to become blind for the disturbance of the characteristic symmetry of the gravitational field in its direct vicinity. That action is called the gravitational force on *m* and represented by $\vec{F}_G$. It is proportional to m_0 - the rest mass of *m* - and to $\vec{a}'$ - the acceleration that the point mass makes blind for the disturbance. If the mass moves with velocity $\vec{v}$, $\vec{F}_G$ is defined as: $\vec{F}_G = m_0.\left[\vec{E}_g + (\vec{v} \times \vec{B}_g)\right]$

* This expression of the gravitational force perfectly agrees with S.R.T. (3). This is not the case for the expression $\vec{F}_G = m_0.\left[\vec{E}_g + 2.(\vec{v} \times \vec{B}_g)\right]$ that is proposed in the version of gravito-electromagnetism deduced from the linearized form of G.R.T.

EPILOGUE

1. Because of the isomorphism between the gravitational and the electromagnetic field, statements analogue to 1, …, 13 characterize the nature of the electromagnetic field.

2. Photons and gravitons can be considered as informatons carrying an energy packet. This assumption explains phenomena related to the gravitational and the electromagnetic field generated by accelerated masses or charges [(3)].

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 "g-information" is the substance of the gravitational field and it supports the idea that informatons really exist.

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