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Gravitational Waves in Vectorial Relativity

J A Franco R

ABSTRACT: in this work it has been arrived at some considerations, coming from the resulting equations and from the logical line of the followed reasoning that conclude with the strong declaration of which the gravitational waves do not exist!

KEYWORDS: Gravitational Waves, Maxwell Equations, Photon, Vectorial Relativity.

I INTRODUCTION

After Einstein's paper was published in 1916, in which gravitational waves were theoretically predicted, it was about all that was heard on the subject for many years. Sir Arthur Eddington, who became one of the strongest supporters of the new theory was skeptical at this respect and reportedly commented, "Gravitational waves propagate at the speed of thought." Similarly, some physicists thought that the predicted gravitational waves were simply consequence of another possible mathematical artifact allowed to construct inside this theory.

However, it was not until 1959 that the relativity physicist, H. Bondi brought about again to the discussion that gravitational radiation could be a physically observable phenomenon [1], with gravitational waves carrying energy, and consequently concluding that a system emitting gravitational waves should lose energy.

Moreover, In 1974 R. A. Hulse and J. H. Taylor of Princeton University did a discovery for which they were awarded the 1993 Nobel Prize in Physics. They detected pulsed radio emissions coming from a rapidly rotating, highly magnetized binary pulsar, whose orbit has evolved since the binary system was initially discovered, in agreement with the loss of energy due to gravitational waves predicted by Einstein's General Theory of Relativity [2].

Since the 1990s technology has become powerful enough to permit detecting them and harnessing them for science. For these purposes the Laser Interferometer Gravitational-Wave Observatory (LIGO) was designed and constructed by a team of scientists from the California Institute of Technology and the Massachusetts Institute of Technology. Construction of the facilities was completed in 1999. Initial operation of the detectors was scheduled for 2001 and it is currently operating.

Additionally, the Laser Interferometer Space Antenna (LISA) is another next-generation project proposed by NASA to detect some of the weakest gravitational waves. The project uses the

[2]Independent Researcher, Caracas, Venezuela, jafrancor@yahoo.com

scientific technique of laser interferometry. LISA is expected to launch in 2011, with a mission life of about 5 years.

In spite of all these efforts, the gravitational radiation has still not been detected!

In this sense, in this work we have arrived at some considerations coming from equations and from a logical line of reasoning that conclude with the strong statement that indeed Gravitational Waves could not exist!

In section II, it is shown that the total effect of magnetic, electric and gravitational fields on a neutral and pure mass m is only given by the gravitational field. In section III, it is shown how the gravitational field on a pure charge q produces a null effect. In section IV, it is shown the photon duality wave-particle character. In section V, it is shown the same duality wave-particle character for any mass. In section VI, it is shown that because the curl of the gravitational field produced by a mass M on a moving mass m is null, then gravitational waves do not exist. In section VII it is calculated the Divergence of the Gravitational field to complete the vectorial definition of Gravitational Field. And, in section VIII it is presented the Curl and the Divergence of the Gravitational Field as two more equations to being added to the well-known equations of Maxwell.

II EFFECT OF THE ELECTRIC, MAGNETIC AND GRAVITATIONAL FIELDS ON A NEUTRAL MASS m.

Let's start saying that a moving mass m at velocity v under the effect of a varying gravitational and central field, produced by another "fixed" mass M, the acting force $\mathbf{F}$ (according to obtained results in [3]) is given by:

$$\mathbf{F} = m.\mathbf{G} = -m.\frac{\dfrac{2.G.M}{r^2}.\dfrac{v}{V_0} - v.\dfrac{dv}{dr}.\left(\dfrac{p_0}{p} - \dfrac{p}{p_0}\right)}{\left(\dfrac{p}{p_0} + \dfrac{p_0}{p}\right)}\mathbf{U_r}\,; \quad \mathbf{G} = -\frac{\dfrac{2.G.M}{r^2}.\dfrac{v}{V_0} - v.\dfrac{dv}{dr}.\left(\dfrac{p_0}{p} - \dfrac{p}{p_0}\right)}{\left(\dfrac{p}{p_0} + \dfrac{p_0}{p}\right)}\mathbf{U_r} \qquad (1)$$

But, if mass m is also under a magnetic field $\mathbf{B}$ and also under an electric field $\mathbf{E}$, both varying or time-dependent, in which the mass m is a neutral particle (or that each atom has charges $+q$ and $-q$, equilibrated), the total acting force over the total charges +Q and -Q of all atoms of mass m becomes:

$$\mathbf{F} = m.\mathbf{G} + Q.(\mathbf{E} + \mathbf{vxB}) - Q.(\mathbf{E} + \mathbf{vxB}) = m.\mathbf{G} \qquad (2)$$

Say, the external magnetic and electric fields have a null effect on the neutral mass (let's discard the electric and magnetic dipole effect, because it will be considered irrelevant for this analysis).

This means that the total effect on the mass m is only given by the gravitational field $\mathbf{G}$.

III EFFECT OF THE ELECTRIC, MAGNETIC AND GRAVITATIONAL FIELDS ON A PURE CHARGE +q.

This is the case of a pure charge $+q$ moving at speed v, not similar to the previous one. On the contrary, as it is known, the force of these three fields on such charge $+q$, is reduced and only given by:

$$\mathbf{F} = q.(\mathbf{E} + \mathbf{vxB}) \tag{3}$$

Say, there is a null effect of the gravitational field on the charge $+q$. Thus, we can say that the total electromagnetic field acting on the charge $+q$, $\mathbf{EM}$, is given by:

$$\mathbf{EM} = \mathbf{F} / q = \mathbf{E} + \mathbf{vxB} \tag{4}$$

With this example, we only tried to emphasize on the different behavior between a mass m and a charge $+q$ when they are under the effect of these three fields.

IV PHOTON HAS A MASS AND AN ELECTROMAGNETIC WAVE SIMULTANEOUSLY

Now we will analyze the field produced by a moving particle of mass, for instance, the case of photon, which is a neutral particle, with a mass given by $m = p / c$, its kinetic energy $K = m.c^2$, which can also be represented by the Planck's constant h times the frequency ν of an electromagnetic wave, $K = h.\nu$. From here, we can realize and observe that the neutral mass of a photon has associated an electromagnetic wave, or, time-dependent electric and magnetic fields, when it moves. But, how a time-varying electromagnetic field can be produced by a neutral particle of mass?. That is a good question to start with. But by now, I don't know how this works. This transcendent fact actually leads us to suspect or think about the inherent unification of the effects of all fields around a particle. Let's follow this aspect to see what we can reach!.

For photon, We know that its neutral mass character and the electric and magnetic fields of its associated electromagnetic wave, meet the wave equation through its speed c:

$$\frac{\partial^2 \mathbf{E}}{\partial t^2} - c^2.\nabla^2 \mathbf{E} = 0 \, ; \qquad \frac{\partial^2 \mathbf{B}}{\partial t^2} - c^2.\nabla^2 \mathbf{B} = 0 \tag{5}$$

This implies that Faraday's Law holds:

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \tag{6}$$

And also its counterpart equation, in the absence of a current and free space,

$$c^2.\nabla \times \mathbf{B} = \frac{\partial \mathbf{E}}{\partial t} \qquad (7)$$

V ANY MOVING MASS m HAS ALSO AN ELECTROMAGNETIC WAVE SIMULTANEOUSLY ASSOCIATED, SIMILAR TO PHOTON

We had observed for photon its dual character of particle and wave when it is in movement, in which the kinetic energy could be expressed either as in its relativistic presentation $K = m.c^2$ (particle character), or as $K = h.\nu$ (wave character). We have established in previous work [4] *Energy in Vectorial Relativity, E≈ m.c²* that any mass has associated an electromagnetic wave, in which, Kinetic Energy can be expressed as $K = m.(2.v^2 - c^2) + M_0.c^2$, and the magnetic and electric fields of such wave would meet the wave equation through its speed v:

$$\frac{\partial^2 \mathbf{E}}{\partial t^2} - v^2.\nabla^2 \mathbf{E} = 0 \, ; \qquad \frac{\partial^2 \mathbf{B}}{\partial t^2} - v^2.\nabla^2 \mathbf{B} = 0 \qquad (8)$$

Similarly meeting:

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \, ; \qquad v^2.\nabla \times \mathbf{B} = \frac{\partial \mathbf{E}}{\partial t} \qquad (9)$$

This way of reasoning would lead us to establish the following two statements:

1) The product of the momentum of a moving mass times its wavelength, the same as with photons, preserves constant expressed through the Planck's constant, as $k = p.\lambda$, where λ is the wavelength of the associated electromagnetic wave.

2) Then, this implies that the Energy relationship expressed through the Planck's constant h and the frequency of the associated electromagnetic wave ν would not longer be true. In other words, $E \neq k\nu$, for particles or bodies with non-null rest mass, different to what happens with photons. ***The contrary to this fact is what has been assumed until now in Physics***. Moreover, This statement would correct the old mathematical-physics paradox of kinetic energy of any mass: $\frac{m.v^2}{2}$ and the similar to that of photon: $K = h.\nu = (p.\lambda).(v/\lambda) = (p).(v) = m.v^2$. As it is observed, this result doubles the correct value. (In fact, as we have obtained before, $K = h.\nu$ is only valid for null rest mass, $M_0 = 0$, and speed $v = c$).

In sum, the relationship between the relativistic kinetic energy and the electromagnetic wave, according to us, should be written as:

$$K = m.(2.v^2 - c^2) + M_0.c^2 = 2.m.v^2 - m.c^2 + M_0.c^2 = 2.\frac{p^2}{m} - c^2.(m - M_0) \tag{10}$$

By forming total energy E**,** including the kinetic, the internal and the potential energy, for ensuring that E preserves constant in any case (including those cases where part of the internal energy converts to any other kind of energy, or there are energy-mass interchanges), and acquiring the expression of momentum, we have:

$$E = K + M_0.c^2 + E_p = 2.m.v^2 - m.c^2 + 2.M_0.c^2 = 2.\frac{p^2}{m} - c^2.(m - 2.M_0) + E_p \tag{11}$$

From previous equation we obtain a suitable expression of the linear momentum:

$$p^2 = \frac{E - E_p + c^2.(m - 2.M_0)}{2}.m \tag{12}$$

These different results obtained here force us to do a revision to Quantum Mechanics, because this discipline strongly depends on the "general" validity of the Energy expression $K = h.\nu$. Moreover, previous relationship is extremely important for correctly deriving Schrödinger's equation. ***See our proposal of reviewing*** Quantum Mechanics in the article *Energy in Vectorial Relativity, E≈ m.c²* appeared in previous journal (JVR **1** (2006) 43-55).

VI CURL OF THE GRAVITATIONAL FIELD PRODUCED BY A MASS M

On the other hand, we had said, and shown in [3], that the gravitational field $\mathbf{G}$, generated by a mass M and acting on a moving mass m, at speed v (relative to M), **is central** and has an almost general expression, with no other terms given by:

$$\mathbf{G} = -\frac{\frac{2.G.M}{r^2}.\frac{v}{V_0} - v.\frac{dv}{dr}.\left(\frac{p_0}{p} - \frac{p}{p_0}\right)}{\left(\frac{p}{p_0} + \frac{p_0}{p}\right)}\mathbf{U_r} \tag{13}$$

Remember that we had observed in [3] that this expression in a radial movement of mass m the Gravitational Field becomes Newton's definition, $\mathbf{G} = -\frac{G.M}{r^2}\mathbf{U_r}$. These concepts had led us to obtain consistent results. As it can be shown, the gravitational field $\mathbf{G}$, in general (static or time-varying), can be represented by the gradient of a potential function: ∇V, where $V = \frac{E_p}{M}$ is the gravitational potential and E_p the potential energy. Gradient of the potential function in a spherical surface is directed perpendicular to such surface and parallel to radius. It implies that because vectorial product of two parallel vectors is null:

$$\nabla \times \mathbf{G} = \nabla \times (\nabla V) = \nabla \times \nabla V = 0 \qquad (14)$$

But, we had observed that there is an associated electromagnetic wave to the moving mass. And, it is apparent that the Gravitational field doesn't depend on other variables such as $\mathbf{B}$ or $\mathbf{E}$. It would seem that the mathematical consideration of a fact like this could be expressed through an equation that we will, on purpose, propose in order to seek for some interrelationship among the three fields, trying to be dimensionally consistent, is expressed in the following manner:

$$\nabla \times \mathbf{G} = \frac{q}{M}.(\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t}) = 0 \qquad (15)$$

Through this equation, we could establish that a moving mass originates time-varying electric and magnetic fields in such a way that their effects lead to the curl of its gravitational field be null. But, in where, the relationship between Electric and Magnetic fields (Faraday's law) preserves intact, with no other additional terms that modify its expression. The existence of these time-varying Electric and Magnetic fields with such features determine completely an electromagnetic wave; this way of interpreting such equation, preserves the classic and accepted way of deriving the wave equation for the photon through its speed c, as we know it. Also, the same way of derivation of the wave equation could be applied to the case of the moving mass through its speed v, as it was previously suggested.

The result, that the curl of the time-varying gravitational field, produced by a moving mass m, be numerically null, but implicitly related to the existing time-varying electric and magnetic fields as the unique contributors to the total kinetic energy of mass m, leads us to establish a **third** statement (as a consequence of such result): **Gravitational waves should not exist!.**.

Comment 1: A fact that also had led us to suspect the consistence of this statement, is that the total energy of photon is completely and exactly determined by the energy of the electromagnetic wave, $K = h.\nu = m.c^2$, which is only associated with the energy conveyed by the electric and by the magnetic fields. As it is known, half and half of this energy are conveyed by each field, respectively. If gravitational waves had existed there, they should have been present (in some way) in the total kinetic energy expression, as the energy conveyed by the gravitational field produced by the photon, say, as part of that total energy, but this fact has not been registered anytime, as in this case.

Comment 2: At the maximum speed that any particle "can develop", c, the contribution of the gravitational field to the total energy of the photon must be noticeable, if such gravitational energy contribution had existed. Then, the correctness of the third statement seems to be ensured by the result, $\nabla \times \mathbf{G} = 0$.

Comment 3: If in the worked formulas or equations the Curl of the Gravitational field hadn't been null, it should have been related to the Electric or Magnetic field in some way. In such case, it would have implied that, either it was separately related to the Electric field, but because of the existing relationship between the magnetic and Electric fields, it also will be related separately to the magnetic field, implying that the kinetic energy of the moving mass can be equally represented by the energy conveyed also by the Gravitational field alone, a thing that has not been observed nor experimentally measured or demonstrated, or it is related simultaneously to the magnetic and electric fields, introducing new constraints to the shape of the magnetic and electric fields (which are already determined by their curls and divergences), things that would lead to inconsistent results. In sum, it is evident that, in general, the only way that the law of Faraday holds and that both halves of the kinetic energy are transported so much by the electric field as by the magnetic field, as is known in the world of the physics, is that $\nabla \times \mathbf{G} = 0$. So, because all previous arguments arrive at the same conclusion: Curl of the Gravitational field is null, it implies a null energy contribution of gravitational waves to the total conveyed energy by a particle and the obliged conclusion that **if no gravitational energy contribution exists gravitational waves do not exist.**

VII DIVERGENCE OF THE GRAVITATIONAL FIELD PRODUCED BY A MOVING MASS M

Additionally, let's establish, as a logical statement, that the Divergence of the Gravitational field is the mass density δ divided by a constant κ_0 ("Gravitational permeability of free space"?), in order to allow the consistence of units (similar to the case of the electric charge: $\Phi_E = \int_S \mathbf{E}.d\mathbf{S} = \frac{1}{\varepsilon_0}\int_V \rho.dV = \frac{Q}{\varepsilon_0}$). By doing the same procedure applied to the electric case, we would have defined completely the vector $\mathbf{G}$ (because we also had previously defined its Curl, and a vector is completely defined if its Curl and its Divergence are defined). Thus, the expression of the Divergence of the Gravitational field should be:

$$\nabla \bullet \mathbf{G} = \frac{\delta}{\kappa_0} \qquad (16)$$

As we have previously said, this is the same as stating the Gauss' Law for gravitational field. Say, the total flux of the Gravitational field times the proportionality constant κ_0 for free space from a volume V equals the net mass contained within V. If δ represents the mass density in [Kg/m^3], Gauss' Law applied to mass may be written as:

$$\Phi_G = \int_S \mathbf{G}.d\mathbf{S} = \frac{1}{\kappa_0}\int_V \delta.dV = \frac{M}{\kappa_0}\,, \qquad (17)$$

Given that V is arbitrary. We also could define, by the same reasoning, Gravitational Displacement as $\mathbf{D}_G = \kappa_0.\mathbf{G}$:

$$\int_S \mathbf{D}_G.d\mathbf{S} = \int_V \delta.dV = M \qquad (18)$$

On the other hand, value of κ_0, can be obtained in the following way:

Since both fields gravity $\mathbf{G}$ and Electric $\mathbf{E}$ have expressions that depend on radius:

$$\mathbf{G}(r) = -\frac{\frac{2.G.M}{r^2}.\frac{v(r)}{V_0} - v(r).\frac{dv(r)}{dr}.\left(\frac{p_0}{p(r)} - \frac{p(r)}{p_0}\right)}{\left(\frac{p(r)}{p_0} + \frac{p_0}{p(r)}\right)}\mathbf{U_r} = G(r).\mathbf{U_r} \text{ . and } \mathbf{E}(r) = -\frac{1}{4.\pi.\varepsilon_0}\frac{q}{r^2}\mathbf{U_r} \quad (19)$$

Where G is the gravitational constant, M is the mass at the point source, V_0 and $v(r)$ are expression of the velocity of a moving mass under this gravitational field at the closest point and at a generic point, p_0 and $p(r)$ are similar expressions of linear momentums, ε_0 is the permittivity of free space and Q the electric charge at the same point source of mass M .

By applying the "Gauss Law" to Gravitation and choosing an uniform Gaussian surface (a sphere of radius *r* centered at the source point) with a differential element of area (a differential of solid angle $d\mathbf{S} = r^2.d\Omega.\mathbf{U}_r$), we will have:

$$\int_S \mathbf{G}(r).d\mathbf{S} = \Phi_G = \int_S G(r).\mathbf{U}_r.(r^2.d\Omega).\mathbf{U}_r = \int_S G(r).(r^2.d\Omega) \quad (20)$$

Given that field $\mathbf{G}$ and square of radius r^2, remain constant over every element of this uniform Gaussian surface, we finally have:

$$\int_S \mathbf{G}(r).d\mathbf{S} = \int_S G(r).(r^2.d\Omega) = G(r).r^2\int_S .d\Omega) = 4.\pi.G(r).r^2 = \frac{M}{\kappa_0} \quad (21)$$

Particularizing at the closest distance between mass M and moving mass at $r = R_0$, we know that $G(R_0) = \frac{G.M}{R_0^2}$. Thus:

$$4.\pi.\kappa_0.\frac{G.M}{R_0^2}.R_0^2 = M \quad \Rightarrow \quad \kappa_0 = \frac{1}{4.\pi.G} \quad (22)$$

VIII TWO MORE MAXWELL EQUATIONS.

According to us, we would have added to the Maxwell Equations two more equations, becoming six in total, that would govern the Magnetic, Electric and Gravitational fields, unifying in this way, the field of the Matter. So, such six equations completely defining the three fields, and **perfectly matching**, would be written as:

1) $\nabla \bullet \mathbf{B} = 0$ (23)

2) $\nabla \times \mathbf{H} = \dfrac{\partial \mathbf{D_E}}{\partial t} + \mathbf{J}$ (24)

3) $\nabla \bullet \mathbf{D_E} = \rho \quad \Leftrightarrow \quad \mathbf{D_E} = \varepsilon_0 . \mathbf{E}$ (25)

4) $\nabla \times \mathbf{E} = -\dfrac{\partial \mathbf{B}}{\partial t}$ (26)

5) $\nabla \bullet \mathbf{D_G} = \delta \quad \Leftrightarrow \quad \mathbf{D_G} = \kappa_0 . \mathbf{G} \qquad \kappa_0 = \dfrac{1}{4.\pi.G}$ (27)

6) $\nabla \times \mathbf{G} = 0 \quad \Leftrightarrow \quad \nabla \times \mathbf{G} = \dfrac{q}{m}\left[\nabla \times \mathbf{E} + \dfrac{\partial \mathbf{B}}{\partial t}\right]$ (28)

In which, the last two obtained equations, as we have to expect and it can be shown in the same way as we did with other equations in [5] are also invariant to the Lorentz transformations. Or, in other words, they also hold in any reference system.

IX CONCLUSION

The correctness of this work, as we have tried to demonstrate it, would imply that looking for Gravitational Waves is useless! Because, it will be impossible to detect something that does not exist! Furthermore, it also contributes to establish that Quantum Mechanics needs to be rebuilt in order to obtain exact results in the properties of the electromagnetic wave associated to a moving mass m with non-null mass at rest, at speed $v < c$, through the Wave Equation, in which Energy is not always equal to the product of the Planck's constant times the frequency for any particle, especially those different of photons (as it was proposed in [4]).

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