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Distortion of space caused by photons

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Abstract

The void space does not have any meaning as itself. The space exists only when a particle (mass particle or a photon -or any other boson-) occupies it. This means, if new particles appear in a region of space, the quantity of space increases in that area, creating distortions in that area of space, distortions that we call gravitation.

The photons transmit the electromagnetic field using their energy. But in parallel, they create new space by its existence itself. If a particle emits photons, apart from the electromagnetic field, creates space by the new space occupied/created by the photons emitted. We will see, that the space created by a photon (and any other elemental particle) is related to the Planck length constant.

All this will be strictly verified using electromagnetic and gravitation equations. The distortion of space calculated using this model will be calculated and will be discovered that is exactly the same as predicted by the gravitation laws. Also, the immediate question how it is possible that particles have different masses and charges will be answered.

1. Definitions

For this paper, we will use these properties of photons:

-The energy of a photon [1]:

$$E_f = h\nu \qquad (1)$$

-The linear momentum of a photon is [2]:

$$p_f = \frac{h\nu}{c} \qquad (2)$$

-They create/occupy space. The space created by a photon (elemental particle) has a radius equal to the Planck length [3] multiplied by the square root of 2π :

$$r_f = \sqrt{2\pi}\, l_p = \sqrt{2\pi}\sqrt{\frac{hG}{2\pi c^3}} = \sqrt{\frac{hG}{c^3}} = 4.051\text{E-}35\, m \qquad (3)$$

We will see that the electromagnetic and the gravitation calculations will validate this value.

The space occupied/created by the photons is the added value of this paper and will be verified during the paper. The rest of the parameters are completely validated by the science community. The references are indicated by [] and are mentioned in the corresponding chapter of this paper.

2. Electromagnetic equation

In our calculations we will use an electron A as an elemental particle emitting photons. Another electron B will receive them.

We call $\frac{dn}{dt}$ the number of photons per second emitted by the electron A. This magnitude is a statistical mean of the number of photons emitted by A during a period of time.

Considering this, the number of photons per second received by the electron B at a distance r of A is just by geometrics:

$$\frac{dn}{dt}\frac{4\pi r_f^2}{4\pi r^2} \qquad (4)$$

As we have done with the number of photons emitted per second $\frac{dn}{dt}$, we consider a statistical mean value of the frequency of these photons that we call ν . With this frequency ν we can assign a mean value of the linear momentum (2) or of the energy (1) of these photons.

If we multiply the number of photons per second received by the electron B by its linear momentum, we have the total linear momentum received by the electron B per second.

$$\frac{dn}{dt}\frac{4\pi r_f^2}{4\pi r^2}\frac{h\nu}{c} \quad (5)$$

The linear momentum change per second is by definition the force that the electron B is subject to. This force is caused by the energy-momentum of the photons received, this means, it has to correspond exactly with the electromagnetic force.

It is possible to work also with energies instead of momentums, you can check another derivation of this, in Annex 1, getting exactly the same result, as you can check.

We know by literature [4] that the electromagnetic force provoked by the electron A to electron B at a distance r is equal to:

$$F_{em}=\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} \quad (6)$$

Where e is the elemental charge of the electron and ε_0 is the vacuum permittivity.

If we equal both equations (5) and (6):

$$\frac{dn}{dt}\frac{4\pi r_f^2}{4\pi r^2}\frac{h\nu}{c}=\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} \quad (7)$$

we get:

$$\frac{dn}{dt}\frac{4\pi r_f^2 h\nu}{c}=\frac{e^2}{\varepsilon_0} \quad (8)$$

We will come back to the implications of this equation later.

3. Number of photons emitted using the concept of mass

A particle that is continuously emitting photons should somehow recover this energy to keep its own energy mc^2 . The way of recovering it, is absorbing continuously photons to recover the energy of the ones that is emitting.

Another way we can understand the energy of a particle, is thinking that the photons that is emitting are not moving outwards, but it is the particle itself which is moving inwards leaving the photons still in its way inwards. It is another way of interpreting mc^2 . It is like the kinetic energy of particle that is all the time moving inwards at speed c (as it if was being smaller and smaller) leaving photons still in its way.

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Whatever analogy we use, we need that the energy of the photons emitted/left in a specific moment (in a period of these photons) should be equal to the energy of the particle not to lose any energy.

$$\frac{dn}{dt}Th\nu = mc^2 \quad (9)$$

Using the relation between period and the other parameters of the electromagnetic radiation [13]:

$$\frac{dn}{dt}\frac{c}{\lambda}h\nu = \frac{dn}{dt}\frac{1}{\nu}h\nu = \frac{dn}{dt}h = mc^2 \quad (10)$$

$$\frac{dn}{dt} = \frac{mc^2}{h} \quad (11)$$

4. Distortion of space created by the photons

As commented in the abstract, the photons occupy space and it is this space the one that creates/transmits gravitation. I have to remark here that we have not used any gravitation or general relativity formula to get here. And we will not do it in this point also.

We will calculate the distortion of space created by the photons emitted by the electron A affecting the electron B, only by geometric relations. This means, we will calculate the ratio between the new space created (the space occupied by these new photons) compared with the existing one (the ratio of the new space compared to a perfect euclidean one).

We know, that considering only the space distortions caused by the electron A, the space is perfectly euclidean at infinity [5]. So, we will calculate the total of photons emitted from electron A from infinity to the position of electron B at r. And we will put the ratio between the space generated by them to the euclidean space. For that, we will use the ratio of sphere surfaces $\frac{4\pi r_f^2}{4\pi r^2}$ for all the photons from infinity to r. This is:

$$\int_\infty^r \frac{dn}{dt}\frac{4\pi r_f^2}{4\pi r^2}dt = \int_\infty^r \frac{dn}{dt}\frac{4\pi r_f^2}{4\pi r^2}dt\frac{dr}{dr} = \int_\infty^r \frac{dn}{dt}\frac{4\pi r_f^2}{4\pi r^2}dr\frac{dt}{dr} = -\int_\infty^r \frac{dn}{dt}\frac{4\pi r_f^2}{4\pi r^2}\frac{1}{c}dr = \frac{1}{c}\frac{r_f^2}{r}\frac{dn}{dt} \quad (12)$$

The value of $\frac{dt}{dr} = \frac{-1}{c}$ is because the photons are moving in direction opposite to the integral.

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Now, we substitute the values of r_f using (3) and $\frac{dn}{dt}$ using (11):

$$\frac{1}{c}\frac{r_f^2}{r}\frac{dn}{dt}=\frac{1}{cr}\frac{hG}{4\pi c^3}\frac{mc^2}{h}=\frac{1}{r}\frac{Gm}{4\pi c^2} \quad (13)$$

$$\frac{1}{c}\frac{r_f^2}{r}\frac{dn}{dt}=\frac{1}{cr}\frac{hG}{c^3}\frac{mc^2}{h}=\frac{Gm}{c^2 r} \quad (14)$$

So the ratio of the new space created compared to the euclidean space is:

$$\frac{Gm}{c^2 r} \quad (14)$$

I repeat again. We have not used any formula regarding gravitation or general relativity to get this result. Just electromagnetic formula and geometrics. By geometrics we have considered that the photons occupy space. And we have calculated how this new space distorts the existing one.

5. Gravitation. General relativity, Schwarzschild equation.

For this chapter we will start from the beginning and we will not use any of the results seen before.

We will use general relativity, more specifically, Schwarzschild equation [5]. According this equation, the space distortion by a point mass is:

$$ds^2=-\left(1-\frac{2Gm}{c^2 r}\right)dt^2+\left(\frac{1}{1-\frac{2Gm}{c^2 r}}\right)dr^2+r^2 sen^2\theta d\vartheta^2+r^2 d\theta^2 \quad (15)$$

In an instant of time and in radial direction we have:

$$ds^2=\left(\frac{1}{1-\frac{2Gm}{c^2 r}}\right)dr^2 \qquad \frac{ds}{dr}=\sqrt{\frac{1}{1-\frac{2Gm}{c^2 r}}}\approx 1+\frac{Gm}{c^2 r} \quad (16)$$

The first element 1 represents the no distortion (Euclidean space). So taking only the relation for the distortion part (the difference with the Euclidean space) we have:

$$\Delta\frac{ds}{dr}=\frac{Gm}{c^2 r} \quad !!! \quad (17)$$

This equation is exactly the same as (14). And remember that for equation (14) we did not use anything related to general relativity or gravitation. Just electromagnetic equations and geometrics (space occupied by the photons).

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This last equation (17) validates the model proposed (the space created by the photons emitted by particles is the one that distorts the euclidean space).

But we will go even further.

6. Changes on a moving object

If the particle emitting photons is moving, according special relativity [6], the frequency of the photons emitted is reduced by the factor:

$$\sqrt{1-\frac{v^2}{c^2}} \quad (18)$$

This means the energy and momentum of the photons will be reduced by that same factor (18). So the electromagnetic field should be reduced by the same factor. But this does not happen.

We will study this phenomenon and let's see how this revalidates once again this theory.

We have equation (8):

$$\frac{dn}{dt}\frac{4\pi r_f^2 h\nu}{c}=\frac{e^2}{\varepsilon_0} \quad (8)$$

So we can write it in the form:

$$\frac{dn_0}{dt}\frac{4\pi r_f^2 h\nu_0}{c}=\frac{e^2}{\varepsilon_0} \quad (19)$$

where

$\frac{dn_0}{dt}$ is the number of photons emitted per second when the electron is motionless.

ν_0 The frequency of the photons when the electron is motionless.

But also, the electron fulfils the equation (8) when it is moving at speed v, this means:

$$\frac{dn_v}{dt}\frac{4\pi r_f^2 h\nu_v}{c}=\frac{e^2}{\varepsilon_0} \quad (20)$$

where:

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$\frac{dn_v}{dt}$ the number of photons emitted per second when the electron is moving at speed v.

ν_v The frequency of the photons when the electron moves at speed v.

By special relativity [6] we know that:

$$\nu_v=\nu_0\sqrt{1-\frac{v^2}{c^2}} \quad (21)$$

So, (20) can be written as:

$$\frac{dn_v}{dt}\frac{4\pi r_f^2 h\nu_0}{c}\sqrt{1-\frac{v^2}{c^2}}=\frac{e^2}{\varepsilon_0} \quad (22)$$

Dividing equation (22) by (19), we get:

$$\frac{dn_v}{dt}=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\frac{dn_0}{dt} \quad (23)$$

This means, the number of photons emitted should increase by the inverse of the factor (18) when the electron is moving at speed v.

Now, we call m_0 the mass of the elctron when it is motionless. And we call it m_v when it is moving at speed v.

Coming from equation (11):

$$\frac{dn}{dt}=\frac{mc^2}{h} \quad (11)$$

We can derive:

$$\frac{dn_0}{dt}=\frac{m_0c^2}{h} \quad (24)$$

and

$$\frac{dn_v}{dt}=\frac{m_vc^2}{h} \quad (25)$$

And applying (23) to (25):

$$\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\frac{dn_0}{dt}=\frac{m_v c^2}{h} \quad (26)$$

Dividing (26) by (24) we get:

$$m_v=m_0\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \quad !!!\ (27)$$

We have obtained this equation increasing the number of photons emitted by the electron to be able to keep the electromagnetic field.

And we have arrived to an equation that was calculated in special relativity in a completely different context. It was obtained to keep the speed of c constant in a moving object [7], not taking into consideration anything related to the number of photons emitted or its energy.

So the consequences of the explained theory based only in electromagnetic forces and geometrics are completely coherent with already known formulas regarding special relativity, as seen in this chapter (and general relativity as seen in chapter 5).

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7. Conclusions

We have shown that the model of the photons transmitting the gravitation solely by the space occupied by them is completely coherent with the transmission of the electromagnetic field created by the photons and its energy.

The mass (space created by the particle) is proportional to the number of photons emitted. And the electromagnetic field is proportional to the energy of all the photons (the number of photons multiplied by the energy per photon).

We have discovered that the space occupied by an elemental particle (specifically photons) has the radius of the Planck length multiplied by the square root of 2π .

We have checked that this is compatible and has been validated by electromagnetic equations, gravitation (general relativity equations) and special relativity equations.

The concept of the mass creating space in its surroundings has been already explored before [14] [15].

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Annex 1. Electromagnetic equation, using energies instead of linear momentum

We will consider again an electron A as an elemental particle emitting photons. Another electron B will receive them.

We call $\frac{dn}{dt}$ the number of photons per second emitted by the electron A. This magnitude is a statistical mean of the number of photons emitted by A during a period of time.

Now, we calculate how many photons has received the electron B to go from infinity to its current position at a distance r of A.

$$\int_{\infty}^{r} \frac{dn}{dt} \frac{4\pi r_f^2}{4\pi r^2} dt = \int_{\infty}^{r} \frac{dn}{dt} \frac{4\pi r_f^2}{4\pi r^2} dt \frac{dr}{dr} = \int_{\infty}^{r} \frac{dn}{dt} \frac{4\pi r_f^2}{4\pi r^2} dr \frac{dt}{dr} = - \int_{\infty}^{r} \frac{dn}{dt} \frac{4\pi r_f^2}{4\pi r^2} \frac{1}{c} dr = \frac{1}{c} \frac{r_f^2}{r} \frac{dn}{dt} \quad (12)$$

The value $\frac{dt}{dr} = \frac{-1}{c}$ is because the photons are moving in direction opposite to the integral.

If we multiply the number of photons received by B by its energy (1), we get the total energy received by B. For this, we will use the frequency ν as the mean frequency of these photons.

$$\frac{1}{c} \frac{r_f^2}{r} \frac{dn}{dt} h\nu \quad (28)$$

We know by the literature, that the electromagnetic energy of a charged particle B because of being at a distance r of another charged particle A is [8]:

$$E_{em} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r} \quad (29)$$

Where e is the elemental charge of the electron and ε_0 is the vacuum permittivity.

If we equal both equations (28) and (29):

$$\frac{1}{c} \frac{dn}{dt} \frac{r_f^2}{r} h\nu = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r} \quad (30)$$

we get:

$$\frac{dn}{dt} \frac{4\pi r_f^2 h\nu}{c} = \frac{e^2}{\varepsilon_0} \quad (8)$$

That is exactly the equation (8) as obtained in chapter 2 using linear momentum instead of energy.

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Annex 2. Another interpretation of the fine structure constant, using angular momentum of an electron

We will use the following properties of electrons:

-They have a charge:

$$e=1.602\text{E-}19\,C \quad (31)$$

-They have a mass:

$$m_e=9.109\text{E-}31\,Kg \quad (32)$$

-They have spin of:

$$s=\frac{\hbar}{2}=\frac{h}{4\pi}=5.273\text{E-}35\,Js \quad (33)$$

-The electron is an elemental particle. And we consider that the size of any elemental particle is the minimum size possible (the Planck length multiplied by the square root of 2π, the size of the photon). This means:

$$r_e=r_f=\sqrt{2\pi}\,l_p=\sqrt{2\pi}\sqrt{\frac{hG}{2\pi c^3}}=\sqrt{\frac{hG}{c^3}}=4.051\text{E-}35\,m \quad (3)$$

-They have speed of rotation:

$$\omega=2\pi\nu \quad (34)$$

The mean frequency of the photons emitted is related to the rotation of the electron.

-They have a moment of inertia I that we are going to calculate. Its form [9] is:

$$I=\beta m r^2 \quad (35)$$

We are going to calculate β and will discover that it is related to the fine structure constant.

First, we present the fine structure constant α that is defined as [10]:

$$\alpha=\frac{e^2}{2hc\varepsilon_0}\approx\frac{1}{137.036} \quad (36)$$

Now, we start with the calculation of the moment of inertia I of the electron. From [11] and [12], we start:

$$I\omega=\frac{\hbar}{2} \quad (37)$$

$$I 2\pi\nu=\frac{h}{4\pi} \quad (38)$$

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Substituting I by (35)

$$\beta m r_f^2 2\pi\nu = \frac{h}{4\pi} \quad (39)$$

We isolate:

$$m\nu = \frac{c^3}{8\pi^2 G\beta} \quad (40)$$

Now, using equation (8) we have:

$$\frac{dn}{dt}\frac{4\pi r_f^2 h\nu}{c} = \frac{e^2}{\varepsilon_0} \quad (8)$$

$$\frac{mc^2}{h}\frac{4\pi r_f^2 h\nu}{c} = \frac{e^2}{\varepsilon_0} \quad (41)$$

Isolating:

$$m\nu = \frac{e^2}{\varepsilon_0}\frac{c^2}{4\pi h G} \quad (42)$$

Making equations (40) and (42) equal:

$$\frac{c^3}{8\pi^2 G\beta} = \frac{e^2}{\varepsilon_0}\frac{c^2}{4\pi h G} \quad (43)$$

Isolating:

$$\beta = \frac{c\varepsilon_0 h}{e^2 2\pi} \quad (44)$$

Using the definition of fine structure constant (36), we write β as:

$$\beta = \frac{1}{4\pi\alpha} \approx 10.905 \quad (45)$$

and α in function of β is:

$$\alpha = \frac{1}{4\pi\beta} \quad (46)$$

This means, as β is the geometric factor that multiplies the moment of inertia of an elemental particle, the fine structure constant is the inverse of this factor divided by 4π .

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Annex 3. Concept of mass

The mass can be interpreted in different ways. In this chapter we have considered the following original interpretations:

-The number of photons emitted by a particle is proportional to its mass (11).
-The space created in the surroundings of the mass is proportional to the mass. (12) (14)
-The distortion of space created in its surroundings is the effect of the gravitational mass.(14)
-The higher difficulty of moving a particle when the space created in the surroundings is higher, corresponds to the concept of inertial mass. And it is directly related to the concept of gravitational mass. Chapter 3 and (14).
-The energy of the mass can be considered as the energy of the photons emitted during a period of time. (9)
-The energy of the mass could be also considered as the kinetic energy of the mass moving inwards. Instead of calculating the energy of the photons emitted, we can consider the mass as moving inwards leaving shells of photons behind. Chapter 3 and (11).
-Considering a specific factor for the moment of inertia (45) of the elemental mass particles, and a constant angular momentum (spin) [11][12], the mass can be interpreted as the inverse of the speed of rotation of this particle (39).

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