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Photon-Graviton Interaction and CPH Theory

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Abstract:

Gravitons are postulated because of the great success of quantum field theory (in particular, the Standard Model) at modeling the behavior of all other known forces of nature as being mediated by elementary particles: electromagnetism by the photon, the strong interaction by the gluons, and the weak interaction by the W and Z bosons. The hypothesis is that the gravitational interaction is likewise mediated by a – yet undiscovered – elementary particle, dubbed the graviton. In the classical limit, the theory would reduce to general relativity and conform to Newton's law of gravitation in the weak-field limit. However, attempts to extend the Standard Model with graviton has run into serious theoretical difficulties at high energies (processes with energies close to or above the Planck scale) because of infinities arising due to quantum effects (in technical terms, gravitation is non-renormalizable). Since classical general relativity and quantum mechanics are

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incompatible at such energies, from a theoretical point of view the present situation is not tenable. Some proposed models of quantum gravity attempt to address these issues, but these are speculative theories. Does a new definition of the graviton solve the problem of quantum gravity?

In this paper, according to the gravitational blue-shift, we have reviewed photon-graviton interaction by using a new definition of graviton and structure of photon.

Keyword: graviton, photon, virtual photon, relativity, blue-shift, color-charge, magnetic-color

Introduction:

The graviton is a hypothetical elementary particle that mediates the force of gravitation in the framework of quantum field theory. If it exists, the graviton is expected to be massless and must be a spin-2 boson. The spin follows from the fact that the source of gravitation is the stress–energy tensor, a second-rank tensor. But by no means is it universally accepted [1]. But there are many articles about the interaction between Photon and graviton or graviton-photon scattering [2, 3 and 4]. How can graviton's mystery be solved? Should graviton be detectable or like photon (same as photoelectric effect) be able to explain the physical phenomena? In the other word, if gravity is caused by curved space-time, how do gravitons fit in?

In quantum mechanics, the concept of a point particle is complicated by the Heisenberg uncertainty principle, because even an elementary particle, with no internal structure, occupies a nonzero volume. There is nevertheless a distinction between elementary particles such as electrons, photon or quarks, which have no internal structure, versus composite particles such as protons, which do have internal structure. According to the quantum mechanics that photon is an unstructured particle, how can we explain the relationship between the photon energy and frequency, and also pair production and decay?

In recent decades, the structure of photon is discussed [5, 6 and 7]. In this article, description the structure of photon is based on the behavior of photons in a gravitational field, leading to a new a definition of the graviton too. In effect, gravitons behave as if they have charge and magnetic effects. These are referred to as negative color charge, positive color charge and magnetic color. From this, it can be shown that a photon is made of color charges and magnetic color.

The importance of attention to the structure of photon

Something that has been attractive in physics is behavior of light in different environments and their interaction with other particles like electron. Doppler Effect, Photo electric effect Mossbauer Effect, curvature of space… all and all is analyzed without paying attention to Structure of the photon. Something that has been pain attention and accepted by physicists in is that photon (and electron) is a point-like and unstructured particle. Point-like particles are mathematical abstractions with zero size. However, even zero-size particles have an extended effect, due to the effect of the field surrounding them [8].

The only thing that has been investigated in astrophysics and astronomy is the Doppler Effect and red (or blue) shift of the gravitational. The efforts and attempts to recognize and explain the structure of photon is an inevitable necessity. Due to this reason, CPH theory has formed based on

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a definition from the structure of photon. So how and where we can start to define the structure of photon? .Such a definition must have both logical and experimental support, one of them for valid theories and another for experiments that are consistent with these theories. So, which theory can be helpful? Relativity or Quantum Mechanics? Citing to both theories is valid, because both of these theories are famous among physicists. Fortunately, these theories have common experimental fields that citing to these common fields can help us to combine and unite both theories. Therefore, we continue to work by these common fields.

Hint: There is much evidence such as the Compton's effect, the pair production, the redshift and blue-shift that lead us to accept photon has a structure.

Gravitational effects on electromagnetic waves

According to the general relativity theory, light moving through strong gravitational fields experiences a red or blue shift. During the photon is falling in the gravitational field, its energy (mass) increases. According to $W = \Delta mc^2$, the force of gravity performs work on the photon, so the mass (energy) of the photon and its frequency increases (or decreases) from v to v' that given by;

$$v' = v(1 \pm \frac{GM_s}{rc^2}) \qquad (1)$$

G is the gravitational constant; M is the mass of the body, c is the speed of light, r is the distance from the mass center of body. The plus sign refers to blue-shift and minus sign refers to redshift.

The change of frequency of the photon in the gravitational field has been demonstrated by the Pound-Rebka experiment. The Pound–Rebka experiment is a well-known experiment to test Albert Einstein's theory of general relativity in 1959. The result confirmed the predictions of general relativity.

The Pound–Rebka experiment

A photon with mass $m = \frac{hv}{c^2}$ has weight as $= \frac{hv}{c^2}g$, in gravitational field. When photon falls a distance equal y toward the earth, according to conservation law of energy we have:

$$hv' = hv + mgy = hv + \left(\frac{hv}{c^2}\right)gy \qquad (2)$$

$$v' = \left(1 + \frac{gy}{c^2}\right)v \qquad (3)$$

If we consider this phenomenon as another evidence to verify the general relativity, we will be stopped in the same old theories. Therefore, if we want to get a different result, we have to change our thoughts. The work that gravitational force does on the photon does not mean a simple concept

of increasing in kinetic energy, but some deeper and more profound concepts are hidden beyond it. If we want to look at this phenomenon from the point of view of quantum field theory, we must accept that gravitons penetrate to the structure of the photon and in addition to the increasing its energy cause increasing electric and magnetic field intensity. Nevertheless, by considering the accepted concepts of quantum mechanics for gravitons, this phenomenon is not justifiable. Therefore, we need to reconsider the concepts of quantum mechanics about graviton and investigate about this phenomenon beyond quantum mechanics.

A new definition of graviton

According to interaction between graviton and photon, we can redefine the graviton. Consider a photon is escaping from a strong gravitational field like a black hole. Suppose that a photon with energy $E = hv$ is escaping of gravitational field. Secondary frequency of photon is given by following equation:

$$v' = v(1 - \frac{GM}{rc^2}) \qquad (4)$$

Photon has spin and includes two perpendicular electric and magnetic fields. By reducing the frequency of photon (photon energy reduction), intensity of electric and magnetic field are reduced too and finally, intensity of both the fields reaches to zero and the photon loses all its energy. Final limit for energy of photon before that reaches or tends to zero and still has spin, is equal to the energy of graviton E_G or $E_{graviton}$, so that:

$$E_G < hv, \forall v \; detectable \qquad (5)$$

Similarly, the mass of the graviton m_G or $m_{graviton}$ is given by:

$$m_G < \frac{hv}{c^2} \;, \forall v \; detectable \qquad (6)$$

However, both of the above equations (5) and (6) do not show some intuitive value and assessable. In addition, the above equations do not have not any specific information about electric and magnetic fields associated with photon. Therefore, we should be looking for an intuitive experience to be able to achieve tangible values and find out that how to produce electrical and magnetic fields associated with the photon. Our approach for such this election is changing the photon energy in a gravitational field that is associated with the intensity of electric and magnetic fields of photon. It means that gravity works on the photon and gravitons enter to the structure of the photon in which it is justified according to the following equation:

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$$F = -\frac{dU}{dx} \qquad\qquad (7)$$

Where dU changing potential energy at small distance dx and F is the force. Now we should explain the process of changing energy (equation 2) by using equation (7). Photon falls at specified distance dy in gravitational field and its potential energy is reduced to dU (its kinetic energy increases). Reduction in potential energy of photon means that its frequency and kinetic energy increases that is given by dv and $dE = hdv$ respectively. From the perspective of quantum mechanics, that photon unstructured, it is impossible to explain this phenomenon. Therefore, if we want to analyze the structure of photon, we must pass the quantum space and enter into sub quantum space. From the perspective of sub quantum space, a number of gravitons enter into photon structure that is justified by equation (7), and the energies of gravitons is added to the energy of photon. Now the question is how many gravitons enter into the structure of photon that generates the smallest possible change of energy that is given by $dE = hdv$? Also changing in energy of photon is associated with changing in intensity of electric and magnetic fields. Therefore, the work done on the photon by gravity must be discussed in such a way that justifies changing in intensity of electric and magnetic fields. Due to this reason in the CPH Theory, gravitons have properties that when gravity works on photon, can alter the intensity of electric and magnetic fields of the photon. This attitude led to the terms color-charge and magnetic-color in which they have used to define gravitons. In other words, identity of graviton changes without any change in its energy.

Color-charges and magnetic-color

Now we are in a position that are able to take a new look at the structure of photon and define the features and properties of graviton in a way that is compatible with the feature of photon, and it is in accordance with experimental conditions very well. A photon with the lowest possible energy also carries electric and magnetic fields. Therefore, the features of gravitons entered into the structure of the photon must behave in a way that along with explaining the energy of photon, describes increasing in intensity of electric and magnetic fields. In other words, some of these gravitons cause increasing the electric field of photon and some other gravitons increase the intensity of magnetic fields. Also, not only a photon at lowest level of its energy is formed by some of the gravitons, but also its formed members have electric and magnetic properties that is called color-charge and magnetic-color in CPH theory. The next step is to specify color-charges and magnetic-colors in which it is obtained by paying attention to at least change in energy of photon in a gravitational field while moving into blue shift of gravity.

Formed elements of photon:

Suppose a photon with NRP[1] mass $m = hv/c^2$ and energy $E = hv$ falls from high h toward the earth relative to an inertial reference frame on the surface. Its frequency increases from v to v', in fact, a number of gravitons enter into the structure of the photon such that $\Delta v = v' - v$. So the

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[1] - Not at Rest Particle

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problem is; how many gravitons enter into the structure of photon to provide at least possible change of the energy of photon (minimum Δv)? So if Δv is minimum, then how many gravitons has entered into the structure of photon? What properties gravitons must have that they can be compatible with photons identity? (Figure1).
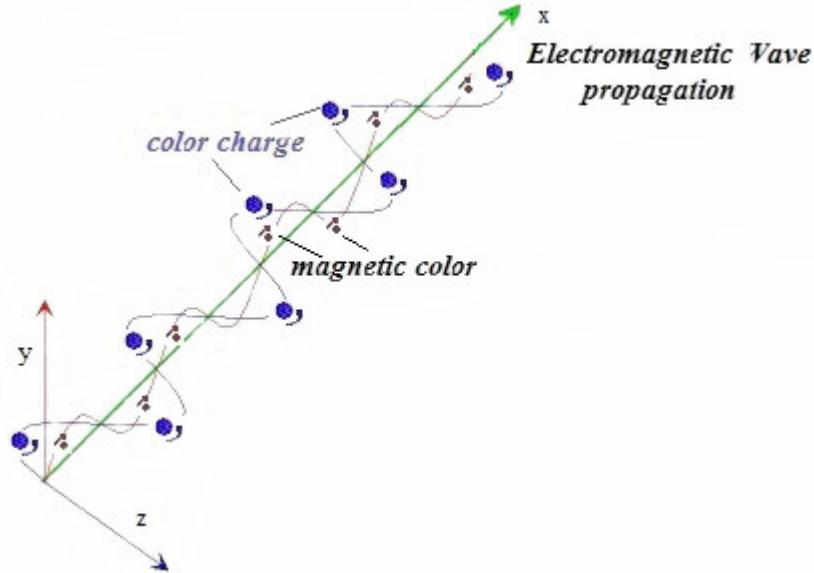

Fig1; paths of gravitons in photon structure, color charges and magnetic color have spin and curvature speed

For finding properties of gravitons and analyzing this process, we must observe these following conditions:

Condition1: photon is carrying two perpendicular electric field and magnetic field.

Condition2: The photon is electrically neutral and particles forming the electric field must neutralize each other.

Condition3: There is two groups' positive and negative color-charges in structure of photon that form photon's electric field and neutralize each other.

Condition4: Because these electric fields are moving, they create magnetic fields around themselves.

Condition5: simultaneously by producing positive and negative electric fields, two magnetic fields are produced around the electric fields do form. Therefore, it will be made two groups of magnetic-colors.

The above features necessitate that we consider each photon including four groups, two groups carry positive and negative effects and two groups carry magnetic effects.

Suppose that a photon with frequency v and energy hv is formed of n_1 elements, so that:

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$$n_1 = n_{11} + n_{12} + n_{13} + n_{14}$$

Moreover, this photon with frequency v' and energy hv' is formed of n_2 elements, so that:

$$n_2 = n_{21} + n_{22} + n_{23} + n_{24}$$

For two levels of energy hv' , hv , we form the below matrices:

$$hv = \begin{bmatrix} n_{11} & n_{12} \\ n_{13} & n_{14} \end{bmatrix} \qquad (8)$$

$$hv' = \begin{bmatrix} n_{21} & n_{22} \\ n_{23} & n_{24} \end{bmatrix} \qquad (9)$$

Now, we consider the matrix of changing energy of photon $\Delta E = hv' - hv$ as follow:

$$\Delta E = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \qquad (10)$$

Matrices (8, 9 and 10) must satisfy the following equation:

$$hv' = \begin{bmatrix} A & B \\ C & D \end{bmatrix} + \begin{bmatrix} n_{11} & n_{12} \\ n_{13} & n_{14} \end{bmatrix} = \begin{bmatrix} n_{21} & n_{22} \\ n_{23} & n_{24} \end{bmatrix} \qquad (11)$$

According to conditions (1-5), it will be determined elements A, B, C, D. We consider the first row of the matrix 14, the elements of A, B for negative and positive colors charges. Element A represents positive color-charges and element B represents negative color-charges. In interaction between gravitons and photons, photon falls at specified distance dy and its energy increases (Equation 4) that due to equation (7) the identity of a number of gravitons change by carrying gravitational force towards color-charges and enter to the structure of photon. We use the symbol of graviton G, for the both negative color-charge as G^- and positive color-charge as G^+, so that:

$$A = \kappa\, G^+ , \qquad B = \kappa\, G^-$$

Where κ is a natural number. In other words, when gravity does the work on photon, a number of gravitons enter into the structure of photon and photon's intensity of electric field increases,

without any electrically effect and it is not created electric charge, because the photon is electrically neutral. So A, B must carry electric effect and their numbers must be equal (conditions2 and 3).

Also according to the relative intensity electric fields and magnetic of electromagnetic waves $E = cB$, since color-charges and magnetic-colors are carrying electric and magnetic fields that they are NRP and countable, therefore, this relative can be replacement by a natural number such as κ, so we have $E = \kappa B$. When a number G^+ enter into photon structure, intensity of positive electric field of photon increases. Therefore, according to Maxwell's electromagnetic equations, the intensity of magnetic field increases, too. Therefore, the element C (equation10) must increases the intensity of magnetic effect around the positive color-charges. Similarly, the element D must increases the intensity of magnetic field around the negative color-charges. The effect of these two elements are the same, but in terms of direction (which is proportional to the electric field) are different. Thus, according to the electric and magnetic field intensity we can be written:

$$C = G_m^+ , \qquad D = G_m^-$$

The negative sign in relation $D = G_m^-$, only determines the direction of magnetic colors around the negative color-charges. So matrix (10) that is called the CPH matrix, will be as follows:

$$CPH = \begin{bmatrix} \kappa\,G^+ & \kappa\,G^- \\ G_m^+ & G_m^- \end{bmatrix} \qquad (12)$$

According to the above expression, we are now able to define the least magnitude of a photon. A photon of minute energy contains some positive color-charges G^+, negative color-charges G^- , right rotation color-magnetic G_m^+ and left rotation color-magnetic G_m^- as shown in the CPH matrix (equation 12). This very small energy can be express as the following;

$$\text{Minute electromagnetic energy: } E_{Minute} = (2\kappa + 2)E_G \qquad (13)$$

Let's call E_{Minute}, the $E_{minimum}$. Thus, each photon is formed of a natural number $E_{minimum}$, so we have;

$$E = n(2\kappa + 2)E_G \text{ , or } \quad E = n\begin{bmatrix} \kappa\,G^+ & \kappa\,G^- \\ G_m^+ & G_m^- \end{bmatrix} \qquad (14)$$

Equations (5) and (6) have previously defined the mass and energy of graviton.

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Sub-Quantum Energy (SQE)

We use CPH matrix (equation16) to define sub quantum energy (SQE). The first column of CPH matrix is defined positive sub quantum energy SQE^+ and the second column of CPH matrix is defined negative sub quantum energy SQE^- , so;

$$\text{Positive Sub Quantum Energy: } SQE^+ = \begin{bmatrix} \kappa G^+ \\ G_m^+ \end{bmatrix} \qquad (15)$$

$$\text{Negative Sub Quantum Energy: } SQE^- = \begin{bmatrix} \kappa G^- \\ G_m^- \end{bmatrix} \qquad (16)$$

The amount of speed and energy of positive and negative sub quantum energies are equal, and the difference between SQE^+ and SQE^- are only in the sign of their color-charges and magnetic-color flow direction.

Therefore, the photon is formed of two types of positive and negative sub quantum energies that we show them by operators, right wedge $\triangleright$ for positive sub quantum energy and left wedge $\triangleleft$ that are defined as follows:

$$\text{Positive Sub Quantum Energy; } SQE^+: \triangleright = +\frac{E_{minimum}}{2} \qquad (17)$$

$$\text{Negative Sub Quantum Energy; } SQE^-: \triangleleft = -\frac{E_{minimum}}{2} \qquad (18)$$

It is obvious that spin of sub quantum energy (SQE) is equal to $\frac{1}{2}$.

Virtual photons: there are two types of virtual photons, positive virtual photon γ^+ and negative virtual photon γ^- that each of them is formed of number same-sign sub quantum energies, which is defined as follows:

$$\text{Positive virtual photon; } k \triangleright = \gamma^+ \qquad (19)$$
$$\text{Negative virtual photon; } k \triangleleft = \gamma^- \qquad (20)$$

A real photon is formed of a positive virtual photon and a negative virtual photon:

$$\gamma^+ + \gamma^- = \gamma \qquad (21)$$

$$(n \triangleright + n \triangleleft) = n(\triangleright + \triangleleft) \text{ or } n|\triangleright\rangle + n|\triangleleft\rangle = \gamma \qquad (22)$$

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$$\gamma^+ = k \vartriangleright, \ \gamma^- = k \vartriangleleft \to \gamma = \gamma^+ + \gamma^- \qquad (23)$$

Where, n, k are natural numbers. So far, the production of electromagnetic energy (photons) was described by using gravitational blue-shift, in reverse phenomena photons decay to negative and positive virtual photons. In redshift, virtual photons also decay to positive and negative sub quantum energies (*SQE*s), and sub quantum energies (SQEs) decay to color-charges and magnetic-colors, too. Color-charges and magnetic-colors away from each other, lose their effect on each other and become gravitons [11].

As charged particles absorb or repulse each other and are ineffective on neutral particles, homonymous virtual photons repulse each other, non-homonymous virtual photons absorb each other and they form quantum energies and it causes two non-homonymous charged particles accelerate towards each other.

Gravitons curve path of light (Path of photon in space-time)

On the left side of Figure 2, when a photon is coming near to massive body, it shifts to blue and the gravity force converts into energy. When photon is escaping from a massive body it shifts to red and energy converts to gravity force (Figure 2).
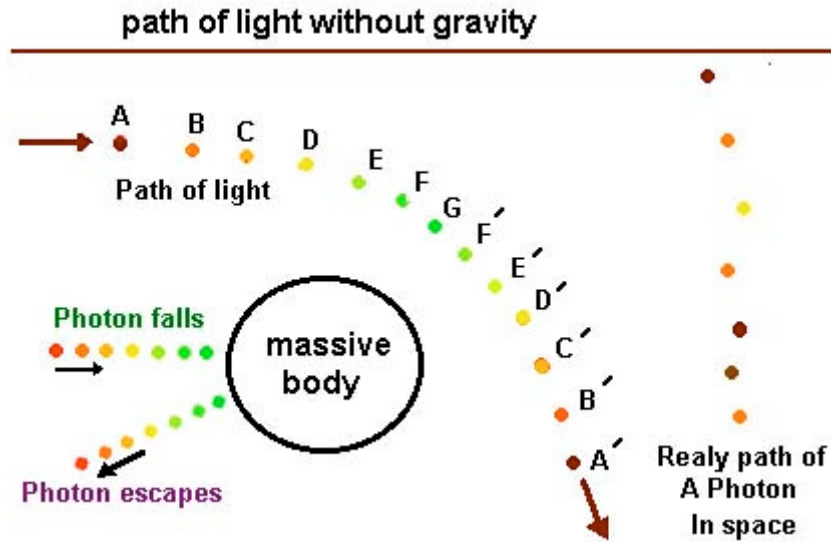

Fig2; path of photon in space

When gravity force acts on photon, the energy of the photon increases and its frequency increases too (or decreases). In red-shift work is negative (frequency decreases) and in blue-shift work is positive (frequency increases). When photon is leaving gravitational field, it shifts to red

and when photon is falling it shifts to blue. When light is moving in space that there is no gravitational effect, the path of light is linear. Now suppose light is moving in gravitational field of a massive body. Gravity works on it. When distance between photon and massive body goes to short, light shifts to blue like photon is falling. But when distance between photon and massive body goes to long, light shifts to red like photon escapes (Figure3). What the inside observer observes is the opposite of what the outside observer observes.
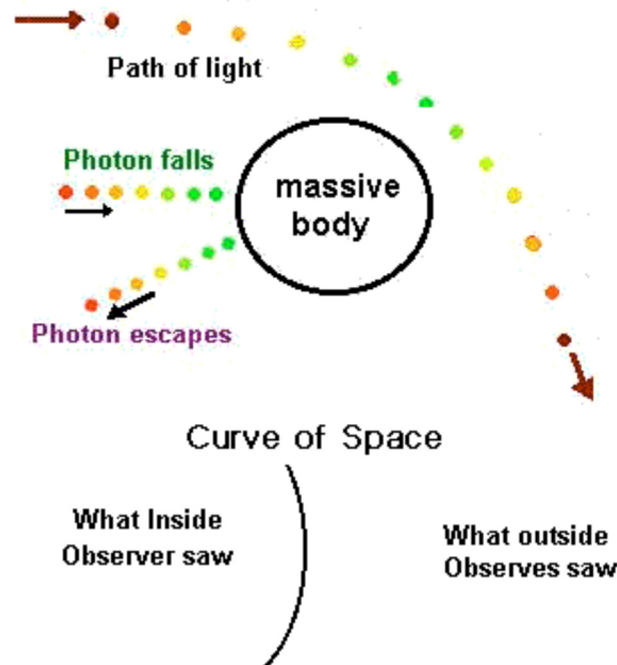
Fig 3; gravitons bend the space

Conclusion

According the sub quantum energy, we have analyzed relationship between gravity and electromagnetic waves and show graviton exists indirectly. Existence of graviton means that gravitational field is ocean of gravitons. So, interaction between gravity and electromagnetic wave replaced with interaction between photon and gravitons.

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