Approaching to Gravity?

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Abstract. It has been detected by the proton collision experiments in Large Hadron Collider of CERN that the Higgs Bosons (H) exists with a mass of around 126 GeV/c^2. It is predicted in this study that the mediating particles, which are theoretically invoked to be gravitons in the gravitational interaction, may be produced by H, just as photons are produced in the case of electromagnetic (EM) interaction. From the simultaneous evaluation of “quantum efficiencies” of virtual gravitons produced by virtual H annihilation in gravitation and virtual photons produced by virtual electron-positron annihilation in EM interaction, we predict that the relative ratio of photon to graviton intensities is in the order of estimated value in Quantum Field Theory (QFT).

1. Introduction

The results [1,2] provided by Large Hadron Collider of CERN proved that the Higgs Bosons (H) exist with a very high mass corresponding to Einstein’s equivalent mass energy of around 126 GeV, although detection of these bosons is so difficult due to their very fast decay in apparently less than one septillionth of a second \( \tau_H \approx 10^{-24} \text{s} \) [3]. Prediction of such high mass particle was a necessity to explain the symmetry breaking reality of universe between matter and anti-matter. This theoretical assumption eventually provided Higgs et al the 2013 Noble Prize in Physics, after 50 years.

The Standard Model (SM) of the universe predicts that the four kinds of mediating forces between the two physical objects or particles in space occurs when the two have the same kind of charge. A certain type of charge of a particle appears in the forms of electric charge, color charge, weak charge and mass charge that determine the role of participation in the interaction processes. These effects respectively correspond to electromagnetic, strong nuclear, weak nuclear and gravitational interactions. Elementary particles named leptons and quarks are the key particles that provide the three of the four kinds of charges except the mass charge, within any kind of particle or object. The fourth one entered the elementary particles’ table as the Higgs Bosons, explaining the mass charge [1,2].

Mediating gauge bosons in any kind of interaction can be produced by the annihilation of the same kind of particle-antiparticle collisions of leptons and quarks. The SM establishes that gauge bosons; photons, W-Z bosons and gluons (g) perfectly explain the three of the four interaction forces; electromagnetic, weak and strong nuclear interaction except for gravitation. Gravitons (G) needed to be theoretically comprehended in Theory of Everything (TOE), fitting in the fourth interaction of the SM in Grand Unified Theory (GUT).

The TOE reduces to General Relativity of Einstein and the gravitation law of Newton in the classical and weak field limit as described by Feynman et al [4]. However, while the general theory of relativity is also macroscopic and the geometric theory of gravitation using the space-time curvature, present study proposes a microscopic model of mediating gravitons due to virtual Higgs boson annihilation, using similar predictions for the electric charge interaction in the SM, and evaluates the recently observed non-stability of these mass charge particles with extremely short lifetimes (see also Ref. [5] for extended discussion).

2. Fundamental principles

In the SM of particle physics uses the Heisenberg uncertainty principal (HUP),
within the duration of any kind of fundamental interactions and, therefore the mediating particles known as virtual gauge bosons (photons, W-Z bosons, g and theoretically gravitons) are produced due to uncertainty in time, \( \Delta t \). This means a particle with a mass of \( \Delta m \) can exist if its duration is less than \( \Delta t \). The production mechanisms are illustrated by the Feynman diagrams involving unstable particle-antiparticle annihilations. The more mass these virtual particles have the shorter the time they can exist, according to Eq.1. Because photons and gravitons are massless, they live forever and the electromagnetic and gravitational interaction can reach infinite distances with the speed of light, while the other two short distance interactions involving heavy W-Z bosons and gluons (g) occur only within the nuclei. Gluons cannot exhibit long distance effect due to g-g coupling, confining the particles within the nuclei [6].

Existence of carrier bosons that are needed for gravitational interaction is a mystery. One should think that gravitons can also be produced by the annihilation of these elementary particles. The question is could this be annihilation of H?

3. Results and discussion

Let us discuss the two long distance fundamental forces; the EM and the gravity. In the EM interaction, there appear force carrying virtual photons as mediating bosons due to HUP, and the most basic annihilation process is the electron-positron annihilation producing the two \( \gamma \)-photons.

Similarly, in gravity, there appear mediating bosons, hypothetically named gravitons and let us assume that the utopic H annihilation continuously produce gravitons in vacuum as proposed by HUP before the actual H boson decays. This annihilation energies with an H mass of around \( \frac{126}{c^2} \text{ GeV} \) corresponds to virtual graviton frequencies in the order of \( \nu \approx 10^{24} \text{ Hz} \) which is nearly \( 10^5 \) times greater than the most energetic \( \hbar \nu \gamma \)-ray energy observed in the EM spectra. In the case of actual gravitons, such frequency corresponds to a wavelength of around 10 attometres (10-18 m) for an individual graviton and cannot have interaction by any kind of known material so that it cannot be sensed by any kind of presently designed detectors.

Gravitons should not be mixed up with the gravitational waves which were predicted by Einstein in 1916 on the basis of his general relativity theory, presuming that the space-time curvature fluctuates due to the rotation or any kinds of motion of the gravitating source until it was, 100 years after, directly detected by the LIGO Scientific Collaboration and Virgo Collaboration teams last week, observing gravitational waves from a pair of black holes by the Advanced LIGO detectors [7]. Period of these waves ranges from the age of universe to the orders of milliseconds, depending on the source whether it is initiated by some quantum fluctuations in the early universe or a rotating supernova. The wave and gravitons are supposed to propagate with the speed of light and this is also the expansion velocity of the gravitational effect unlike the case of Newtonian gravity that supposes infinite velocity. As has been discussed in detail [5], the angular momentum is conserved in the H annihilation by decaying into two gravitons with spins of 2 in opposite directions just as in the case of para-positronium decaying into two photons in its annihilation [8].

Let us now consider, simultaneously that an individual electron and an individual H boson as sources of respectively EM and gravitational interactions are separately propagating the particular force carrying bosons due to the requirement of HUP, having \( \Delta x \) uncertainties in the order of the thermal de Broglie wavelengths of each individual particle. The ratio of the thermal de Broglie wavelengths is given by

\[
\frac{\Delta m}{c^2} = \frac{\hbar}{c^2 \Delta t} \quad \text{or} \quad \Delta E \approx \frac{\hbar}{\Delta t} \quad \text{(1)}
\]
\[
\frac{\lambda_H}{\lambda_e} = \sqrt{\frac{m_e}{m_H}} 
\]  

(2)

where \(m_e\) and \(m_H\) are respectively the electron and H masses. Intensities of propagated gauge bosons into empty space from the spherical surface areas of \(4\pi r^2\) with diameters in the orders of the thermal de Broglie wavelengths \((\lambda = 2r)\) of each individual particle can be written as follows:

\[
I_p = \frac{1}{(4\pi r^2)_e} (\eta_p \hbar \omega_p) = \frac{1}{\pi \lambda_e^2} (\eta_p \hbar \omega_p) \quad (3-a)
\]

\[
I_G = \frac{1}{(4\pi r^2)_H} (\eta_G \hbar \omega_G) = \frac{1}{\pi \lambda_H^2} (\eta_G \hbar \omega_G) \quad (3-b)
\]

where \(\eta_p\) is the photon emission rate and \(\eta_G\) is the G emission rate, i.e. numbers of emitted force carrying bosons per second, and \(\omega_p\) and \(\omega_G\) are the gauge photon and gauge G angular frequencies, respectively. One should notice that Eqs. (3a and b) explain the inverse square laws.

Using Eq.(2) and considering photon and G energies \((\hbar \omega_p = m_e c^2\) and \(\hbar \omega_G = m_H c^2\) respectively) correspond to Einstein’s equivalent mass energy of annihilating particles, the ratio of photon to G intensities is given by the direct proportion of photon and G emission rates in respectively EM and gravitational interactions as follows:

\[
\frac{I_p}{I_G} \approx \frac{\eta_p}{\eta_G} \quad (4)
\]

It is basically considered [5] that the emission rates are basically given by the virtual annihilation rates around the actual particles and that depends on the availability of a certain particle defined by its lifetime. In the first case, electron-positron pair appears and annihilates and in the latter, H and a-H pair appears and annihilates in every short enough \(\Delta t\) time duration given by HUP in Eq. (1). In other words the quantum efficiency \((Q)\) of mediating bosons in each interaction is proportional with the life times;

\[
Q \propto \tau \quad (5)
\]

where \(\tau\) is the lifetime of each particle acting role in the interaction processes.

In the SM the mean lifetime of Higgs bosons is predicted to be in the order of \(\tau_H = 1.56 \times 10^{-22} \text{ s}\). Because of very limited detector resolutions, apparently this measurement can only be estimated within a factor of 1000 [9]. Therefore we take the lifetime for H as one septillionth of a second \((\tau_H \approx 10^{-24} \text{ s})\) [5], which fits in the width of the H lifetime within limiting factor.

According to HUP, average life of a virtual H pair around the incident H can only be;

\[
\Delta t \approx \frac{\hbar}{\Delta E} = 5.2 \times 10^{-27} \text{ s} \quad (7)
\]
where the reduced Planck constant, $\hbar = 6.6 \times 10^{-16} \text{eV.s}$ and $\Delta E \approx 126 \text{ GeV}$ for H bosons. This means that only around a couple of hundred, $(\tau_{H}/\Delta t) \approx 200$, virtual H annihilation is permitted producing virtual immortal G (since they are massless) before the actual unstable H boson decays within its lifetime which is assumed to be in the order of $\sim 10^{-24} \text{s}$ [5].

On the other hand, electrons, the basic source of EM interaction, are very stable and the electron's mean lifetime is given as $4.6 \times 10^{36}$ years [10,11], which is much longer than the life of the universe. Therefore it has been considered [5] that an electron producing electric charge interaction is as old as the universe which allows electronic life time taken as $\tau_{e} = 14 \times 10^{9} \text{years} = 4.4 \times 10^{27} \text{s}$ with a very high confidence and this means that the electron of incidence continuously produce virtual gauge photons by the virtual electron-positron annihilations since the beginning of the universe. Similar arguments in the above paragraph for the lifetime of virtual electron-positron pair around an actual electron having Einstein’s equivalent mass energy of $0.511 \text{ MeV}$ works out to be

$$\Delta t \approx \frac{\hbar}{\Delta E} = 1.3 \times 10^{-21} \text{s}$$

(8)

Therefore, huge numbers of around $(\tau_{e}/\Delta t) \approx 3.4 \times 10^{36}$ virtual electron-positron annihilations have occurred around the actual electron since the beginning of universe, producing immortal gauge photons for the EM interaction.

This means that photon to graviton intensity ratio in Eq.(4) is in the order of $(3.4 \times 10^{36} / 200) \approx 10^{36}$ which is also equals to the ratio of photon to graviton emission rates produced in respectively EM and gravitational interactions. This should also correspond to the relative strength of the EM in comparison to the gravitation which is given as in the order of $10^{36}$ too, determined from “coupling constant” arising in the QFT.

4. Conclusion

It has been proposed that gauge bosons (gravitons) in the mass charge interaction may be produced by the annihilation of these mysterious H bosons with their anti-character just as photons are produced as gauge bosons in the case of electric charge interaction, due to basic principles of quantum electrodynamics. From the estimated “quantum efficiencies” of gravitons and photons emitted around an actual H and electron, respectively, it has been shown that relative strength of gravitational interaction initiated by an H is in the order of 10-36 of the EM interaction initiated by an electron and the ratio found by the predictions in this letter is quite consistent with the Quantum Field Theory. The huge difference between the EM and gravitational interaction comes from the fact that the EM is produced by a very stable source such as electrons with very long lifetimes while gravitation is produced by a very unstable source such as H bosons with lifetimes in the order of $10^{-24} \text{s}$.

Acknowledgements

I thank Research Associate Ali Baltakesmez of Çankırı Karatekin University for assisting in preparation of this manuscript.

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