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# **Opinion Article**

#### 2 A possible microscopic model for gravitational interaction

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#### 4 ABSTRACT

Following the discovery of Higgs Bosons (H) with a mass of around 126  $GeV/c^2$ , it is 5 hypothesized in this study that the gauge bosons (theoretically predicted to be gravitons) in the 6 mass interaction may be produced by H, just as photons are produced in the case of 7 electromagnetic (EM) interaction. Although the hypothesis is extremely difficult to prove 8 experimentally in gravitation mechanism, from the parallel estimation of "quantum efficiencies" 9 of virtual gravitons produced by virtual H annihilation in gravitation and virtual photons 10 11 produced by virtual electron-positron annihilation in EM interaction, due to Heisenberg's Uncertainty Principle (HUP), we evaluate that the relative ratio of photon to graviton intensities 12 is in the order of  $10^{36}$  which is in agreement with the relative strength between *EM* and 13 14 gravitational interactions predicted in Quantum Field Theory (QFT).

15 Keywords: Gravitation, Electromagnetic interaction, Higgs Bosons

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#### 17 I. INTRODUCTION

It has recently been shown by CMS and ATLAS collaborations [1,2] that Higgs Bosons (H) exist with a very high mass of around 126  $GeV/c^2$ , and that proves the existence of Higgs Field that is theoretically predicted over half a century ago, by Higgs [3] and others [4,5]. It was a necessity to assume such field due to the thermodynamic point of view and this also explained symmetry breaking reality of universe between matter and anti-matter. This theoretical assumption of Higgs in 1963 provided him the 2013 Noble Prize in Physics, after 50 years.

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Detection of these particles is so difficult due to their very fast decay in space so that theseparticles exist apparently less than one septillionth of a second [6].

It is well established by the Standard Model (*SM*) [7-8] that gauge bosons; photons, W-Z bosons and gluons (g) perfectly explain the three of the presently known four interaction forces; electromagnetic, weak and strong nuclear interaction except for gravitation. Gravitons (*G*) needed to be theoretically involved in Theory of Everything (*TOE*), filling the fourth cornerstone of the SM in Grand Unified Theory (*GUT*) [9].

According to the SM of universe, interaction between the two species in space occurs when 31 the two have the same kind of charge. A certain type of charge of a particle appears in the forms 32 of electric charge, color charge (strong charge), hypercharge/isospin charge (weak charge) and 33 34 mass charge (inertial charge) that determine the role of participation in the interaction processes. These interaction processes respectively correspond to electromagnetic interaction, strong 35 nuclear interaction, weak nuclear interaction and gravity. Sub-atomic particles known as leptons 36 37 and quarks are the key elementary particles that provide the three of the four kinds of charges except the mass charge, within any kind of particle or object. One important piece of the puzzle 38 39 was missing on the sheet of elementary particles and that was H bosons which is responsible for mass charge of elementary particles and that was proven to appear in the Large Hadron Collider 40 of CERN [10]. Gauge bosons can be produced by the annihilation of same kind of particle-41 antiparticle collisions of Leptons and quarks. 42

In this paper, it is demonstrated that the relative strength ratio between electromagnetic (EM) and gravitational interactions predicted in Quantum Field Theory (*QFT*) can be proven by the ratio of photon to graviton emission intensities produced respectively by an electron in the

*EM* interaction and by an *H* in the gravitational interaction. It is proposed that the huge difference between the *EM* and gravitational interaction comes from the fact that the *EM* is a result of very stable source such as electrons while gravitation is a result of very unstable source such as *H* bosons.

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51 **II.** 

#### I. BASIC PREDICTIONS AND DISCUSSION

In the *SM* of particle physics it is predicted that, within the duration of any kind of interaction, the gauge or interaction bosons (photons, *W-Z* bosons and g) are produced due to the well-known fact, the Heisenberg uncertainty principal (*HUP*),

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$$\Delta x \Delta p \approx \hbar$$
 or  $\Delta E \Delta t \approx \hbar$  (1)

56 corresponding to emissions of particle or energy of

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$$\Delta m \approx \frac{\Delta E}{c^2} = \frac{\hbar}{c^2 \Delta t} \quad \text{or} \quad \Delta E \approx \frac{\hbar}{\Delta t}$$
 (2)

This means a particle with a mass of  $\Delta m$  can exist if its duration is less than  $\Delta t$ . In other 58 words non-existence of a particle due to the  $\Delta x$  and  $\Delta t$  uncertainties results in an emission of 59 particle,  $\Delta m$  or energy,  $\Delta E$ . This is probably a rather unusual interpretation of HUP as such 60 "something may appear from nothing if something returns to nothing within very short  $\Delta t$ 61 amount of time defined by Heisenberg's Uncertainty relation". Although it is most of the times 62 considered to be micro violations of energy conservation, all of the production mechanisms can 63 be demonstrated by the energy-time diagrams of Feynman [11] involving unstable particle-64 antiparticle annihilations of the SM. 65

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These force carrying particles are known as "virtual particles" since they are produced by many virtual annihilation phenomenon occurring around an actual particle, per time duration defined by  $\Delta t$ , as a consequence of *HUP*. The more mass these virtual particles have the shorter the time they can exist, according to Eq.2. 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 occur only within the nuclei.

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As can be seen in the Feynman diagrams of Fig. 1 (a)-(c), annihilation of positrons with electrons produces the three known gauge bosons; respectively photons, *W-Z* bosons and gluons except the gravitons which are not yet observable. 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*?



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**FIG.1:** Three possible positron annihilations shown by Feynman diagrams.

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82 Let us think about the two long distance interactions; the EM and the gravitation. In the EM interaction, there appear force carrying virtual photons as gauge bosons due to HUP, and the 83 most basic annihilation process is the electron-positron annihilation producing two  $\gamma$ -photons. 84 Similarly, in gravity, there appear gauge bosons, hypothetically named gravitons and let us 85 86 assume that the utopic H annihilation continuously seething with gravitons in vacuum as proposed by HUP before the actual H boson decays. This annihilation energies with an H mass 87 of around 126 GeV /  $c^2$  corresponds to virtual graviton frequencies in the order of  $v \approx 10^{24} Hz$ 88 which is nearly 10<sup>4</sup> times greater than the most energetic  $\hbar v \gamma$ -ray energy observed in the EM 89 spectra. In the case of actual gravitons, such frequency corresponds to a wavelength of around 10 90 91 attometers for an individual graviton and cannot have interaction by any kind of "baryonic matter" so that it cannot be sensed by any kind of presently known detectors. This might just be 92 affected by a detector mainly consisting of particles with less than 10 attometers diameter. 93

Gravitons having a wavelength of around 10 attometers probably would have a planar 94 wave structure similar to an *EM* wave such as two planar fields perpendicular to each other with 95 possibly the one known as Higgs field. Since *EM* fields affect the particles that create *EM* wave, 96 fields of gravitons should also affect the particles that create gravitons. Due to the fact that the 97 "Higgs field" affects H bosons, our predictions might likely be true. Photon is created by the 98 annihilation of two fermions and gravitons are created by the annihilation of two bosons. One 99 can re-consider the "Maxwell like" equations and their corresponding equations in QFT in terms 100 of the two perpendicular fields of gravitons, consisting of at least Higgs field. 101



FIG.2: An illustration of (a) an individual electron and (b) an individual H boson having
particle-antiparticle pairs appearing as a consequence of HUP at random around actual particles
at the center.

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One important issue that we have to raise is that how the angular momentum is conserved in the *H* annihilation process. Since the  $H^0$  and anti- $H^0$  (a-H) system would have zero spins, S = 0 and  $M_s = 0$ , the system preferentially decays 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 [12].

113 Let us now consider, in parallel, an individual nonrelativistic electron and an individual 114 nonrelativistic *H* as sources of respectively *EM* and gravitational interactions, separately 115 propagating the particular force carrying bosons due to the requirement of *HUP*. Assuming  $\Delta x$ 

uncertainties are in the order of "the thermal de Broglie wavelengths" of each individual particle,as schematically illustrated in Fig.2. The ratio of the thermal de Broglie wavelengths is given by

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$$\frac{\lambda_{H}}{\lambda_{e}} = \sqrt{\frac{m_{e}}{m_{H}}}$$
(3)

119 where  $m_e$  and  $m_H$  are respectively the electron and *H* masses. Intensities of propagated gauge 120 bosons into empty space from the off-shells of related spheres with surface areas of  $4\pi r^2$  in 121 Fig.2(a) and (b) with diameters in the orders of the thermal de Broglie wavelengths ( $\lambda = 2r$ ) of 122 each individual particle can be written as follows:

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$$I_{P} = \frac{1}{(4\pi r^{2})_{e}} (\eta_{P} \hbar \omega_{P}) = \frac{1}{\pi \lambda_{e}^{2}} (\eta_{P} \hbar \omega_{P})$$
(4-a)

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$$I_G = \frac{1}{(4\pi r^2)_H} (\eta_G \hbar \omega_G) = \frac{1}{\pi \lambda_H^2} (\eta_G \hbar \omega_G)$$
(4-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. (4a and b) explain the inverse square law  $1/r^2$ .

Using Eq.(3) 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: 133  $\frac{I_P}{I_G} = \frac{\eta_P}{\eta_G}$ (5)

134 It is important to notice that Eq.(5) only depends on the emission rates, i.e. the "quantum 135 efficiency" ratio of photon to G, and not any of the parameters described earlier. If it was, the 136 *EM* interaction and the gravity would not have been universal or they might have been 137 temperature dependent, for instance.

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 life time. 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 Eqs(1) and (2). In other words the quantum efficiency (*Q*) of each interaction is proportional with the life times;

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$$Q \propto \tau$$
 (6)

144 where  $\tau$  is the lifetime of each particle acting role in the interaction processes.

Mean lifetime of Higgs bosons is in the order of  $\tau_H = 1.56 \times 10^{-22} \ s$  as predicted in the *SM*. However the width of the *H* lifetime was originally measured by reconstructing many Higgs bosons from its well-known decay products and then mapping their masses. Because of very limited detector resolutions, apparently this measurement can only be estimated within a factor of 1000 of the value predicted by the *SM* [13]. Therefore we take the lifetime for H as one septillionth of a second ( $\tau_H \approx 10^{-24} s$ ) as also mentioned in the introduction, which fits in the width of the *H* lifetime within a factor of 1000 around the time predicted in the *SM*.

According to *HUP*, average life of a virtual *H* pair around the incident *H* sketched inFig.2(b) can only be;

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$$\Delta t \approx \frac{\hbar}{\Delta E} = 5.2 \times 10^{-27} \, s \tag{7}$$

where the reduced Planck constant,  $\hbar \approx 6.6 \times 10^{-16} eV.s$  and  $\Delta E \approx 126 \ GeV$  for an *H*. This means that only around  $({\tau_H}/{\Delta t}) \approx 200$  virtual *H* annihilation is permitted producing virtual immortal *G* (since they are massless) before the actual unstable *H* boson decays within its life time which is assumed to be in the order of  $\sim 10^{-24} s$  in this study.

On the other hand, electrons, the basic source of *EM* interaction, are very stable and the electron's mean lifetime is given as  $4.6x10^{26}$  years, at very high confidence level [14,15], which is much longer than the life of universe. Therefore we should consider that any electron of the incidence exists since the beginning of the universe for over 14 billion years  $\tau_e = 14x10^9$  years =  $4.4x10^{17}$  s. Bearing in mind that the 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 *MeV* works out to be

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$$\Delta t \approx \frac{\hbar}{\Delta E} = 1.3 \times 10^{-21} s \tag{8}$$

167 Therefore, huge numbers of around  $(\tau_e / \Delta t) \approx 3.4 \times 10^{38}$  virtual electron-positron annihilations 168 have occurred around the actual electron illustrated in Fig.2(a) since the beginning of universe, 169 producing immortal gauge photons for the EM interaction.

This means that photon to graviton intensity ratio in Eq.(5) is in the order of  $(3.4x10^{38}/200) \approx 1.7x10^{36}$  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*. This result implies the fact that mean lifetime of *H* is in the order of  $10^{-24}s$  and is almost 100 times less than it is predicted in the *SM*.

The fact that the strength ratio very slightly increases with the intervals of quintillionth, i.e. in the order of  $10^{18}$  per s as the time passes, meaning gravitational force relatively reduces and that may also explain the expansion of universe. It follows that relative strength ratio of the *EM* to gravitational interaction became in the order of  $10^{18}$  at one second after the universe began.

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#### 183 III. CONCLUSION

It has been proposed that gauge bosons (theoretically predicted to be gravitons) in the mass 184 charge interaction may be produced by the annihilation of these mysterious H bosons with their 185 186 anti-character just as photons are produced as gauge bosons in the case of electric charge interaction, due to HUP predicted in quantum electrodynamics. This would be the first evidence 187 to explain gravitation mechanism with gravitons in mass charge interaction. It has been proposed 188 that gravitons should have a very short wavelength of around 10 attometers and very high energy 189 so that such particles cannot be sensed by any kind of presently known detector. From the 190 estimated "quantum efficiencies" of gravitons and photons emitted around an actual H and 191

electron, respectively, it has been comparatively shown that relative strength of gravitational interaction initiated by an *H* is in the order of undecillionth  $(10^{-36})$  of the *EM* interaction initiated by an electron and the ratio found by the predictions in this letter is quite consistent with the *QFT*. 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  $10^{-24} s$ .

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