



# Superluminal graviton condensate vacuum

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## Abstract

In this study, we argue fundamentally and physically on the nature of the graviton as the only elementary particle in the universe, constituting the fabric of vacuum spacetime and all matter and all energy forms. We demonstrate that the universe's functioning is consistent with the current laws of physics and that a non-tachyonic graviton string-particle carrying superluminal energy exists. The graviton model proposed herein unifies dark energy, quantum gravity, and dressed zero-point vacuum energy field in a single energy manifold. The model provides an alternative interpretation of the vacuum energy, the dark energy, and the cosmological constant value as well as an explanation for the cosmological "coincidence problem". Our model describes the zero-point vacuum energy as an evaporation product of hidden compacted extra dimensions superluminal energy of the universe, rather than being due to any supersymmetry fine-tuned fields cancellation. Furthermore, the proposed model also predicts how the graviton's superluminal oscillation is ticking down the remaining lifetime of the universe, acting as a cosmological clock. Spacetime should end after a Big Freeze or a Big Rip scenario governed by a global vacuum instantaneous catastrophic event, to which a new cycle of Big Bang follows. Our model explains why the massless spin 2 in-place superluminal vibrating graviton and condensate consisting everything including spacetime must be essentially the only massless cold boson elementary particle and why fundamentally the vacuum is superluminal condensate energy. An experiment with the Atlas detector is proposed to indirectly verify the theory by measuring potential superluminal propagation of dark photons. Essentially, the research reveals that the entire dark sector consists of superluminal energy, making it directly undetectable. Additionally, it suggests that quantum gravity originates from the dark sector.

**Keywords:** *Quantum Gravity; Dark Energy; Dark Matter; Zero-Point Vacuum Energy; Graviton; Quantum Cosmology; Dark Sector.*

## 1. Introduction

A quantum theory of gravity, except the loop quantum gravity one [1-4], is a unification theory of everything described by one single field through which all other quantum fields manifest. In this theory, all fields, including vacuum, are permutations and distortions of the quantum gravity one consisting of a condensate of stable gravitons [5-6]. However, all attempts to include such a theory in the Standard Model (SM) have proven unfruitful because the graviton energy is non-renormalizable. In other words, quantum vacuum fluctuations have enormous energy equivalent to huge effective rest mass. This equivalence lies in the intimate nature of the quantum vacuum, as a state of spacetime dominated by the processes of creation and annihilation of virtual particles.

The difficulties in unifying the theory of gravity with the Standard Model could be due to the imposition of the constancy of the speed of light, on which the causality principle governing all the observed phenomena is based. Even if no experiment has ever demonstrated the violation of this principle (excluding all the experimental evidence of superluminal phenomena that have recently led to controversies and disputes in the physics community), in this study, we will consider the speed of light as a free parameter, not limited above. In other words, we want to investigate whether it is possible to build a theory that can pave the way for physics beyond the Standard Model by removing this constraint. The quantum vacuum, understood as zero energy point state (ZPE), is the pillar on which the theory proposed is constructed. Notably, it takes the form of a condensate of non-tachyonic particles (gravitons) oscillating at superluminal frequencies. The condensate energy, therefore, is of superluminal nature. The physical laws governing this state must be invariant to spacetime transformations extended to superluminal motions.

As anticipated, quantum theories predict an enormous vacuum energy and rest mass. The question is: why do we not observe them? Assuming this prediction is correct, this energy is somehow hidden in the spacetime domain. Also, the supersymmetric SUSY theory [7-9] failed to explain the observed tiny relative vacuum energy. Besides that, there is another serious problem with vacuum energy. Suppose quantum vacuum is what we call classical spacetime, which includes about 70% of all universe energy. In that case, it is in accelerated expansion with the vacuum ZPE energy density kept at a constant value of 2.7 Kelvin. If this holds, then the universe defies the energy conservation law at the large cosmological scale as well as the second law of thermodynamics that demands a steady energy flow from a higher temperature to a lower one. Thus, where is this higher temperature source that drives the universe's accelerated expansion and its origin, and why can we not observe it? It is as if energy would flow from the absolute zero to the temperature of 2.7 K, which is against any law of nature. Therefore, returning to our initial question, "Why does vacuum space appear to be basically 'nothing'?" we propose that the vacuum is intrinsically superluminal energy.

In the following, we postulate the existence of a condensate, similar to the Bose-Einstein one (BEC) [10-15], of superluminal vibrating closed-loop gravitons, translating at subluminal velocity (non-tachyonic particles). This condensate allows explaining the intimate connection between classical spacetime and quantum mechanics. These particles are non-tachyonic particles vibrating at superluminal frequencies. In the framework of theoretical physics, it is possible to have superluminal rotation without superluminal translation. In other words, an object can rotate faster than the speed of light, but the center of the rotation moves at subluminal velocity. Under this assumption, the postulates of Einstein's theory hold.

This superluminal graviton model<sup>1</sup> does not violate any physics rules. It describes in a quantum framework the fabric of spacetime, and even if the limit of the speed of light does not hold, the graviton explains the energy source by which all ordinary matter and light were created and the origin of all the known physical laws. In fact, from the special relativity theory, we know that matter and light in the vacuum must obey the light-speed limit, but this limit does not constrain spacetime. Therefore, in this study, we do not deem it necessary to prove why Lorentz-invariance violation (LI) for the superluminal graviton [16-23] is not breaking physics. Notably, LI [24-32] is not a mandatory condition for the universe's existence.

The graviton's total energy is discretized and integrates all the known energies, i.e., superluminal energy [33-39], dark oscillation energy, gravity energy, and zero-point vacuum energy (ZPE) [40-41]. Notably, the vacuum field fluctuations are responsible for the Heisenberg Uncertainty Principle and the non-deterministic nature of quantum mechanics. Moreover, the ZPE field dressing the bare graviton couples with the other known fields: the electroweak, the strong fields, and the Higgs field. This means the gravitons create, for example, the electromagnetism phenomenon and, at the same time, the quanta of gravity.

We explain that there are two discrete spacetime domains in the universe in superposition and entangled with each other: the superluminal oscillation of the graviton closed-loop string (i.e., the Boson) at the Planck scale and the luxons 4-dimensional spacetime of ordinary matter and light. The ZPE vacuum energy binds together these two manifolds.

More importantly, we explain analytically why the ZPE of the Lorentz invariant vacuum is the evaporation product of the graviton oscillation of superluminal dark energy. The latter is estimated to be about  $\sim 10^{120}$  orders of magnitude larger than the observed value of about  $10^{-9}$  J per cubic meter (better known as the cosmological constant problem) [42-47]. We show that superluminal energy cannot produce any rest mass: ordinary matter and light belong only to the luminal/subluminal energy spectrum. According to this concept, we should see the limit  $c$  not as the speed of causality but as a critical value of the energy phase transition parameter (in analogy to the typical state transitions of condensed matter), through which ordinary energy and spacetime pass into the state of dark energy and superluminal spacetime. This is why the universe exists and is homogeneous. Vacuum energy, although enormous, is not directly observable due to its intrinsic superluminal property. Alternatively, the superluminal dark energy of the vacuum condensate is almost transparent to ordinary spacetime and has no effect except for the ZPE field of the residual vacuum.

Finally, we calculate some intrinsic critical parameters of the graviton model like its current radius upper limit, oscillation speed, evaporation decay, and lifetime, and propose a hypothesis on the remaining life of the universe related to the evaporation of gravitons.

## 2. Results and discussion

### 2.1. Vacuum ZPE energy, superluminal dark energy, and cosmological constant $\Lambda$

All the terms listed in section 2.1 represent the same energy quantity. We can demonstrate this using our normal luxons Cartesian spacetime and the Einstein-Hilbert action [48]. This involves an integral over spacetime of the sum of a metric tensor term that involves the curvature scalar  $R$ , and an all-matter Lagrangian that includes a potential energy function  $U$  of the other quantum fields present in the vacuum. This potential energy of the vacuum, known as zero-point vacuum energy (ZPE), is at the minimum energy value  $U(\text{vacuum}) = U_0$ , possible. This includes dark matter and the potential energy  $U$  of the vacuum, which is at the minimum energy value possible:

$$\mathcal{L} = \frac{c^4}{16\pi G} R - U_0 = -\frac{c^4}{16\pi G} (R - 2\Lambda). \quad (1)$$

With,

$$U_0 = \frac{c^4}{8\pi G} \Lambda. \quad (2)$$

Where  $\Lambda$  is the cosmological constant,  $G$  is the gravitational constant and  $c$  is the speed of light in the vacuum. Using the above expression eq.(2) for the effective cosmological constant value, natural units  $c = 1 = 8\pi G$  we get,

$$U_0 = \Lambda \quad (3)$$

Equation (3) shows that the value of the cosmological constant and the energy of the quantum vacuum ZPE are effectively the same. This has been estimated through astronomical observations [46] [47] [49] to be of the order of about  $10^{-9}$  J/m<sup>3</sup> energy density in SI metric units. This value represents a very tiny effective rest mass for the free space ZPE vacuum. We refer to the value calculated in equation (3) as Dark Energy (DE). It is important to note that we are currently ignorant of how and from where this energy originates. This energy constantly drives the observed accelerated expansion of our universe, which is at a fixed state of equation vacuum energy density parameter  $\omega_0 = -1$ . The energy density is equal to about the scale of  $10^{-9}$  Joules per cubic meter.

The problem now is, also known as the unsolved cosmological constant problem, why the  $\Lambda$  value is so tiny observed astronomically thus actual experiment empirical evidence although the QFT and QED theory predicts actually for the vacuum enormous energy in the order of  $10^{113}$  J/m<sup>3</sup>; therefore, more than 120 orders of magnitude difference of the theoretical predicted quantum physics value compared to the actual experimentally astronomically observed from the expansion of the universe calculated by the Planck satellite telescope data [49] and also CMB data, tiny value of  $10^{-9}$  Joules per cubic meter. This is also referred to sometimes as the worst and most embarrassing prediction in physics ever, because of the size of the discrepancy and that we are completely in the dark here of knowing what is going

<sup>1</sup>). A small video presentation of the model: <https://tinyurl.com/2u8hb84b>.

on. In quantum theory, it is not permissible to adjust the predicted value of QED to match the actual measured value because we are dealing with the quanta of the vacuum spacetime itself, which is the background and has no other background or lowest energy level to normalize against. The question then arises as to how to resolve this issue. The answer lies in dark energy, which appears to be constantly emanating from the vacuum and expanding the universe with a fixed energy density. This implies that the total amount of dark energy in the universe is increasing with cosmological time. However, the origin of this extra dark energy remains a mystery, and no established theoretical explanation has been put forward yet.

A de Sitter [50] space is a mathematical theoretical Cartesian space filled only with dark energy devoid of any matter including dark matter or light radiation. Such a hypothetical nonphysical space is theorized to be filled only with dark energy, corresponding to a positive vacuum energy density  $\Lambda$  with negative outgoing pressure.

It's possible that the de Sitter dark energy spacetime domain, which is a mathematical tool, could physically exist in a superposition state along with our normal luxons energy spacetime domain within our universe. Only a tiny amount of the enormous QED predicted dark energy value may leak out as dark energy noise from the de Sitter's hidden dark energy spacetime domain towards our observed luxons normal spacetime. This dark energy noise is seen by us as ZPE vacuum energy in our spacetime. Its fluctuations are also known as quantum foam of virtual particles of the vacuum.

In the scenario described above, the majority of the dark energy is contained within the de Sitter spacetime, which is hidden from our normal spacetime. We can only observe a small portion of the dark energy in the form of a vacuum ZPE dark energy noise field. This noise field is a tiny fraction of the total dark energy reservoir of our universe and is a result of the de Sitter dark energy evaporation that slowly leaks towards our luxons spacetime. This leakage is responsible for the observed expansion of the universe.

Therefore, the previous eq. (3) describing the vacuum energy should now be amended as follows:

$$U_{QED} = \Lambda_{(\text{hidden})} + \Lambda_{(\text{observed})} \quad (4)$$

The  $U_{QED}$  theory of quantum mechanics has predicted that the vacuum of space contains a vast amount of potential energy. This energy consists of the observed  $\Lambda_{(\text{observed})}$ , small vacuum zero-point energy (ZPE) and a much larger, yet to-be-confirmed, dark energy  $\Lambda_{(\text{hidden})}$  that is hidden within the de Sitter dark energy's spacetime domain. This domain is in superposition with our universe's spacetime which is occupied by luxons.

Next, we will discuss and argue why equation (4) can only be true if there exists a hidden energy component  $\Lambda_{(\text{hidden})}$ , which we refer to as hidden-dark energy. This component must be superluminal (non-Lorentz-invariant), massless, and not responsible for the observed expansion of the universe. Instead, it is the Lorentz-invariant (i.e., obeys the speed of light causality) dark energy's evaporation product, leaked energy component into our spacetime  $\Lambda_{(\text{observed})}$ , that is responsible for the observed expansion of the universe.

The key takeaway from this section is that this superluminal hidden-dark energy component residing in de Sitter space is serving as a massive energy reservoir for our universe. This means that contrary to previous beliefs in the literature, the expansion of the universe does not violate the law of conservation of energy in physics at large cosmological scales.

So, what drives the expansion of our universe can be physically interpreted as a partial phase energy transition of dark energy to luminal and sub-luminal energy in the form of the ZPE field of the vacuum fluctuating quantum foam of virtual particles-antiparticles pairs, virtual bosons, and virtual fermions. This energy phase transition happens at the critical value  $c$ , the speed of light in the vacuum which is also the speed of light information propagation in our spacetime or otherwise referred to as the speed of causality in our luxons spacetime domain. Which luxons spacetime, however as we will clarify next, is not the only spacetime in our universe but a second Planck-sized Cartesian extra dimensions superluminal spacetime domain and causality exists in superposition or hyperspace and which consists from a "sea" of massless bare gravitons vacuum condensate we used to call simply free vacuum space.

## 2.2. A de Sitter superluminal dark energy space and its zero mass-energy equivalence

In the previous section, we have argued that there must be a hidden reservoir of the missing predicted by quantum QED and QFT, dark energy that would reside at a discrete de Sitter spacetime isolated from our normal luxons spacetime and only a small amount of dark energy decays to Lorentz-invariant ZPE vacuum noise that expands the universe. However, for this to happen the graviton condensate must be a fluid of non-tachyonic translation in-place superluminal oscillating gravitons. Meaning, that the bare gravitons which are omnipresent inside the condensate are not freely translating in space not even close to a relativistic speed but instead more or less at a fixed position with very little displacement space allowed amongst them that however oscillating at superluminal speed.

A De Sitter space is a maximally symmetric Lorentzian manifold with constant positive scalar curvature. It is a solution to the equations of general relativity with a positive cosmological constant. The dark energy equation of state parameter  $\omega_0$  is -1 for the cosmological constant, and it contributes to the energy density of the universe in the form of vacuum energy.

However, our previous argument of a superluminal oscillation dark energy, non-tachyonic translating condensate de Sitter spacetime domain contains additional information about superluminal oscillations energy. This requires a more elaborate mathematical description that incorporates such a component.

One potential approach to including this additional information would be to consider a scalar field with superluminal oscillations. The energy density of the scalar field would need to be non-negative for the energy conditions of general relativity to hold.

One possibility for a relevant scalar field equation of motion is:

$$\partial^2\phi / \partial t^2 - \partial^2\phi / \partial x^2 + m^2\phi = -\lambda\phi^3, \quad (5)$$

Where  $\phi$  is the scalar field,  $m$  is the mass of the field and  $\lambda$  is a coupling constant representing the strength of the field self-interaction. The negative cubic self-interaction causes energy to become superluminal and requires extra care to satisfy general covariance.

The canonical generalization of the De Sitter universe with a scalar field such as this is the power-law inflationary model which has the following metric:

$$ds^2 = dt^2 - a(t)^2(d\chi^2 + \sin^2\chi d\Omega^2), \quad (6)$$

Where  $a(t)$  is the scale factor,  $\chi$  is an angular coordinate and  $d\Omega^2$  is the metric of the two-sphere. In power-law inflation, the scalar field  $\Phi$  is taken to be homogeneous and minimally coupled to gravity. The Hubble parameter is  $H = \text{constant}$ , and  $a(t) \sim t^{(H)}$ , leading to an expo-

ponential expansion during the initial period after the Big Bang. Incorporating superluminal oscillation energy into this model will require further development. However, the addition of a scalar field with non-standard properties has the potential to create a rich and complex theoretical framework, with important implications for the evolution of the universe.

A more straightforward simple novel approach from the authors herein will also demonstrate a very important observation of this research that superluminal rest energy like the described herein case of a non-tachyonic (i.e. particles are not translating in vacuum space with superluminal speed) superluminal in-place oscillating condensate of particles is incapable of generating any mass although of enormous intrinsic energy. Therefore, such a condensate would appear in our spacetime as massless and basically as 'nothing' although expected to have an enormous energy. This is exactly how we perceive empirically more or less vacuum space, as "nothing"! Therefore opposite to tachyonic superluminal theories [51] [52] a spacetime like that will not generate negative mass but instead will rather have zero rest mass but still enormous energy. The only rest mass effect that would be observable in our spacetime would be this tiny amount of leaked ZPE Lorentz-invariant vacuum energy due to the slow evaporation noise energy released in our spacetime by the gravitons superluminal oscillating condensate residing at de Sitter space.

It is possible to demonstrate quantitatively that the de Sitter superluminal vibration, hidden dark energy spacetime, and our normal luxons spacetime are all 4-dimensional Cartesian spacetimes. Therefore, it is reasonable to assume that the Einstein mass-energy equivalence equation applies to all of them. There is no theoretical proof against this assumption, and the fact that there is no empirical evidence to support it is not evidence against it either.

Therefore, assuming the ratio of the QED predicted non-Lorentz-invariant vacuum energy density  $\rho_{vac}$  to the actual Lorentz-invariant vacuum ZPE observed density value  $\rho_\lambda$  measured by the accelerated expansion of the universe  $\Lambda$ CDM model according to the following equation (7) we see that this ratio must be equal to a corresponding speed ratio,

$$\frac{\rho_{vac}}{\rho_\lambda} = \frac{E_{vac}/V}{E_\lambda/V} = \frac{m_{vac}v_{vac}^2/V}{m_\lambda c^2/V} = \frac{v_{vac}}{c} \quad (7)$$

Where  $v_{vac}$  is the theorized in our theory dark energy's in de Sitter space interaction propagation speed of dark energy longitudinal speed component and also quantum scalar gravity interaction longitudinal speed component inside the vacuum de Sitter space which coincides with the tangential revolution speed (i.e. oscillation) of the superluminal graviton string-particle theorized in our research being both the fundamental stable particle of vacuum's dark energy and also quantum gravity. In equation (7) V is the volume of vacuum space and c is the speed of light in the vacuum observed in our luxons spacetime. Also, we assume that the two effective rest masses in equation (7) are equal  $m_{vac} = m_\lambda$  which is consistent with our previous analysis that a superluminal in-place oscillating string-particle without any or very little translational motion cannot generate ever any rest mass although having an enormous energy. Therefore the only observable mass  $m_{vac}$  the dark energy superluminal non-Lorentz-invariant oscillation creates is the leaked in our spacetime Lorentz-invariant evaporation dark energy noise ZPE field of the vacuum which has an effective rest mass we have measured  $m_\lambda$ .

Therefore, as shown by equation (8) below in combination with equation (7) besides the transverse interaction propagation speed component at c speed the speed of normal light in the vacuum, among gravitons inside this graviton condensate residing in de Sitter space described, there must be also a longitudinal interaction component that as the calculation shows of equation (8) is superluminal 122 orders of magnitude faster than c.

$$\frac{\rho_{vac}}{\rho_\lambda} = \frac{10^{13} \text{ J/m}^3}{10^{29} \text{ J/m}^3} \rightarrow v_{vac} \approx 10^{122} \cdot c \quad (8)$$

Thus, in SI units,

$$v_{vac} = v_{DE} \approx 3 \cdot 10^{30} \text{ m/s} \quad (9)$$

It is possible that the humongous hidden intrinsic interaction propagation speed value of vacuum free-space dark energy, which is estimated in equations (8) and (9)  $v_{DE}$  within de Sitter space, might be the reason for the "apparent" non-locality intrinsic characteristic of quantum mechanics that is observed in our spacetime. This is seen as "instantaneous action at a distance" in quantum entanglement experiments.

Although this speed estimated may seem initially ridiculous and unrealistic however given the size of the observable universe estimated at  $8.8 \times 10^{26}$  m in diameter [49] [53] and the entire non-observable universe is predicted to be at least about 250 times larger [49] than that thus about  $2.2 \times 10^{29}$  m in diameter, then it is not that far stretched to see that a hidden dark interaction speed and speed of dark information propagation of  $\approx 10^{30}$  m/s is needed to harmonize and keep the entire universe as a causality connected and coherent single system.

Imagine the universe being a molecule, what speed of electromagnetic interactions inside the molecule is needed for the molecule to exist as a coherent system? That's right,  $3 \times 10^8$  m/s the speed of light c which is spatially much much larger than the tiny dimensions of the molecule. Also, another observation we can gather from the above analysis is that if we accept the Einstein energy to mass conversion equation to be universal correct  $E=mv^2$  for any 4-dimensional spacetime possible (i.e. three spatial plus one temporal dimension) where m is the rest mass and v the propagation speed of the energy E inside that effective rest mass then we can conclude that a system can have an enormous intrinsic amount of energy enclosed in a relative tiny effective rest mass or practically zero mass if it possesses an enormous large speed of energy propagation inside that rest mass  $m=E/v^2$ . Our research shows that this is exactly the case in our universe thus vacuum free-space and dark energy are actually intrinsically superluminal energy. This last point will become more obvious later on when we will do more specific quantitative calculations of our model. Notice also that such a superluminal oscillation with no translational motion cold de Sitter spacetime would produce no heat having exactly zero Kelvin temperature opposite to the about 2.7 Kelvin temperature of the vacuum ZPE of our luxons spacetime without breaking the 2<sup>nd</sup> law of thermodynamics because the superluminal energy characteristic.

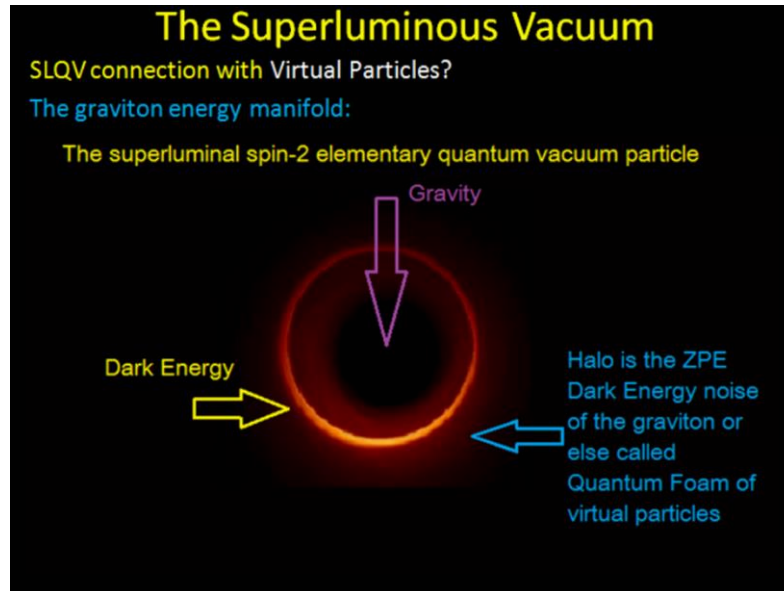
### 2.3. The energy manifold of the proposed superluminal oscillating non-tachyonic graviton

The proposed model for describing our bare graviton stationary particle involves a superluminal oscillating Planck-sized extra-dimensional string energy manifold. This manifold is essentially a 2D closed circular loop revolving freely around a fixed center in space, much like a flywheel. The motion of this loop can be described using the polar parametric equation:

$$r(t) = r_0 \theta(t) = \omega t + \theta_0 \quad (10)$$

Where  $\theta_0$  is the initial starting polar angle of any point in the circle from the x-axis in Cartesian space,  $r_0$  the fixed radius of the circle, and  $\omega$  is the constant angular velocity of any point in the circle with time  $t$ .

A physical illustration of the 2D energy manifold of the proposed graviton model is shown in Fig. 1:



**Fig. 1:** Proposed Superluminal Vibrating Non-Tachyonic Graviton Energy Manifold. the  $R_g$  Radius of the Bare Graviton Is Defined from the Center of the Manifold to the Bright Ring Perimeter. the Bright Ring Shown in the Illustration Is the Superluminal Dark Energy (DE) Component of the Graviton.

According to our research proposal, the only stable elementary bare model particle of the vacuum is the spin-2 graviton massless Boson however our research indicates that it must be an in-place superluminal harmonic oscillating closed loop Planck-sized extra dimensions string with no translational motion (i.e. not to be confused with tachyon) that fills all vacuum free space creating an omnipresent in our universe superluminal graviton condensate. This stable superluminal vacuum quanta elementary particle carries both the Dark Energy which is actually a non-Lorentz-invariant unknown superluminal state of energy, quantum gravity, and Lorentz-invariant ZPE of the vacuum in our universe, and the origin also for the other three known forces, strong and electro-weak forces as we will show later on in this paper.

In more detail, in Fig. 1 we can identify all three discrete feature components of the total energy manifold of the proposed 2D graviton model all integrated in a single energy manifold. Firstly, the superluminal oscillation rotation (i.e. hidden Dark Energy component of the graviton) shown in Fig. 1 as the bright ring revolving like a flywheel with superluminal tangential speed  $c_g$  which is the Dark Energy (DE) component of the proposed graviton energy manifold and hidden energy reservoir in our universe. Secondly, the DE's superluminal rotation evaporated energy thus its generated dressed ZPE Lorentz-invariant noise field (i.e. obeys the  $c$ , luxons spacetime speed limit) surrounding the bare graviton manifold shown in fig.1 as a cloud of virtual particles or else known as quantum foam of the vacuum.

Notice here importantly, that our non-tachyonic superluminal oscillation graviton model without continuous translational motion inside the condensate total discrete energy manifold for the graviton shown in fig.1, represents not a massless spin-2 Boson (i.e. bare graviton) but rather this manifold has mass since it includes the ZPE Lorentz-invariant vacuum halo noise field generated by the graviton, therefore, a rest mass is created. However, this noise is mixed continuously and homogeneously with the noise generated by all gravitons inside the vacuum condensate and is therefore impossible to be individually defined and calculated for a single graviton. Therefore a bare graviton massless spin -2 Boson particle definition is necessary for further analyzing our model thus the  $R_g$  radius of bare graviton is defined from the center of the manifold (see fig.1 ) to the bright ring perimeter. The bright ring shown in the illustration is the superluminal Dark Energy (DE) component of the graviton that as we have shown in the previous section does not generate any mass even if we have the extraordinary case of a practically stationary Boson particle with no translational motion that would by definition be massive and having a rest mass in our spacetime but instead due to the superluminality intrinsic property does not generate any mass and appears as massless. So, taking a side in the debate among researchers over the last years about a massive estimated around  $10^{-32}$  eV/ $c^2$  model [54] of the graviton our research predicts a bare graviton (i.e. without its ZPE dressed field) is a superluminal oscillating non-tachyonic massless spin-2 cold Boson which actually fits the observations and could be also a possible cold dark matter  $\Lambda$ CDM candidate [55-57].

Lastly, in Fig. 1 we distinguish the quantum gravity component of the manifold thus the singularity dark inner ring region shown, is a region of true void and absent of any kind of energy that creates gravity.

Because the hypothesized superluminal nature of the described graviton elementary particle of the vacuum which can be described as being the most elementary particle in the universe, resembling a microscopic BH, evaporates and the product of its evaporation is the mainly Lorentz-invariant ZPE vacuum energy however because its superluminal intrinsic property, it will not evaporate as normally expected at an instant but instead is stable and will long live towards the possible end of our universe inside the graviton's vacuum condensate. As the gravitons we theorize are actual superluminal elementary particles, evaporate very slowly inside their condensate the spacetime vacuum and therefore also universe is expanding in volume keeping however the ZPE energy density more or less at a fixed value in compliance with the  $\Lambda$ CDM model. We say more or less because it is still a subject under investigation of a measured state of the equation of the DE parameter  $w_0$  if the expansion is of declining acceleration thus quintessence [58] or exponential increasing acceleration thus phantom energy [59] or fixed acceleration value thus the standard  $\Lambda$ CDM model [49]. The above described so far also solves

the observed cosmological constant discrepancy between the observed vacuum energy density and the theoretical QED prediction of the free space vacuum density since due to the intrinsic superluminal property the missing energy (i.e. Dark Energy) is hidden and we observe only its Lorentz-invariant noise component thus the ZPE.

The absence of the two previous energy fields shown in Fig. 1 thus DE bright ring and halo ZPE noise halo field as shown in Fig. 1 depicted as the black "true void" region or else after the event horizon of the BH thus singularity of the BH is generating quantum gravity. The absence of any energy is the gravity. Of course, if vacuum space has an omnipresent gravity you would not feel it since a hidden absolute frame of reference and you would only feel its gradient which would act like a negative pressure at the locations where the normal matter is located in the Universe like planets or stars for example, where presumably these "vacuum quanta gravitons" resembling stable quantum Planck-sized black holes are in higher number concentration than the rest of the surrounding vacuum space.

Notice here, although we say in the beginning that the graviton manifold resembles a quantum microscopic black hole (BH) it is not necessarily to collapse in such for a radius less than one Planck length assuming the Schwarzschild radius equation (11) holds universal for any speed larger than the  $c$  limit that would shrink even more the minimum radius beyond by which the manifold of fig. 1 collapses to a BH:

$$r_s = \frac{2GM}{\nu^2} \quad (11)$$

$r_s$  = event horizon of a Schwarzschild black hole

$G$  = gravitational constant

$M$  = object mass

$\nu > c$  speed of light

Therefore, the energy manifold of our proposed graviton model inside the ring thus depicted black region in Fig. 1 could be alternatively described as a true void region where any type of energy is absent thus quantum gravity.

#### 2.4. Spin-2 conjecture to superluminal oscillation

We will try to prove in the next pages our conjecture that an elementary particle can have an integer spin-2 value as theorized in the literature for the graviton Boson particle spin value [54] [60], if and only if representing it as a closed loop string, it has a superluminal symmetric rotation oscillation. Therefore by showing this conjecture being potentially true, we will strengthen our case of the superluminal oscillating spin-2 massless graviton model we propose herein.

We will prove our following conjecture,

$$\text{spin} - 2 \leftrightarrow \text{superluminal rotation} \quad (12)$$

Spin of particles general equation:

$$S_z |s, m_s\rangle = \hbar m_s |s, m_s\rangle \quad (13)$$

$$\text{For electron, } |m_s| = 1/2 \rightarrow |S_z| = \frac{\hbar}{2} = \frac{h}{4\pi} \Rightarrow 4\pi\text{-symmetry} \quad (14)$$

$$\text{For photon, } |m_s| = 1 \rightarrow |S_z| = \hbar = \frac{h}{2\pi} \Rightarrow 2\pi\text{-symmetry} \quad (15)$$

$$\text{For graviton, } |m_s| = 2 \rightarrow |S_z| = 2\hbar = \frac{h}{\pi} \Rightarrow \pi\text{-symmetry} \quad (16)$$

Applying Thomas Precession of QM of SM of particles [61] [62] for each of the above spin cases of eq (14) to (16) and also using Nobel Laureate Smoot's equation (17) [63] correlating spin, Thomas Precession, and special relativity Lorentz-factor  $\gamma$  for symmetrical rotation,

$$\frac{\omega_p}{\omega} = \frac{\Delta\theta}{2\pi} = \gamma - 1 \quad \text{Smoot's equation} \quad (17)$$

"Angles are velocity dependent. The velocity dependence of angles has an important effect concerning rotational motion. Angular rotation is  $\omega$  accompanied by angular precession  $\omega_p$ , where precession has the sense of counter-rotation. This is Thomas precession, as shown in Figure 1 below" [62],

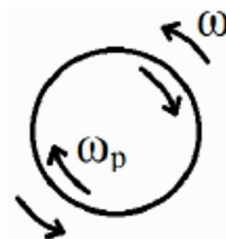


Fig. 2: Thomas Precession for Symmetrical Rotations [62].

We get when applying Smoot's eq (17) using closed string loops manifolds for the particle cases electron eq (14), photon eq (15), and graviton eq (16) correspondingly:

For electron,

$$\frac{\omega_p}{\omega} = \frac{\Delta\theta}{2\pi} = \frac{2\pi}{2\pi} = \gamma - 1 \Rightarrow \gamma = 2 \tag{18}$$

Where,

$$\Delta\theta = \frac{h}{|S_e|} - 2\pi = 4\pi - 2\pi = 2\pi \tag{19}$$

Is the algebraic difference of the rotation angle of the  $4\pi$ -symmetry of the electron spin calculated previously in equation (13) from the normal expected value of a symmetrical  $2\pi$  rotation.

From the result of the eq. (18), we see that for the spin-  $\frac{1}{2}$  electron the angular speed of precession is time dilated times two in the lab frame Lorentz-factor  $\gamma=2$ , thus a normal  $2\pi$  symmetrical rotation in the particle's frame is converted to a  $4\pi$ -symmetry rotation in the lab frame.

Correspondingly, we calculate for the photon

$$\frac{\omega_p}{\omega} = \frac{\Delta\theta}{2\pi} = \frac{0}{2\pi} = \gamma - 1 \Rightarrow \gamma = 1 \tag{20}$$

With,

$$\Delta\theta = \frac{h}{|S_p|} - 2\pi = 2\pi - 2\pi = 0 \tag{21}$$

Therefore from the result of eq. (20), we see that a spin-1 photon has no Thomas precession rotation and appears in all frames of references the same without any SR time dilation effect.

However, for the spin-2 graviton, we calculate correspondingly,

$$\frac{\omega_p}{\omega} = \frac{\Delta\theta}{2\pi} = -\frac{\pi}{2\pi} = -\frac{1}{2} = \gamma - 1 \Rightarrow \gamma = \frac{1}{2} \tag{22}$$

With,

$$\Delta\theta = \frac{h}{|S_g|} - 2\pi = \pi - 2\pi = -\pi \tag{23}$$

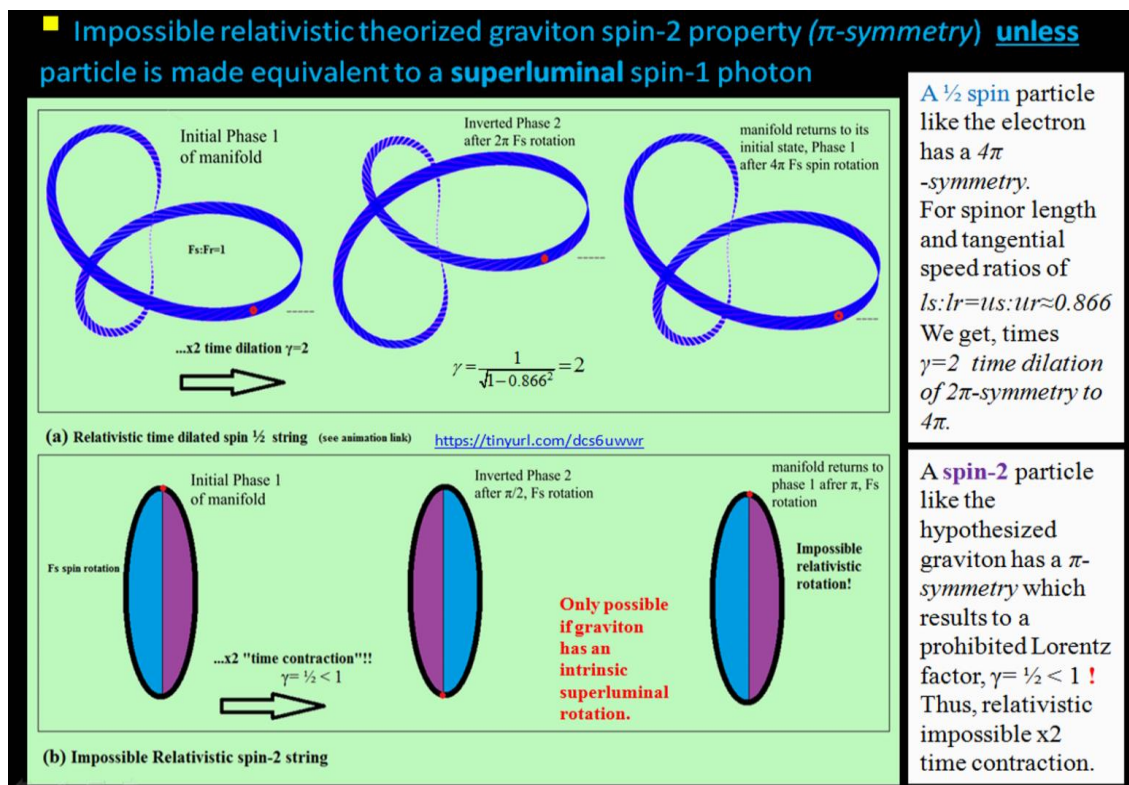


Fig. 3: Spin Closed-Loop String Rotations of (A) Electron Spin-  $\frac{1}{2}$  ( $4\pi$  Symmetry) Animation: <https://Tinyurl.Com/Dcs6uwvr> And (B) Graviton Spin-2 ( $\pi$ -Symmetry) Compared Demonstrating in Case (B) Of Graviton Possible Intrinsic Superluminal Speed Rotation.

Equation (22) yields an unexpected result for the spin-2 graviton, which cannot be explained by special relativity (SR). According to the equation, the Lorentz factor  $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$  calculates an x2 time contraction in the lab frame, which is impossible under SR and contradicts the normally expected time dilation. This suggests that a superluminal symmetric rotation must be assumed for the spin-2 graviton to explain the observed phenomenon.

Therefore for the graviton, the reported value alone of its hypothesized in the literature spin-2, assuming graviton being a closed-loop string particle, strongly infers to the possible superluminal harmonic energy oscillation of the massless graviton Boson.

The above analysis results are illustrated as a summary in Fig. 3:

## 2.5. The superluminal dark energy component of graviton evaporation into ZPE of the vacuum

We have shown so far herein, that the superluminal Dark energy component of the graviton energy manifold shown in Fig. 1 (see revolving bright ring at superluminal tangential speed) very slowly evaporates with cosmological time and radiates around the bare graviton as an incoherent cloud noise field that is Lorentz-invariant energy in contrast to the bright ring superluminal energy and is what we observe in our luxons spacetime universe as zero-point vacuum energy (ZPE).

Although the graviton described herein resembles a quantum micro-black hole it is not actually a black hole since the Schwarzschild radius calculation of it considering its superluminal vibration speed  $c_g$  previously estimated value see equations (8) & (9), results in a Schwarzschild radius many orders of magnitude smaller than the calculated upper size limit of the graviton radius  $R_g$  as we will calculate in the next section of the paper. You cannot expect the particle that is responsible in the first place for creating BHs to be a BH by itself. The inner dark region shown in Fig. 1 inside the paper is just a region of "true void" totally absent of any type of energy.

Therefore when referring inside the paper as the vacuum ZPE being the product of the evaporation energy of the graviton's dark energy component (see bright ring in fig.1) this should not be confused with cosmological BHs evaporation thus Hawking radiation although the effects are similar.

The superluminal speed vibrating graviton model described herein loses very slowly its vibrational energy thus  $c_g$  speed and vibrational frequency decrease with cosmological time. This reduction of the bare graviton's superluminal oscillation energy is transformed into our known vacuum ZPE.

According to our graviton model, after billions of years of cosmological time, the vibration speed of gravitons will eventually drop to the critical energy phase transition value, which is the speed of light  $c$ . At this point, all gravitons in the universe will become luxons, which are normal photons with enormous total light-radiated energy and effective mass conversion. This will result in the universe ending not with a Big freeze or a Big rip, but rather a Big flash.

Since the theorized herein graviton as shown in the previous comment, is not the same as a micro-black hole, it will not evaporate at an instant but is actually the stable elementary particle of the vacuum and quantum gravity.

Its slow evaporation to vacuum ZPE should not be confused with Hawking radiation of Black holes.

Thermodynamically, the superluminal bare graviton is at exact zero Kelvin temperature since it is not a luxon (i.e. photon) that can create heat. The about fixed 2.7 Kelvin temperature of free vacuum space we observe is the product of the graviton's continuous evaporation radiated Lorentz-invariant spectrum component thus vacuum ZPE (i.e. zero-point energy) which is kept at a fixed temperature of 2.7 Kelvin due to the expansion of the universe in volume which is promotional to the total ZPE added in the universe with time by the gravitons evaporation.

In our model, the source and cause of the continuous evaporated energy (ZPE) by the superluminal vibrating graviton is its continuous reduction with the cosmological time of its superluminal oscillation speed and frequency and also the graviton radius  $R_g$  increases with cosmological time reaching closer to normal photons wavelengths and eventually crossing below the Planck frequency threshold. This deceleration of the graviton's vibration speed is converted to the known observed vacuum ZPE.

Notice, that the above-described evaporation mechanism of hidden from our luxons spacetime Superluminal dark energy component of the proposed in fig.1 graviton energy manifold also solves the conservation of energy at cosmological scale problem which was believed until now that is violated but as we show in our model it is not since the superluminal dark energy oscillation component of the graviton acts like a hidden omnipresent energy reservoir of our universe that very slowly releases with time ZPE vacuum energy and results to the accelerated expansion of our universe.

## 2.6. Calculation of an upper possible size limit for the radius of the graviton $R_g$

Our model proposal of the superluminal oscillating non-tachyonic massless spin-2 Boson string-particle graviton assumes extra three-spatial xyz Cartesian dimensions [31] and one temporal thus an extra microscopic dimensions 4-dimensional spacetime in Planck or even possible sub-Planck size scale dimensions. In the previous section 2.5, of a superluminal vacuum consisting of a "sea" of superluminal vibrating non tachyonic gravitons condensate we calculated a possible oscillation speed for the Dark Energy component see eq. (7) & (8) of the proposed graviton particle energy manifold. We herein continue the quantitative analysis and calculate an upper size limit for the radius  $R_g$  of the graviton manifold (i.e. bare manifold without the dressed zero point energy ZPE component of the graviton).

"To the question, is there anything smaller than a Planck length?

We can give an example of a physical result that has a value smaller than the Planck length. In 1973, Jacob Bekenstein published a paper where it was shown that the surface area of a black hole increases  $1A_p$  for every bit of information that crosses the event horizon [64]

$1A_p$  is the Planck Area - equal to  $l_p^2$ .

The surface area of a sphere is given by  $4\pi R^2$

Therefore, the new surface area after the 1bit was added is given by  $4\pi R_{\text{new}}^2 = 4\pi R_{\text{old}}^2 + l_p^2$ .

Consequently,

$$R_{\text{new}} = \sqrt{R_{\text{old}}^2 + \frac{l_p^2}{4\pi}} \quad (24)$$

To calculate the change in radius:



$$\delta R = R_{\text{new}} - R_{\text{old}} \quad (25)$$

$$\delta R \approx R_{\text{old}} \left( 1 + \frac{l_p^2}{8\pi R_{\text{old}}^2} \right) - R_{\text{old}} \quad (26)$$

We get,

$$\delta R \approx \frac{l_p^2}{8\pi R_{\text{old}}} \ll l_p \quad (27)$$

Therefore, using Bekenstein's result, the change in radius of a black hole when 1 bit of information is added is much smaller than 1 Planck length (taken into consideration that the radius  $R$  for a typical black hole will be on the orders of thousands of km's which can be calculated approximately at a typical value of  $10^{40} l_p$ ) [64].

By Ansatz, the authors assign this bit of information having a radius equal to  $\delta R$  and the one bit of information in the Black hole to be the single bare graviton with radius  $R_g$  :

$$\delta R = R_g \quad (28)$$

Therefore assigning approximately the Radius of a typical Black hole as previously mentioned  $R_{\text{old}} \approx 10^{40} l_p$  we can calculate from equations (27) & (28) above, an upper limit estimate of the graviton radius of:

$$R_g \approx \frac{l_p^2}{8\pi R_{\text{old}}} \approx 3.98 \times 10^{-42} l_p \Rightarrow R_g \approx 10^{-42} l_p \quad (29)$$

Thus an upper limit of the graviton radius forty-two orders of magnitude smaller than the Planck length and physical dimension in meters SI units:

$$R_g \approx 36.43 \times 10^{-77} m \Rightarrow R_g \approx 10^{-77} m \quad (30)$$

From equation (7) result we can calculate the effective energy of the superluminal dark energy component of a bare massless spin-2 graviton Boson as follows:

$$E_g \approx 2hf \approx 2h \frac{c_s}{2\pi R_g} \quad (31)$$

Where the number two in front of the equation (31) is because the spin-2 property of the two-dimensional graviton particle in the x or y directions,  $c_s$  the superluminal tangential rotation speed of the bare graviton manifold previously calculated at  $c_s \approx 10^{122} \cdot c$  where  $c$  is the speed of light in the vacuum,  $2\pi R_g$  denominator term being the Compton wavelength of the graviton and  $R_g$  being its reduced Compton wavelength and equal to the radius of the bare graviton. The  $h$  is the Planck constant.

Therefore, the above equation (31) can be re-written as:

$$E_g \approx \frac{2\hbar c_s}{R_g} \quad (32)$$

Where  $\hbar$  is the reduced Planck constant and  $E_g$  is the effective luminal energy of the graviton's superluminal dark energy component if this were to be transformed to our luxons spacetime. This enormous energy is hidden from our spacetime and does not produce any mass and we observe only the evaporation product with cosmological time of the graviton's DE component, namely the known Lorentz-invariant ZPE of the vacuum calculated by the observed expansion of the universe to be at a fixed energy density per cubic meter ZPE value of the order of  $10^{-9} J$ .

To get an idea of what enormous energy would be released in our spacetime universe if the superluminal graviton would decay in our luxons spacetime the above equation gives a value of,

$$E_g \approx 1.73 \times 10^{74} J \approx 1.08 \times 10^{91} eV \quad (33)$$

However, this superluminal DE energy of the graviton is hidden and has no catastrophic result in our luxons spacetime since it cannot be transformed to normal light and mass. If we were to calculate an effective rest mass for the bare graviton's DE component this would result only in a tiny practical zero mass of:

$$M_g = \frac{E_g}{c_s^2} \Rightarrow \sim 0.192 \times 10^{-86} K_g \Rightarrow \sim 1.077 \times 10^{-51} \frac{eV}{c^2} \quad (34)$$

This result of eq. (34) is "nothing", exactly as empirically the vacuum appears to us, as nothing and massless.

## 2.7. Superluminal graviton coupling with the Higgs Boson

We propose that the initial detection of the unstable spin-0 Higgs boson particle, which was announced on July 4th, 2012 at the LHC CERN Atlas detector, was correct in its observation of decay to two opposite spin  $\gamma$ -photons. However, we suggest that this particle is not the elementary particle of the vacuum. Instead, we believe that it is the stable superluminal vibration spin-2 massless graviton, as previously described.

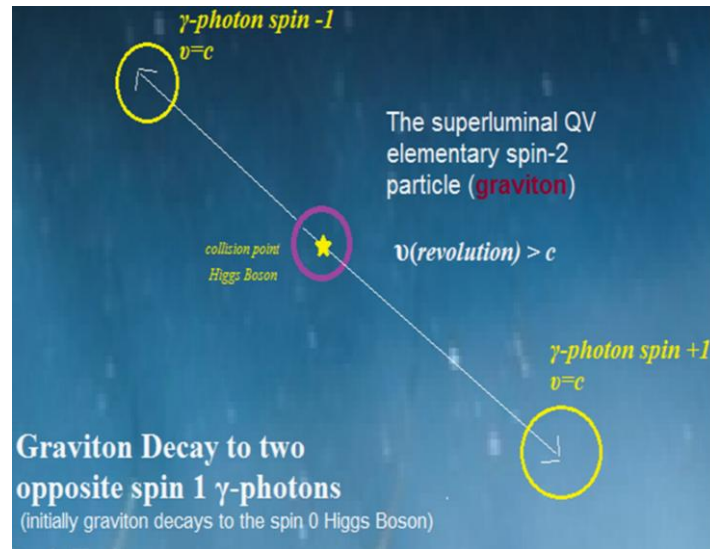


Fig. 4: Higgs Boson of Spin-0 Being Actually A Static Scalar Imprint of the Spin-2 Graviton.

The two matter proton beams violently colliding at a point in vacuum space caused an abrupt deceleration of a source spin-2 graviton's superluminal rotation speed, see fig.4 magenta ring, to  $c$  speed that gave a static imprint of the graviton thus the Higgs Boson. This process could be characterized as similar to the neutrino oscillation phenomenon and is essentially a phase transition mechanism. Subsequently, the generated spin-0 Higgs Boson decayed to the two opposite spin-1  $\gamma$ -photons detected inside the LHC Atlas detector [65]. This grants further research in the future. This theory's phenomenology predicts that the Higgs Boson's decayed into two photons that had however an overall superluminal time-of-flight (TOF) from the beam collision point to the inner wall Atlas detector's sensor calorimeters. Thus, the two photons produced during their first moments of flight were initially superluminal propagation dark photons caused by the initial displacement of gravitons at the beams' collision point before turning into normal photons. This light propagation speed in the vacuum discrepancy the theory predicts could be however very small and currently undetectable by the instrumentation therefore possibly a larger diameter detector chamber would be needed to test this prediction. Nevertheless, if this experiment result prediction is confirmed this would infer that the vacuum is intrinsically superluminal vibrational energy.

## 2.8. Superluminal graviton's ZPE component coupling to electro-weak and strong forces

We theorize in our graviton model shown in fig.1 that its ZPE Lorentz-invariant Halo noise field (see in fig.1 the cloud) embedded in its energy manifold illustrated in fig.1, is the origin of the other three known forces and phenomena electro-weak and strong force besides quantum gravity.

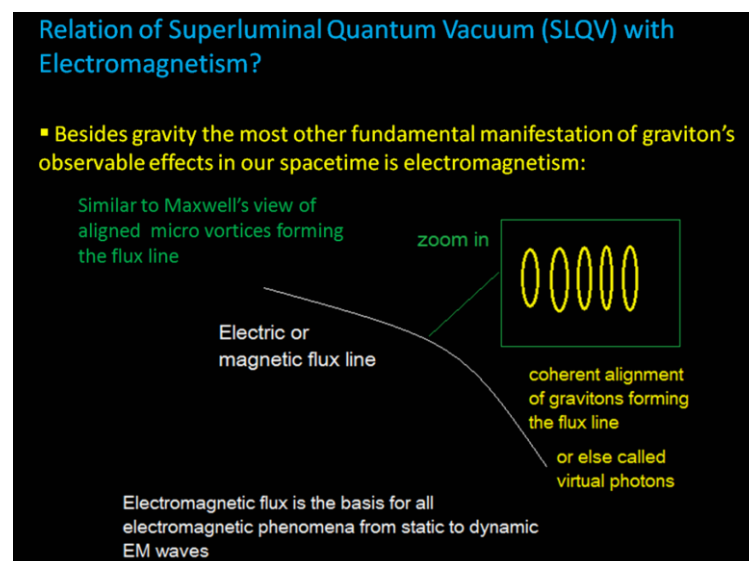


Fig. 5: Coupling of Superluminal Gravitons with Electromagnetism.

In Fig. 5 we demonstrate how this is possible. Zooming in on a tiny region of the magnetic or electric flux line (i.e. electric and magnetic flux lines are theoretically identical only their divergence differentiates, with magnetic flux according to Maxwell having zero divergence and electric flux having a non-zero divergence), we observe that the line is actually made up of coherently aligned superluminal gravi-

ton's which ZPE Lorentz-invariant (i.e. obeying  $c$  speed limit) dressed noise field component (see fig.1 cloud field) thus virtual photons is the elementary energy that constitutes the EM flux. We could adopt a similar approach for the electromagnetic, weak, and strong particles of the Standard Model (SM). According to this approach, all elementary particles originate from the ZPE (Zero Point Energy) Lorentz-invariant energy of the vacuum. This energy is generated by the superluminal graviton condensate. In simpler terms, we could say that all particles are fundamentally formed by the quantum foam of virtual particles. This takes the form of a coherent ZPE energy flux manifold corresponding to each particle.

This view is now strongly supported by the latest 2023  $5\sigma$  run 2 and run 3 results of the Fermilab  $g-2$  muon anomalous magnetic moment experiment that indicates that virtual particles are not simply mathematical formalism but have a real effect on our spacetime universe [66].

We theorize based on our research that the mass phenomenon in our spacetime as well as electromagnetism, weak and strong interactions phenomena are essentially coherent formations and localized concentrations and gradients of polarized graviton vacuum condensate (i.e. by coherent polarized gravitons we mean groups of gravitons that their manifolds, see fig.1 & 5 ring shape, are aligned in the same direction). Otherwise, when left freely in free vacuum space this graviton vacuum condensate remains an incoherent mess meaning that in that state gravitons randomly vibrate in all directions without any alignment creating gravity but without generating any mass in space. The authors theorize that cosmological black holes (BHs) may not necessarily contain a matter-mass almost singularity core formation at their center. Instead, they could be highly localized anomalies in space that affect the number density of the vacuum gravitons condensate. This condensate inside BHs is an incoherent mess of randomly oriented gravitons generating local gravity without creating mass in space. Therefore in our model, although mass is a priori for the generation of electro-weak and strong forces, it is not for the generation of gravity which is also consistent with the theory of General relativity (GR). This is also the exact reason deduced, of why our graviton model proposed also as cold dark matter  $\Lambda$ CDM candidate in section 2.3 would add gravity in the outskirts of galaxies but without adding any extra mass. This is precisely why our model is also a promising candidate for explaining the strange behavior of dark matter.

## 2.9. Big flash: prediction of the remaining lifetime of the universe by using an intrinsic superluminal oscillating vacuum graviton condensate

By using our previous sections calculations of a possible intrinsic superluminal property of the vacuum and hidden universal energy reservoir we calculate here the remaining lifetime of our spacetime and universe.

The observable Universe is about 14,000 Mpc (Megaparsec and 1pc approximately 3.26 lys) or about 46 Gly (i.e. 46 billion light years) in radius therefore for the highest expansion estimate we have from the Planck space telescope mission of expansion rate of about 74Km/s/Mpc from supernovas and Cepheids measurements, the radius of the observable universe is superluminal increasing in one year (31,536,000 seconds) by about  $\delta R=3.45$  lys (1.06 pc) in contrast to the more conservative estimation from the CMB data of 67.5Km/s/Mpc which gives a superluminal radius expansion each year of about  $\delta R=3.15$  lys (0.96 pc) [49]. The observable universe at its outskirts is expanding at a speed roughly three times faster than the speed of light  $c$  in the vacuum.

Therefore our cosmic horizon (i.e. how far in distance we can see) is limiting each year in diameter by 6.9 lys according to the Planck space telescope measurements or by 6.3 lys according to CMB. We lose the sky each year that passes.

The volume of our observable universe is currently about  $V=3.58 \times 10^{80} \text{ m}^3$  (about  $4.4 \times 10^{26}$  m radius) therefore its volume increases in a year taking the Planck satellite data  $\delta R=3.45$  lys, at a rate of about:

$$\delta V = \left(\frac{4}{3}\right)\pi\delta R^3 \approx 1.45 \times 10^{50} \text{ m}^3 \quad (35)$$

Where  $\delta R$  the radius increase in SI meter units,

$$\delta R = 3.45 \text{ lys} = 3.264 \times 10^{16} \text{ m} \quad (36)$$

Thus, the universe increases its volume in one year by:

$$\frac{\delta V}{V} \approx 0.4 \times 10^{-28} \%. \quad (37)$$

Corresponding to a radius increase each year by:

$$\frac{\delta R}{R} \approx 0.74 \times 10^{-8} \%. \quad (38)$$

With the energy of the vacuum ZPE kept at a fixed density with expansion, of about  $10^{-9} \text{ J/m}^3$  this would also mean a total ZPE vacuum energy of the observable universe of  $E_{\text{vac}} \approx 10^{-9} \text{ J/m}^3 \times 3.58 \times 10^{80} \text{ m}^3 \approx 3.58 \times 10^{71} \text{ J}$  or  $2.23 \times 10^{28} \text{ TeV}$ .

According to our model of the non-tachyonic superluminal oscillation graviton, the rate of the expansion of the volume of the universe and added total vacuum ZPE in the universe, is due to the energy released in our spacetime from the evaporation of the gravitons particles in the vacuum caused by the deceleration of oscillation frequency of the gravitons particles with cosmological time and directly proportional.

Therefore, in one year reported by the result of equation (37) above, the increase in volume of the universe is directly proportional to the deceleration rate per year of the gravitons superluminal revolution speed estimated previously in our work at  $C_g \approx 3 \times 10^{122} c$ , or else in SI m/s units  $C_g \approx 3 \times 10^{130} \text{ m/s}$ . Where  $c$  is the speed of light in the vacuum.

Our theory predicts that, at the time the above  $c_g$  superluminal value of the graviton condensate decelerates at a steady state per year (i.e. state of the equation parameter  $\omega_0 = -1$   $\Lambda$ CDM [49]) down to  $c$  luminal value thus the speed of light in the vacuum then the universe will end in a Big Flash as we described in our previous section instead of a Big Freeze heat death or Big Rip.

Therefore we can estimate the remaining lifetime of our universe before the Big Flash event using the following equation:

For,

$$\frac{\delta V}{V} = \frac{\delta c_g}{c_g} \approx 0.4 \times 10^{-30} \rightarrow |\delta c_g| \approx 1.2 \times 10^{-100} m/s, \quad (39)$$

Per year reduction in the superluminal graviton's oscillation speed.

For  $c_g \gg c$  we get,

$$RT_{univ} \approx \frac{c_g}{\delta c_g} \times 1 \text{ Year} \approx 2.5 \times 10^{230} \text{ years} \quad (40)$$

The above final result of equation (40) is the estimated remaining lifetime  $RT_{univ}$  of our universe before its end by the Big Flash event described before that our model predicts.

Of course, that does not mean that a heat death thus the Big Freeze, or even a Big Rip (we have to wait for the Euclid space telescope data) will not happen before obliterating any normal matter and light energy in our universe and possible the universe will not be able to create any organic life even earlier than that but the calculation of equation (40) estimates instead ultimately the end of vacuum spacetime itself with a Big Flash and the beginning of a new Big Bang cycle. Big Flash will happen everywhere and at the same instant assuming a flat and homogeneous vacuum similar to a universal vacuum catastrophic decay event.

Also, notice that for the superluminal oscillation of the vacuum graviton's condensate, we used to call vacuum free space, each graviton superluminal oscillation (i.e. revolution of the graviton-string particle manifold similar to the revolution of a flywheel) acts like a cosmic clock counting down towards the end of the spacetime and the universe.

Currently, the graviton's universal superluminal time is equal to the period of its one full  $2\pi$  rotation oscillation is effectively in our luxons spacetime  $T_g \approx 2.1 \times 10^{-207} s$  or else about  $0.39 \times 10^{-163} t_p$  of the Planck time. This is the quantum spacetime time unit according to our research and is dilating (i.e. elongating) each year by the same rate calculated in equation (39) of  $\approx 0.4 \times 10^{-30}$  as well as proportionally the graviton Compton wavelength by  $\delta \lambda_g = \delta(2\pi R_g) \approx 14.6 \times 10^{-107} m$  with  $R_g$  being the bare graviton radius thus increasing in period per year

$$\text{by } \delta T_g = \frac{\delta \lambda_g}{c_g} \approx 12.16 \times 10^{-207} s.$$

When the graviton's superluminal oscillation speed drops down to luxon speed thus the  $c$  value speed of light in the vacuum, therefore equal to the Planck Frequency of:

$$F_p = \frac{1}{2\pi} \sqrt{\frac{c^5}{\hbar G}} = E_p / \hbar \approx 2.952 \times 10^{42} \text{ Hz} \quad (41)$$

Or else calculated Planck Period  $T_p$  :

$$T_p = \frac{1}{F_p} \approx 0.34 \times 10^{-42} s \quad (42)$$

Then all the intrinsic hidden superluminal energy reservoir of the vacuum according to our theory will be released at once everywhere in the universe as luxons very high  $\gamma$ -radiation resulting in a Big Flash and the end of spacetime.

Nevertheless, at the same time, our theory predicts that this starts a new cycle of the Big Bang thus a cyclic universe since all this enormous energy released and effective mass by the Big Flash will collapse instantly to a singularity and a new Big Bang.

## 2.10. Macroscopic quantum effects, apparent wave particle duality and nonlocality explained by a sea of vacuum superluminal cold gravitons condensate

We have proposed previously a superluminal cold gravitons condensate model for the vacuum and spacetime. We will briefly describe here how this theorized omnipresent condensate explains deterministically and causality-local-connected macroscopic quantum effects like the double-slit self-interference experiment and also its Aharonov-Bohm version, but may also explain quantum entanglement phenomenon, previously thought to be nonlocal and indeterministic phenomena by some i.e. collapse of wavefunction interpretation theories or deterministic i.e. Bohemian mechanics and pilot wave interpretation theory but still all these current explanations of these phenomena including the Everett many-worlds interpretation being nonlocal as a common characteristic of all these existing theories. In order to describe all these phenomena actually as being local an extra-dimensions 5<sup>th</sup> unknown force of nature is introduced we outline describe here in our novel vacuum quantum spacetime model.

In our proposed model of vacuum free-space consisting of and being a sea of superluminal vibrating cold gravitons condensate we presented each bare graviton particle being an energy manifold of a superluminal speed rotating dark energy ring around its fixed center void, and also being dressed around its ring formation with a mantle of Lorentz-invariant quantum foam of virtual particles we call ZPE (i.e. zero-point energy) of the vacuum. We describe in our theory this ZPE as being an evaporation product of the superluminal oscillating cold graviton in our model. Therefore, in our model the ZPE of the vacuum is the fundamental energy substrate and origin for the three known forces, strong force, weak force and electromagnetism. More or less in our model the ZPE of the vacuum can be described as an omnipresent scalar field where the quantum foam fluctuation are so fast that it can be actually considered as a scalar field. This omnipresent spacetime field can be disturbed and behaves effectively as a medium for the propagation of the above described forces.

It is known that in macroscopic quantum effects like the double slit self-interference and the Aharonov-Bohm effect instantaneous spacetime superposition thus nonlocality and wave-particle duality of these phenomena assumptions are necessary to explain these phenomena by the existing theories otherwise the interference wavefunction cannot be explained without the instantaneous action superposition of the particle (i.e. in the self-interference double slit experiments, the interference pattern is formed by a single particle in spacetime superposition). In collapse interpretation theories the interference wave function then instantly collapses to impact absorption (i.e. decoherence) point on the detector screen whereas in the Bohemian mechanics pilot wave interpretation the particle is guided deterministically.

ly by the interference wavefunction to its collapse position on the detector screen. In the pilot-wave theory the wavefunction is emanating and originating from the particle itself.

All these existing interpretations are assuming nonlocality and more or less spacetime superposition thus macroscopic wave-particle duality of these particles.

In our proposed theory and model the particles are particles and the wave property is due to the omnipresent ZPE vacuum field they are interacting with. Thus the interference wavefunction is describing actually the wave fluctuations these particles are causing with their motion to the ZPE vacuum scalar spacetime field. So, now there is no macroscopic wave-particle duality property to the particle but the waves are originating from the ZPE vacuum which acts as a medium and is disturbed by the motion of the particle in the double-slit self-interference experiment.

Therefore, our proposed model of the vacuum is explaining now these phenomena as locally causality connected phenomena where no collapse of wavefunction is needed or other superposition explanation to explain the wavefunction. The interference wavefunction is attributed to the ZPE scalar field of the vacuum and not the particle which we have in wavefunction collapse theories and also Bohemian mechanics pilot wave theory. Although, in our theory similar to the pilot-wave interpretation the single particle is interacting with the ZPE interference waves formed in the double-slit which waves guide the particle to its final impact (i.e. absorption) point position on the detector screen.

In other words, the spacetime foliation also necessary to explain the instantaneous propagation of the gauge Coulomb scalar potential in the Aharonov-Bohm double-slit self-interference experiment in the form of an interference wavefunction also known by the classical double slit experiment, is real and physical and originates from the sea as we describe it in our proposed theory, of superluminal vibrating cold (i.e. at rest) gravitons condensate which acts more or less like a quantized medium for spacetime.

In the Aharonov-Bohm version of the double slit experiment for example that what is changing the phase of the interference wavefunction and shifting the interference fringes on the detector screen are not caused by any electromagnetic field interaction emanating from the solenoid behind the double slit mask but is due to the displaced cold gravitons of the vacuum around the solenoid that is propagating like a domino effect and interacting with the electrons passing by around the solenoid and we explain as gauge Coulomb scalar potential. Essentially, the current in the solenoid displaces the vacuum gravitons and creates ripples in the ZPE vacuum scalar field that interferes with the electron charge particles passing by around the external solenoid area. As a reminder here, the ZPE scalar field is the mantle outer surface layer of the gravitons in our model.

Our theory and explanation is therefore a local causality connected and deterministic interpretation of these phenomena.

Nevertheless, it is important to notice here and keep in mind that by "causality connected" we do not necessarily mean light information causality since the cold gravitons in our theory especially in the near-field of the interaction can be displaced (i.e. domino effect) with superluminal speed many-many times the speed of light from their rest positions inside the vacuum gravitons condensate. Practically perceived by us as Instantaneous-Action-at-a-Distance. Therefore, in our proposed theory we advocate that at the most fundamental level all these quantum phenomena described in the literature as indeterministic and nonlocal and non-causality connected phenomena can actually be superluminal connected deterministic phenomena thus local phenomena due to this extra dimension 5<sup>th</sup> unknown force hidden inside the vacuum.

In classical physics, under specific circumstances, potentials can be propagated superluminally and appear to have instantaneous propagation, especially in the near-field of interactions. Our explanation of gravitons as the fundamental carrier of electromagnetic potential, capable of being displaced superluminally, explains apparent "nonlocal" electromagnetic phenomena like the Aharonov-Bohm effect, rendering them as locally connected.

## 2.11. Superluminal dark spacetime sector

According to our research so far, matter and light moving inside the vacuum manifest our light Einsteinian spacetime but there is another totally distinct second and hidden Dark spacetime sector out here in which the source dark energy and dark matter resides and is manifested in our luxons spacetime as what we used to call vacuum free space.

These two distinct spacetimes are in superposition occupying the same Cartesian space and also entangled gravitationally and by the ZPE of the vacuum that we claim is an energy evaporation product of the Dark Energy residing in the dark spacetime sector into our light spacetime sector. Still, most of the dark energy is residing in the dark sector and only a relative tiny fraction of energy is leaked slowly into our spacetime in the form of ZPE.

Subsequently, there are now two major general effects we can describe from this research:

First, assuming now that the ZPE of the vacuum is the background and source of all quantum fields responsible for the three known quantum forces the SF, WF and EM and also taking into account our previous argument that ZPE sources out from the hidden dark spacetime sector by the slowly evaporating hidden dark energy residing there, we then can deduce logically that all of the known three quantum forces SF, WF and EM that are responsible for all matter and light in our luxons spacetime, actually originate from the dark spacetime sector and hidden dark energy component.

Second, as we have described, our known luxons Einsteinian spacetime sector consists of Lorentz-invariant energy that we observe in two prime energy phases as matter and light, which as we described are all fluctuations, excitations and condensations of the same and single ZPE vacuum field that sources out from the dark sector. However, in contrast, the dark spacetime domain consists exclusively only of an omnipresent non Lorentz-invariant energy thus according to this research a "superluminal vibrating non-tachyonic cold graviton condensate" the characteristics we have described previously in our research. This quantum condensate consists of bare massless spin-2 cold gravitons which as we describe are the carriers of both the superluminal dark energy hidden in the dark spacetime sector and also quantum gravity. Finally, opposite to the SF, WF and EM forces that are mediated indirectly to our spacetime from the dark sector due to its superluminal dark energy's evaporation into our known vacuum ZPE and spacetime, in contrast gravity is mediated and communicated directly from the dark spacetime sector to our luxons (i.e. photons) spacetime.

To clarify further here is an energy flowchart, Fig. 6, of the herein described concept:

## Dark Sector Entanglement with Light Spacetime and Energy Flowchart

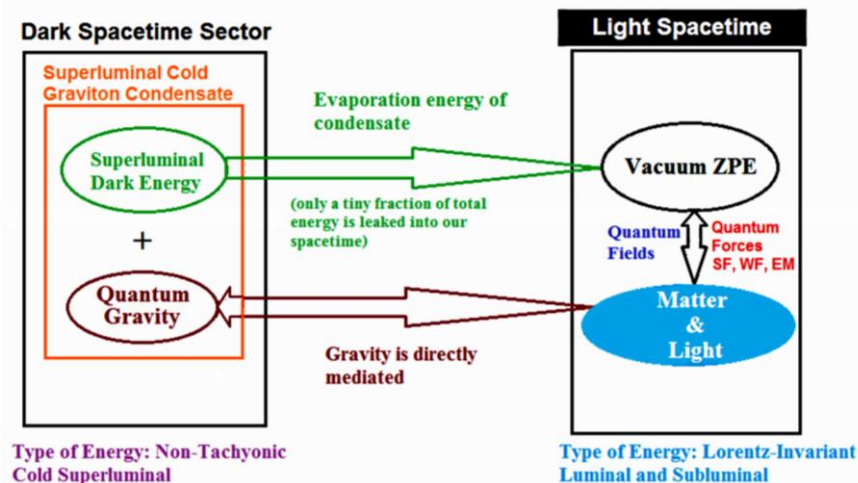


Fig. 6: Dark Sector Coupling with Our Normal Light Spacetime.

Notice the arrow in the illustration connecting the matter-light and the vacuum ZPE is bi-directional meaning the coherent matter and light energy can again become incoherent and return back to vacuum ZPE.

But the model does not allow the transition of luminal energy to superluminal thus the transition of luminal vacuum ZPE from our spacetime back to the dark sector. Therefore, once superluminal energy is transformed to luminal it cannot transition back to superluminal because that would violate the 2nd law of thermodynamics which is obeyed by both spacetime. Energy flows always from high to low. Of course, this also means that the vacuum ZPE cannot contain any superluminal component and is entirely Lorentz-invariant.

As shown in Fig. 6 the two spacetimes are only bi-directional gravitationally coupled since gravity is directly mediated and communed between the two spacetime discrete and entangled domains.

### 3. Conclusion

In this research, the author proposes a finite energy manifold for the graviton. This manifold is intrinsically superluminal closed loop string vibration energy. We demonstrate that by giving the graviton a single intrinsic superluminal property, we can explain the origin of quantum mechanics and current cosmology, including quantum gravity and dark energy. Additionally, this property solves the cosmological constant problem and the conservation of energy dilemma at large cosmological scales of the universe. The author of this paper is making a bold claim and prediction, based on their research so far. They propose the existence of a superluminal vibration energy graviton, which is an elementary particle in this universe. This particle integrates in one single energy manifold, which includes the ZPE of the vacuum, dark energy, and quantum gravity. According to the author, this proposed particle is the energy by which all current elementary particles of the Standard Model, including the Higgs Boson, are constituted. Based on this analysis, we have added a special note at the end of section 2.3 to suggest that the proposed massless superluminal oscillation cold graviton model could be a viable candidate for cold dark matter  $\Lambda$ CDM.

In addition to not interacting with normal matter and light electromagnetically, We have presented evidence that this hypothetical quantum candidate for cold dark matter, which exhibits very little translational motion, is capable of generating gravity in space without possessing any detectable mass property. According to this current understanding, the mysterious dark matter particle cannot be detected through conventional methods like colliding matter beams in large accelerators. This is because it does not interact with light or normal matter in any way. Instead, it only interacts with extremely large sources of gravity like around galaxies. It is a conclusion and general prediction of this research and author herein, that dark matter does not interact with light because it is not light energy but instead an out of phase superluminal vibration energy.

In general, the research presented here explains why the immense superluminal energy of the vacuum appears as nothing in this spacetime. It practically has no mass except for a small Lorentz-invariant vacuum zero-point energy (ZPE) mass. This research shows that this tiny mass is the leaked evaporated noise field of the hidden dark energy component of an omnipresent vacuum space superluminal oscillation non-tachyonic graviton condensate. We demonstrate that the superluminal non-tachyonic graviton condensate described in this paper does not produce any unphysical negative mass, as is the case with tachyonic particle models [33][34] in the scientific literature. Instead, this condensate is unable to generate any mass at all, resulting in zero mass and being considered massless.

Nevertheless, it is important to notice here that according to this theory we observe only the evaporating energy of this superluminal energy condensate, the tip of the iceberg, we call ZPE of the vacuum and although the bare graviton particle inside this condensate is massless the dressed graviton with its evaporating ZPE, is massive.

However, it is almost impossible to isolate a single graviton's mass (i.e. its dressed ZPE field component) since its evaporating ZPE energy component thus mass is diffused within the condensate with that of all other gravitons inside the condensate.

It has been theoretically demonstrated that we can only observe the Lorentz-invariant evaporation part of the hidden superluminal dark energy oscillation component of the graviton condensate in this spacetime. Thus, we observe only the tip of the iceberg as a vacuum ZPE noise field which this added energy drives the expansion of the universe. This proposed model suggests that the extra zero-point energy (ZPE) in the vacuum originates from the evaporation decay of the hidden superluminal oscillation dark energy component of gravitons.

One of the most extraordinary and striking conclusions of this research is that the stable physical elementary particles of gravity, dark energy, and dark matter, along with the stable quantum particle of free space vacuum and the fabric of spacetime itself, are all the same particle. We propose that this particle is a superluminal, oscillating, massless, cold graviton. Residing in a four-dimensional de Sitter spacetime, there is a bosonic closed-loop string particle with spin-2, which can be described as a massless Planck-sized extra Cartesian dimension. Ideally, it has a spatially discrete 2D energy manifold, as shown in Fig. 1.

This research predicts that the bare graviton is a massless Boson particle with a spin of 2. It is noteworthy that this particle is "cold," meaning that it has minimal translational motion and can be considered a stationary massless particle with unique properties in nature. This paper provides analytic proof (section 2.4) of the existence of a closed-loop spin-2 bosonic particle with superluminal oscillation, which is stationary and has no mass.

In addition to presenting a quantitative and qualitative analysis and formalism of this proposed novel energy manifold of the graviton and basic parameters calculation, We have also calculated the possible remaining lifetime of this universe. This findings suggest that spacetime and the universe will end with what we call a "Big Flash", caused by the evaporation of the non-tachyonic superluminal energy gravitons condensate to vacuum ZPE and the expansion of the universe. "When the frequency of superluminal oscillation of gravitons slows down to the critical value of  $c$ , the speed of light, the universe will experience a Big Flash. This event can be best described as a catastrophic vacuum decay of spacetime, occurring everywhere simultaneously and instantaneously. After this event, the universe will start a new cycle of the Big Bang.

Generalizing, according to this theory presented herein, free space vacuum appears massless and empirically as nothing in this luxons spacetime because almost all of vacuum's quantum energy resides in the form of a non-observable hidden superluminal oscillating dark energy reservoir in this universe, inside a de Sitter superluminal oscillation spacetime different from this luxons spacetime and made up physically by a cold superluminal graviton condensate. These two discrete physical spacetime domains in this universe, this familiar luxons spacetime and this novel theorized superluminal oscillation physical de Sitter spacetime of hidden superluminal dark energy are coupled and entangled together via the known and observable vacuum ZPE energy which is actually the leaked Lorentz-invariant evaporation energy component of the de Sitter superluminal spacetime to this luxons spacetime and is only a very tiny percent of the total superluminal quantum energy of the vacuum and hidden dark energy that is phase transitioning to this luxons spacetime and is responsible for the observed expansion of this luxons spacetime and universe.

This novel theory proposes that two discrete spacetime domains exist in superposition within the same universe. This completely discards any supersymmetric SUSY explanations of quantum fields cancellation, as the tiny ZPE vacuum energy density can now be explained as an energy phase transition product resulting from the described superluminal oscillating dark energy cold graviton condensate's evaporation. This tiny relative partial energy phase transition from superluminal oscillation non-tachyonic dark energy to normal luxons and normal matter is happening at exact  $c$  speed critical value thus the speed of luxons (i.e. photons) in the vacuum in this spacetime. Therefore normal matter and light energy and mass phenomenon are exclusive only to this luxons spacetime and the hidden superluminal non-Lorentz invariant massless dark energy component of graviton's condensate is exclusive only to the described superluminal de Sitter spacetime domain. Only a small percentage of superluminal energy, also known as vacuum zero-point energy (ZPE), is transferred from de Sitter spacetime to luxons spacetime as leaked phase-transitioned energy. On the other hand, gravity potential energy is directly and fully communicated between the two spacetime domains. The leaked Zero-Point Energy (ZPE), which is Lorentz-invariant, is the fundamental energy or "substance" that creates all Quantum Field Theory (QFT) quantum fields in this spacetime, including the photon field, quark field, electron field, and more. As a result, the dressed ZPE field of the gravitons, which can be seen as the cloud halo field of the graviton in Fig.1, is the source of the other three quantum forces, i.e., the electromagnetic, weak, and strong force, in addition to gravity. The condensate contains polarized and coherent alignments of gravitons, which are responsible for creating all the known particles of the Standard Model and quantum field excitations. The local gravity is determined by the localized number density gradient of gravitons in Cartesian space, regardless of the coherence of the graviton formations which are responsible for the mass of the known particles in the standard model. This completes the description of a theory of everything (TOE) that fits all in one particle, the superluminal oscillation cold massless graviton model described here and also we believe explains why this universe is mandatory to include superluminal energy in order to exist in its current observed form and status and governed by the known physics laws of relativity and quantum. Notice that in section 2.7, an experimental result prediction was made for the detection of the Higgs Boson at CERN LHC Atlas. This prediction would strongly suggest, if not confirm, the intrinsic superluminal energy nature of the vacuum.

We outline described in section 2.10 without using in this stage any formalism a theory and mechanics by which previous nonlocal and non-causality connected quantum macroscopic phenomena like the double-slit self-interference or Aharonov-Bohm effect can be described as local and causality connected phenomena using a 5<sup>th</sup> extra-dimensions unknown superluminal force hidden inside the vacuum namely the novel proposed by us consisting all vacuum and spacetime, superluminal vibrating cold graviton condensate model. Our model describes the zero-point vacuum energy as an evaporation product of hidden compacted extra dimensions superluminal energy of the universe, rather than being due to any supersymmetry fine-tuned fields cancellation.

According to this research and model but also previous published research [67] of the author, there isn't a definitive and constant speed of causality or the speed of energy-information propagation in the universe we observe. Instead, the speed of causality is influenced by the type of energy content present in a particular spacetime. The author argues herein that in this universe there are actually two physical discrete and entangled together spacetime domains, each with its own speed of causality. This familiar luxons spacetime which is dominated by normal light energy and mass and has a speed of causality at critical  $c$  phase transition value the speed of light in the vacuum and also a second non-directly observable by us, superluminal oscillating hidden de Sitter dark energy spacetime which has a superluminal dark energy propagation speed and dark energy speed of causality  $v_{DE}$  calculated in section 2.2 being about 122 orders of magnitude larger than the  $c$  value.

We argue that this hidden superluminal dark energy interaction speed is the cause for the "weird" quantum mechanics behavior like non-local quantum phenomena like quantum entanglement we observe in this normal space-time, superposition of quantum particles, quantum tunneling and in general indeterministic nature of quantum mechanics. We argue hereby this is because the quantum vacuum is intrinsically superluminal energy. As demonstrated also in section 2.11 and Fig. 6, this theory renders the observable universe as being local connected.

Last but not least, this theoretical novel physical model of the graviton offers an explanation for the Cosmic "coincidence problem" [68] since it demonstrates that both dark matter and dark energy effects have the same origin. Similar in overall to this paper conclusions, were made by Witten's E. paper [69] but a 5-dimensional zero energy Kaluza-Klein stable vacuum were the graviton resides was assumed linked to a ZPE 4-dimensional thus our spacetime vacuum. Instead, we propose hereby a stable superluminal energy Planckian Kaluza-Klein type of graviton vacuum linked to our 4-dimensional luxons spacetime ZPE vacuum.

#### 4. Declarations

The author has no relevant financial or non-financial interests to disclose.

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