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Research paper

The superluminous vacuum

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Abstract

The Standard Cosmological and Particle Models of physics have set both in their formalism an absolute limit, the speed of light *c* or else called the speed of causality and claim that this is also a physical limit in nature in our visible Universe. This however, we claim is also unproven up to today and nature has always imposed exceptions and violations in accepted theories many times in the past and proved that these were merely human formalism and experiments artifacts and used technology restrictions and that physical limits and rules are constantly broken and bend in nature. We hereby will try to theoretically demonstrate, why and how the very existence and empirical evidence in our Universe of vacuum space, either in its theorized ideal absolute form thus free space or partially vacuum characterized as QED or QCD vacuum and its zero-point energy and fluctuations, maybe actually the biggest proof in nature for superluminous energy being possible without violating causality. That the apparent effect of "nothingness" of vacuum space maybe the evidence for superluminocity and was right in front of us all this time hidden. We herein try to answer a fundamental physics question why vacuum space appears to us, basically, as nothing assuming that 'nothing' does not exists in nature and why a hypothetical superluminous vibration, Planck sized particle generates apparent nothingness in our spacetime. The novelty of the research herein infers that free space is the dark energy and which is superluminous energy.

Keywords: *Vacuum Space; Quantum Vacuum; Superluminocity; Special Relativity; Dark Energy; Quantum Cosmology; Quantum Gravity.*

1. Introduction

The concept of vacuum being quantized and acting behind the scene effectively as a medium for strong and electro-weak interactions and gravity is not a new one in science and physics and was the last decades brought back by string theory and other quantum gravity theories like quantum loop gravity [1] [2], gravitons [3] [4] or superfluid vacuum theory (SVT) [5] [6] all trying to explain the origin of gravity and all other of the four known forces as intrinsic and inherent physical properties of the vacuum which many believe today that deciphering the vacuum holds the key for answering the big unsolved problems in physics like the cosmological constant problem [7] [8], dark energy [9] [10] and dark matter [11] [12]. We could say that the quantum vacuum research is of paramount importance and main body for the beyond the standard model of particle physics research, quantum field theory development and in extension cosmology nowadays. After matter and light, the vacuum maybe the last frontier we must conquer to understand nature and the Universe in its most fundamental level.

However, all these theories trying to explain the vacuum phenomenon limit themselves by using and obeying the speed of causality dictated by the observable speed of light *c*, the basis to explain all visible matter and energy in our Universe and their interactions but vacuum is neither light nor matter it is the absence of these which does not necessarily translates to nothingness.

The best clue nature gives us that the vacuum is not nothingness, is the finite zero-point energy (ZPE) and vacuum fluctuations (ZPF) [13] [14] and virtual particles popping in and out of the vacuum which however contradicts the predicted by QED enormous vacuum energy density [15] [16] thus the cosmological constant discrepancy and maybe biggest unsolved problem in physics today. Therefore, the author herein by ansatz supports the idea that by observing the vacuum ZPE and ZPF in combination with the cosmological constant problem, that we see only the tip of the iceberg and that most of the undisturbed vacuum energy is hidden and inaccessible from us and our apparatus. The ZPF and ZPE of the hidden vacuum energy just indicates then that the "disguise" is not perfect and subject of Heisenberg Uncertainty Principle. Under this context, if this theorized undisturbed "exotic" type of vacuum energy is hidden, out of phase of our spacetime and beyond known normal matter and light, it is safe to assume that it must also violate our known physics primary and fundamentally by violating the "Holy Grail" which is the speed of light in the vacuum thus the absolute speed of causality [17] [18]. After that, all normal matter and normal luminous energy and all four of the fundamental forces in our observable Universe can be explained and worked out as manifestations in our spacetime of a locally disrupted and defected vacuum. With the fourth force thus gravity being the only force that can be also communed from the entire not only disturbed but also undisturbed hidden vacuum energy into our spacetime. This last, would also explain the dark energy and possible also dark matter phenomena and why these appear being so elusive.

However, proving superluminocity property for a hypnotized sub Planck sized, probably Bosonic alike type of vacuum quanta proves a vain task by using known established theories that prohibit this in the first place since they are based on the *c* speed limit.

Nevertheless, we could use these existing theories to infer by ansatz that according to all our above assumptions, it is a necessary condition for the vacuum. In other words, that the apparent "nothingness" of the vacuum is an effect in our spacetime of an undisturbed and hidden superluminous vacuum energy. In the next paragraphs we will do just this, to try to demonstrate in general the concept that superluminocity property is a necessary condition for the vacuum to exist in our spacetime observable Universe.

2. Results and discussion

Assuming the vacuum hidden energy to be a type of superluminous condensate [19] [20], close at the boundary condition c where the observed ZPF energy fluctuations of the hidden vacuum energy is happening, the virtual particle pairs and virtual photons popping out of the vacuum could be decelerated superluminous vacuum quanta changing phase from superluminous to normal luminous c or subluminous energy states.

Notice, that because the assumed possible condensate nature of the vacuum by the term superluminocity of its vacuum quanta (i.e. vacuum fundamental particles) we do not necessarily refer to translational motion of the hypothetical vacuum quanta but rather to their in-place vibrational speed. As a rough analogy, similar to Brownian motion of atoms [21] or zitterbewengung of particles [22] .

As an example in fig.1 we show a cartoon of what such a Planck sized (or less) vacuum quanta could be, as a two-dimensional Bosonic looped string similar to quantum loop gravity theory [1] and an example of a possible vibration mode of this string is demonstrated in this animation permalink[1].

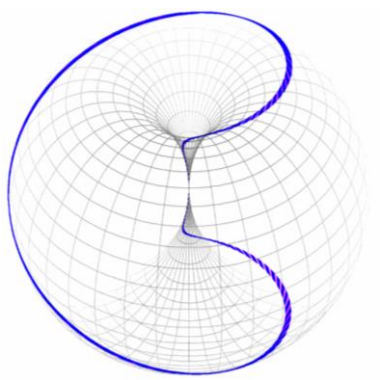

Fig. 1: Cartoon Example of Hypothetical Vacuum Quanta Similar to Quantum Loop Gravity Theory, Vibrating Bosonic Looped String. A Possible Vibration Mode of the String Is Demonstrated by This Animation: Https://Tinyurl.Com/5anyx5tx.

Next, let us examine now what our known and established theories are telling us about how probable to exist is such a hypothetical elementary superluminous vibrating quanta consisting this superluminous undisturbed vacuum energy condensate.

2.1. The superluminous vacuum and special relativity

Assuming that this hypothetical hidden superluminous undisturbed vacuum energy and an example of its possible finite Planck sized (or less) superluminous vibrating quanta shown in fig.1 is subject of relativistic Lorentz length contraction and time dilation relative to the lab inertial frame of reference for a stationary observer in the lab frame and also outside the vibration volume or surface of this vacuum quanta then let us see what Special Relativity [17] is telling us about this hypothetical superluminous quanta and how it would appear to us in the lab frame.

Given the two Lorentz transformation equations (1) & (2) for length contraction and time dilation relativistic effects:

For $\upsilon > c$,

$$L = \sqrt{1-(\upsilon/c)^2}\,L_0 = \sqrt{\beta}L_0 i \tag{1}$$

$$T = \frac{T_0}{\sqrt{1-\frac{\upsilon^2}{c^2}}} = \frac{T_0}{\sqrt{\beta}i} \qquad \text{with } \beta = \left|1-(\upsilon/c)^2\right|. \tag{2}$$

Therefore, the reciprocal of the Lorentz factor γ [17] being a pure imaginary number,

$$\alpha = \frac{1}{\gamma} = \sqrt{\beta}i. \tag{3}$$

There can be many interpretations of the equation's (3) pure imaginary Lorentz factor result. Starting with that this case is prohibited and rather a formalism artifact by design since the Lorentz factor was derived and is complying with the special relativity postulate that always $\upsilon < c$.

Nevertheless, under the context of our research herein and strictly interpreting this mathematical result to special relativity physics it could be also likewise infer simply that superluminous speed and energy cannot exist in our known spacetime domain which would demand the result of equitation (3) to be a real number instead of a pure imaginary number. This however is consistent with our ansatz that the dormant vacuum energy does not reside in our spacetime (i.e. phased-out energy from our known spacetime due to its superluminoci-

[1] https://tinyurl.com/5anyx5tx

ty property) and that we observe and perceive this only as an apparent effect of nothingness or void in cosmological space but also in the intermediate space between atoms inside matter as well as in quantum chromodynamics (QCD). Also, in electromagnetism, EM flux observed for example around and inside a permanent magnet or electrical solenoid could be as well described as coherent distortions (i.e. opposite to incoherent ZPF distortion of the vacuum similar to noise) of the dormant vacuum energy.
Another interesting interpretation by special relativity [17] of this result of equation (3) using spacetime graphs is that for $\upsilon < c$ our spacetime domain can be characterized as time-like indicating the passage of time for every spatial distance transversed whereas for superluminous case $\upsilon > c$ as space-like meaning that there is no notion of time in a spacetime domain like that and you can transverse any distance in no time as it would appear in our time-like spacetime. A characteristic we find also in quantum entanglement experiments resembling instantaneous action at a distance [23] [24]. Also opposite to popularized science usually communed by media there is no proof that the arrow of time is reversed (i.e. from future to past) at superluminous speeds, which would be true if equations (1) to (3) gave us a negative result, and that therefore causality would be broken but instead only that instantaneous action at a distance within the superluminous vacuum space-like domain exists.

2.2. The "impossible" spin-2 relativistic graviton

One of the beyond the Standard Model of physics candidates for the quanta of gravity and therefore also possible for the vacuum is the theorized graviton elementary Boson particle which has a spin of 2 [3] [4]. However we will demonstrate here that such a spin-2 particle cannot fundamentally exist according to special relativity and quantum mechanics unless it has a superluminal intrinsic property.

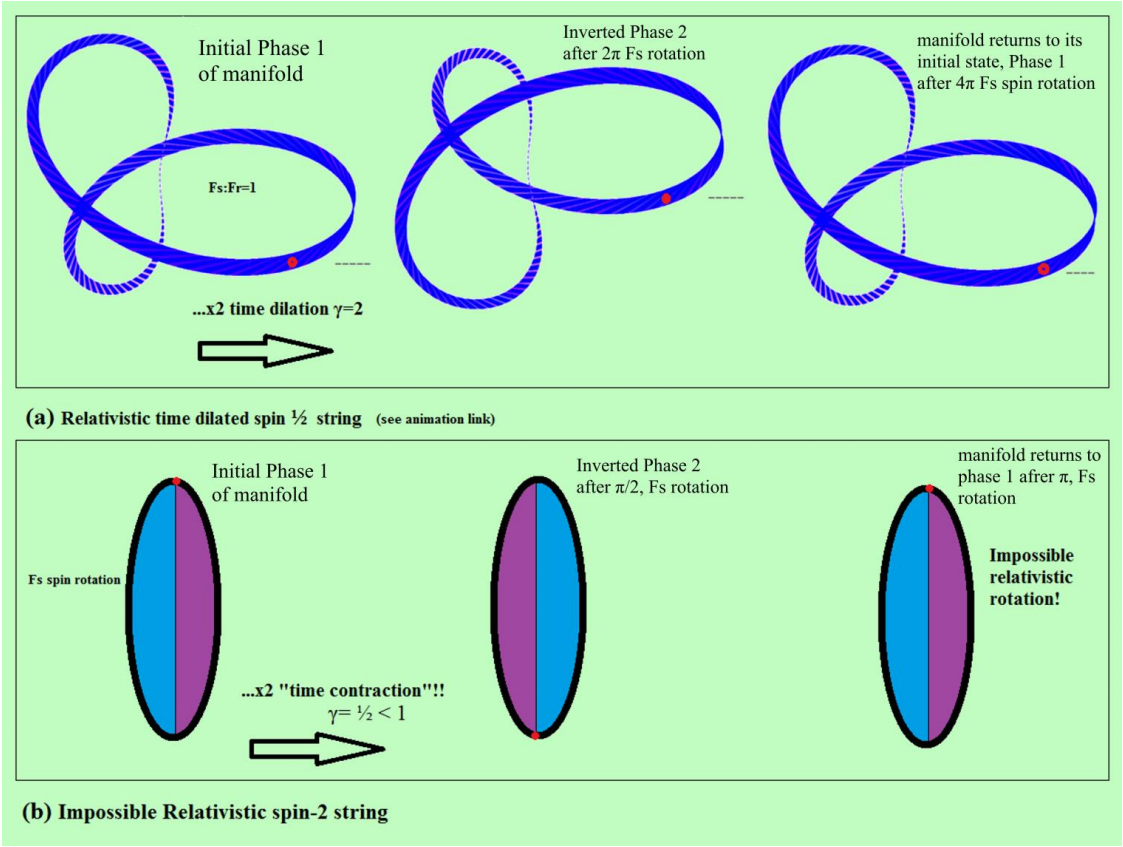

Fig. 2: Cartoon Representations of (a) Relativistic Spin – ½ String. Animation: https://tinyurl.com/249trrvc. (b) Impossible Relativistic Spin- 2 String.

In a neutron interferometer self interference experiment measuring the 4π-Symmetry characteristic of ½ spin particles, the particle will return to its initial measured state (i.e. phase) after a 4π (i.e. 720°) rotation in the lab frame [25] [26] due to relativistic Thomas precession induced time dilation [17] [27] by a Lorentz factor of 2 (i.e. γ=2) for a given angular frequency *Fs* spin rotation having a tangential velocity with a constant speed scalar value of $\upsilon_S = (\sqrt{3}/2)c \approx 0.866c$.

Similar, a spin 2 particle would theoretically return to its initial phase after π or else 180° of rotation.
However, the spin-2 surprisingly resulting π-symmetry of the graviton particle is a prohibited condition in special relativity since this would require a Lorentz factor as shown in equation (4),

$$\gamma = \frac{1}{2} < 1. \tag{4}$$

With γ less than one which is not allowed in special relativity and is not possible for a relativistic particle obeying the *c* speed limit. Notice, that a hypothetical γ= ½ if possible, results into "time contraction" instead of the normal expected time dilation, of the particle inside its rotational frame relative to a stationary observer in the lab frame and outside the rotational volume of the particle. But space-like "time contraction" and nullification as we described before is only possible when superluminocity is involved.
This is demonstrated by the cartoon illustrations in fig. 2 and linked animation. In fig. 2(a) we see a symbolic representation of a spin- ½ particle vibrations as a string relativistic rotation of *Fr* angular frequency revolution of the string along the z-axis with a constant tangential velocity speed value of $\upsilon_r = c$ and in superposition with a second rotation of *Fs* angular frequency, of the whole manifold shown,

around the equatorial xy plain with a tangential velocity speed value at the equator of $\upsilon_S = (\sqrt{3}/2)c \approx 0.866c$. The relativistic spin- ½ string shown with a Fs:Fr frequency ratio equal to one (i.e. Fs:Fr=1 corresponding to a path length ratio of the two rotations *ls:lr≈0.866*) that results to a Lorentz factor $\gamma = 2$. The spin- ½ manifold shown in fig.2(a) because its x2 relativistic time dilation (i.e. $\gamma = 2.$), returns to its initial state after 4π *Fs* rotation when measured in the lab frame instead of 2π. A simulation of the 4π-symmetry property of spin- ½ particles observed in the lab frame shown as a relativistic vibrating string or ribbon can be found in this permalink[2].
In fig. 2(b) we demonstrate the theorized in the literature impossible relativistic spin-2 rotation therefore π-symmetry of the graviton since this would only be possible if "time contraction" instead time dilation was assumed which is however forbidden by the special relativity theory but allowed by superluminocity.
Moreover, notice if we would to assume for the graviton a vibrational speed of $\upsilon_S = 5c$, substituting this value to equation (2) would result to an imaginary Lorentz factor value shown in equation (5) of:

$$\gamma = \frac{1}{\sqrt{4i}} = \frac{1}{2i}. \tag{5}$$

2.3. Quantum Planck-sized black holes

So far we have shown in section 2.1 that Special Relativity (SR) theory does not prove that superluminocity is wrong but rather that it is not possible to exist in our *c* bounded time-like spacetime domain and that the SR equations when adopted to superluminocity result to imaginary Lorentz transforms which mathematically it was shown can be interpreted as the apparent nothingness we experience and perceive for the vacuum. Assuming that "nothingness" does not exist in nature and our Universe, by ansatz then vacuum space must be a type of superluminous vibrating energy hidden and out of phase from our spacetime domain and more likely this superluminous energy to reside to a space-like domain and we can directly only observe its energy zero-point fluctuations (ZPF). In section 2.2 we examined by a relativistic quantum mechanics model one of the candidates of quantum gravity and possible also elementary vacuum quanta if we want to understand Dark Energy and demonstrated the relativistic impossibility of its theorized in the literature spin-2 property which we proved by ansatz that it would be possible only if superluminocity was involved.
Following, in the section herein we will show why the "nothingness" we experience as vacuum space could be a condensate of quantum sub-Planck sized black holes thus the possible quanta of vacuum and in the same time also being the quanta of gravity and by ansatz how these can be interpreted as superluminous vibration energy quanta.
Taking into account the Planck vibration frequency we can safely conclude that it is also the maximum EM radiation frequency that could be observable in our visible Universe and spacetime derived from among other physical constants like the reduced Planck constant *ħ* and *G* gravitational constant, by the *c* speed limit of light as shown in equation (6):

$$F_p = \frac{1}{2\pi}\sqrt{\frac{c^5}{\hbar G}} = E_p / h \approx 2.952 \times 10^{42}\,\text{Hz} \tag{6}$$

Assuming a hypothetical unknown Planck-sized or less, vacuum elementary Boson like particle that would have a vibration at a frequency F_V larger than the Planck frequency F_P as in equation (7),

$$F_V > F_p, \tag{7}$$

could then this characterized as being a quantum black hole? Thus, more or less what a hypothetical gravity quanta can effectively be described to be. By ansatz, observing equations (6) & (7) this could be however only attended to if the vibrational speed of this particle is superluminous.
These hypothetical superluminous vacuum elementary particles thus also quantum black holes, would form a condensate that would have all the characteristics of vacuum space, the "nothingness" we experience caused by the inner singularity of a black hole and its event horizon region and black hole photon ring [28] being responsible for the zero-point energy ZPE and fluctuations ZPF of vacuum space.
Besides that, superluminous vacuum space would be now the origin and source of the quantum gravity in our spacetime and Universe. 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 normal matter is located in the Universe like planets or stars for example, where presumably these "vacuum quanta gravitons" or quantum Planck-sized black holes are in higher concentration than the rest of vacuum space.

2.4. A superluminous gedanken experiment

The goal of the gedanken experiment is to demonstrate that if there is a possible Planck length sized or less sub-particle that vacuum space is made up of then why essentially it must be superluminous.
For example a hypothetical macroscopic 1-dimensional energy string (e.g. an electromagnetic flux line) closed into a loop thus a 2-spatial dimensional object when spun physically around an axis aligning with its diameter (i.e. like a spinning coin on the table) at relativistic speed close to *c* or *c* will appear in normal time as a 3D solid sphere that appears still thus static (i.e. as a solid given that the initial 1-dimensional energy string had sufficient energy).
What just happened?
A 2D spatial dimensions + 1D temporal dimension object due to its extreme vibrational speed (i.e. physical relativistic spin) was translated into our spacetime frame of reference (i.e. Earth or else lab frame) into a 3D spatial dimensions object + 0D temporal dimensions object (i.e. the object appears still and static). The spatial 3D object is not moving therefore it cannot have a temporal dimension attributed. We observe that during this process that the temporal dimension inside the rotational frame of the 2D object is translated due to its

[2] https://tinyurl.com/249trrvc

extreme spinning speed into an extra spatial dimension in the lab frame, from 2D to 3D spatial and its temporal dimension was nullified in the lab frame.
Does this above observation remind us something from special relativity? This is analogue to what is said about a photon moving at *c* speed experiences no time thus zero time although it still travels through space (i.e. time-like spacetime). The object appears still and static in the lab frame.
We can observe the same phenomenon in the static magnetic flux of a macroscopic permanent magnet. It is assumed that the magnetic flux is coherent flow of virtual photons moving at *c*. However, in the lab frame the flux of the magnet appears as static.
So, let us now expand our thinking to an initial 3-spatial dimensions object spun around its central axis at *c or close to c*. In what form will it appear in the lab frame? Following the logic above it would appear in the lab frame as a 4-spatial dimensions still object. Nevertheless, since in our spacetime we have not yet observed so far such objects or phenomena we must assume that all elementary particles are actually vibrating {1D spatial + 1D temporal} or {2D spatial + 1D temporal} energy strings which is also supported by our previous published research [29]. As a note, we are assigning in our gedanken experiment the third thus z spatial dimension (i.e. thickness) in the particle frame to be zero for thickness equal to the Planck length or less. There is no absolute physical 1D or 2D spatial object in the Universe.
Coming now to a hypothetical superluminous vibrating energy string quanta 1D or 2D spatial dimensions (could be at the Plank length size or less) that may be as well the unknown elementary sub-particle by which vacuum space medium is hypothetically made up of. According to theory we described herein but also special relativity equations presented and analyzed (1), (2) and (3) the particle will have pure imaginary spatial and temporal dimensions therefore no real dimensions. Meaning, it will have zero dimensions in total in the lab frame thus non-observable in our Universe and appearing as "nothing" or strictly mathematically as a non-physical virtual particle.
Exactly, apart of some negligible zero-point vacuum energy fluctuations, how we perceive vacuum space in our *c* bounded time-like spacetime domain Universe. As "Nothing"!
Therefore, it is inferred that if such elementary possible Planck length sized vacuum sub-particle exists it must vibrate at superluminous speed.

2.5. Quantum foam and relativistic image doubling effect infer to a superluminal vacuum

Both, the Casimir effect [30] [31] and also the g-2 muon latest Fermilab experiment [32] of the measurement of anomalous magnetic moment of the muon, support strongly the grained quantized structure of the vacuum within its ZPF fluctuations of its ZPE energy value. Thus the actual existence of Planck-sized spontaneous virtual particles like virtual photons and virtual particle pairs creation of matter-antimatter and annihilation in the vacuum (i.e. virtual electron-positron pairs creation and annihilation). This omnipresent constant dynamic quantum foam [33] [34] or vacuum noise, pair creation and annihilation can by ansatz of the author herein also interpreted as being superluminous effects as shown similar independently by this recent optical experiments study [35] of the, “Observation of image pair creation and annihilation from superluminal scattering sources”, or in this Cosmic-rays study in the atmosphere where the speed of light inside a transparent medium is less than *c* of the vacuum (e.g. on air) but still superluminal behavior can be observed relative to the predicted speed of light inside this medium in the form of Relativistic Image Doubling effect (RID) [36].
This quantum foam noise virtual particles as shown [34] exhibits a stochastic Lorentz-Invariance violation where virtual particles can initially and momentarily exceed the speed of light at high sub-Planck energies similar to Cherenkov radiation [37] effect observed by accelerated particles faster than the speed of light inside a medium like water where the speed of light is about one third less than the speed *c* in the vacuum, and then decelerate into normal luminous speed *c* and subsequently to subluminous speed inside the medium. Similar as described in the previous referenced study [36], of cosmic-rays penetrating the atmosphere. Due to their initial high momentum, cosmic-rays can penetrate the atmosphere initially with higher speed than the atmospheric speed of light value and then decelerate to lower speed generating an optical effect called Relativistic Image Doubling or RID in short. An observer from the ground would then see two cosmic-ray trail columns forming instead of one, starting from a central point in space and expanding in both opposite directions up and down simultaneously depending the observer’s relative position. This last example describes the general RID effect that the author hereby infers that is directly correlated with the quantum foam spontaneous virtual pairs creation and annihilation and therefore by ansatz can be used as evidence for the intrinsic superluminous energy of free space vacuum.
Strangely but not unexpected according to this research herein, consistent superluminal behavior was reported in the literature by experiments for the near-field (i.e. within one wavelength distance from the source) radiation of electric dipole sources like for example a transmitting dipole antenna where almost instantaneous propagation at superluminal phase and group velocities was measured in the near-field and strange simultaneous ingoing and outgoing radiation at the source within one wavelength, reminder of the previous mentioned RID effect possible caused by rapidly decelerating within one wavelength period to *c* of initially superluminal virtual photons consisting the EM flux of the near-field EM radiation waves created in the vacuum [38-41] . This, once more supports the possible intrinsic superluminal nature of free space vacuum. Also undeniable experiments proof of superluminal $v>c$ photonic tunneling exists [42-46].

3. Conclusion

We have tried herein to answer a novel question and idea about what we observe in general as nothingness in vacuum space is actually an intrinsic and hidden physical property of the vacuum namely, superluminous energy or else the hidden dark energy. By attacking the problem by various angles we demonstrated that it is possible, without violating existing established theories and causality in our spacetime. However, the author concludes that in order this to be done this superluminous vacuum energy although inside our Universe does not reside in our time-like or light-like spacetime but in a space-like spacetime domain where there is no any concept of time when projected in our time-like or light-like spacetime and actions through space could appear as instantaneous. Under the context of possible different spacetimes coexisting in the same Cartesian space in superposition the author theorizes herein, and not the spacetime intervals definitions within the same spacetime known in the literature, these definitions could be extended as following:
Simply put, time-like or light-like spacetime is our known spacetime where causality is dictated by the speed of light. Thus for example, light-like in the vacuum where the speed of light is *c* and time-like inside for example a transparent medium like glass where the speed of light is lower than *c*. Space-like discrete spacetime could then be defined as a a hypothetical spacetime where causality is dictated by faster than light FTL speed limit and when projected in our time-like or light-like spacetime this could even resemble to "Instantaneous action at a distance" or else known by famous Einstein as "Spooky action at a distance".

However, such a spacetime domain has not yet being discovered within our cosmos and therefore not regarded today as a possible explanation for the observed Quantum Entanglement phenomena which however does not necessarily mean that it is not an open possibility. On the other hand, dark energy seems to have a space-like spacetime behavior which could offer probably a direct correlation of dark energy with the quantum entanglement phenomenon.

Nevertheless, the "disguise" of this superluminous vacuum energy (i.e. dark energy) from our normal spacetime domain is not perfect hence we only see the tip of the ice-berg in the form of noise thus the zero-point energy ZPE fluctuations of the vacuum ZPF. The author in this paper at this time wishes not to present a complete theory of his idea and hypotheses but rather to open up to the science and research community the perspective of the possibility of supeluminocity of the vacuum in our Universe for debate, fruitful discussion and further independent research. That could potentially prove to be the missing key to finally explain and uncover many up to today big unsolved problems in physics like the cosmological constant problem, dark energy, dark matter and quantum gravity.

For example about dark energy, according to the current debatable arguments the low observed vacuum energy in our universe thus the ZPE non-zero energy but very tiny small, is explained effectively by the SM and QFT [47] assuming supersymmetry (SUSY), as contributions of all the quantum fields like photon field, electron, quark, gluon, Higgs, etc. that supposedly cancel out to generate this very small vacuum energy value! This however, has not yet been proven since SUSY is not found so far to exist in nature by lab experiments (e.g. LHC) and brings out a big problem and discrepancy namely the cosmological constant problem thus the around 120 orders of magnitude discrepancy between the observed tiny vacuum energy and the predicted QED enormous value of vacuum energy and therefore a new hidden unknown type of energy had to be postulated to explain this discrepancy thus the Dark Energy (DE) which however is an unknown.

Trapped in our possible wrong footing, over so many years we are unwilling to believe the obvious solution to this dilemma which is not caused by nature but could be actually a human formalism artifact of a particular wrong aspect of an effective theory.

Possible solution to the mystery: What if it is exactly the other way around? Namely, instead it is dark energy, which could be actually more close to the predicted QED enormous value of vacuum energy but is hidden type of energy for various reasons we discussed herein, that is contributing to all other quantum fields and actually is their origin and ZPF of the vacuum is just the observable noise of dark energy (i.e. hidden vacuum energy).

Maybe we humans got it all backwards once more, resulting to theories like that all known QFT's quantum fields somehow magically cancel out, which however is an unproven theory. Possible, cosmological constant problem and mystery is a product not of nature but of our wrong understanding. The author hereby proposes that it is all about vacuum energy (i.e. its hidden part) which actually is that what we call dark energy but for some reason it is elusive and we cannot directly observe it, only its zero-point energy noise thus the ZPF of the vacuum.

We explained here what this reason could be of dark energy being so elusive. Namely, dark energy is a superluminous [48] type of unknown energy which is phased-out of our time-like spacetime and resides in our Universe in a different space-like spacetime state. Therefore, free space vacuum although appears to violate our known physics of matter and light and the boundary condition c because it resides in different space-like spacetime than ours it is not violating causality when its interactions are projected in our normal spacetime beyond the ZPF vacuum noise energy. Ultimately, the research hereby infers that free space is the dark energy and intrinsically superluminous in nature.

In section 2.5 we presented independent research sources that support what is theorized herein about the intrinsic superluminal energy of free space vacuum, where we directly correlate vacuum quantum foam spontaneous pair creation and annihilation with the observed known Relativistic Image Doubling effect RID which is only possible to be observed when superluminocity is involved. Similar superluminal behavior was reported also herein by independent experiments published results on the near-field of radiating macroscopic electric dipole sources where the RID effect is again observed.

Last but not least, recent work by Dragan A. & Ekert et al. [49] [50] with two papers published by the years 2020 and 2022 correspondingly and which scored more than any other physics papers in the Journal's Altmetric with more than 30,000 downnloads each, steered the science community and conclusively have shown that contrary to what was believed before, superluminocity does not violate relativity but rather surprisingly when properly taken into consideration as an extension actually describes perfectly and unavoidably the indetermenistic nature of quantum mechanics, its non-locality and superposition properties. Therefore fundamentally unifying the two theories is possible when superluminocity in spacetime is taken into account. Take also into consideration the two very recently published astrophysical papers [51] [52] which reveal observational evidence that observed certain macroscopic supermassive Black Holes growth cannot be explained in normal matter starving galaxies (i.e. previously theorized that Black Holes growth due the continuous consumption of normal matter) and therefore their growth can only be explained as these being sources of Dark Energy and contributing to the expansion of our universe. This complies with our theory presented herein that shows that by origin the macroscopic Black Holes could actually be local defects in the otherwise homogeneous omnipresent superluminous free space quantum vacuum condensate. Thus, regions where density of the superluminous vacuum quanta is relative very high generating a lot of gravity and Dark Energy. In other words, Black Holes could be regions in space with abnormal very high dark energy density that is constantly and intrinsically increasing over time and contributing to the expansion of the whole observable universe.

As a general final remark by the author herein, we must say that after more than 200 years of unsuccessfully trying to unify relativity with quantum physics by putting a hard limit the speed c of light in the vacuum (but not necessarilly the speed limit of the vacuum itself), maybe it is time to reconsider this obvious limitation in the theory that opposes any further investigation of our known unknowns in physics today and evolve the theory. After all, one of the main purposes of theoretical physics is to predict nature before verified by experiments even when direct observations at the time are not available but plenty of clues are left behind by nature. The author herein therefore suggests that free space vacuum thus the dark energy fundamentally differs from known matter and light described by our known physics by being hidden superluminal energy. New physics must be theorized to include superluminocity and should be taken seriously under the scope in order to make the next breakthrough in science.

Declarations

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

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The author confirms being the sole contributor to this work and has approved it for publication.

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