The Cosmological Constant Problem, the CMB Mass of Neutrinos, Quasars, Stable Vacua, and Non-Existence of Pure Energy as the Keys to the New Physics

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Abstract: The cosmological constant problem is a serious problem in particle physics and cosmology so a solution to this problem should lead to new physics. The value of cosmological constant is about 120 orders of magnitude too low than it should be. Here we showed that today the vacuum energy is about 119 orders of magnitude lower than it should be (in the Planck units or as a dimensionless quantity) because the superluminal pure inertial energy (it means that the gravitational energy is equal to zero) is frozen inside the stable-neutrinos/gravitational-charges and is about 119 orders of magnitude higher than the indirectly observed gravitational energy. We showed here that geometric mean of the Planck mass of neutrinos and the very low particle mass of neutrinos leads to the CMB/cosmological mass of neutrinos observed in experiments. The vice versa should be correct as well so the Planck mass and the sum of the experimental CMB/cosmological masses of different neutrinos lead to the very low particle mass of neutrinos so it leads to new physics as well. The Planck mass of neutrinos, which is associated with maximum rotation of their spin, solves the hierarchy problem as well. Quasars (a torus with a central condensate), which are the objects with high gravitational-mass density, can be the big cousins of the gravitational charge but of the weak and electromagnetic charges also. In the Scale-Symmetric Theory (SST), such a structure is characteristic for bare fermions – such a structure radically simplifies theories in particle physics and cosmology. The similarity of different scales leads to new physics also. There are two stable vacua (Higgs field and Einstein spacetime) so the physical constants are invariant. Pure energies, i.e. without inertial mass or inertial and gravitational masses, are not in existence.

1. Introduction

Here, applying the Scale-Symmetric Theory (SST) [1], we showed that the cosmological constant problem, the CMB/cosmological mass of neutrinos, quasars, stable vacua, and non-existence of pure energy are the keys to the new physics.

The shortest description of SST is as follows. In the liquid-like initial inflation field composed of non-gravitating tachyons (inertial mass only), there were created the pairs of superluminal closed strings (the entanglons responsible for quantum entanglement) from which, during the inflation, were created the quasar-like tiny neutrinos (i.e. there is a torus with central condensate) which are, generally, paired. It means that there is the two-component vacuum i.e. the residual inflation field (i.e. the Higgs field) associated with the gravitational fields, and the Einstein spacetime composed of the spin-1 neutrino-antineutrino pairs associated with the Standard-Model interactions. Our Cosmos must have boundary because only then the three physical constants $\hbar$, G, and c, which appear in the Planck critical quantities, are invariant.

2. The cosmological constant problem

In the General Relativity (GR), we assume that curvature of spacetime is forced by gravitational masses and that we can always equate the inertial and gravitational mass. But the SST shows that the last assumption is incomplete [1]. It follows from the fact that in GR, the equality of inertial and gravitational mass leads to equality of inertial and gravitational energy (it is because $E = mc^2$, where c is the invariant) and from the fact that in GR, a pure inertial mass (gravitational mass is equal to zero) does not appear. SST shows that when an object has gravitational mass then indeed such mass is always equal to inertial mass. But SST shows as well that only gravitational masses can not move with speeds higher that the speed of light in "vacuum" c – the pure inertial masses are superluminal (the superluminal quantum entanglement is the experimental proof) [1]. It is obvious that inflation was possible only if initial inflation field was free from gravitational masses because then there does not appear the problem concerning the exit from the black-hole state. It means that we can assume that the always attractive gravitational charges, i.e. the smallest gravitational masses, are built of the superluminal pure inertial masses – to such a conclusion leads as well the SST formulated on the assumption that whole Nature emerged due to the succeeding phase transitions of the inflation field composed of the non-gravitating tachyons [1]. Such theory is unique (i.e. there do not appear free parameters i.e. there do not appear additional particles as it is in string/M theory [2], [3]), mathematically coherent, and leads to a thousand fundamental results (to the physical constants as well) consistent or very close to experimental data [4]. Of course, SST is only the lacking part of the Theory of Everything (ToE), not the ToE.

The SST shows that the always attractive gravitational charge is the result of interaction of the SST Higgs field (HF; we call it the Higgs field) composed of the non-gravitating tachyons with the stable neutrinos (there are four stable neutrinos: the electron-neutrino, muon-neutrino and their antiparticles) [1]. Tau-neutrino consists of entangled three different stable neutrinos and it is the electron-neutrino-like neutrino [5]. The stable neutrinos are built of the superluminal entanglons that are the binary closed strings composed of the tachyons [1]. The constituents of stable neutrinos, i.e. entanglons, are responsible for the superluminal quantum entanglement [1]. Within SST we can equate the inertial mass of the stable neutrinos with always attractive gravitational charge of them (they produce gradients in the HF because of the internal helicity of the closed strings and because of the dynamic viscosity of the non-gravitating tachyons all particles consist of) – the gradients are the gravitational fields. We can see that GR does not act correctly inside the stable neutrinos – their inertial and gravitational masses are indeed the same but due to the superluminal entanglons, the inertial energy frozen inside stable neutrinos, expressed in kilograms, is about $0.6 \cdot 10^{119}$ times higher than the observed gravitational mass – it is the reason that value of the cosmological constant, Λ, for the Einstein "vacuum" (for the Einstein spacetime (ES)) is such small in comparison with predicted $\Lambda = 1$ expressed in the Planck units [$\hbar$]. Why predicted value should be $\Lambda = 1$? It follows from the fact that the ES consists of the spin-1 neutrino-antineutrino pairs and from the fact that the cosmological constant concerns the unobserved tremendous inertial energy frozen inside the neutrino-antineutrino pairs and the observed relatively very small gravitational mass.

Notice that the cosmological constant, Λ, is not fixed by the GR because GR is the incomplete theory. I recommend the review article [6] that concerns the cosmological constant and dark energy in GR and String Theory.

In GR, we can define the cosmological constant as follows [6]

$$\Lambda = \Lambda_{Einstein} + 8\pi\rho_{vacuum} \,, \tag{1}$$

or

$$\rho_{\Lambda} \equiv \rho_{vacuum} + \Lambda_{Einstein} / (8\pi) \,. \tag{2}$$

SST shows that formula (2) is within GR wrongly interpreted. In reality, there is the two-component vacuum. The two stable vacua are the Higgs field associated with gravitational fields and the Einstein spacetime associated with the three Standard-Model (SM) interactions: electromagnetic, weak and strong (there as well appears the superluminal quantum entanglement). The inertial-mass density of HF is about $4.2 \cdot 10^{42}$ times lower than the gravitational-mass density of ES but the superluminal inertial-energy density of HF is about $5 \cdot 10^{45}$ higher than the gravitational-energy density of ES [1]. Gravitational masses curve the HF whereas ES is practically flat – it causes that when we consider masses then the two-component spacetime is flat whereas when we consider energies then the two-component spacetime is curved as it is in GR. Assume that we consider the masses of the two stable vacua, not energies. Then in formula (2), ρ_{vacuum} is the density of the ES which in GR, due to the smoothness of ES, can be neglected. On the other hand, the term [$\Lambda_{Einstein} / (8\pi)$] denotes the mass density of dark energy. SST shows that dark energy consists of the additional ES components which behave the same as the ES components so formula (2) is correct. SST shows that due to the superluminal speeds, there only one part of $0.6 \cdot 10^{119}$ parts of dark energy (it can represent the unitary spin of the neutrino-antineutrino pairs) can be observed (the rest is frozen inside the additional neutrino-antineutrino pairs) so in GR is

$$\rho_{\Lambda}\,[\hbar] \equiv \Lambda_{Einstein} / (8\pi) = 1 / (8\,\pi\, 0.6 \cdot 10^{119}) \approx 2.4 \cdot 10^{-121}\,[\hbar] \,, \tag{3a}$$

where $\Lambda_{Einstein} = 1 / 0.6 \cdot 10^{119}\,[\hbar]$, or

$$\Lambda_{Einstein} = 1 / 0.6 \cdot 10^{119} \approx 1.7 \cdot 10^{-119}. \tag{3b}$$

But in reality, the ratio of the present-day gravitational mass densities of dark energy, $\rho_{DE} = 5.38 \cdot 10^{-26}$ [kg m^{-3}], and ES spacetime, $\rho_{ES} = 1.10 \cdot 10^{28}$ [kg m^{-3}], is [7]

$$\rho_{DE} / \rho_{ES} \approx 4.9 \cdot 10^{-54} \,. \tag{4}$$

Notice as well that the ratio of the present-day gravitational mass density of dark energy and the Planck density, $\rho_{Planck} = 5.16 \cdot 10^{96}$ [kg m^{-3}], is

$$\Lambda_{Einstein} = \rho_{DE} / \rho_{Planck} \approx 1.0 \cdot 10^{-122}, \tag{5a}$$

or

$$\rho_\Lambda \equiv \Lambda_{Einstein} / (8\pi) \approx 0.40 \cdot 10^{-123} . \quad (5b)$$

Emphasize that according to SST, vacuum energy is not dark energy only – dark energy is a very small part of vacuum energy. Vacuum energy, i.e. the ground state of ES and dark energy, does not redshift like photons because the spins of the neutrino-antineutrino pairs do not rotate. Photons are the rotational energies of such free or entangled pairs. There are only two different three-dimensional stable vacua not separated spatially with different amounts of vacuum energy – it is inconsistent with the String Theory (there are many metastable vacua widely separated [6]). Moreover, the real unobserved value of cosmological constant is $\Lambda_{Einstein} = 1$ and such vacuum, due to the superluminal quantum entanglement, can contain very high number density of bits of information so there can appear complex structures.

3. The CMB/cosmological mass of neutrinos

We described properties of neutrinos in many papers [1], [5], [8] – [18]. They are crucial to understand Nature. Here we showed that the CMB/cosmological mass of neutrinos, the same as the cosmological constant problem, leads to new physics.

The SST neutrinos acquire their masses because of the Higgs mechanism described within SST [1]. Within SST, we calculated as well the mass of stable neutrino $m_{Neutrino(e,\mu)} = 3.3349306 \cdot 10^{-67}$ kg (we call this mass the particle mass to distinguish this mass from the wave mass of stable neutrinos) and equatorial radius of stable neutrino $r_{Neutrino(e,\mu)} = 1.1184555 \cdot 10^{-35}$ m [1]. Calculate the maximum wave mass of stable neutrino, $M_{Planck,neutrino}$, (we will call them the Planck-type neutrinos or Planck neutrinos) – it is associated with its rotation i.e. the wavelength is equal to the equatorial circumference $2\pi r_{Neutrino(e,\mu)}$ – the Planck-mass/maximum-wave-mass of stable neutrinos is

$$M_{Planck,neutrino} = h \ \nu / c^2 = 2 \pi \hbar / (2 \pi r_{Neutrino(e,\mu)} c) = 3.1451 \cdot 10^{-8} \text{ kg} . \quad (6)$$

We can assume that the distribution of energies of rotating-spin neutrinos in high-energy-density regions of the Universe was the maximum-entropy probability distribution so it was the log-normal distribution (see the explanation below formula (7)). Such distribution was characteristic, for example, during the period of production of the cosmic microwave background (CMB) or near the jets of quasars – it was due to the production of the Planck-type neutrinos by relativistic muons carried by the relativistic jets of the neutron black holes (NBHs) all gravitational black holes consist of [7]. Mean energy/mass of neutrinos with log-normal distribution is equal to geometric mean of initial and final energies/masses. In such a way we can calculate the CMB/cosmological mass of stable neutrinos, $M_{CMB,neutrino}$

$$M_{CMB,neutrino} = (M_{Planck,neutrino} \ m_{Neutrino(e,\mu)})^{1/2} = 1.0241 \cdot 10^{-37} \text{ kg} = 0.057451 \text{ eV}. \quad (7)$$

The rotating-spin neutrinos, due to the dynamic viscosity of the entanglons the neutrinos consist of, decrease local dynamic pressure (rotations are the ordered motions so they decrease local pressure). It means that around rotating-spin neutrinos is created a metastable ES condensate. The components of the condensate are the carriers of the photons [1] so neutrinos with rotating spin, which are surrounded by ES condensate, behave as photons – it is the reason that log-normal distribution is characteristic for neutrinos. Notice that the particle mass of neutrinos is invariant [1]. The increases in masses of neutrinos are illusory and follow from the created metastable ES condensates. The metastable condensates around rotating neutrinos behave as dark energy (DE) i.e. the ES components the condensates consist of interact gravitationally only i.e. they are not entangled [7]. The DE metastable condensates can take over the rotational energy of the central neutrino i.e. DE can transform into elementary photons (i.e. into not entangled elementary photons) and vice versa. But probability to do the same with the dark-matter (DM) loops [17] is practically equal to zero because, initially, we must simultaneously rotate all the spins of the ES components in a DM loop by 90 degrees. Such highly synchronized process is practically impossible. Notice that probability to create in ES a loop composed of entangled and rotating ES components is much higher than for transformation of a DM loop into such loop. Transformation of a loop with rotating ES components into DM loop is practically the irreversible process.

Outside the regions with very high energy density, the Planck-type neutrinos reduce their energy/mass so only not numerous detected neutrinos should have very higher energies.

Calculate the sum of the CMB/cosmological masses of the three degenerate neutrinos with different flavours (the stable neutrinos have the same mass whereas the tau-neutrino has mass three times higher)

$$M_{3,CMB} = \Sigma_{a=e,\mu,\tau} M_a = 5\ M_{CMB,neutrino} = 0.28726 \text{ eV}. \quad (8)$$

This value is consistent with experimental data: 0.320 ± 0.081 eV [19].

Notice that the geometric mean can be expressed as the exponential of the arithmetic mean of logarithms [20]

$$(\Pi^{n}_{i=1}\ a_i)^{1/n} = exp[(\Sigma^{n}_{i=1}\ ln\ a_i) / n]. \quad (9)$$

Here $n = 2$, $a_1 = M_{Planck,neutrino}$ and $a_2 = m_{Neutrino(e,\mu)}$.

Emphasize that the vice versa should be correct as well i.e. the Planck mass and the sum of the experimental CMB/cosmological masses of different neutrinos lead to very low particle mass of neutrinos so it leads to new physics as well.

The Planck mass of a neutrino, which is associated with maximum rotation of its spin, solves as well the hierarchy problem. The components of an ES condensate that accompanies such neutrino, take over the rotation energy of the neutrino, i.e. in regions with lower energy density, the rotational energy of neutrinos is emitted via photons.

In reality, the discovered Higgs boson is an ES condensate, not a screened Planck mass – it is the reason that the Higgs boson mass is so light. It is true that heaviest mass scale is associated with gravity but it is not true that we need additional undiscovered particles to solve the hierarchy problem as, for example, it is postulated in the String Theory (the s-particles). We as well do not need some other mechanisms that screen the Planck mass to reduce it to the Higgs mass. Just Planck mass is carried by the ES condensate that accompanies a stable neutrino with maximum rotation speed (it is equal to the speed of light in “vacuum” c at distance equal to the equatorial radius of stable neutrino).

4. Quasars

Quasars (a torus with a central condensate), which are the objects with high gravitational-mass density, can be the big cousins of the gravitational charge but of the weak and electromagnetic charges also. In SST, such a structure is characteristic for bare fermions – such a structure radically simplifies the theories used in particle physics and cosmology. In such a way, we unified the structures of proton and nucleus of active galaxy [21].

5. Stable vacua

Our Cosmos must have a boundary because only then the three physical constants $\hbar$, G, and c, which appear in the Planck critical quantities, are the invariants. SST shows that these three fundamental physical constants depend on densities of the two stable vacua i.e. Higgs field and Einstein spacetime [1]. The Universe does not decelerate its expansion due to the gravitational attraction because there expands the dark energy, not the two stable vacua. The today stable vacua expanded during the inflation but SST shows that the expansion of the Universe was separated in time from the inflation. Of course, we cannot distinguish DE and ES but density of DE in comparison with ES is very, very low (see formula (4)) – it does not concern the local quantum fluctuations. We can say that changes in density of the dark energy, due to its expansion, can only infinitesimally change the values of the physical constants – the present-day detectors can not measure such small deviations.

Due to the stable vacua, the speed of light in “vacuum” c is invariant in relation to source or the last-interaction object (it can be detector).

We can see that the invariance of the fundamental constants leads to new physics also.

6. No pure energies

It is obvious that pure energies can not be separated from physical-volumes/inertial-masses. In the initial inflation field, there were only two types of energies i.e. the rotational and kinetic energies of the non-rotating tachyons. During the inflation were created the neutrinos that created the gradients in the Higgs field so there appeared the gravitational potential energy but notice that to obtain the negative potential energy we need the tachyons i.e. we need inertial masses – it means that Nature can not create a gravitational mass composed of inertial mass and negative potential energy from nothing. The Big Bang from nothing is the absurd idea.

Due to the possible phase transitions of the Einstein spacetime, there appeared the other types of potential energies but they all are associated with masses [1]. For example, electric charges can force the radial polarization of the virtual electron-positron dipoles in the flat Einstein spacetime – it is the electromagnetic potential [1]. There can be also the radial emissions of gluons and pions by the cores of baryons – in such a way is produced the nuclear potential associated with the nuclear strong interactions [1]. There can be potentials associated with exchanges of some objects, for example, there can be exchanged the Einstein-spacetime condensates – in such a way is produced the potential associated with the weak interactions [1]. There is the positive/repulsive potential associated with the expanding dark energy – it expands because of the dynamic pressure that is higher than gravitational force per unit area [7], and so on.

The non-existence of pure energies as well points new physics.

7. Summary

Here we showed that today the vacuum energy is about 119 orders of magnitude lower than it should be (in the Planck units or as a dimensionless quantity) because the superluminal pure inertial energy (i.e., gravitational energy is equal to zero) is frozen inside the stable-neutrinos/gravitational-charges and is about 119 orders of magnitude higher than the observed gravitational energy.

We showed here that geometric mean of the Planck mass of neutrinos and the very low particle mass of neutrinos leads to the CMB/cosmological mass of neutrinos observed in experiments. The vice versa should be correct as well so the Planck mass and the sum of the experimental CMB/cosmological masses of different neutrinos lead to very low particle mass of neutrinos so it leads to new physics as well.

The Planck mass of neutrinos, which is associated with the maximum rotation of their spin, solves as well the hierarchy problem. In reality, the Planck mass is the maximum mass of the metastable ES condensates that can take over the rotational energy of the central neutrino – it causes that energy of neutrinos can be emitted via photons.

Quasars (a torus with a central condensate), which are the objects with high gravitational-mass density, can be the big cousins of the gravitational charge but of the weak and electromagnetic charges also. Such similarity leads to new physics also.

The invariance of the fundamental constants (it needs the two stable vacua) leads to new physics also.

Non-existence of pure energies as well points new physics.

References

[1] Sylwester Kornowski (6 June 2016). “Foundations of the Scale-Symmetric Physics (Main Article No 1: Patricle Physics)”
http://vixra.org/abs/1511.0188

[2] M. B. Green, J. H. Schwarz, and E. Witten (1987). “Superstring Theory”
Cambridge Univ. Pr., Cambridge, UK

[3] J. Polchinski (1998). “String Theory”
Cambridge Univ. Pr., Cambridge, UK

[4] Sylwester Kornowski
http://vixra.org/author/sylwester_kornowski

[5] Sylwester Kornowski (13 August 2016). “The PMNS Neutrino-Mixing Matrix Within the Scale-Symmetric Theory”
http://vixra.org/abs/1608.0145v3

[6] Raphael Bousso (5 March 2012). “Cosmological Constant Problem, Dark Energy, and the Landscape of String Theory”
arXiv:1203.0307v2 [astro-ph.CO]

[7] Sylwester Kornowski (29 June 2016). “Foundations of the Scale-Symmetric Physics (Main Article No 2: Cosmology)”
http://vixra.org/abs/1511.0223

[8] Sylwester Kornowski (18 December 2015). “Cosmic Neutrino Background”
http://vixra.org/abs/1307.0048

[9] Sylwester Kornowski (23 December 2015). “The Higgs Mechanism and Tower of Higgs Bosons”
http://vixra.org/abs/1310.0094

[10] Sylwester Kornowski (28 December 2015). “The Inflation in the Scale-Symmetric Theory”
http://vixra.org/abs/1311.0174

[11] Sylwester Kornowski (6 January 2016). “The Hierarchy Problem and Oscillations of Neutrinos in the Scale-Symmetric Theory”
http://vixra.org/abs/1408.0179

[12] Sylwester Kornowski (18 January 2016). “The Einstein-Spacetime, Dark-Energy and Dark-Matter Particle and the Higgs Boson”
http://vixra.org/abs/1502.0132

[13] Sylwester Kornowski (23 January 2016). “The Superluminal Interpretation of Quantum Mechanics”
http://vixra.org/abs/1505.0124

[14] Sylwester Kornowski (26 January 2016). “Cross-Sections for Scattering of Neutrinos on Nucleons and Electrons”
http://vixra.org/abs/1509.0002

[15] Sylwester Kornowski (18 December 2016). “The Superluminal Neutrinos Once More”
http://vixra.org/abs/1512.0118
[16] Sylwester Kornowski (25 November 2016). “Interactions of the Dark-Matter Loops with Baryonic Matter Once More”
http://vixra.org/abs/1606.0191
[17] Sylwester Kornowski (7 November 2016). “Dark-Matter Structures: Mass, Sizes and Detection”
http://vixra.org/abs/1611.0065
[18] Sylwester Kornowski (10 February 2017). “How Quasars Created the Dark-Matter Structures of Present-Day Galaxies?”
http://vixra.org/abs/1702.0125
[19] Richard A. Battye and Adam Moss (6 February 2014). “Evidence for Massive Neutrinos from Cosmic Microwave Background and Lensing Observations”
Phys. Rev. Lett. **112**, 051303
[20] Michael J. Crawley (6 May 2005). “Statistics: An Introduction using R”
Published by Wiley, ISBN 9780470022986
[21] Sylwester Kornowski (7 January 2016). “Unification of the Structures of Proton and Nucleus of Active Galaxy”
http://vixra.org/abs/1409.0068