The Hierarchy Problem and Oscillations of Neutrinos in the Scale-Symmetric Theory

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Abstract: The hierarchy problem follows from the very big energetic gap between the Planck scale and the masses of the most massive known particles. This problem is solved within the Scale-Symmetric Theory. This theory starts from the four succeeding phase transitions of the superluminal non-gravitating Higgs field composed of pieces-of-space/tachyons (due to the size of our Cosmos, there are possible four transitions only). There appear the very different scales i.e. the superluminal-quantum-entanglement scale, luminal Planck scale, electric-charges scale and cosmological scale. Due to the irreversible processes during the inflation, the electron-neutrinos and muon-neutrinos are the stable particles. The observed oscillations follow from the decays or creations of the unstable tau "neutrinos" that consist of three different stable neutrinos and from the exchanges of the free neutrinos (they interact gravitationally only) for the neutrinos in the neutrino-antineutrino pairs the Einstein spacetime consists of.

1. The Scale-Symmetric Theory

The General Relativity leads to the non-gravitating Higgs field composed of tachyons [1A]. On the other hand, the Scale-Symmetric Theory (SST) shows that the succeeding phase transitions of such Higgs field lead to the different scales of sizes [1A]. Due to the saturation of interactions via the Higgs field and due to the law of conservation of the half-integral spin that is obligatory for all scales, there consequently appear the superluminal binary systems of closed strings (entanglons) responsible for the quantum entanglement, stable neutrinos and luminal neutrino-antineutrino pairs which are the components of the luminal Einstein spacetime (it is the Planck scale), cores of baryons, and the cosmic structures (protoworlds) that evolution leads to the dark matter, dark energy and expanding universes (the "soft" big bangs) [1A], [1B]. The non-gravitating tachyons have infinitesimal spin so all listed structures have internal helicity (helicities) which distinguishes particles from their antiparticles [1A]. SST shows that a fundamental theory should start from infinite nothingness and pieces of space [1A]. Sizes of pieces of space depend on their velocities [1A]. The inflation field started as the liquid-like field composed of non-gravitating pieces of space [1A]. Cosmoses composed of universes are created because of collisions of big pieces of space [1A], [1B]. During the inflation, the liquid-like inflation field (the non-gravitating superluminal Higgs field) transformed partially into the luminal Einstein spacetime (the big bang) [1A], [1B]. In our Cosmos, the two-component spacetime is surrounded by timeless wall – it causes that the fundamental constants are invariant [1A], [1B].

Due to the symmetrical decays of bosons on the equator of the core of baryons, there appears the atom-like structure of baryons described by the Titius-Bode orbits for the nuclear strong interactions [1A].

The resultant weak charge of the neutrino-antineutrino pairs is equal to zero and their Principle-of-Equivalence mass is very small (about $6.7 \cdot 10^{-67}$ kg) so their detection is much more difficult than detection of neutrinos.

The inertial-mass density of the non-Principle-of-Equivalence Higgs field is about $4 \cdot 10^{42}$ times lower than the Principle-of-Equivalence mass density of the Einstein spacetime. The superluminal Higgs field leads to the gravitational interactions whereas the luminal Einstein spacetime to the electromagnetic, weak and strong interactions i.e. to the Standard-Model interactions. We can see that unification of the General Relativity and the Standard Model within the same methods is impossible.

Due to the third phase transition that leads to the core of baryons and next to the atom-like structure of baryons, there appear the charged leptons and hadrons so the most massive as well i.e. the Higgs bosons, [2], and the top quark [1A], [1D]. But even the heaviest particles do not solve the hierarchy model. The known particles, beside the neutrinos, consist of the entangled (it is due to the superluminal quantum entanglement of the Einstein-spacetime components) and/or confined (it is due to the Mexican-hat mechanism characteristic for the Einstein-spacetime components) Einstein-spacetime components [1A].

Due to the quantum entanglement and the fourth phase transition of the modified Higgs field, there can appear the cosmic object-antiobject pairs (the protoworld-antiprotoworld pairs) that solve the matter-antimatter asymmetry in our Universe.

2. The hierarchy problem

The hierarchy problem follows from the very big energetic gap between the Planck scale (the Planck energy is about $2.2 \cdot 10^{-8}$ kg = $1.2 \cdot 10^{19}$ GeV) and masses of heaviest known particles (less than 10^{3} GeV). We can see that the Planck energy is about 10^{16} times greater than the masses of the heaviest known particles. There are two different ideas to explain the gap.

The first method follows from the supersymmetry. Within this method we assume that there is the fermion-boson symmetry i.e. that each particle has its much heavier superpartner referred to as sparticle (the spin gap between particle and its sparticle is half-integral). A field composed of the heavy sparticles around the Planck mass/energy causes that the energetic gap between the Planck scale and quark scale is cancelled. But, unfortunately, up to now no sparticle was discovered.

The second method follows from the scale symmetry. Within this method we assume that the two very different scales follow from two very different mechanisms/phenomena. Within many scale-symmetric theories is one in which is assumed that the very big energetic gap follows from phase transition.

How the hierarchy problem is solved within the Scale-Symmetric Theory and what this theory says about the two different methods i.e. supersymmetry and scale symmetry?

The Scale-Symmetric Theory shows that there is in existence a substitute of the mainstream supersymmetry but within such supersymmetry we cannot solve the hierarchy problem. Just the "sparticles" of the neutrons and protons are the pions whereas the "sparticles" of the electrons are the photonic loops composed of the entangled neutrino-antineutrino pairs which can transform into electron-positron pairs, quark-antiquark pairs, and so on [1A]. Their masses are too small to solve the hierarchy problem.

The so far not discovered sparticles are the neutrino-antineutrino pairs i.e. the Einstein-spacetime components – above we substantiated why their detection is very difficult. The non-Principle-of-Equivalence energy frozen inside the Einstein-spacetime components (it is the energy of the superluminal entanglons) is about $0.6 \cdot 10^{119}$ times greater than the Principle-of-Equivalence mass of the Einstein-spacetime components. The equivalent mass of the non-Principle-of-Equivalence energy frozen in a neutrino is about $2 \cdot 10^{52}$ kg [1B]. The geometric mean of the Principle-of-Equivalence mass of the Einstein-spacetime components and of the tremendous energy frozen inside them is about $16 \cdot 10^{-8}$ kg. For one component of a neutrino-antineutrino pair is $8 \cdot 10^{-8}$ kg. This value is close to the Planck energy and such is the origin of this energy. But we must emphasize that the upper limit for the rotational energy of a neutrino is close to the Planck energy also but this energy is not a gravitating mass. We can see that the non-Principle-of-Equivalence energy frozen inside the Einstein-spacetime components is tremendous but their Principle-of-Equivalence mass is very small. The known particles, besides the neutrinos, consist of the confined and/or entangled Einstein-spacetime components – sometimes there are one or more neutrinos. It concerns the Higgs bosons and the top quark as well.

The very small Principle-of-Equvalence mass of the Einstein-spacetime components in comparison with the non-Principle-of-Equivalence energy frozen inside the Einstein-spacetime components solves the hierarchy problem. The geometric mean of the small mass and of the tremendous frozen energy leads to the Planck scale whereas the confinement and/or entanglement of the small masses carried by the Einstein-spacetime components lead to the quark scale. The two very different mechanisms that lead to the two very different scales result from the succeeding phase transitions of the superluminal non-gravitating Higgs field.

3. “Oscillations” of neutrinos

The Scale-Symmetric Theory shows that there are only two species of stable neutrinos i.e. the electron-neutrinos and muon-neutrinos. There are the antineutrinos as well so there are four different stable neutrinos. The third unstable “neutrino”, i.e. the tau “neutrino”, consists of entangled three different stable neutrinos i.e. the tau “neutrino” in reality is a nucleus composed of three different stable neutrinos. It can decay to three stable neutrinos or to a carrier of photon/gluon (i.e. to the Einstein-spacetime component) plus stable neutrino.

There are not in existence the “observed” oscillations of neutrinos. Just due to the irreversible processes during the inflation, the stable neutrinos are the stable particles i.e. the neutrino-antineutrino pairs cannot decay to some quanta. The “oscillations” of neutrinos follow from the decays or creations of the tau “neutrinos” and from the exchanges of the free neutrinos (they interact gravitationally only) for the neutrinos in the Einstein-spacetime components. Since the mass of Earth follows from the entangled or/and confined Einstein-spacetime components so at night we should observe more “oscillations” and we know that it is true. The difference should be small because there is as well the Einstein spacetime which mass density is much higher than the Earth.

4. Summary

The hierarchy problem follows from the very big energetic gap between the Planck scale and the masses of the most massive known particles. This problem is solved within the Scale-Symmetric Theory. This theory starts from the four succeeding phase transitions of the superluminal non-gravitating Higgs field composed of pieces-of-space/tachyons (due to the size of our Cosmos, there are possible four transitions only). There appear the very different scales i.e. the superluminal-quantum-entanglement scale, luminal Planck scale, electric-charges scale and cosmological scale.

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The Scale-Symmetric Theory based on the four succeeding phase transitions of the superluminal non-gravitating Higgs field composed of pieces-of-space/tachyons was formulated in May 1997. The part of the Scale-Symmetric Theory describing the atom-like structure of baryons was formulated in August 1985.

References

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