The Scale-Symmetric Physics as the Realistic/Unique String Theory

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Abstract: Here we show that the Scale-Symmetric Theory (SST) is the realistic/unique String Theory realized by Nature. The SST starts from 7 parameters only (there do not appear free parameters) and a few very simple symmetries that follow from initial parameters. We present the realistic interpretation of the different string theories, the compactification of the higher degrees of freedom, new fermion-boson supersymmetry, new SS-duality concerning shapes (a self-similar duality), the S-duality (a strong-weak duality), T-duality (duality of different spacetime geometries; duality of large and small distance scales), U-duality (unified duality; a symmetry for combined S-duality and T-duality), the origin of radions and dilatons. There appear following fundamental spacetime objects: the luminal gravitating 26-degrees-of-freedom Einstein-spacetime components, the superluminal 10-degrees-of-freedom spin-1 entanglons responsible for the quantum entanglement and the 6-degrees-of-freedom non-gravitating tachyons carrying infinitesimal imaginary spin (existence of such tachyons results from extended General Relativity; the gravitational fields consist of them). There as well appear the 58- and 122-degrees-of-freedom stable objects composed of the 26-degrees-of-freedom spacetime objects. The 11-dimensional supersymmetric M-theory and its 10-dimensional components cannot be realized by Nature (it follows from the thermodynamics of the tachyonic liquid at the beginning of the inflation). New symmetries of the initial liquid-like spacetime lead to the succeeding phase transitions of the non-gravitating Higgs field composed of tachyons.

1. Introduction

Within the Standard Model we still cannot calculate exact masses and spin of nucleons from the initial conditions (since 1964). On the other hand, within the Cosmological Standard Model we cannot define properties of the dark matter and dark energy and calculate their abundances from some initial conditions. We as well do not understand the origin of physical constants and applied in physics mathematical constants. It suggests that the two leading mainstream theories, i.e. the Quantum Physics and General Theory of Relativity, are the incomplete theories and that there should be a theory superior to these two theories. Such theory should lead to initial conditions applied in these two theories and should describe the

lacking part of the Theory of Everything. We showed that the Scale-Symmetric Theory described in tens of papers (http://vixra.org/author/sylwester_kornowski) is the lacking part.

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/energies [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 (it is the quantum-entanglement scale), stable neutrinos and luminal neutrino-antineutrino pairs which are the components of the luminal Einstein spacetime (it is the Planck scale), cores of baryons (it is the electric-charges/condensates/loops/quantum-physics scale), and the cosmic structures (protoworlds; it is the cosmological scale) 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].

SST shows that to obtain results consistent with experimental data, the big piece of space that transformed into the inflation field had before the collision a rotational energy very low in comparison with kinetic energy [1A]. It leads to conclusion that there was low anisotropy of the inflation field i.e. of the expanding superluminal non-gravitating Higgs field. It means that to such field we can apply the Kasner metric, [2], that is a solution to the vacuum Einstein equations so the Ricci tensor always vanishes. The Kasner metric is for an anisotropic cosmos without matter so it is a vacuum solution for the Higgs field. The one of the two semi-symmetrical Kasner solution, $(2/3, 2/3 - 1/3)$, we interpret as virtual Higgs cyclones with toroidal and poloidal motions. Such tori appear in the succeeding phase transitions of the Higgs field [1A].

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].

Applying 7 parameters only and a few new symmetries, [1A], we calculated a thousand of basic physical (and mathematical) quantities (there are derived the physical and mathematical constants as well) consistent or very close to experimental data and observational facts. In SST there do not appear approximations, mathematical tricks, and free parameters which are characteristic for the mainstream particle physics and mainstream cosmology.

The quantum mechanics (QM) acts correctly only when we neglect gravity. On the other hand, the General Relativity (GR) acts correctly only when we assume that gravity is classical. But can we neglect quantum phenomena describing sources of very strong gravitational fields?

Some particles have non-zero gravitational mass and, as for example electron, are the quantum particles so scientists still try to unify gravity and quantum mechanics within the same methods. Is it possible? SST shows that due to the inflation, there appeared the two-component spacetime i.e. the superluminal non-gravitating Higgs field and the luminal gravitating Einstein spacetime [1A]. On the other hand, the gravitational fields are the

gradients produced in the Higgs field by the Einstein-spacetime components whereas the Standard-Model interactions are associated with excited states of the Einstein spacetime. Since properties of the two components of spacetime are very different so unification of GR and QM within the same methods is impossible. Just due to the inflation, the GR and Standard Model were irreversibly separated. We can unify them partially only via the succeeding phase transitions of the Higgs field.

The GR has no physical sense at zero distance. There appear divergences which are perturbatively nonrenormalizable – there are infinitely many independent parameters unless we neglect large energy scales but then such theory is incomplete. On the other hand, in QM, we consider the sizeless bare particles so this theory is mathematically and physically incoherent. It is the reason that in the mainstream string theory (MST) we start from open and closed one-dimensional strings and we try to describe how they propagate through 26-, 11- or 10-dimensional spacetime and how they interact with each other [3].

Within MST, we try to unify QM and GR within the same methods. The foundations of the MST are the excitations of strings (there appear excitation modes). In quantum gravity, the size/length scale is close to the Planck length (about 10^{-35} m). One of such excitations is graviton with zero mass and two units of spin. The spin-2 graviton follows from the fact that the source of gravitation is the second-rank stress-energy tensor – it is some analogy to the spin-1 photon emitted by the source of electromagnetism which is the first-rank four-current tensor. Notice as well that in the mainstream bosonic string theory there appear tachyons with imaginary mass i.e. the particles moving with superluminal speed. We can see that MST is a theory of quantum gravity and particles so it is a candidate for a theory of everything (ToE) but it still is the useless theory. Just we still are unable to find a solution to MST leading to physical constants, to coherent and complete mechanism for cosmological inflation, to all properties of particles, to curved but practically flat spacetime, or to the origin of dark matter or dark energy. Why? How we should modify MST to obtain the realistic/unique string theory? And SST shows that GR provides the main idea for useful modification of MST. GR leads to non-gravitating tachyons/pieces-of-space – on the other hand, the SST shows that only size of them about 10^{29} times smaller than the Planck length leads to coherent and useful theory. SST shows that MST does not start from true initial cosmological conditions.

2. New symmetries in Scale-Symmetric Theory [1A], [4], the spacetime objects [1A], [1B], and radions [5]

The very simple thermodynamics of the tachyonic liquid leads to new symmetries. They are as follows.

Due to defined dynamic viscosity of tachyons (tachyons have infinitesimal imaginary spin) and their non-gravitating mass density, there appear superluminal closed strings composed of tachyons – the strictly defined radius of the closed strings is about 10^{-45} m i.e. about 10^{10} times smaller than the Planck length. The calculated imaginary non-gravitating spin of each fundamental closed string is half-integral and they are the invariant objects. Due to the infinitesimal spin of tachyons, the closed strings have internal helicity so in the tachyonic liquid there appeared the closed strings with left- and right internal helicity. To dampen the turbulences in the expanding tachyonic field during the inflation, the resultant internal helicity and spin of the field must be equal to zero. It led to production of groups of four closed strings arranged in pairs in such a way that in a pair the internal helicities are opposite whereas spins are parallel and overlap (the pairs are the superluminal spin-1 entanglons responsible for the quantum entanglement). The two entanglons in a group had antiparallel spins. We can see that the spin-1 entanglons/bosons and the internal helicity of closed string define the signature of spacetime. Entanglons are the 10-degrees-of-freedom spacetime objects (the x-, y- and z-

coordinate, two different radii, the spin/toroidal and winding/poloidal speeds, two angular velocities describing rotation of spin and linear speed associated with time). There are not in existence open or free fundamental strings – all fundamental closed strings, due to the dynamic viscosity of tachyons and the spin and winding/poloidal speeds, are confined in entanglons. But due to the dynamic viscosity of tachyons, the entanglons produce tachyonic vortices (they can be open and they can merge) and tachyonic jets. Notice as well that tachyons are the 6-degrees-of-freedom spacetime objects (the x-, y- and z-coordinate, one radius, spin speed and linear speed associated with time).

We can see that described here the four-particle symmetry conserves the resultant internal helicity and resultant spin of the Higgs field via dampening turbulences.

In MST, the fundamental phenomena are the vibrations of the open or closed strings with size close to the Planck length. In SST there is the very different scenario. The spin speed of a closed string is about 10^{27} times greater than the winding speed (such ratio leads to the gravitational constant G). It causes that due to the dynamic viscosity of tachyons, each entanglon produces two antiparallel tachyonic half-jets overlapping with the direction of spin of the entanglon, and two tachyonic vortices with radius close to R that is the radius of single closed string. The two vortices can transform into one vortex with radius close to $2R$ – such open vortex fixes the distance about $4\pi R$ between interacting entanglons. When the vortices do not merge then the fixed distance is about $2\pi R$. It leads to conclusion that there were produced fundamental surfaces/branes composed of entanglons with the average length of the side of the mesh equal to about $3\pi R$. In such a mesh, all spins of entanglons must be perpendicular to the mesh and should point one side.

We showed that due to the infinitesimal spin of the tachyons, the fundamental closed strings have internal helicity and it is the signature of spacetime. It leads to conclusion that the fundamental surfaces/branes composed of entanglons must have internal helicity as well – just they must mimic the signature of spacetime. The simplest object which can have internal helicity is a torus (notice that a torus is the simplest example of a Calabi-Yau manifold in MST). The tachyons in the produced jets by entanglons collide with the chaotically moving tachyons in the non-gravitating Higgs field. Due to the collisions, there is produced around the fundamental torus a gradient in the Higgs field – it is the gravitational field (within SST is described the mechanism of emission of gravitational potential energy also [6]). Described here mechanism is the Higgs mechanism which transforms the non-gravitating objects into the smallest/fundamental gravitating objects [7]. But it is not the whole story. The exchanged and bound entanglons have the same linear speed so to stabilize the spin-$1/2$ torus of neutrino (which has internal helicity) there must appear the radial speeds of exchanged entanglons. Due to the exchanged entanglons the torus consists of, inside the torus appears a loop (it is the fundamental spin-1 radion composed of entanglons; to conserve the spin of torus, the radions are produced as the pairs with antiparallel spins so it is the spin-0 boson) whereas due to the radial speeds of entanglons, in centre of the torus there appears the spin-0 central condensate/scalar composed of entanglons also (it is the fundamental dilaton). Such is the internal structure of the neutrinos. Due to the spin-1 signature of spacetime, the neutrinos were produced during the inflation as the neutrino-antineutrino pairs. Such pairs are the components of the luminal gravitating Einstein spacetime and they are the 26-degrees-of-freedom objects. There are produced surfaces composed of the Einstein-spacetime components – they are stable due to the two shortest-distance quantum entanglement.

Due to the saturation of interactions of the entanglons via Higgs field, the bigger and bigger structures consist of K^2, K^4, K^8 and K^{16} tachyons, where K^2 is the number of tachyons in the fundamental closed string.

The saturation that is a new symmetry and the copied spin-1 signature of spacetime on the bigger and bigger structures quantize their masses, radii and linear velocities. It causes that there as well appear the 58-degrees-of-freedom core of baryons and the 122-degrees-of-freedom cosmological structures (the cores of protoworlds) which lead to new cosmology and to the origin of the dark matter and dark energy.

3. Superiority of the Scale-Symmetric Theory over the supersymmetric M-Theory

The GR shows that there can be in existence non-gravitating tachyons. On the other hand, the SST shows that the 10-degrees-of-freedom entanglons have very simple structure (it follows from the very simple thermodynamics of the tachyonic liquid [1A]) so in the 10-degrees-of-freedom field the boson-fermion supersymmetry cannot appear. The boson-fermion supersymmetry can be realized in the 26-degrees-of-freedom spacetime – inside the tori carrying the half-integral spin (fermions) there appear the binary systems of radions which are the zero-spin bosons, for example, the pions (bosons) are the superpartners of nucleons (fermions). On the other hand, the supersymmetric M-theory is still useless so it suggests that probably such theory cannot be realized by Nature.

M-theory is the unknown 11-dimensional theory whose low energy limit is the supergravity theory in eleven dimensions. The S-duality and T-duality may be combined to obtain equivalences of any of the five 10-dimensional superstring theories (Type I, heterotic SO(32), heterotic $E_8 \times E_8$, Type IIA and Type IIB) with M-theory.

The SST shows that gravitational fields are the gradients produced in the Higgs field which is the classical field. Moreover, the entanglons, free neutrinos and free neutrino-antineutrino pairs (they interact gravitationally only) are the classical objects as well. Just the Higgs field and the ground state of the Einstein spacetime are not the quantum fields. In a quantum way can behave only the excited states of the Einstein spacetime i.e. the rotational energies of the neutrino-antineutrino pairs or structures composed of entangled and/or confined neutrino-antineutrino pairs. Sometimes such structures can contain neutrino(s). Due to the superluminal quantum entanglement, a quantum object can disappear in one place and appear in another one, and so on. Just there is transmitted the structure composed of the superluminal entanglons (they can carry rotational energy also), not the luminal Einstein-spacetime components which are the classical objects. We can see that the phenomena characteristic for gravity and quantum mechanics are very different so unification of these two theories within the same methods is impossible. We can unify them only via the succeeding phase transitions of the Higgs field.

The Scale-Symmetric Theory starts from the Higgs field composed of the non-gravitating tachyons. The first phase transition leads to the bosonic string theory (the theory of superluminal entanglons) but it is not the bosonic string theory described within MST. But we can see that these two different bosonic string theories have a few tangent points, for example, there appear the tachyons and only bosons (the fundamental closed strings, which are the fermions, were during the inflation produced as the binary systems that are the bosons).

In SST, to construct models of gravitationally massless or massive particles, we begin by specifying the shapes and properties of the fundamental objects in the different scales. They are the 6-degrees-of-freedom tachyons, the 10-degrees-of-freedom superluminal entanglons, the 26-degrees-of-freedom luminal Einstein-spacetime components, the 58-degrees-of-freedom cores of baryons and the 122-degrees-of-freedom cores of protoworlds [1A], [8]. In SST, there is only one unique composition of spacetime instead of about 10^{500} different vacuum states for superstring theory.

4. General Relativity leads to non-gravitating tachyons

Within GR we obtain formula for the total energy of the Principle-of-Equivalence particles (their inertial mass is equal to their gravitational mass). Assume that the word "imaginary" concerns physical quantities characteristic for objects that have broken contact with the wave function that describes state of the Universe. This means that such objects cannot emit some particles so they should be the internally structureless objects i.e. they are some pieces of space carrying only the inertial mass (they are the non-gravitating objects). Substitute ic instead the speed of light in "vacuum" c, iv instead the kinetic speed v and im instead the gravitational mass M, where $i = sqrt(–1)$ is the imaginary unit. Then the formula for the total energy of a field composed of the non-gravitating pieces of space is

$$E = m\,c^2 / sqrt(v^2 / c^2 \; – \; 1). \tag{1}$$

We can see that now the non-gravitating pieces of space must be superluminal (v must be higher than the speed of light, c, in "vacuum") i.e. they are the non-gravitating tachyons. The field composed of non-gravitating tachyons we refer to as the Higgs field. It is the Higgs field which causes that non-gravitating objects, due to the interaction with the Higgs field, acquire their gravitational mass (the Higgs mechanism). The Higgs mechanism leads to the lightest gravitational mass carried by the stable neutrinos i.e. the electron-neutrinos and muon-neutrinos and their antiparticles (according to SST, the unstable tau-neutrinos consist of three entangled different stable neutrinos).

5. Compactification of the higher degrees of freedom and the fermion-boson supersymmetry

Consider the fundamental Principle-of-Equivalence objects i.e. neutrinos, cores of baryons and cores of protoworlds. Respectively, they are the 26-, 58- and 122-degrees-of-freedom objects. The nontrivial compactification of their higher degrees of freedom leads to the abstract 5-degrees-of-freedom structure. Such structure consists of **torus**/fermion/charge carrying half-integral spin and producing **jets**/lines-of-forces (virtual pairs, if appear, are polarized along the lines of forces), **two-circles**/boson/pair-of-radions inside torus which are the fourth spatial degree of freedom (in baryons, circumference of one circle is close to the range of the nuclear strong interactions; both radions in a pair have internal helicity the same as the torus and antiparallel spins to conserve the spin of torus), and **ball**/scalar/condensate/vacuum-expectation-value/dilaton (in baryons, such ball defines the coupling constant for the nuclear weak interactions). In GR and QM, such complex structures are compactified to mathematical point and it causes that these theories are the incomplete theories. It is the reason that there appear many incorrect interpretations, approximations, mathematical tricks, free parameters and unsolved basic problems. Such physics is very messy and the MST cannot change it.

Notice that the torus/fermion and the circle(s)/boson lead to the fermion-boson supersymmetry but this supersymmetry is not associated with the 10-degrees-of-freedom objects – the fermion-boson supersymmetry concerns the more complex fundamental objects.

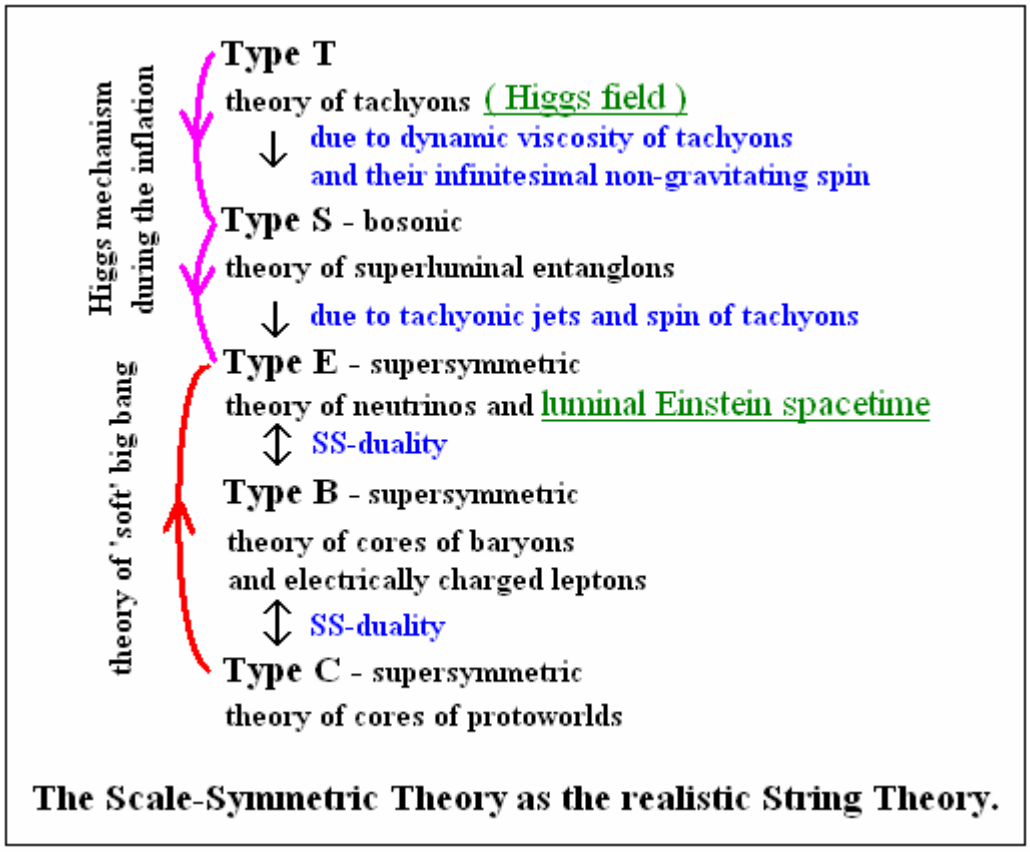
The open radions/loops produced by the core of baryons cause that the strong field has internal helicity. On the other hand, the gluons and photons are the rotational energies of the neutrino-antineutrino pairs so there are three internal helicities. It causes that the rotating neutrino-antineutrino pairs behave in different way in fields having internal helicity (the nuclear strong fields have internal helicity – it leads to the 8 Types of gluons) and in fields without internal helicity (the electromagnetic fields and gravitational field do not have

internal helicity – it leads to the 1 Type of photons). We can see that the gluons outside the nuclear strong fields behave as photons and vice versa.

6. The realistic interpretation of the different string theories

The Scale-Symmetric Theory, i.e. the realistic/unique string theory, contains one bosonic string theory and three superstring theories.

Type S (binary closed Strings) bosonic string theory is the theory of the superluminal entanglons responsible for quantum entanglement [9] – it contains the 10- (i.e. the superluminal entanglons) and 6-degrees-of-freedom (i.e. the non-gravitating tachyons) objects. Typical size is about 10^{-45} m. Resultant internal helicity is zero. There do not appear open strings/radions.



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Type E superstring theory is the theory of the **E**instein-spacetime components and neutrinos – it contains the 26-degrees-of-freedom objects (i.e. the luminal neutrinos and Einstein-spacetime components), entanglons and tachyons. Typical size is about 10^{-35} m. There appears the supersymmetry between matter and forces i.e. the fermion-boson supersymmetry. Fermions have non-zero internal helicity. In such theory appear open strings/radions.

Type B superstring theory is the theory of the cores of **B**aryons – it contains the same objects as the Type E superstring theory and the 58-degrees-of-freedom cores of baryons. Typical size is about 10^{-15} m. There appears the supersymmetry between matter and forces i.e. the fermion-boson supersymmetry, for example, the pions are the superpartners of nucleons. Fermions have non-zero internal helicity. The symmetrical decays of some virtual boson on surface of the torus of the core of baryons lead to the atom-like structure of baryons.

Within this theory is described internal structure and interactions of mesons and charged leptons also. In such theory appear open radions composed of entangled carriers of gluons and photons that can rotate.

Type C (Cosmological) superstring theory is the theory of the fundamental cosmological structures (protoworlds) – it contains the same objects as the Type B superstring theory and the 122-degrees-of-freedom cores of protoworlds. Typical size is about 10^{24} m. There appears the supersymmetry between matter and forces i.e. the fermion-boson supersymmetry i.e. the very early Universe (it was the spin-0 binary system of two left-handed Cosmic Loops) was the superpartner of the spin-1/2 left-handed Protoworld. Evolution of the protoworlds leads to the dark matter and dark energy. The very early Universe was the closed radion.

7. The SS-duality (the Self-Similar duality) and other dualities

The Scale-Symmetric Theory, i.e. the realistic string theory, is the unique theory so pure dualities are not allowed. Just in unique theory cannot appear non-trivial mathematically different descriptions of the same phenomena as it is in MST. There is big difference between, for example, the particle-wave duality and the T-duality (it relates theories with different spacetime geometries; it is the duality of large and small distance scales). The particle-wave duality concerns an entangled object but it concerns the different phenomena. On the other hand, there are two Calabi-Yau manifolds that give rise to the same physics – it is possible only in an incomplete string theory.

But, of course, we can apply the same methods to self-similar structures in non-perturbative theories (the SST is the non-perturbative theory). And the SS-duality (the Self-Similar duality) is such a duality.

The SS-duality is the only one realistic duality which appears in the Scale-Symmetric Theory and concerns the neutrinos, cores of baryons and cores of protoworlds. Such structures contain torus, circular radions and spherical condensate. These three different objects is said to be self-similar because their 5-degrees-of-freedom compactification looks the same on any scale.

To convert one of the three mentioned object into one of the other two objects, we must change masses and dominant internal velocity (i.e. we must change the coupling constants) and we must change sizes in such a way to conserve the half-integral spin of dominant torus.

In MST, a coupling constant is not a number but depends on dilaton which is a particle of a scalar field. When we exchange the scalar field with minus itself then it exchanges a very large coupling constant with a very small one. We can say that due to such S-duality, even when coupling constant is very large, we can apply a perturbative theory to obtain required results. In MST, the coupling constant is a dynamical variable but the supersymmetry breaking causes that the scalar fields reach a minimum. It is assumed that supersymmetry breaking scale should be close to 1 TeV. On the other hand, the unique SST shows that supersymmetry described within MST cannot be realized by Nature so we should not detect the superpartners predicted by this theory. But sooner or later we should detect the last important fundamental particles i.e. the spin-1 Einstein-spacetime components (the neutrino-antineutrino pairs) – due to the fact that their resultant weak charge is equal to zero, their detection is much difficult than neutrinos. Emphasize that in unique string theory, S-duality should not appear.

In SST, the dilatons are the weak-condensates/balls in centres of the fundamental tori. They are the scalars and their volume in baryons and charged leptons depends on relativistic mass. For example, mass of dilaton in electron is equal to mass of radion with radius equal to the reduced Compton length of the electron (its mass is 0.2552 MeV). At low energy, the mass

of dilaton in baryons is $424.1\ \mathrm{MeV}$. The energy of the condensates/dilatons composed of tachyons and entanglons that appeared during the inflation is the VEV (the vacuum expectation value) [10].

Consider a point on surface of a radion/ring. Assume that a string is the trajectory of the point. Since the components of a radion rotate and are moving along the circle that is the compactification of the radion, in addition to travelling along the radion, the string wraps around the radion. The winding number m is equal to number of times the string winds around the circular radion with radius, say, R_{radion}. The internal momentum of the radion is

$$p = M v = n \hbar / R_{radion}, \tag{2}$$

where n is some integer and denotes the momentum modes. As we said, a torus is the simplest example of a Calabi-Yau manifold. A realistic torus we can divide into longitudinal circles of the same radius. T-duality acting on the longitudinal circles changes their radii from R_{wind} to $1/R_{wind}$ and simultaneously interchanges the momentum modes and winding modes. It is assumed that T-duality exchanges a large distance scale with a small distance scale i.e. changes spacetime geometry. But the different string theories described within the SST show that such transformations are not realized by Nature and that such compactification of extra degrees of freedom must lead to incomplete theories. In SST, the radii of the longitudinal circles are defined as follows

$$r_d = r_1 K^{d-1} / 2, \tag{3}$$

where r_1 is the radius of the fundamental closed string, K^2 is number of tachyons in the closed string whereas $d = 1, 2, 4, 8$. On the other hand, the radii of radions are two times bigger than the corresponding longitudinal circles.

In SST, due to the spin-1 signature of the spacetime, for single radions is $n = 1$, $m << n$ and $R_{wind} << R_{radion}$ so string length is close to the circumference of the radion, whereas for the fundamental tori is $n = 1/2$, $m << n$ and $R_{wind} = R_{radion} / 2$ – it leads to conclusion that string length is close to the mean circumference of torus. It means that for both radions and tori the square of string length divided by corresponding radius of a radion or by corresponding mean radius of a torus is close to 1 so the T-duality in SST is trivial. The same concerns the unitary duality (U-duality) which combines S-duality and T-duality.

8. Summary

Here we proved that the Scale-Symmetric Theory is the realistic/unique string theory.

Due to the new symmetries (i.e. the four-particle symmetry and the saturation of interactions of the superluminal entanglons), the infinitesimal spin of tachyons, and preserving the spin-1 signature of spacetime, there appeared the succeeding phase transitions of the superluminal non-gravitating Higgs field that existence follows from GR.

During the inflation, there were produced objects with 10- (superluminal entanglons) and 26 degrees of freedom (the Einstein-spacetime components i.e. the neutrino-antineutrino pairs, and neutrinos). The luminal gravitating Einstein spacetime stopped the inflation.

The Higgs mechanism took place during the inflation and transformed partially the Higgs field into the neutrinos and neutrino-antineutrino pairs (the stable neutrinos are the lightest gravitational masses).

In the Einstein spacetime can be created the 58- (the cores of baryons and bare charged leptons) and 122-degrees-of-freedom (the cores of the protoworlds) objects.

The 5-degrees-of-freedom compactifications of the 26-, 58- and 122-degrees-of-freedom objects consist of three fields i.e. there is a spin-1/2 torus/charge/fermion, a spin-0 two-circles/pair-of-radions/boson and a spin-0 ball/dilaton/scalar. When velocity of baryons increases then mass of radion decreases (it leads to the running coupling for the strong interactions [1A]), whereas mass of torus and mass and volume of dilaton increase. The charge-radion symmetry is the realistic fermion-boson supersymmetry. The superpartners postulated in the mainstream string theory are not in existence.

In the Scale-Symmetric Theory appear following theories: the Type T theory of tachyonic Higgs field, Type S bosonic string theory of superluminal entanglons, Type E supersymmetric theory of the Einstein-spacetime components and neutrinos, Type B supersymmetric theory of baryons, mesons and charged leptons, and the Type C supersymmetric theory of fundamental cosmological structures.

SST shows that due to the very simple structure of the 10-degrees-of-freedom object, the non-unique 11-dimensional superstring M-theory cannot be realized by Nature.

In unique string theory, pure dualities should not appear. Due to the succeeding phase transitions, in the SST string theory there appears the approximate self-similar duality (SS-duality) – i.e. we can apply the same methods to self-similar shapes.

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