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

Sylwester Kornowski

Abstract: Here we show that the Scale-Symmetric Physics (S-SP) is the realistic/unique String Theory realized by Nature - S-SP starts from 7 parameters only (there do not appear free parameters) and 3 very simple formulae that follow from new symmetries. We present the realistic interpretation of the different string theories, of the compactification of the higher degrees of freedom, new fermion-boson supersymmetry, of new SS-duality concerning shapes (a self-similar duality), of 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), of radions and dilatons. There appear following spacetime objects: the luminal 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 tachyons carrying infinitesimal imaginary spin (existence of such tachyons results from General Relativity; the gravitational fields consist of them). There as well appear the 58- and 122-degrees-of-freedom stable objects composed of the luminal 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 tachyonic Higgs field.

1. Introduction

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? Maybe due to the inflation, the QM and classical GR have been

permanently separated and we cannot unify them within the same methods? Maybe, as it is in the Scale-Symmetric Physics (S-SP) [1], we can only describe why during the inflation these theories were irreversibly split [2]?

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 of MST that leads to physical constants, to coherent and complete mechanism for cosmological inflation, to all properties of particles (for example, we still cannot calculate mass and spin of proton with required accuracy), to curved but practically flat spacetime, or to the origin of dark matter. Why? How we should modify MST to obtain the realistic/unique string theory? And S-SP 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 S-SP shows that only size of them about 10^{29} times smaller than the Planck length leads to a thousand theoretical results consistent or very close to the most important experimental results. Just MST does not start from initial cosmological conditions.

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

The very simple thermodynamics of the tachyonic liquid and its evolution lead to new symmetries. They are as follows.

1.

Due to defined dynamic viscosity of tachyons (which have infinitesimal imaginary spin) and their non-gravitating mass density, there appear only superluminal closed strings composed of tachyons with strictly defined radius (it 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 damp the turbulences in the expanding tachyonic field, 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, 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 are the signature of spacetime. Entanglons are the 10-degrees-of-freedom spacetime objects (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 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.

We can see that described here the four-particle symmetry conserves the resultant internal helicity and resultant spin of spacetime or a field and damps turbulences.

2.

In MST, the fundamental phenomena are the vibrations of the open or closed strings with size close to the Planck length. In S-SP 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 jets overlapping with the direction of spin of the entanglon, and two tachyonic vortices with radius R that is the radius of single closed string. The two vortices can transform into one spin-1 vortex with no internal helicity and next can open fixing the $4\pi R$ distance between interacting entanglons. When the vortices do not unite then the fixed distance is $2\pi R$. 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 $3\pi R$ and all spins of entanglons were parallel (the calculated mean distance leads to the mass of the torus of neutrino).

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 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 collide with the chaotically moving tachyons in the tachyonic spacetime (in the tachyonic non-gravitating Higgs field). Due to the collisions, there is produced around the fundamental torus a gradient in the tachyonic spacetime – it is the gravitational field (within S-SP as well is described the mechanism of emission of gravitational potential energy [6]). Described here mechanism is the Higgs mechanism which transforms the non-gravitating spacetime objects into the smallest/fundamental gravitating spacetime objects [7]. But it is not the whole story. The free 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 exchanges of the entanglons. Due to the tachyonic jets, there appears a circular condensate inside the torus (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) and the spin-0 central condensate/scalar composed of entanglons as well (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 luminal neutrino-antineutrino pairs. Such pairs are the components of the luminal Einstein spacetime and they are the 26-degrees-of-freedom spacetime objects. There are produced surfaces composed of the Einstein-spacetime components but they are stable due to the two shortest-distance quantum entanglement. Due to the weak interactions, there can appear free neutrinos i.e. fermions. Notice as well that due to the two internal helicities of an entanglon, the tachyonic field between interacting entanglons has lowered pressure that additionally stabilizes the torus of neutrinos. Also the produced jets, due to the curvature of surface of the closed strings, create lowered pressure between entanglons on the surface of the neutrino torus. It all causes that neutrinos are the very stable objects.

Due to the saturation of interactions of the entanglons via tachyonic spacetime, 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 protoworlds) which lead to new cosmology and to the origin of the dark matter and dark energy.

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

The GR shows that there must be in existence non-gravitating tachyons. On the other hand, the S-SP shows that the 10-degrees-of-freedom entanglons have very simple structure (it follows from the very simple thermodynamics of the tachyonic liquid [1]) so in the 10-degrees-of-freedom spacetime (so in the 10-dimensional spacetime as well) 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). We can see that the supersymmetric M-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 x E_8, Type IIA and Type IIB) with M-theory which at low energy regime leads to the 11-dimensional supergravity.

The S-SP shows that gravity is directly associated with the gravitational fields produced by the luminal Einstein-spacetime components and neutrinos – it is the classical theory because the tachyons are the classical objects. On the other hand, 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, 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 tachyonic field.

The Scale-Symmetric Physics starts from the Higgs field composed of the non-gravitating tachyons and 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 irreversibly trapped – there appeared the binary systems of them i.e. the superluminal entanglons that are the bosons).

In S-SP, to construct models of gravitationally massless or massive particles, we begin by specifying the shapes and properties of the spacetime objects. They are the 6-degrees-of-freedom tachyons, the 10-degrees-of-freedom superluminal entanglons and the 26-degrees-of-freedom luminal Einstein-spacetime components [8]. In S-SP, there is only one unique composition of spacetime instead of about 10^{500} different vacuum states for superstring theory. A natural anthropic explanation is the nonsensical idea (I believe in God).

The new symmetries which appear in the S-SP lead to the succeeding phase transitions of the tachyonic field. Due to the phase transitions, we obtain different scales of sizes, energies and speeds. We obtain five scales i.e. the Higgs-field-component superluminal scale associated with gravitational fields, the quantum-entanglement superluminal scale associated

with QM, the luminal Planck scale associated with the luminal Einstein-spacetime components (it concerns the internal structure and properties of neutrinos), the baryonic scale that leads to the atom-like structure of baryons (it leads to the internal structure and properties of mesons and charged leptons as well), and the cosmological scale that leads to the origin of the dark matter and dark energy and to the expanding Universe.

The S-SP starts from 7 parameters and 3 very simple formulae only and is free from approximations, mathematical tricks and free parameters i.e. it is the unique theory. Within such a theory, I calculated a thousand results which are consistent or very close to experimental data.

4. General Relativity leads to non-gravitating tachyons

Within GR we obtain formula for the total energy of particles that inertial mass is equal to their gravitational mass (the Principle-of-Equivalence objects). 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 gas composed of the non-gravitating pieces of space is

$$E = m\,c^2 / \mathrm{sqrt}(v^2 / c^2 - 1). \qquad (1)$$

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 gas composed of non-gravitating tachyons I refer to as the modified 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).

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 equal to the range of the strong interactions; both radions in a pair have internal helicity the same as 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 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 and free parameters. And the MST does not solve correctly the problem.

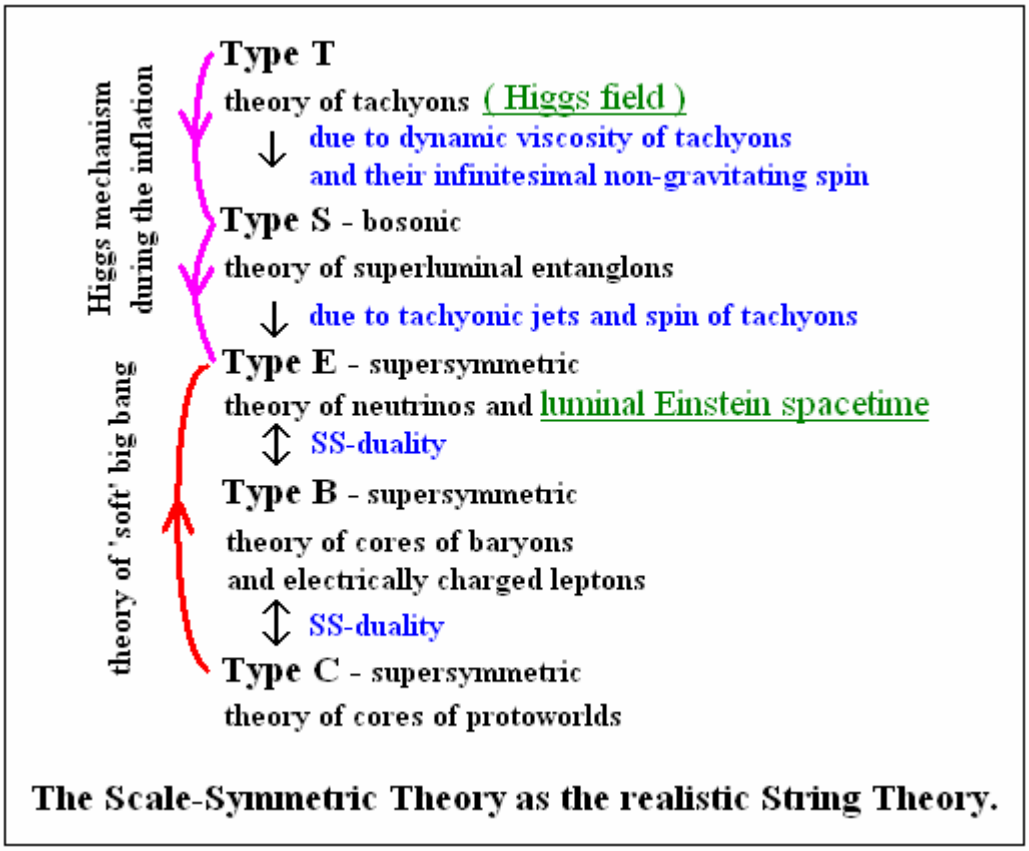
Notice that the torus/fermion and the circle(s)/boson lead to the fermion-boson supersymmetry but this supersymmetry is not associated with the 10-degrees-of-freedom spacetime objects – the fermion-boson supersymmetry concerns the much more complex spacetime composed of the 6-, 10- and 26-degrees-of-freedom spacetime objects.

The open radions produced by the core of baryons cause that the strong field has internal helicity so the same carriers of gluons and photons (i.e. the Einstein-spacetime components), which have three different internal helicities, behave in strong fields in different way than in electromagnetic field which has not internal helicity (there are 8 types of gluons and only one of photons).

6. The realistic interpretation of the different string theories

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

Type S (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) spacetime objects. Typical size is about 10^{-45} m. Resultant internal helicity is zero. There do not appear open strings/radions.



The Scale-Symmetric Theory as the realistic String Theory.

Type E superstring theory is the theory of the **E**instein-spacetime components and neutrinos – it contains the 26-degrees-of-freedom spacetime 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. Here appear open strings/radions.

Type B superstring theory is the theory of the cores of **B**aryons – it contains the same spacetime 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 as well. Here appear open radions composed of entangled and rotating carriers of gluons and photons.

Type C (Cosmological) superstring theory is the theory of the fundamental cosmological structures (protoworlds) – it contains the same spacetime 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 left-handed Protoworld carrying the half-integral spin. Evolution of the protoworlds leads to the dark matter and dark energy. The very early Universe was the closed radion.

The Higgs mechanism was valid during the inflation and it is the mechanism which partially transformed the tachyonic Higgs field into the luminal Einstein spacetime i.e. into the gas composed of the neutrino-antineutrino pairs [7], [10]. Due to the Higgs mechanism and regions in the Einstein spacetime with higher gravitational pressure than the dynamic pressure, the inflation had been stopped [11].

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

The Scale-Symmetric Physics, 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 S-SP 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 Physics 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 S-ST 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 S-ST, 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 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 S-SP show that such transformations are not realized by Nature and that such compactification of extra degrees of freedom must lead to incomplete theories. In S-SP, 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 S-SP, 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 S-SP 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 Physics 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 binary systems of closed strings (entanglons), the infinitesimal spin of tachyons and preserving the spin-1 signature of spacetime, there appeared the succeeding phase transitions of the non-gravitating tachyonic Higgs field that existence follows from General Relativity.

During the inflation, there were produced spacetime objects with 6- (tachyons), 10- (superluminal entanglons) and 26 degrees of freedom (the luminal Einstein-spacetime components i.e. the neutrino-antineutrino pairs). The luminal Einstein spacetime stopped the inflation.

The Higgs mechanism took place during the inflation and transformed partially the non-gravitating tachyonic Higgs field into the neutrinos i.e. into the smallest gravitational masses.

Since the end of the inflation, there can be created the 58- (the cores of baryons and bare charged leptons) and 122-degrees-of-freedom (the cores of the fundamental cosmological objects i.e. 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 [12]), 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 Physics 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.

S-SP shows that due to the very simple structure of the 10-degrees-of-freedom spacetime 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 S-SP string theory, there appears the approximate duality (i.e. we can apply the same methods to self-similar shapes) concerning similar shapes i.e. the self-similar duality (SS-duality).

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