CPT Symmetry and Symmetry-Breaking in the Scale-Symmetric Theory

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Abstract: During the inflation, to eliminate turbulences in the created spacetime, there appeared the four-fermion/quadrupole symmetry. It caused that the two-component spacetime (the non-gravitating Higgs field plus luminal Einstein spacetime) is globally perfectly symmetrical. Here we described physical meaning of the fundamental symmetries. The CPT symmetry is incomplete so wrongly understood. Symmetry-breaking is characteristic for the components of the quadrupoles because of their internal helicity. The matter-antimatter asymmetry is due to the fourth phase transition of the Higgs field, not due to a CPT-symmetry violation. Here, applying the Scale-Symmetric Theory, we calculated the decay-rate asymmetry for decays of the kaon-long (0.003346) and B mesons (0.7126). These results are close to experimental data. The C, P and T violations follow from the fact that inside the bare fermions there is a torus with internal helicity and that such tori (and loops) produce the weak half-jets in the two-component spacetime and fields. The half-jets are very weak so the asymmetry is very small as well. Due to these half-jets, there appears an asymmetry between parallel and antiparallel orientation of spin and velocity of fermions and their antiparticles (there is more fermions with parallel orientation and more antifermions with antiparallel orientation). But there is the second reason of asymmetries: simultaneously with creation of the dark matter (it can have a residual left-handed internal helicity) there appeared in our Universe the additional electron-antineutrinos that have the left-handed internal helicity so symmetry of the Einstein spacetime inside the Universe is not perfect. We as well motivate why the nuclear strong interactions are CP-invariant.

1. Introduction

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 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 that evolution leads to the dark matter, dark energy and expanding universes [1A], [1B].

The non-gravitating tachyons have infinitesimal spin so all listed structures have internal helicity (helicities) which distinguishes particles from their antiparticles [1A]. **Torus (a physical loop is a thin torus) is the simplest object that can have internal helicity.**

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. Cosmoses composed of universes are created because of collisions of big pieces of space. During the inflation, the liquid-like inflation field transformed partially into the luminal Einstein spacetime. In our Cosmos, the two-component spacetime is surrounded by timeless wall – it causes that the fundamental constants are invariant [1A].

The Principle-of-Equivalence particles consist of the entangled and/or confined neutrino-antineutrino pairs and/or neutrinos.

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 coupling constant for the two shortest-distance quantum entanglement is very big (about $3{\cdot}10^{92}$) so the core of the baryons is practically indestructible [1A].

During the inflation, to eliminate turbulences in the created spacetime, there appeared the four-fermion/quadrupole symmetry [1A]. It caused that the two-component spacetime (the non-gravitating Higgs field plus luminal Einstein spacetime) is globally perfectly symmetrical.

Here we described physical meaning of the fundamental symmetries. The CPT symmetry is incomplete so wrongly understood. Symmetry-breaking is characteristic for the components of the quadrupoles because of their internal helicity. The matter-antimatter asymmetry is due to the fourth phase transition of the Higgs field, not due to a CPT-symmetry violation.

Here, applying the Scale-Symmetric Theory, we calculated the decay-rate asymmetry for decays of the $K^o{}_L$ and B mesons.

We motivate that the C, P and T violations follow from the fact that inside the bare fermions there is a torus with internal helicity and that such tori (and loops) produce the weak half-jets in the two-component spacetime. The half-jets are very weak so the asymmetry is very weak as well. Due to these half-jets, there appears a weak asymmetry between parallel and antiparallel orientation of spin and velocity of fermions and their antiparticles (there is more fermions with parallel orientation and more antifermions with antiparallel orientation).

But there is the second reason of asymmetries. Simultaneously with creation of the dark matter (it can have a residual left-handed internal helicity) there appeared in our Universe the additional electron-antineutrinos that have the left-handed internal helicity so symmetry of the Einstein spacetime inside the Universe (the Cosmos consists of universes [1B]) is not perfect.

We as well motivate why the nuclear strong interactions are CP-invariant.

2. The fundamental symmetries

The succeeding phase transitions of the superluminal non-gravitating Higgs field lead to the internal structure of the tori/charges inside the half-integral-spin bare fermions/objects [1A].

Such structure does not appear in the mainstream theories and it is the main reason that they are such messy i.e. to obtain theoretical results consistent with experimental data we must apply many approximations, mathematical tricks and tens of free parameters that origin is unknown.

SST shows that the tori/charges produce the central scalar condensate but because of the zero-spin of the condensates, we can neglect them in our considerations concerning the CPT symmetry (C means charge conjugation, P means parity and T means time reversal).

SST shows that a torus/charge consists of the next smaller tori/charges and that all the spins of the smaller tori/charges point the interior of the torus/charge (fermion) or all the spins point the exterior (antifermion). Emphasize as well that the spins of the smaller tori/charges are perpendicular to surface of the torus/charge.

The internal helicity of a torus and the dynamic viscosity of the non-gravitating tachyons all particles and fields consist of cause that tori produce the weak half-jets in the two-component spacetime and fields – the half-jets decouple from the tori on their internal equator [1A].

2.1

Invariance-symmetry: translation in time; conserved quantity: energy

It follows from the fact that both the mean kinetic energy of free and bound tachyons and their mean rotational energy cannot change with time because of the timeless boundary of the Cosmos. The invariance of the initial conditions for the present-day Cosmos leads to the law of conservation of energy. We can define the universal unit of time as the mean time between the collisions of the all free tachyons. Such global unit of time is invariant. Local units of time, due to the gravitational fields, can vary. In stronger gravitational field, the Higgs field is more “stretched” so time is going slower. But due to the tremendous pressure in the Higgs field (in approximation 10^{180} Pa [1A]) and constancy of the volume of this field as a whole, the state of the Higgs field does not change under the translation in time.

2.2

Invariance-symmetry: translation in space; conserved quantity: linear momentum

Due to the elastic collisions of the tachyons with the timeless wall, the mean linear speed of all tachyons is invariant. The same concerns the mean volume of tachyons that is directly proportional to their mean inertial mass. From it follows the invariance of the product of the mean inertial mass and mean speed i.e. the invariance of linear momentum.

2.3

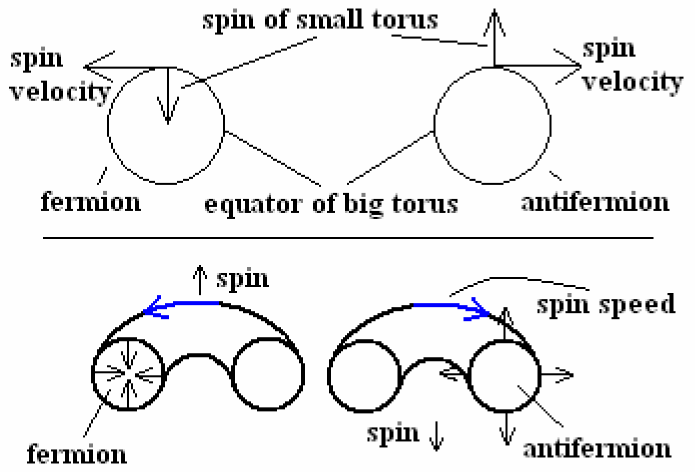
Invariance-symmetry: rotation in space; conserved quantity: angular momentum

The mean size of the tachyons and their mean angular velocity are invariant so the product of the mean inertial-mass of tachyons, their mean spin speed and mean radius, i.e. their mean angular momentum, is invariant.

2.4

Invariance-symmetry: charge conjugation (C); conserved quantity: charge parity

This symmetry is wrongly understood. Due to the second phase transition, there appeared the weak charges of neutrinos, whereas due to third phase transition, there appear the negative and positive electric charges [1A]. To change a negative charge into positive charge we must to turn the directions of the local smaller tori a torus consists of by an angle of 180^{o} in the planes defined by spin and spin velocity of the smaller tori. It leads to conclusion that the charge conjugation (C) is equivalent to the spin reversal (S) of the torus i.e. $C = S$ (see Fig.).

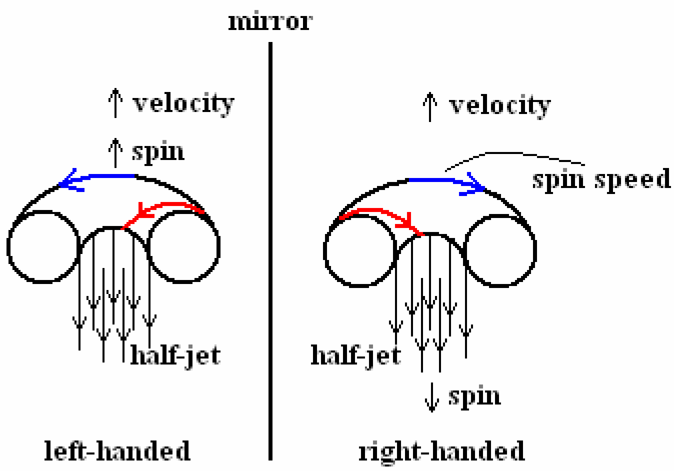


Charge conjugation (C) changes spin (S) i.e. C=S

2.5

Invariance-symmetry: coordinate inversion (*P*); conserved quantity: spatial parity

This symmetry is wrongly understood. Under the mirror-reflection inversion of a torus with internal helicity there changes the direction of spin of the torus (*S*) and its internal helicity (*H*). It leads to conclusion that the parity (*P*) is equivalent to the simultaneous spin reversal (*S*) and internal-helicity reversal (*H*) of the torus i.e. $P = SH$ (see Fig.).

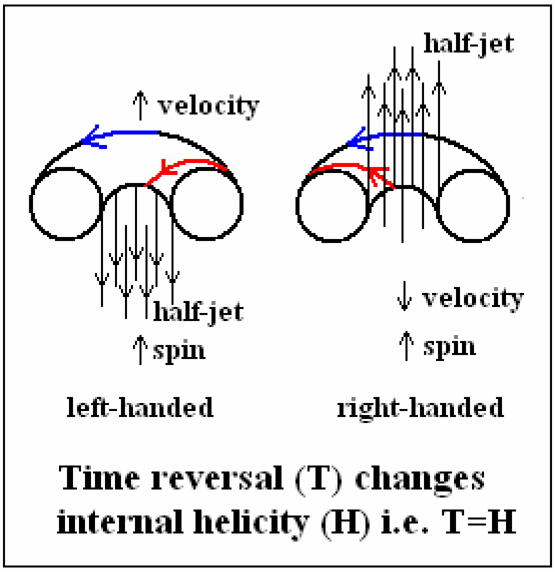


Parity (P) changes spin (S) and internal helicity (H) i.e. P=SH

2.6

Invariance-symmetry: time reversal (*T*); conserved quantity: time parity

This symmetry is wrongly understood. Due to the internal helicity of loops and tori and dynamic viscosity of the non-gravitating tachyons all particles and fields consist of, the fermions produce very weak half-jets in the two-component spacetime and fields in which the fermion is embedded. The very weak half-jets cause that more fermions is moving in direction antiparallel to the half-jet but symmetry is almost perfect. To change direction of motion of a fermion, we must change direction of the half-jet. To do it we must change internal helicity (H) of the torus. Since time reversal (T) means the change in direction of motion of the fermion so the time reversal (T) is equivalent to the internal-helicity reversal (H) of the torus i.e. $T = H$. (see Fig.).



2.7
Invariance-symmetry: CPT; conserved quantity: product of parities

This symmetry is wrongly understood. From points **2.4**, **2.5** and **2.6** follows that there is satisfied following formula for a fermion and its antifermion

$$CPT = S\,SH\,H = S^2\,H^2 = 1^2\,1^2 = (-1)^2\,(-1)^2 = 1 \text{ (always)}. \tag{1}$$

This means that symmetry-breaking of a system composed of fermion-antifermion pairs is impossible. The observed in our Universe the baryon-antibaryon asymmetry does not follow from a CPT-symmetry violation. Asymmetry follows from creation in the Einstein spacetime the cosmic vortices with internal helicity. Such vortices transform into expanding universes with the baryon-antibaryon asymmetry [1A]. The phenomena in the left-handed vortices cause that there appear the proton-electron pairs whereas in the right-handed vortices cause that there appear the antiproton-positron pairs [1A], [1B].

Notice that there can be in existence fermions with right internal helicity and antifermions with left internal helicity so there appears the 4-stable-neutrino symmetry (quadrupole symmetry). SST shows that the tau-neutrino is unstable and is built of 3 different stable neutrinos [1A]. Neutrinos were produced during the inflation so to eliminate turbulences they were produced as the groups of four stable neutrinos so the CPT symmetry was unconditional.

Notice that in our Universe there were produced the left-handed protons and right-handed electrons (positrons are left-handed), [1B], so there can be created the electron-positron pairs.

3. The decay-rate asymmetry

The half-jets, which are very weak, cause that there appears a little more fermions that prefer the parallel orientation of their spin and velocity, and a little more antifermions that prefer the antiparallel orientation. This causes that there is the lack of an exact T-symmetry (or of an exact CP-symmetry) but departure of a perfect symmetry is insignificant.

Notice as well that the Protoworld, which transformed into the dark matter, was left-handed [1B]. It suggests that there can be in existence some residual left-handed twisting of the dark matter. More detailed considerations show that the Protoworld (so the residual left-handed dark matter as well) was an analog to the electron-antineutrino [1A]. Moreover, due to the core-of-Protoworld→electron-antineutrino transition, inside our expanding Universe there appeared additional electron-antineutrinos (from the beta decays) which have the left-handed internal helicity [1B]. It causes that the positively charged pions in the K-Long kaons, $K^o{}_L$, decay more frequently than the negatively charged pions (the binding energy of such pions is a little lower because the positrons behave similar to the core of the Protoworld)

$$K^o{}_L \rightarrow \pi^- \ e^+ \ \nu_e \ \textit{(more often)}, \tag{2a}$$

$$K^o{}_L \rightarrow \pi^+ \ e^- \ \nu_{e,anti} \ \textit{(less often)}. \tag{2b}$$

According to SST, loops having internal helicity can transform into torus with internal helicity plus a central scalar condensate [1A]. On the other hand, the succeeding phase transitions of the superluminal non-gravitating Higgs field lead to internal structure of the tori/charges inside the bare fermions.

According to SST, the coupling constant for the weak nuclear interactions of a condensate composed of the neutrino-antineutrino pairs is directly proportional to squared mass of the condensate [1A]. On the other hand, the decay-rate asymmetry, R_{DA}, should be directly proportional to mass/energy.

Loops and tori with internal helicity produce a half-jet. The decay-rate asymmetry, R_{DA}, should be maximum, i.e. equal to 1, for the large loops responsible for the strong nuclear interactions which are produced inside the core of baryons [1A]. It follows from the fact that spin speed for such loops is equal to the speed of light in “vacuum” c so their coupling constant for the strong nuclear interactions is $\alpha_{LL,strong} = v/c = 1$ [1A].

The above remarks show that in SST, the decay-rate asymmetry, R_{DA}, is defined as follows

$$R_{DA} = sqrt(\alpha_{Weak} / \alpha_{LL,strong}) = sqrt\ (\alpha_{Weak}). \tag{3}$$

According to SST, the coupling constant for the weak interactions of the electrons with protons (notice that the Kaon-Long, $K^o{}_L$, appears in the nuclear interactions and that in its decay appears electron/positron) is $\alpha_{Weak(proton-electron)} = 1.1194583 \cdot 10^{-5}$. Applying formula (3), for the decays of $K^o{}_L$, we obtain that the decay-rate asymmetry should be

$$R_{DA,K\text{-}Long} = sqrt(\alpha_{Weak(proton-electron)}) = 3.346 \cdot 10^{-3}. \tag{4}$$

This value is close to experimental data [3].

According to SST, the bottom quarks are created from the loops overlapping with the $d = 4$ Titius-Bode orbit [1A]. Spin speed of pions on this orbit is $v = 0.5078c$ so the coupling constant for the bottom quark is $\alpha_{b\text{-}quark} = v/c = 0.5078$. On the other hand, the B mesons can contain bottom quark so applying formula (3), for the decays of the B mesons, we obtain that the decay-rate asymmetry should be

$$R_{DA,B\text{-}meson} = sqrt(\alpha_{B\text{-}meson}) = 0.7126. \quad (5)$$

This value is close to experimental data also [3].

Why are the nuclear strong interactions CP-invariant? SST shows that each neutral pion, which is responsible for the nuclear strong interactions of baryons, is composed of two left-handed large loops with antiparallel unitary spins so neutral pion produces simultaneously two antiparallel half-jets so the velocity-spin asymmetry does not appear for pions and antipions. On the other hand, there are natural terms in the QCD Lagrangian that are able to break the CP-symmetry so, contrary to SST, in the mainstream QCD there appears the strong CP problem.

4. Summary

During the inflation, to eliminate turbulences in the created spacetime, there appeared the four-fermion/quadrupole symmetry. It caused that the two-component spacetime (the non-gravitating Higgs field plus luminal Einstein spacetime) is globally perfectly symmetrical. Here we described physical meaning of the fundamental symmetries. The CPT symmetry is incomplete so wrongly understood. Symmetry-breaking is characteristic for the components of the quadrupoles because of their internal helicity. The matter-antimatter asymmetry is due to the fourth phase transition of the Higgs field, not due to a CPT-symmetry violation.

Here, applying the Scale-Symmetric Theory, we described the origin of the T (or CP) violation and calculated the decay-rate asymmetry for decays of the K-Long, K^o_L (0.00335) and B mesons (0.7126). These results are close to experimental data.

The C, P and T violations follow from the fact that inside the bare fermions there is a torus with internal helicity and that such tori (and loops) produce the weak half-jets in the two-component spacetime. The half-jets are very weak so the asymmetry is very weak as well. Due to these half-jets, there appears a weak asymmetry between parallel and antiparallel orientation of spin and velocity of fermions and their antiparticles (there is more fermions with parallel orientation and more antifermions with antiparallel orientation).

But there is the second reason of asymmetries: simultaneously with creation of the dark matter (it can have a residual left-handed internal helicity) there appeared in our Universe the additional electron-antineutrinos that have the left-handed internal helicity so symmetry of the Einstein spacetime inside the Universe is not perfect.

We as well motivated why the nuclear strong interactions are CP-invariant. It results from the fact that each neutral pion, which is responsible for the nuclear strong interactions of baryons, produces simultaneously two antiparallel half-jets so the velocity-spin asymmetry does not appear.

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