The Correct Theory of Electroweak Interaction

Sylwester Kornowski

Abstract: This is a review paper on electroweak (EW) interaction. Here we compared the orthodox EW theory with the EW theory described in the Scale-Symmetric Theory (SST). We showed the true origin of the three mechanisms by which neutrinos and scalar and vector bosons/condensates acquire their gravitational mass. We calculated the surplus of baryonic matter from the properties of the inflation field and densities of fields. We present the EW equation that leads to the atom-like structure of baryons and we raise many other key issues on the basis of earlier scientific papers.

1. Introduction

In the orthodox particle physics, the electroweak (EW) interaction is the unified description of electroweak and weak interactions [1]. There appears the unification energy ~246 GeV, i.e. the vacuum expectation value (VEV). In the Standard Model (SM), the carriers of electromagnetic and weak interactions, i.e. the photon γ and the $W^{\pm}$ and Z bosons, are produced by the spontaneous symmetry breaking of the electroweak symmetry caused by the Higgs mechanism. The symmetry breaking is due to an abstract rotation in the (W_3, B) vector boson plane by the Weinberg angle Θ_w, where W_3 and B are vector bosons which coalesce into the massive Z boson and the massless photon γ. Such a model leads to the formula which ties the masses of the $W^{\pm}$ and Z bosons

$$Z = W^{\pm} / \cos\Theta_w . \quad (1)$$

Spontaneous symmetry breaking is a spontaneous process which does not concern the Lagrangian (or the equation of motion) but the lowest-energy vacuum solutions i.e. the vacuum solutions do not exhibit the same symmetry.

The broken symmetry leads to the spin-0 massless Goldstone bosons [2] which are not discovered so it was a problem in the SM EW theory. But an exception was found for local symmetry in which, in contrast to global symmetry, Goldstone bosons do not occur. Instead, there vector particles appear with zero helicity that have a mass matrix.

In the Scale-Symmetric Theory (SST), the description of the EW interactions is completely different, more complete and more accurate.

The phase transitions of the SST inflation field lead to the atom-like structure of baryons [3] and to new cosmology [4]. Hadrons and electrically charged leptons consist of the Einstein-spacetime (ES) components i.e. of the neutrino-antineutrino pairs with invariant mass and speed equal to the speed of light in "vacuum" c i.e., due to the internal structure of neutrinos and of the two-component spacetime (the SST Higgs field plus ES), the Special Theory of Relativity (SR) does not concern the neutrino-antineutrino pairs [3].

There are three species of neutrinos. Masses of the electron- and muon-neutrino are the same whereas mass of tau-neutrino is three times higher (tau-neutrino is the electron-neutrino-type neutrino) [5].

The torus in the bare fermions and in the core of baryons (bare particle = torus plus central condensate) have internal helicity (it is not the orthodox external helicity) so interactions of neutrinos and antineutrinos with bare fermions are different – it leads to the Weinberg angle [6].

In SST, the $W^{\pm}$ and Z bosons are the composite particles [7] and they are not responsible for the weak interactions at lower energies. For the weak interactions are responsible the spin-0 ES virtual condensates (their total mass is equal to zero) so they are the Goldstone bosons. Such bosons, when interact with electromagnetic energy, can be the real particles as well as the Higgs boson or can be dressed in the fundamental leptonic pairs i.e. $(e^+e^-)_{bare}$ (the neutral electron-positron pair with a mass of $(e^+e^-)_{bare} = 1.020814$ MeV; $e^-_{bare} = e^- / (1 + a)$, where a is the radiation/anomalous-mass coefficient $a = 0.0011596522$ [8]) or dressed in $e^+_{bare}\nu_e$ or $e^-_{bare}\nu_{e,anti}$. It causes that in SST, the one of the three definitions of the Weinberg angle [6] is

$$\sin^2\Theta_w = (e^+e^-)_{bare} / \Delta\pi^{\pm} = 0.22223(3) , \qquad (2)$$

i.e. $\Theta_w = 28.13^o$ and $\Delta\pi^{\pm}$ is the mass distance between the charged and neutral pion [8].

We can see that in SST, for the weak interactions are responsible the massive scalar ES condensates which can absorb a spin-1 leptonic pair.

Here, we use the Particle Data Group (PDG) data available at website [8]. If any quantity occurs only in SST or differs from the PDG data, it is exposed in this paper.

In SST, there does not appear a VEV because the SST unification of electromagnetic and weak interactions is valid all the time. It follows from the fact that the carriers of photons and gluons (i.e. the neutrino-antineutrino pairs), when rotate, decrease pressure in ES around them so the ES around photons and gluons is thickened – such spin-0 thickened ES can interact weakly so the system as a whole (i.e. photon/gluon plus ES condensate) interacts electromagnetically and weakly. Moreover, there is valid the Einstein formula $E = mc^2$, where $E = hf$ (f is frequency) while m is the mass of the ES condensate.

Here we showed the true origin of the three mechanisms by which neutrinos and scalar and vector bosons/condensates acquire their gravitational mass. We calculated also the surplus of baryonic matter (the matter-antimatter asymmetry) from the properties of the inflation field and densities of fields. We present the SST EW equation that leads to the atom-like structure of baryons as well.

2. The three mechanisms by which the neutrinos and scalar and vector bosons (condensates) acquire their gravitational mass

The tachyons are the structureless objects so they cannot emit some particles i.e. they are the perfectly bare particles with infinitesimal spin. It means that they have only the inertial mass so such physics is beyond both the General Theory of Relativity and Standard Model.

We need the phase transitions of the initial inflation field (it is the main part of the Scale-Symmetric Theory) to explain in a simple way why the neutrinos and scalar and vector ES condensates acquire their gravitational mass. Such scale symmetric phase transitions do not appear in the Standard Model and the General Theory of Relativity. We can not decipher the three phenomena applying the Standard Model methods i.e. via considering symmetries of the Lagrangians. We need the SST phase transitions also to show that monopoles are the very, very unstable objects.

We try to show that Nature "applies" very simple mathematics to behave as it behaves.

2.1 How do the neutrinos acquire their mass?

According to SST the initial inflation field composed of the non-gravitating balls, as a whole, had left-handed internal helicity and superluminal speed so during a collision the balls "transformed" into non-gravitating tachyons with linear and rotational energies. To obtain correct results, we must assume that the mean linear speed of the SST tachyons v_t and the mean spin speed on their equators v_{st} are $v_t = 2.386343972 \cdot 10^{97}$ m/s and $v_{st} = 1.725741 \cdot 10^{70}$ m/s [3].

At the end of the SST inflation, density of the survival of the inflation field $\rho_{N(HF)}$ (of the Higgs field) was and still is $\rho_{N(HF)} = 2.645834 \cdot 10^{-15}$ kg m^{-3} [3] – it is because of the stable boundary of our Cosmos which has radius about 10,000 times bigger than the present-day Universe [4].

Most of the inflation field transformed into the spin-1 superluminal binary systems of closed strings (entanglons) which are responsible for the quantum entanglement [3]. Their poloidal speed is equal to v_{st} while the toroidal speed is very close to v_t [3]. During the SST inflation, all entanglons had been frozen inside the neutrinos the neutrino-antineutrino pairs consist of – the entanglons can be only exchanged between the ES components or/and neutrinos.

The internal helicity of closed string resulting from the infinitesimal spin of the tachyons and their viscosity, $\eta_t = 1.87516465 \cdot 10^{138}$ kg m^{-1} s^{-1} [3], means that the entanglons a neutrino consists of transform, outside the neutrino, the chaotic motions of tachyons into divergently moving tachyons. The direct collisions of divergently moving tachyons with tachyons the Higgs field consists of produce a gradient in this field. The gravitational constant, G, results from behaviour of all closed strings a neutrino consists of. Because the constants of interactions are directly proportional to the mass densities of fields carrying the interactions then the G we can calculate from following formula

$$G = g\, \rho_{N(HF)} = 6.6740007 \cdot 10^{-11}\ \text{m}^3/(\text{kg s}^2), \tag{3}$$

where the g has the same value for all interactions and is equal to

$$g = v_{st}^{\,4} / \eta_t^{\,2} = 25{,}224.563\ \text{m}^6/(\text{kg}^2\ \text{s}^2)\ . \tag{4}$$

Notice that the gravitational constant strongly depends on the mean spin speed of the tachyons which is equal to the poloidal speed of the closed strings the entanglons consist of.

We can see that masses of the electron- and muon-neutrinos are the smallest gravitational masses. Such is the mechanism which causes that neutrinos (so the ES components as well) acquire their masses.

Emphasize that within the Standard Model we can not explain how neutrinos acquire their mass.

2.2 How do the scalar and vector bosons/condensates acquire their mass?

In this Paragraph we describe the SST analog to the orthodox Higgs mechanism i.e. we will describe the phenomenon which causes that the ES condensates are meta-stable.

The Einstein spacetime is flat and its mass density is $\rho_{ES} = 1.10220055 \cdot 10^{28}$ kg m^{-3} – it is the initial parameter in SST [3]. We should show what phenomenon thickens the ES.

Behaviour of the bare fermions (torus plus central condensate) with the different SST sizes (scales) is similar. Nucleons can create the bare electron-positron pairs so we can assume that by an analogy a bare electron can emits a quantum M_X and the ratio of such energy to the mass of the bare electron is the same as the ratio of the mass of the bare electron to the mean mass of the two nucleons $M_N = (n + p)/2$

$$M_X = {e^-_{bare}}^2 / M_N = 2.774631 \cdot 10^{-4} \text{ MeV} . \qquad (5)$$

Emission of such quanta by nucleons causes that in distances equal to their range, value of the attractive force acting on electrons is increased. It behaves as a “trough” in the Einstein spacetime circling the nucleons – it looks as a Mexican-hat potential.

How we can calculate the range of M_X? From the theory of baryons [3] we know that range of four neutral pions is equal to the equatorial radius of the core of baryons $A = 0.6974425$ fm. But inside the core of baryons there is transition from the weak interactions of leptons (it is defined by $\alpha_{W(electron-muon)} = 0.9511082 \cdot 10^{-6}$ [3]) to the weak interactions of baryons (it is defined by $\alpha_{W(proton)} = 0.01872286$ [3]). Such transition, due to the binding energy, decreases mass of the neutral pion by $\pi^o_{Free}\alpha_{W(electron-muon)}/\alpha_{W(proton)}$. The experimental mass of the free neutral pion is $\pi^o_{Exp.} = 134.9770(5)$ MeV [8]. Here, to obtain the correct result, we must assume that mass of neutral pion is $\pi^o_{Free} = 134.9766$ MeV – such a mass overlaps with the experimental result. It leads to conclusion that mass of the bound neutral pion is

$$\pi^o_{Bound} = \pi^o_{Free} (1 - \alpha_{W(electron-muon)} / \alpha_{W(proton)}) = 134.96974 \text{ MeV} . \qquad (6)$$

It means that range of $4\pi^o_{Bound} = 539.87897$ MeV is A. On the other hand, range is inversely proportional to mass so range L_o of M_X is

$$L_o = A \, 4\pi^o_{Bound} / M_X = 1.3570616 \cdot 10^{-9} \text{ m} . \qquad (7)$$

Such a lowest-energy “trough” is placed just outside the fifth shell in the hydrogen atom.

Such a range expressed in the equatorial radii of the bare electron, $r_{bare(electron)} = 38660707 \cdot 10^{-13}$ m [3], is

$$L_o = 3510.183 \, r_{bare(electron)} . \qquad (8)$$

Since behaviour of the lightest neutrinos and the core of baryons is similar so around the ES components is created a sphere with a radius of [3]

$$L_{o,ES} = 3510.183 \, r_{neutrino} \approx 3.926 \cdot 10^{-32} \text{ m} . \qquad (9)$$

It is the effective radius of the non-rotating-spin lightest neutrinos. Such range is a little shorter than the mean side of a cube occupied by one ES component in ES. It leads to conclusion that it is easy to create the meta-stable ES condensates. The invariance of the $L_{o,ES}$ suggests that mass density of all the ES condensates is the same.

2.3 How do the tori/charges acquire their mass? Monopoles

Since the spin speed of tachyons is about 27 orders of magnitude lower than their linear speed then the poloidal speed of the tori/charges (the weak charges in neutrinos and the electric charges of electrically charged leptons and hadrons) is much lower than their toroidal speed.

The broken symmetry in weak interactions follows from the poloidal speed of tori so "abundance" of the broken symmetry is very low.

The very different values of the two speeds (energy is directly proportional to squared speed) cause that the interactions of the spin-1 ES components in the plane of the equator of the tori (there are exchanged the loops overlapping with the equators) are much stronger when the unitary spins are parallel and distance between their directions is close to $\sim 2\pi r_{neutrino}$ – such distance is characteristic for the torus/electric-charge of proton inside its core [3]. Speed of such exchanges is equal to the toroidal speed. To create a monopole, the directions of the unitary spins must overlap so distance is smaller $\sim 2\pi r_{neutrino}/3$ [3] but speed of exchanged loops is much lower because is equal to the poloidal speed. The low poloidal speed causes that monopoles are the very unstable objects.

From the above considerations and formula (9) follows that surface density of the proton torus is about 300,000 times higher than surface density of the ES condensates. It is the second phenomenon that causes that groups of the ES components have mass density higher than the ES. Such very high surface density causes that neutrinos are scattered, generally, on the proton torus and ES components.

Emphasize that the mass density of the ES condensates is very close to the mean mass density of ES. Density of the ES condensates is $2.7307 \cdot 10^{23}$ kg/m^3 [3] above the mean mass density of the ES ($\rho_{ES} = 1.10220055 \cdot 10^{28}$ kg/m^3) i.e. the ρ_{ES} is 40,363 times higher so the ES spacetime is practically flat.

Notice also that the two closed strings the entanglons consist of are very close one to the other [3] so the two exchanged loops can merge so the mean distance of entanglons on the neutrino torus is close to $\sim 3\pi r_{neutrino}$.

3. The matter-antimatter asymmetry

Dynamic pressure p of a field is defined as follows

$$p \sim \rho\, v^2 , \tag{10}$$

where ρ is density of the field while v is mean speed of constituents.

On the other hand, pressure for unit acceleration and unit area is directly proportional to mass of the field

$$p \sim M . \tag{11}$$

From (10) and (11) we obtain

$$M_1 / M_2 = (\rho_1 / \rho_2)\, (v_1 / v_2)^2 . \tag{12}$$

The surplus of nucleons over antinucleons should be a result of a global broken symmetry due to the weak interactions. Such broken symmetry follows from the left-handedness of the initial inflation field so it concerns the spin speed of tachyons. If $M_1 = \Delta M_{Baryons}$ is the surplus mass of nucleons then $v_1 = v_{st}$ and $\rho_1 = \rho_N$ is the mean density of a nucleon. On the other hand, $M_2 = M_{Cosmos}$ should be the mass of the inner Cosmos, $\rho_2 = \rho_{ES}$ should be the density of the Einstein spacetime at the end of inflation (so today as well), and $v_2 = v_t$ should be the mean linear speed of tachyons.

We already calculated the inner mass of the Cosmos $M_{Cosmos} = 5.870 \cdot 10^{119}$ kg [4]. In paper [3] we showed that range of gluons for thermal nucleons is $R_{N,gluon} = 2.95821$ fm. Such range leads to the mean density of nucleons $\rho_N = 1.54 \cdot 10^{16}$ kg/m^3.

Applying formula (12) we obtain

$$\Delta M_{Baryons} = M_{Cosmos} \, (\rho_N / \rho_{ES}) \, (v_{st} / v_t)^2 = 4.3 \cdot 10^{53} \text{ kg} . \tag{13}$$

This mass of the surplus of baryons is consistent with what we know about our Universe. Some part of the surplus nucleons can be scattered in whole Cosmos. There can be bigger structures outside the Universe.

We assumed that the torus and central condensate of the Protoworld were built of baryons [4]. But there is a high probability that these two parts were built of the entangled ES components, the same as it is in the core of baryons. Such a change does not force further changes in the SST theory.

4. The EW equation that leads to the atom-like structure of baryons

We need the SST EW theory to explain the atom-like structure of baryons. The main equation looks as follows [3]

$$(\alpha_{W(proton)} + \alpha_{EM}) / \alpha_{W(proton)} = A / B = 1.38976 , \tag{14}$$

where α_{EM} is the fine-structure constant while the radii of the orbits are $R = A + dB$, where $d = 0, 1, 2, 4$ [3].

Formula (14) is a result of the fact that inside the core of baryons acts the nuclear weak force while outside of it there act both the electromagnetic and nuclear weak forces.

5. Summary

Here we compared the orthodox EW theory with the EW theory described in the Scale-Symmetric Theory (SST). They are the very different theories. In the SST EW theory we focus on the physical side of such theory which causes that such theory is mathematically much simpler than the orthodox EW theory.

We showed that without the phase transitions of the initial inflation field and the atom-like structure of baryons the orthodox EW theory is blind, is incomplete and gives results with low accuracy. It is the reason that within the orthodox EW theory we cannot solve many basic problems such as the origin of the gravitational mass of neutrinos, instability of monopoles or matter-antimatter asymmetry. The same concerns the Standard Model as a whole.

Within SST we calculated all need coupling constants and we deciphered internal structure of bare particles. On such foundations we can define potentials and find the stable and meta-stable states.

The global broken symmetry (the matter-antimatter asymmetry) follows from the external left-handedness of the SST initial inflation field.

Here we showed that, in general, the electroweak interaction for rotating particles is not broken. But electroweak interaction is broken inside bare fermions because the tori interact electromagnetically whereas the central condensates interact weakly.

There is no force in our Cosmos to destroy protons. The weak and electromagnetic interactions of the core of baryons lead to the atom-like structure of baryons.

SST shows that the tremendous non-gravitating energy frozen inside neutrinos protects them from the neutrino “oscillations”. An illusion of oscillations follows from the collisions of neutrinos with other neutrinos and from exchanges of neutrinos for neutrinos the ES components consist of.

Within SST we described many other problems concerning the electroweak interaction – some of them are described in [9] – [13].

References

[1] Steven Weiberg (1996). “The Quantum Theory of Fields”
Volume II “Modern Applications”
Cambridge University Press 1996
First published 1996

[2] J. Goldstone, *Nuovo Cimento* **9**, 154 (1961)

[3] Sylwester Kornowski (23 February 2018). “Foundations of the Scale-Symmetric Physics (Main Article No 1: Particle Physics)”
http://vixra.org/abs/1511.0188

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

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

[6] Sylwester Kornowski (5 February 2019). “The Origin of the Experimental Weinberg Angle”
http://vixra.org/abs/1902.0043

[7] Sylwester Kornowski (7 June 2017). “The Origin of the Z and W Bosons”
http://vixra.org/abs/1705.0202

[8] M. Tanabashi *et al.* (Particle Data Group).
Phys. Rev. D **98**, 030001 (2018)
“10. Electroweak Model and Constraints on New Physics” – Revised March 2018 by J. Erler and A. Freitas.

[9] Sylwester Kornowski (21 June 2019). “The Relationship between CKM and PMNS Matrices in the CP-Violation Sectors”
http://vixra.org/abs/1901.0226v7

[10] Sylwester Kornowski (1 February 2019). “Why is the Weak Mixing Angle in Electroweak Theory not Consistent with the Experimental Data?”
http://vixra.org/abs/1901.0450

[11] Sylwester Kornowski (26 January 2019). “An Illusion of Periodic Changes in Survival Probability for Neutrino Oscillations”
http://vixra.org/abs/1901.0364

[12] Sylwester Kornowski (14 January 2019). “The Origin of Jarlskog Invariant and Applications”
http://vixra.org/abs/1901.0181

[13] Sylwester Kornowski (4 February 2019). “The Nuclear Weak Coupling Constant”
http://vixra.org/abs/1902.0060