Particle Physics and Cosmology Need New Methods

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Abstract: To formulate the lacking part of ultimate theory, particle physics needs new methods. Theories starting from sizeless bare fermions are non-reversible so incoherent. Within such theories we lose information. Theories starting from flexible, so changing-spin, closed strings and/or based on continuous trajectories of the quantum particles, are incoherent as well. To fit theoretical results to experimental data within the incoherent theories, we apply approximations, mathematical tricks and free parameters i.e. such theories are very messy. New methods are based on the origin of the half-integral spin. This spin is characteristic for all scales/sizes and for all types of interactions (bosons consist of the half-integral-spin fermions), even for the fifth force i.e. the entanglement. This suggests existence of succeeding phase transitions of the fundamental spacetime based on the half-integral-spin constancy. This theorem should be accepted as an axiom. The phase transitions do not need time-dependent equations. They lead to internal structure of bare fermions, to different types of black holes, tori, balls and loops composed of the Einstein-spacetime components and next to coupling constants of interactions. At least for period of spinning, the quantum particles are the stable, so time-independent, structures. Knowing the time-independent statistical arrangements and internal structure of bare particles, we can calculate with very high accuracy physical quantities for whole spectrum of energy. It is the Scale-Symmetric Theory. Such a theory shows a statistical interpretation of the canonical quantum mechanics and only such a theory leads to the origin of the basic physical constants. This theory leads also to the superluminal interpretation of the quantum mechanics and to the abundance of the deterministic mass.

1. The problem and the grounds

To formulate the lacking part of ultimate theory, particle physics needs new methods. To describe Nature, physics cannot start from sizeless points. Theories starting from sizeless points are non-reversible so incoherent. Within such theories we lose information about physical objects and about lengths of mathematical and physical intervals. New methods must cause that in theories will not appear sizeless bare fermions and bosons, singularities, and infinite energy of fields. Only such a theory can lead to the lacking part of the ultimate theory and show a statistical interpretation of the canonical quantum mechanics. To formulate such theory we need the non-gravitating tachyons and two-component spacetime. They are the superluminal non-gravitating Higgs field and the luminal Einstein spacetime composed of the neutrino-antineutrino pairs. Existence of tachyons follows from the non-locality of interactions of entangled photons. Just the entanglement must be a realistic phenomenon. Existence of the two components of spacetime follows from existence of the two long-distance interactions i.e. gravity and electromagnetism. The components of the two

spacetimes are the classical and non-relativistic particles. But emphasize that the Einstein spacetime as a whole is the quantum spacetime.

In mathematics and physics we frequently apply following formula $0 = 1 / \infty$. This formula has no physical meaning. Infinite number of divisions of a segment which length, for example, is equal to 1 leads to the infinite set composed of sizeless points. The reversible formula looks as follows: $0 \cdot \infty = 0$. It is because due to the transition from the segment to the infinite number of sizeless points we lose information about the length of the segment. In physical world information cannot be lost. Just such transition causes that we obtain incoherent theory. To fit the theoretical results to experimental data within the non-reversible theories (there appear the singularities and infinities) as, for example, within the Quantum Theory of Fields (QTFs), we apply approximations, mathematical tricks and free parameters. The quantum particles are the excited states of the classical spacetimes so they are the many-classical-particle phenomena. It is the reason that there is valid the connection between the classical Lagrangian and the canonical quantum mechanics discovered by Feynman [1] so we can apply the Hamilton's principle $\delta S = 0$ concerning the action S. More details about the Lagrangian in the Quantum Physics we can find here [2]. But we can see that we still neglect the internal structure of the bare fermions so of the bare bosons (they are the many-fermion particles) as well and the Grassmann variable incorporating the fermions to the Feynman's path integral does not solve the basic problem concerning the internal structure of the bare fermions. The bare fermions consist of a torus/charge and ball/condensate in its centre and look similar to the active galaxies, for example, the NGC 4261. It is due to the high density of the active galaxies. Since the Feynman's path integral is not valid for bare fermions whereas both the classical Lagrangian and canonical quantum mechanics lose information about bare particles, so we must apply new methods to formulate the lacking part of the ultimate theory.

Bohmian Mechanics is a deterministic interpretation of quantum mechanics but the Bohmian particles does not solve the main problem i.e. the non-reversibility of the canonical quantum mechanics. To formulate reversible theory we need tachyons. Tachyons interact with the Principle-of-Equivalence (PoE) particles (i.e. with the observed particles) so tachyons point out them (i.e. the PoE particles) the places in the Einstein spacetime with lowered pressure. Such places are produced by the entangled massless-energy vortices (the "ghosts"). They appear to eliminate turbulences in the Einstein spacetime or produce waves in such a way that circumference of a vortex is equal to $n\lambda$, where λ is the de Broglie length defined by a PoE quantum particle whereas n are the natural numbers. Such vortices are the stable states i.e. their lifetime is longer than period of spinning of the vortex. Then, probability to find a quantum particle in place with lowest pressure is highest. It leads to the statistical interpretation of the quantum physics and wave functions.

The Principle of Equivalence is a consequence of the observed equality of gravitational and inertial mass. According to this principle, the General Theory of Relativity (GR) allows local inertial frames only. But the superluminal non-gravitating Higgs field is beyond the Principle of Equivalence. Moreover, in the GR we as well neglect the internal structure of the bare fermions and of the cosmic structure that appeared before the beginning of the observed expansion of the Universe.

Theories starting from flexible, so changing-spin, closed strings and/or based on continuous trajectories of the quantum particles are incoherent as well. Due to the superluminal entanglons responsible for quantum entanglement, the quantum particles disappear in one place and appear in another one, and so on – it leads to the wave function.

New efforts should be based on phase transitions of field composed of superluminal pieces of space, i.e. on phase transitions of a field composed of gravitationally massless tachyons i.e. of the internally structureless pieces of space. Such pieces cannot emit any particles so cannot

create or polarize spacetime or field. Just they are the uncharged and gravitationally massless particles. It is presented in the Scale-Symmetric Theory (SST) [3]. Only such theory leads to the origin of the basic physical constants. Since the tachyons and the binary systems of closed strings (the entanglons) the Einstein-spacetime components consist of are the gravitationally massless and electromagnetically uncharged particles so the components of the two spacetimes are classical and non-relativistic. The time-dependent equations are useless when we try to describe phase transitions of the Higgs field and local regions of Einstein spacetime. The phase transitions depend on distances of the components only i.e. on mass density only. There does not act the Fermat's principle of least time.

There can be two states of a volume: nothingness or fully filled. Define the space as the fully filled volumes. Define the R as the ratio of volume of space to the total volume i.e. to the sum of volumes of nothingness and space. There are the three possibilities:

$R = 0$: it is the nothingness i.e. the timeless volume,

$R = 1$: it is the timeless space,

$0 < R < 1$: it can be the living spacetime when the pieces of space are moving.

Time follows from collisions of the moving pieces of space whereas the internally structureless physical volumes (the moving pieces of space) are the space.

SST shows that today the R for the Higgs field is $R = 1.3245 \cdot 10^{-58}$ whereas the mean speed of the pieces of space is $2.386344 \cdot 10^{97}$ m/s. Only such initial conditions lead to experimental data.

New methods are based on the origin of the half-integral spins. This spin is characteristic for all scales/sizes (there are the superluminal closed strings, neutrinos, nucleons, electrons, cosmic structures, and so on) and types of forces (bosons consist of the half-integral-spin fermions), even for the fifth force (i.e. for the entanglement [3A]) but the carriers of this force are not the PoE particles so a direct detection of them is impossible. The existence of many different half-integral-spin particles suggests existence of succeeding phase transitions of the fundamental spacetime based on the half-integral-spin constancy. This is the dogma in physics i.e. the theorem that should be accepted as an axiom. The 0-spin and 1-spin particles arise due to the pairing of the half-integral-spin fermions and loops whereas the 2-spin particles are the quadrupoles of the half-integral-spin fermions. The phase transitions lead to the internal structure of bare fermions, to different types of modified black holes (there is not a singularity but there is a circle with spin speed equal to the speed of light in "vacuum" c), tori/charges, balls/condensates and loops composed of the Einstein-spacetime components and next to coupling constants of interactions. At least for period of spinning, the quantum particles are the stable, so time-independent, structures. Knowing the time-independent statistical arrangements and internal structure of fermions, bosons and vortices/loops, we can calculate with very high accuracy physical quantities for whole spectrum of energy. Such a theory shows a statistical interpretation of the canonical quantum mechanics and only such a theory leads to origin of the basic physical constants. It is the Scale-Symmetric Theory. Such theory starts from 7 parameters only and three time-independent formulae defining the phase transitions and the atom-like structure of baryons. The three formulae follow from basic phenomena that we can treat as dogmas. They follow from the saturation of fundamental interactions and the symmetrical decays of bosons in very high temperature typical for the strong interactions. Among the four basic physical constants i.e. the Planck constant, gravitational constant, speed of light c and electric charge of electron, the half-integral spin is the most fundamental physical constant and to such conclusion should lead and leads the lacking part of ultimate theory i.e. the SST.

Most important are the phase transitions that lead to the different types of black holes that masses are quantized. There are the black holes in respect of the strong interactions i.e. the

core of baryons, in respect of the weak interactions i.e. the ball/condensate in centre of the torus inside the core of baryons and the centre of muons, and in respect of the gravitational interactions i.e. the cosmological object that appeared after the inflation but before the observed expansion of our Universe, and the biggest neutron stars. The observed gravitational black holes should consist of the biggest neutron stars that are the modified neutron black holes.

The torus of an electron is the spin-polarized surface only composed of the Einstein-spacetime components. The greatest radius of such torus is equal to the reduced Compton length: $\lambda_{Compton(electron)} / (2\pi) = \lambda\!\!\!^{-}_{C(electron)}$. Density of such torus is the same as the mean density of the Einstein spacetime and period of spinning is in approximation 10^{-20} s so it is very difficult to detect such torus. Mass of the bare electron appears due to the rotational energies of the Einstein-spacetime components (there is loop and ball in its centre) but lifetime of such mass in a defined place of the Einstein spacetime is about 10^{-20} s as well. We can see that it is very difficult to investigate internal structure of electrons. Much simpler is investigation of internal structure of proton. The two different experimental results for the charge radius of proton lead to the atom-like structure of baryons [4].

2. Types of mechanics, elimination of turbulences and nonlinearity

There is the very good description of the transition from the classical mechanics (we know all trajectories) to statistic mechanics (the phase spaces contain averaging parameters also). But due to the lack of the correct description of the internal structure of spacetime(s), the description of the transition from the statistic mechanics to quantum mechanics is not good understood. The Scale-Symmetric Theory leads to two spacetimes. The fundamental spacetime, i.e. the non-gravitating Higgs field, is practically the scalar statistical spacetime whereas in the Einstein spacetime can appear the quantum particles. They disappear in some places and appear in places of Einstein spacetime where pressures are lower than the mean, and so on. The quantum particles "see" such places due to the modified Higgs field composed of the tachyons and due to the superluminal components (entanglons) from which the Einstein-spacetime components consist of. Sometimes the quantum particles arise in places very distant from the places of disappearing. This means that trajectories of quantum particles have no sense in the quantum mechanics. To describe "motions" of the quantum particles such as, for example, electrons and photons we need the wave functions and probabilities. Due to the superluminal particles such description is coherent.

We know that mechanics of chaos is the nonlinear mechanics. What is the origin of the linear→nonlinear transition? The Newtonian gravity is linear because is associated only with the perfect-gas-like almost-scalar spacetime. Today, due to too low density of the non-gravitating Higgs field, in such spacetime quantum particles cannot appear. Nonlinearity is associated with the Einstein spacetime. Properties of this spacetime (the possible confinement or/and entanglement of the neutrino-antineutrino pairs can change local mass density [3A]) cause that superposition is not characteristic for the Einstein spacetime. This is due to the internal structure of the virtual bare particles and local binding energies that locally change mass density of the Einstein spacetime. But the locally changing mass density of the Einstein spacetime changes as well the gradients (the gravitational fields) produced by masses in the superluminal Higgs field which is directly associated with the gravitational interactions. The locally changing mass density of the Higgs field leads to the nonlinearity of the metric tensor in the Einstein equations. Since the metric tensor defines geometry of spacetime then geometry of spacetime depends nonlinearly on mass density. Similarly is for the weak, strong and electromagnetic interactions because they are associated with the quantum spacetime (the Einstein-spacetime components are in the today Universe the classical particles whereas this spacetime as a whole, due to the superluminal Higgs field and the exchanged entanglons,

behaves as quantum spacetime). The changing local mass densities lead to the mechanics of chaos [3C]. When we take into account the internal structure of bare particles and appropriate binding energies, very often we can reject the perturbation theory [3]. In the places in the Einstein spacetime where appear turbulences are produced vortex-antivortex pairs that reduce the higher pressures. Next, such pairs can transform into fermion-antifermion pairs. We can see that Nature launched the defensive system to eliminate turbulences from the quantum spacetime.

There are no trajectories of the quantum particles. Assume that in some point A of a quantum field is the initial state (input (I)) of a quantum particle whereas in some point B is the final state (output (O)). Then we can say about some arrangement of points in which the quantum particle was. The arrangement of the points can sometimes lead to time-independent statistical picture. For example, all the directions of spins of the virtual electron-positron pairs created in surrounding of a bare electron, due to the electric polarization of the pairs which follows from the superluminal interactions of the Einstein-spacetime components, cross the circular axis inside the torus of the bare electron i.e. the statistical picture of the electric field produced by the virtual pairs leads to a loop on the circular axis. This means that knowing the internal structure of bare electron, i.e. the distribution of electric charge and mass in bare electron, and coupling constants of interactions, we can calculate, for example, the radiation mass of electron [3A].

We should emphasize once more that there are not in existence continuous trajectories of quantum particles so we cannot apply the Feynman's path integral in quantum physics.

3. Time

We wrote that time is defined by collisions of the moving pieces of space that in our cosmos are the tachyons. The Einstein-spacetime components transform their chaotic motions into divergently moving jets of tachyons. Then, the collisions of tachyons produce depressions/gradients in the superluminal Higgs field i.e. the Einstein-spacetime components produce the gravitational fields. In a place with lower inertial mass density of gravitational field, number density of collisions is lower so time is going slower. Generally, in places with higher gravitational mass density time is going slower. During collisions of, for example, protons, inside them, due to the possible confinement of the gluons that are the rotational energies of the neutrino-antineutrino pairs, gravitational mass density can be different in different places so time is going in different way as well. This leads to conclusion that we should not apply time-dependent equations in particle physics because of different local times.

There is the second reason also. The Scale-Symmetric Theory shows that the half-integral spin is the most fundamental physical constant that appeared due to the first phase transition of the Higgs field (at the beginning of the inflation, this liquid-like field was the inflation field [3B]). It is the spin of the closed strings. Since the closed strings have internal helicity so the closed strings were produced during the era of inflation as the pairs in such a way that spin of each pair was unitary and its total internal helicity was equal to zero. This causes that the law of conservation of the half-integral spin of the fermions that were produced due to the phase transitions of the Higgs field is a dogma. Spin of nucleons is defined by the torus inside the core. For the strong interactions are responsible the loops created on the circular axis inside the torus. Spin of one loop must be unitary but since spin of the torus as a whole must be conserved so the loops appear as the zero-spin pairs. They are the neutral pions. When we accelerate the stable torus then the spin speed decreases so from following formula: **mass-of-torus · mean-spin-speed · mean-radius-of-torus = ħ/2**, we obtain that mass of torus must increase i.e. time is going slower and slower. On the other hand, spin of the virtual loop is defined by the Uncertainty Principle: **mass-of-loop · period-of-spinning (lifetime) = ħ**. From this formula follows that when we accelerate the proton, due to the decreasing spin speed, the

lifetime of the loop increases so the mass of loop decreases i.e. time is going faster and faster. This phenomenon causes that strong interactions are weaker for higher energies. But most important is the fact that we need two different definitions for time. It proves that we should not apply time-dependent equations for the strong interactions.

4. The superluminal interpretation of quantum mechanics and abundance of the deterministic mass

The two long-distance interactions, i.e. gravity and electromagnetism, lead to the two parallel spacetimes i.e. the superluminal Higgs field and the Einstein spacetime. The first spacetime consists of the non-PoE tachyons whereas the second consists of the luminal PoE particles. A direct detection of tachyons is impossible whereas it is very difficult to detect the Einstein-spacetime components [3A]. Due to the internal structure of the Einstein-spacetime components (they consist of the non-PoE superluminal binary systems of closed strings), they can exchange their superluminal components so there appears the superluminal quantum entanglement. It is the third long-distance force but due to the non-Principle-of-Equivalence binary systems of closed strings, these carriers of the fifth force cannot be detected directly. It is the scene for the quantum mechanics i.e. the superluminal spacetime plus luminal spacetime and plus the long-distance superluminal entanglement.

The photons are the quantum particles. They are the rotational energies of the Einstein-spacetime components that are the carriers of photons. Due to the long-distance superluminal entanglement, the carriers of photons, so the photons as well, can be entangled. A photon is the entangled wave packet. When due to a measurement process, rotational energy of one of the carriers of an entangled wave packet is positioned then due to the long-distance superluminal entanglement, the total energy of the wave packet, practically at once, appears in the place of measurement. It is the collapse of energy.

The electrons are the quantum particles as well. The torus inside bare electron defines the electric charge and spin of electrons. The torus is composed of entangled Einstein-spacetime components. Such torus disappears in one place and appears in another one, and so on. Due to the superluminal spacetime and superluminal entanglement, the torus “see” arrangement of places in the luminal Einstein spacetime in which potential energy of the torus can be lower or in which can be satisfied the Uncertainty Principle. We can see that there appear the probabilities. The changing arrangement of places in which appears the torus leads to wave function. But in a defined time, the torus can be in one place only and such place is positioned in a measurement process. This leads to conclusion that the measurement process converts probability functions into non-probabilistic measurements. In a different way can behave mass of an electron. Due to the superluminal entanglement, mass of an electron can be taken to pieces and such pieces expand when torus/charge of electron changes place.

Due to the superluminal spacetime and superluminal entanglement, the quantum mechanics is non-local. It is the probabilistic theory but the many-worlds interpretations are incorrect.

Due to the superluminal entanglement, the components of the neutrino-antineutrino pairs cannot transfer gravitational mass but can transfer tremendous amount of gravitationally massless energy. It is the reason that entanglement does not disturb gravity and other interactions.

Generally, cosmos consists of the classical and quantum particles. Most important is question what is abundance of the probabilistic mass in the today Universe? And the answer is as follows. If we take into account the mass of the Einstein spacetime (today it consists of classical particles) then abundance of the deterministic mass is practically equal to 100%. If we neglect the mass of the Einstein spacetime then abundance of the deterministic mass is in approximation 77%. It is the ratio of the mass of the core of nucleons (the mass is about 727 MeV – it is the mass of the classical structure) to the mean mass of the nucleons (the mass is

about 939 MeV), multiplied by 100%. Most of the indeterministic part is the statistically deterministic part. It is due to the entanglement that leads to the polarization of the Einstein spacetime and due to the virtual dipoles as, for example, the electron-positron pairs. This leads to conclusion that there is very small part in the indeterministic part that can lead to free will. In general, there is very high probability for correct prediction of the future of our Universe and its smaller parts.

5. Summary

To formulate the lacking part of ultimate theory, particle physics needs new methods. Theories starting from sizeless bare fermions are non-reversible so incoherent. Within such theories we lose information about lengths of intervals and physical objects, for example, about internal structure of the bare fermions. Theories starting from flexible, so changing-spin, closed strings and/or based on continuous trajectories of the quantum particles are incoherent as well. We need two different definitions of time to describe the strong interactions so we should not apply in this case the time-dependent equations. To fit theoretical results to experimental data within the incoherent theories, we apply approximations, mathematical tricks and free parameters i.e. such theories are very messy.

New methods are based on the origin of the half-integral spin. When we neglect the Higgs field then this spin is characteristic for all scales/sizes and for all types of interactions (bosons consist of the half-integral-spin fermions), even for the fifth force i.e. the entanglement. This suggests existence of succeeding phase transitions of the Higgs field based on the half-integral-spin constancy.

This theorem should be accepted as axiom. The phase transitions do not need time-dependent equations. They lead to the internal structure of bare fermions, to different types of modified black holes, tori, balls/condensates and loops composed of the Einstein-spacetime components (i.e. composed of the neutrino-antineutrino pairs) and next to coupling constants of interactions. At least for period of spinning, the quantum particles are the stable, so time-independent, structures. Knowing the time-independent statistical arrangements and internal structure of fermions, bosons and vortices/loops, we can calculate with very high accuracy physical quantities for whole spectrum of energy. Such a theory shows a statistical interpretation of the canonical quantum mechanics and only such a theory leads to the origin of the basic physical constants. It is the Scale-Symmetric Theory.

The superluminal interpretation of the quantum mechanics shows that this theory is non-local. The measurement process converts probability functions into non-probabilistic measurements.

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