Comments on the theory of noncontractible space and the misuse of the theory of vacuum

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Abstract

I comment critically on the use and misuse of the theory of vacuum, pseudoparticles and pseudotensors. The mathematical and phenomenological arguments against the Higgs mechanism and the inflationary scenario are presented. I conclude with a proposal on how to mathematically improve our understanding of fundamental interactions, basing it on the theory of noncontractible space. The nature of the force of gravity appears crucial in my reasoning.
I. INTRODUCTION

In this comment, I should like to address a few important issues in field theory with its implications in particle physics and cosmology. Understanding the dynamics of the largest and the smallest entities of the Universe requires a formulation of theories that can explain the appearance of physical structures, physical forces and all the observed phenomena. One can say nowadays that cosmology represents literally the theory of everything, with measurements and observations made in the laboratory or at the outskirts of the Universe.

The natural question arises whether one can be satisfied with the present, widely accepted theoretical mechanisms that attempt to resolve the fundamental questions in physics.

My answer to this question is firmly negative. Why? Let me explain it in the next section.

II. DISSATISFACTION WITH STANDARD MODELS

Despite the fact that we can describe the world of elementary particles by the non-Abelian gauge theory $SU(3) \times SU(2)_L \times U(1)$, there is a lot of unanswered questions. Particles and interactions are described by local quantum fields in the form of the second quantization in Minkowski spacetime of the special theory of relativity. The two basic principles, relativity and quantization, applied to the perturbation theory of non-Abelian gauge interactions allow to confront theory with experiments, giving us the confidence in the standard model $SU(3) \times SU(2)_L \times U(1)$. Calculations of the QCD bound state spectra with lattice gauge theory improve further our understanding of the world of elementary particles.

However, there are plenty of reasons to be dissatisfied with the standard model: the problem of ultraviolet infinities is resolved only in perturbative approach by the theory of renormalization: neutrinos are massless Dirac particles, the scalar Higgs sector is a theoretical construct with arbitrarily inserted parameters; all masses are free parameters; there is no candidate for a dark matter particle; no baryon- or lepton-number violating interactions that are required by cosmological considerations; no link whatsoever with the theory of gravity.

The standard model in cosmology is called concordance model, with the following ingredients: Einstein’s theory of general relativity can describe the Universe expanding from the initial singularity in the form of Friedmann-Robertson-Walker geometry; the flatness and
horizon problems, as well as the structure formation problem, are claimed to be resolved by adding an inflaton scalar field whose dynamics is defined by various types of potentials.

The idea to introduce ad hoc in cosmology a scalar field instead of a certain quantum theory of gravity at distances close to Planck scale, is very pragmatic and unusual. However, the consequences are far-reaching: similarly as in the scalar Higgs sector in particle physics, all parameters of any version of inflationary cosmology are free unknown parameters; inflation cannot predict mass density or the cosmological constant but only total mass density of the Universe; primordial spectrum of density contrast is again given by unknown potential of the inflaton scalar; as a consequence of the Planck and GUT scales dynamics of the inflaton, there is an imprint of gravitational waves in the tensor mode of the fluctuations of the CMB temperature field. The cosmological principle also assumes perfect homogeneity and perfect isotropy built in Friedmann-Robertson-Walker geometry, because there are no mechanisms to break them in a natural way.

That was just a brief overview of the problems with which standard models in particle physics and cosmology are confronted.

III. UNIFICATION PROGRAMS AND GRAVITY

There is a general agreement that the force of gravity is also a local gauge force in analogy with the $SU(3) \times SU(2)_L \times U(1)$ unitary groups gauge forces. Common wisdom asserts at the same time that general relativity is incompatible with quantum mechanics. Let us analyze these statements in more detail.

Einstein’s theory of gravity or general relativity (GR) is singular at vanishing distances when collapse of astrophysical objects occurs or at the Big Bang cosmological initial singularity. The same singularity occurs in the nonrelativistic Newton’s theory of gravity. Maxwell’s theory of classical electrodynamics, as a classical gauge field theory of electromagnetism, is singular because if one attempts to compute self-energy of the electron, it diverges owing to the zero distance singularity. It appears in both nonrelativistic and relativistic computations in classical electrodynamics. We call the zero-distance singularity in quantum local field theories, relativistic or nonrelativistic, the ultraviolet infinity. Renormalization theory in perturbative calculations should be applied to remove the singularity in a consistent way, respecting Lorentz and gauge invariance, as well as the quantum principle in the form of the
second quantization.

The difference between non-renormalizable and renormalizable field theories is only the number of counter terms needed to remove the ultraviolet infinities; thus, renormalizable theories have greater predictability in comparison with non-renormalizable theories, where the number of counter terms rises with the number of quantum loops. Although the local quantum theory with gravitons is a non-renormalizable theory, it can be treated with a renormalization theory just like quantum electrodynamics, but with a necessary addition of an increasing number of amplitudes to resolve the large number of counter terms.

We can conclude that, contrary to the usual wisdom, relativity and quantum principles are not incompatible in any respect and certainly not with respect to the zero-distance singularity (ultraviolet infinity) in any gauge or non-gauge field theories, because the quantum principle deals with energies, relativity with velocities and the ultraviolet singularity is a problem of the zero-distance between physical entities. Physical infinities, unlike mathematical ones, usually have a physical dimension and a clear physical meaning, as well as physical consequences. The ultraviolet catastrophe of the black body radiation and its solution by Planck is an instructive example.

The second problem is the physical nature of the force of gravity.

The issue of the nature of the force of gravity is closely related to the unification programs. The universal law of gravity formulated by Newton equals the forces between massive bodies on Earth with the forces between planets. Maxwell’s theory of electrodynamics unifies the forces of electricity and magnetism with the theory of light.

The third attempt of unification by Kaluza and Klein, and later by Einstein, was to unify the forces of gravity and electromagnetism. We now know that these early attempts were unsuccessful. The origin of the electromagnetic force is in an Abelian local gauge force $U(1)$. The revolutionary consequence of Maxwell’s theory is the existence of the electromagnetic waves, vector-type waves as a solution to the wave equations with charged sources. The experiments performed by Hertz proved the existence of waves connected to the electric and magnetic forces, with characteristics precisely described by Maxwell’s theory.

By complete analogy with electrodynamics, the theorists assume the existence of gravitational waves in Einstein’s theory of gravity. Gravitational waves are solutions to the wave equations. If the gravitational waves exist, then Einstein’s field equations should have the form of the wave equations. However, from the work of Sciama, Waylen and Gilman it
is clear that Einstein’s equations can be put in the form of the generally covariant integral equations. Thorne put Einstein’s equations into the very suggestive quasi-wave-type equations, but they evidently remain what they are, coupled nonlinear integral equations \[2\]. There are nonlinear wave equations in electrodynamics because of the feedback to sources. They are possible because gauge degrees of freedom in electrodynamics are internal degrees of freedom, which are completely distinct from the spacetime degrees of freedom that define propagation of waves. This is not the case in gravity, where internal gauge degrees of freedom coincide with the propagation spacetime degrees of freedom, making it impossible to form wave equations from Einstein’s field equations. Only empty space (vacuum) and pure electromagnetic sources, as unrealizable and unphysical sources, could lead to the Robinson-Trautman type of gravity wave equations \[3\].

Although one can conclude that no exact wave equation exists for any realistic physical source, the theorists believe in its existence because, for example, it is possible to form wave equations for some form of linearized Einstein’s gravity. This is wrong reasoning because any approximate form of general relativity cannot be a substitute for the general covariance and relativity principles of the genuine theory of general relativity. One has to prove the existence of the wave equation for the exact form of GR and then make a certain kind of approximation. The inverse procedure, when we make the approximation of Einstein’s gravity and then claim that we have a wave equation, is obviously not a proof of the existence of gravitational waves.

Moreover, I showed in ref.\[4\] that the slowing of the period in the binary pulsar systems can be understood within the perturbation theory of general relativity. The kinetic energy loss of the isolated binary pulsar system is compensated by the gain in potential energy. The interpretation that the kinetic energy loss is compensated by the gravity radiation is then considered as an indirect proof of the existence of gravitational waves. These two scenarios differ obviously at the second order of perturbation theory, but the corrections are too small to be observed at present.

It is interesting to mention that Cooperstock \[5\] proved an inability of the gravity waves to carry energy and momentum for certain sources. He used a properly defined energy-momentum tensor and its integrals without referring to any pseudotensor quantities. It means that the gravity waves, even for simple and well understood sources, are not physically observable entities.
From the basic mathematical and physical reasoning, I conclude that gravity is not a local gauge force and that the unification program based on this assumption will fail. Thus, a quantization of gravity should not be pursued through the second quantization of the classical local tensor field, whose existence cannot be established.

IV. THE MISUSE OF THE THEORY OF VACUUM

One of the most important concepts in quantum physics is the concept of vacuum described in Dirac’s hole theory [6]. The vacuum state in QED is defined as a state filled with negative energy electrons and the Pauli exclusion principle secures the stability of the ground state. The inevitable consequence is a prediction of the existence of antiparticles, like positrons in QED. The discovery of positrons and the success of the QED perturbation theory guarantee our confidence in Dirac’s definition of vacuum.

Faced with new problems, the theorists have to develop new concepts and mechanisms to solve the obstacles. Let us review a few examples where new concepts, albeit widely accepted by the physics community, are not physically and mathematically convincing.

The first example is the Higgs mechanism, described by Englert, Brout and Higgs [7, 8]. They start with a certain classical scalar field that has imaginary mass. It could be shown that, at the tree level for a quantum field and the special choice of the self-interacting quartic potential for scalars, the mass of the scalar particle becomes a real number. This is achieved by redefinition of the scalar field in order to preserve the vanishing vacuum expectation value of the scalar. Gauge bosons and fermions acquire masses if they are coupled to this scalar field that should belong to the scalar representation of the underlying gauge group. Thus, the scalar field with its interactions plays the role of a kind of a deus ex machina to solve the mass problem of elementary particles but at a very high price. Although the mass problem is not solved because all masses are free parameters, we can at least perform perturbative calculations even for the spontaneously broken symmetry gauge field theories.

The second example is very illustrative because it has a few steps of reasoning before reaching the final physical consequences: (1) BPST [9] found four dimensional Euclidean classical Yang-Mills solutions, i.e. acausal solutions, because we are living in Minkowski spacetime, (2) ’t Hooft calculated a quantum tunneling process based on the BPST solutions, with the imaginary time resulting in the violation of chiral symmetry [10], (3) Peccei and
Quin \[11\] assume that, if the theory contains global $U(1)$ symmetry, the problematic P and CP violating terms induced by BPST pseudoparticles could be removed; and finally, (4) Weinberg \[12\] concludes that the pseudoscalar axion then must exist. Therefore, starting from the unphysical BPST pseudoparticles living in the four dimensional Euclidean space, and by the tunneling with the imaginary time, we are faced with a consequence of the existence of the pseudoscalar particle axion with unknown mass and couplings. Certain models predict that this particle should be the most important particle in the Universe dominating its present mass density.

The third example represents the radical way how to apparently resolve the problems of initial conditions in cosmology, i.e. introduction of the inflationary cosmology. It is assumed that the dynamics of one or more inflaton scalar fields defines the fate of the Universe at the GUT scale. This is achieved by the miraculous adjustment of the selfinteracting scalar potentials, a game similar to the adjustment of the scalar potentials and Yukawa couplings in the Higgs mechanism. Although the theory of quantum gravity is not established and the treatment of quantum fields in curved spacetime is far from being an absolved subject, the theorists predict the consequences of the inflationary cosmology from Planck time to the present. New astrophysical data are being repeatedly accommodated with new and more complicated scalar potentials of new inflationary models.

However, all three examples have a lot in common: the problems are apparently resolved by assuming a transition to a new artificially constructed vacuum accompanied by a transition from imaginary to real mass, or imaginary time quantum tunneling of the acausal instanton solutions, or with an ad hoc treatment of inflaton scalar fields at Planck and later epochs. Evidently, a clear picture of Dirac’s vacuum, built from quantum and relativity physics, is lost.

It would be fair to say, from the historical point of view, that it is advantageous to have a certain practical and pragmatical mechanism to gain some insight into the physical realm rather than be completely helpless. At least we can make calculations in particle physics and cosmology, but the merit and the background of the above three examples look more like fabulous adventures of Baron Münchhausen. How to solve the tantalizing problems of fundamental interactions will be explained in the next chapter, where the idea of bootstrapping, experienced also by Baron Münchhausen, plays a vital role.
V. THE NONCONTRACTIBLE SPACE AND THE PHYSICAL WORLD OF FINITENESS

Any new theory in particle physics and cosmology has to fulfil many requirements with respect to the basic physical principles, mathematical consistency and phenomenological applications.

My fascination with particle physics started when I learned as a student about violation of parity in weak interactions. Why should the world of elementary particles be asymmetric with respect to the mirror symmetry?

Having learned all about Weinberg-Salam model, ’t Hooft-Veltman work etc., I still did not understand why the world was asymmetric. How can the spinless Higgs boson be responsible for violation of discrete symmetries and the generation of large masses of heavy quarks and small masses of leptons at the same time? It reminds me of the phlogiston theory of the pre-Lavoisier chemistry or of the theory of aether of the pre-Einstein physics.

Could we learn anything useful from the higher dimensional theories or from the super-symmetric theories?

What could be the guiding principle in an attempt to solve the problem of elementary particles’ masses?

To find an answer, let us in the beginning summarize all our previous reasoning: 1. gravity is not a local gauge force and any attempt to unify it with the standard model gauge forces cannot succeed, 2. elementary scalar fields, such as the Higgs scalar and the inflaton scalar in particle physics and cosmology, should be avoided in construction of the theories of fundamental interactions, 3. the theory of quantum gravity should be introduced, 4. an alternative mechanism of the gauge symmetry breaking must be postulated.

I shall now expose my theory as a possible solution to the many problems in particle physics and cosmology:

1. The world of particle physics is defined by all possible gauge symmetries allowed by conformal SU(3) family as its imbedding symmetries: the whole SU(3) and the SU(2)×U(1) subsymmetry [13]. The number of allowed gauge degrees of freedom in the conformal space exactly matches that of the realized strong and electroweak gauge degrees of freedom in Minkowski space $6 \times 8 = 4 \times 8 + 4 \times 3 + 4 \times 1$. Therefore, we need the higher dimensional conformal space only to solve the SU(2) global anomaly problem [13] and as a scheme for
the strong-electroweak unification. The two additional dimensions are only the dimensions of the auxiliary parameters and not real physical dimensions. However, conformal space appears naturally as a space of all conformal transformations of Minkowski spacetime \[14\].

2. The SU(2) global anomaly problem can be solved only by the exact cancellation between the weak gauge boson effective action and that resulting from fermions (quarks or leptons) interacting with weak gauge bosons \[13\]. The negative sign in front of the second effective action appears because of the functional integration over fermion fields as grassmannian variables. A kind of global supersymmetry is present between already observed elementary fermions and gauge bosons, but not forming new supermultiplets with particles of 0, 1/2, 1, 3/2 or 2 spin.

3. Mixing angles of weak bosons and fermions (quarks or leptons) are correlated \[13\] as a consequence of the invariance of the functional measure of the electroweak theory on the flavor and boson rotations.

4. Chirally asymmetric couplings of fermions and weak bosons appear as a necessity of the mathematical consistency of the BY theory of \[13\], as well as of the Majorana nature of neutrinos.

5. Instead of the Higgs mechanism, I introduced a noncontractible space as a symmetry breaking mechanism. It assumes that the spacelike domain of the four dimensional Minkowski spacetime has lower bound (upper bound in the Fourier transformed spacetime) fixed at tree level within the relativistic quantum theory with the non-Abelian quartic self-couplings of weak gauge bosons \[13\]. Thus, the conformal, discrete and gauge symmetries are broken as a consequence of the assumed property of the space. This is very appealing because we have a common comprehension on how to simultaneously break spacetime symmetries (conformal and discrete) and gauge (internal) symmetries by mass terms generated in the local relativistic quantum field theory in the noncontractible space.

6. The fermion masses are calculable via bootstrap Dyson-Schwinger equation (the first instance of the Baron Münchhausen bootstrapping). There is no arbitrariness like with Yukawa couplings. On the contrary, mass functions of particles and all the other observables are defined by their gauge invariant couplings \[13, 15\]. The appearance of light and heavy Majorana neutrinos and other properties of the spectrum is discussed in detail in ref. \[13\].

7. The perturbative treatment of the UV finite BY theory \[13\] of strong and electroweak interactions is explained in \[16\]. The recipe is straightforward and fulfils Lorentz, gauge and
translational symmetries. The UV cutoff is the universal physical constant that should be extracted by the fit of experimental data by the formulas of the BY theory.

8. Since gravity is not a local gauge force and Einstein’s gravity is an incomplete theory, I choose Einstein-Cartan theory of gravity, formulated by Sciama and Kibble [17], as my favorite classical and quantum theory of gravity.

9. The problem with general relativity is that it does not include rotational degrees of freedom of spacetime and matter. It is possible to construct the angular momentum in GR but not as a tensor quantity [18]. If one allows that the linear affine connexion has a symmetric and an antisymmetric part as an object within Riemann-Cartan geometry, a new relation emerges between torsion of spacetime and angular momentum including spin of matter.

10. Torsion is coupled to the total angular momentum; thus, the quantum mechanical spin of matter also enters the algebraic equations. The quantum theory acts in Einstein-Cartan gravity on the first quantized level through spin terms that vanish in the classical limit. The classical part of the angular momentum is always present, influencing torsion of spacetime even in the classical limit of the vanishing Planck constant.

11. Spin-torsion effects can avoid the zero-distance singularity [19, 20] in cosmology, with the minimal cosmic scale factor fairly compatible with the universal UV cutoff in particle physics [13]. If the assumption of the noncontractible space is correct, then there is no singularity within black holes and spin densities of matter configure themselves as a bouncing force to prevent a collapse beyond the critical universal distance (scale).

12. At this stage, it would be fruitful to comment on the particle creation process by black holes proposed by Hawking. He claims [21] that, in the absence of a deeper theory in which spacetime itself is quantized, one should be satisfied with an approximation, where the spacetime metric is treated classically but is coupled to the quantum mechanically treated matter fields. His starting equation is then the wave equation [21], namely for scalar fields: \( \phi_{ab} g^{ab} = 0 \). This is in analogy with the coupling of the external classical electromagnetic field with quantum matter fields, but as previously exposed, this kind of analogy is misleading and wrong. There is no local quantum gravity tensor field, and the quantum principle is built in Einstein-Cartan gravity only on the first quantized level through the matter spin densities. Since there are no Hawking type wave equations in Einstein-Cartan gravity, Hawking radiation by black holes is forbidden. This is consistent with our physical insight.
into the absence of any direct local physical process between gravity and particles. The
Minkowski spacetime physics and the Riemann-Cartan spacetime physics are linked only
indirectly through Einstein-Cartan equations and tetrad fields.

13. The cosmological constant problem presents the most elusive problem in physics, and
any attempt to understand and solve it, requires a reference to the theory of everything,
i.e. to the theory of all fundamental interactions. The standard wisdom assumes an incred-
ible mixture of concepts, from the local quantum and classical field theory and GR up to
Planck scale, various unification schemes, quantum gravity etc., as it is neatly reviewed in
ref. [22]. If the cosmological constant is defined as the zero point energy of a local field or the
vacuum energy, the theoretical calculus overestimates the observed value by 40, 50 or even
more orders of magnitude [22]. This is a clear signal that a strong departure from the usual
wisdom is necessary. It can be achieved by making a strict distinction between the local
structure of spacetime described by BY theory [13] (Minkowski spacetime, second quanti-
zation of local fields) and the global structure of spacetime described by Einstein-Cartan
gravity [17] (Riemann-Cartan spacetime, first quantization) as UV finite field theories (non-
singular with respect to the zero-distance singularity). We can expect that the cosmological
constant problem should be solved within Einstein-Cartan (EC) cosmology. The additional
rotational degrees of freedom of EC gravity provide a kind of bootstrap (the second instance
of Baron Münchhausen bootstrapping) at spacelike infinity to fix the normalization of the
mass-density of the Universe in the model with expansion, acceleration and vorticity [20]:
\[ \lim_{R \to \infty} \rho_m/\rho_\Lambda = -2, \quad \kappa \rho_m(R = \infty) = 6H^2(R = \infty), \quad \kappa = 8\pi G_N c^{-4}. \]
Namely, the number density of matter particles appears in both EC equations: curvature vs. energy-momentum
and torsion vs. spin-angular momentum, and the same coupling constant \( \kappa \) figures in both
equations. To conclude, the cosmological constant vanishes:
\[ \rho_\Lambda = -\frac{1}{2} \lim_{R \to \infty} \rho_m = 0. \]

14. It is important to address the question of how to solve classic cosmological problems,
such as the horizon problem, the flatness problem and the structure formation problem
within EC gravity and without inflaton scalars. In the EC gravity, the global structure
of spacetime is completely defined by the matter content of the Universe, including all
its physical processes, but the reverse statement is also valid: the expansion and vorticity
influence, for example, abundances of the surviving species of particles, etc. At the earlier
stages of the evolution, spin densities not only help to avoid the initial singularity [20], but
also trigger the initial primordial density contrast, which is a necessary ingredient for the
structure-formation. Assuming lepton CP violation, the light neutrino spin densities induce primordial vorticity and subsequent growth of the angular momentum of large scale structures, and ultimately the torsion of spacetime. The mass-density normalization at the final evolutionary stage at $T_\gamma = 0$ tells us that the limiting effective mass-density is the critical one, where the mass-density is twice the critical one, and the limiting effective contribution of torsion terms (quadratic and linear) is minus one critical density. The question of the horizon problem, why a large number of causally disconnected regions have the same CMB temperature, has a very clear answer within EC cosmology: local physical processes in any patch of the Universe are the same and the whole Universe acts in its patches like a global force. Thus, any cosmic observable of homogeneity or deviation from homogeneity or isotropy is global by definition and in this respect well defined. This is in accord with Machian reasoning.

15. The central questions of modern cosmology - what is dark matter and what is dark energy - in my theory have unique answers: (1) heavy Majorana neutrinos are cold dark matter particles, because they are cosmologically abundant and stable $\tau_{N_i} \gg \tau_U$ (the Higgs mechanism generated heavy Majorana neutrinos cannot be cosmologically stable), (2) angular momentum (acting like a torsion) of the Universe is dark energy and its evolution with redshift and its clustering with dark matter halos are to be expected.

16. In the paper, I argue two possible scenarios to solve the small CMB power at large scales and large peculiar velocities of clusters, assuming that the present Universe is in the vicinity of spacelike infinity $\rho_{\gamma,0}/\rho_{m,0} = \mathcal{O}(10^{-4})$: (1) a small Hubble constant and a small contribution of torsion at low redshifts, and (2) a large Hubble constant and a large contribution of torsion at low redshifts. It seems that observations favor the large Hubble constant, while the theory requires a large torsion in the vicinity of infinity. Therefore, future observations must observe the redshifting of the clustered angular momentum of the Universe as dark energy.

17. Now I can go back to the problem of the broken parity in weak interactions, i.e. the existence of only left handed weak currents. Why did nature choose the left-handed and not the right-handed weak currents? The resolution of this dilemma lies in the insight into the complete local and global structure of spacetime: the index theorem and homotopy in particle physics require the left-handed weak currents, while the left-chirality of weak interactions, together with the violation of the lepton number and the leptonic and baryonic
CP violation, results in the right-handed chirality of the vorticity of the Universe and the total chirality vanishes. It means, in other words, that if we chose the left-handed coordinate system, weak currents would be right-handed and the vorticity of the Universe left-handed. Thus, particular chiralities are only the substance of our conventions. Moreover, for the Universe to exist, the broken parities in particle physics and cosmology must be a mathematical and phenomenological necessity. The absence of the zero-distance singularity is the ultimate condition for the existence of the physical world.

VI. EPILOGUE OR FACING WITH THE BRUTAL PHYSICAL REALITY

There are great expectations from new experiments and observations in particle physics, astroparticle physics and cosmology, such as LHC, neutrino oscillation experiments, $0\nu2\beta$ decay experiments, AMS at ISS, Auger observatory, LSST, IceCube, underground detectors for DM-baryon interaction, imaging atmospheric Čerenkov telescopes, Planck and Herschell missions, James Webb telescope, etc. At the dawn of probable discoveries and surprises, I have to list phenomenological predictions of my theory of the noncontractible space in more detail:

1. The absence of the asymptotic freedom in QCD embedded in the noncontractible space $\lim_{\mu \to \infty} \frac{1}{\alpha_s} \neq 0$ means larger QCD amplitudes starting from $\mu \geq 200\text{GeV}$ [16]. The papers referenced in [16] of Tevatron and especially ref. [30], where the quotient of jet cross sections at two different center of mass energies free of systematic errors is measured, strongly suggest a larger QCD coupling than in the Standard Model (SM) at larger scales. QCD loop corrections to the electroweak processes and a deviation due to the larger QCD coupling, are probably marginally observed by HERA and LEP II [16]. In the year 2000, certain experiments at LEP II ($\sqrt{s} \simeq 210\text{GeV}$) claimed a discovery of the Higgs scalar with a mass $M_H \simeq 114\text{GeV}$ ($\sqrt{s} \simeq M_Z + M_H$), but it was just a nonresonant QCD enhancement above the scale 200 GeV and its influence on the electroweak couplings. A similar phenomenon appeared at HERA in 1996-1997. The LHC should completely resolve the issue and if the universal cutoff exists, the LHC can measure it very accurately.

2. The small fine structure constant induces small electroweak quantum corrections, but the combined data of LEP II, SLC and NuTeV show the discrepancies in $\sin^2\Theta_W$ and $A_{FB}$ from the SM. The dependence on the Higgs mass is logarithmic and the dependence on the
cutoff of BY theory in ref. [13] is also logarithmic but with different functional dependences. Even the measurement of the muon anomalous magnetic moment shows some deviation from the SM. The LHC data gives the opportunity to study in detail the quantum loop structure of the electroweak sector and the symmetry-breaking mechanism. Any future linear collider will accomplish this task even better.

3. Although the oscillations of light neutrinos are well established, the precise masses, mixing angles and particularly the CP violating phase in lepton sector and the Majorana or Dirac nature of neutrinos, must be determined by future experiments.

4. The greatest challenge for the astroparticle and particle physics will be to identify cold dark matter particles, the heavy Majorana neutrinos with masses from $\mathcal{O}(10^{12} \text{eV})$ to $\mathcal{O}(100 \text{eV})$. It is not excluded that the LHC discovers the pair of the lightest of the three heavy species. The galactic center H.E.S.S. source J1745-290 is a perfect source of gamma rays coming from annihilation of the CDM particles. No time-variability of the source spectrum, point-like topology of the source and the characteristic power spectrum are almost impossible to interpret by other astrophysical processes. This H.E.S.S. source, if coming from the CDM annihilation, refers to very high masses of the CDM particles and large annihilation cross sections; thus, it differs significantly from the standard expectations of the supersymmetric models. Recent astrophysical results of the antimatter search (Pamela, ATIC, etc.) and the diffuse photon background (Fermi-LAT), are still inconclusive for the indirect CDM search. New Auger data confirms the GZK cutoff, meaning that very rare cosmic rays of the highest energies are suppressed owing to the interaction with the CMB. However, there is still a possibility that subdominant flux of heavy Majorana neutrinos produced at very large cosmic distances can cause UHE cosmic rays type events by annihilation with galactic heavy neutrinos [31].

5. A great task for cosmology and astrophysics is to measure the separate abundances of dark matter and dark energy (angular momentum of the Universe). The $\Lambda CDM$ concordance model is already under scrutiny because of the observed anomalous anisotropic large scales flows, small large scale power of the CMB, violation of parity (isotropy), etc.

6. The measurement of the vorticity, its chirality and magnitude should be exercised by the CMB (corrected Ellis-Bruni covariant variables must be used [29]), by the Faraday rotation of distant radio sources [33], by examination of spiral galaxies [34], by the anisotropic anomalous flow of the clusters of galaxies [35], by the study of galactic correlation...
functions, by the study of the high-redshift objects, etc. If the vorticity does not vanish, its imprint is everywhere.

7. LISA mission, originally devoted to catching gravity waves, might measure solar gravity potentials with high accuracy. The presence of the anomalous cosmic force as a consequence of the cosmic acceleration (this is a new independent cosmic parameter like expansion or vorticity) can then be easily established [36].

8. There are no tensor mode cosmic matter perturbations in my concept of the Universe, contrary to the inflationary scenario, for two reasons: 1. gravity waves do not exist, and 2. inflationary epoch does not exist. However, the gravity wave searches must give the ultimate negative or positive answer, similarly to Michelson-Morley experiment agenda to study aether, in order to formulate physical laws. Anyhow, it is more probable to observe the action of quadrupole potentials [37] on light rays, than to observe quadrupole radiation.

9. The ultraviolet cutoff is explicitly contained in Green’s functions of my BY theory, treated perturbatively or nonperturbatively as a quantum relativistic field theory in the noncontractible space. In ref. [38] I show that the UV cutoff (minimal length) can be measured in quantum mechanics as a source of spectral line broadening, using a formalism of the quantum holonomy operators. The effect is more pronounced for smaller scale of the quantum mechanical system, such as in the nuclear transitions.

To conclude, the theorists should be more humble with respect to mathematics and in their theories use particles, vacua and tensors, instead of pseudoparticles, pseudovacua and pseudotensors. The predictions of their theories will then be more trustworthy. Otherwise, we shall witness an endless search for gravity waves, Higgs bosons, inflaton scalars, axions, neutralinos, Hawking radiation, instantons, unparticles, extra dimensions, ...

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