Thirty Unsolved Problems in the Physics of Elementary Particles

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Unlike what some physicists and graduate students used to think, that physics science has come to the point that the only improvement needed is merely like adding more numbers in decimal place for the masses of elementary particles or gravitational constant, there is a number of unsolved problems in this field that may require that the whole theory shall be reassessed. In the present article we discuss thirty of those unsolved problems and their likely implications. In the first section we will discuss some well-known problems in cosmology and particle physics, and then other unsolved problems will be discussed in next section.

1 Unsolved problems related to cosmology

In the present article we discuss some unsolved problems in the physics of elementary particles, and their likely implications. In the first section we will discuss some well-known problems in cosmology and particle physics, and then other unsolved problems will be discussed in next section. Some of these problems were inspired by and expanded from Ginzburg's paper [1]. The problems are:

1. The problem of the three origins. According to Marcelo Gleiser (Darthmouth College) there are three unsolved questions which are likely to play significant role in 21st-century science: the origin of the universe, the origin of life, and the origin of mind;
2. The problem of symmetry and antimatter observation. This could be one of the biggest puzzle in cosmology: If it's true according to theoretical physics (Dirac equation etc.) that there should be equal amounts of matter and antimatter in the universe, then why our observation only display vast amounts of matter and very little antimatter?
3. The problem of dark matter in cosmology model. Do we need to introduce dark matter to describe galaxy rotation curves? Or do we need a revised method in our cosmology model? Is it possible to develop a new theory of galaxy rotation which agrees with observations but without invoking dark matter? For example of such a new theory without dark matter, see Moffat and Brownstein [2, 3];
4. Cosmological constant problem. This problem represents one of the major unresolved issues in contemporary physics. It is presumed that a presently unknown symmetry operates in such a way to enable a vanishingly small constant while remaining consistent with all accepted field theoretic principles [4];
5. Antimatter hydrogen observation. Is it possible to find isolated antimatter hydrogen (antihydrogen) in astrophysics (stellar or galaxies) observation? Is there antihydrogen star in our galaxy?

Now we are going to discuss other seemingly interesting problems in the physics of elementary particles, in particular those questions which may be related to the New Energy science.

2 Unsolved problems in the physics of elementary particles

We discuss first unsolved problems in the Standard Model of elementary particles. Despite the fact that Standard Model apparently comply with most experimental data up to this day, the majority of particle physicists feel that SM is not a complete framework. E. Goldfain has listed some of the most cited reasons for this belief [5], as follows:

6. The neutrino mass problem. Some recent discovery indicates that neutrino oscillates which implies that neutrino has mass, while QM theories since Pauli predict that neutrino should have no mass [6]. Furthermore it is not yet clear that neutrino (oscillation) phenomena correspond to Dirac or Majorana neutrino [7];
7. SM does not include the contribution of gravity and gravitational corrections to both quantum field theory and renormalization group (RG) equations;
8. SM does not fix the large number of parameters that enter the theory (in particular the spectra of masses, gauge couplings, and fermion mixing angles). Some physicists have also expressed their objections that in the QCD scheme the number of quarks have increased to more than 30 particles, therefore they assert that QCD-quark model cease to be a useful model for elementary particles;

9. SM has a gauge hierarchy problem, which requires fine tuning. Another known fine-tuning problem in SM is "strong CP problem" [8, p. 18];
10. SM postulates that the origin of electroweak symmetry breaking is the Higgs mechanism. Unfortunately Higgs particle has never been found; therefore recently some physicists feel they ought to introduce more speculative theories in order to save their Higgs mechanism [9];
11. SM does not clarify the origin of its gauge group $SU(3)\times SU(2)\times U(1)$ and why quarks and lepton occur as representations of this group;
12. SM does not explain why (only) the electroweak interactions are chiral (parity-violating) [8, p. 16];
13. Charge quantization problem. SM does not explain another fundamental fact in nature, i.e. why all particles have charges which are multiples of $e/3$ [8, p. 16].

Other than the known problems with SM as described above, there are other quite fundamental problems related to the physics of elementary particles and mathematical physics in general, for instance [10]:

14. Is there dynamical explanation of quark confinement problem? This problem corresponds to the fact that quarks cannot be isolated. See also homepage by Clay Institute on this problem;
15. What is the dynamical mechanism behind Koide's mixing matrix of the lepton mass formula [11]?
16. Does neutrino mass correspond to the Koide mixing matrix [12]?
17. Does Dirac's new electron theory in 1951 reconcile the quantum mechanical view with the classical electrodynamics view of the electron [13]?
18. Is it possible to explain anomalous ultraviolet hydrogen spectrum?
19. Is there quaternion-type symmetry to describe neutrino masses?
20. Is it possible to describe neutrino oscillation dynamics with Bogoliubov-deGennes theory, in lieu of using standard Schrödinger-type wave equation [6]?
21. Solar neutrino problem — i.e. the seeming deficit of observed solar neutrinos [14]. The Sun through fusion, send us neutrinos, and the Earth through fission, antineutrinos. But observation in SuperKamiokande etc. discovers that the observed solar neutrinos are not as expected. In SuperKamiokande Lab, it is found that the number of electron neutrinos which is observed is 0.46 that which is expected [15]. One proposed explanation for the lack of electron neutrinos is that they may have oscillated into muon neutrinos;
22. Neutrino geology problem. Is it possible to observe terrestrial neutrino? The flux of terrestrial neutrino is a direct reflection of the rate of radioactive decays in the Earth and so of the associated energy production, which is presumably the main source of Earth's heat [14];
23. Is it possible to explain the origin of electroweak symmetry breaking without the Higgs mechanism or Higgs particles? For an example of such alternative theory to derive boson masses of electroweak interaction without introducing Higgs particles, see E. Goldfain [16];
24. Is it possible to write quaternionic formulation [17] of quantum Hall effect? If yes, then how?
25. Orthopositronium problem [18]. What is the dynamics behind orthopositronium observation?
26. Is it possible to conceive New Energy generation method from orthopositronium-based reaction? If yes, then how?
27. Muonium problem. Muonium is atom consisting of muon and electron, discovered by a team led by Vernon Hughes in 1960 [19]. What is the dynamics behind muonium observation?
28. Is it possible to conceive New Energy generation method from muonium-based reaction? If yes, then how?
29. Antihydrogen problem [20]. Is it possible to conceive New Energy generation method from antihydrogen-based reaction? If yes, then how?
30. Unmatter problem [21]. Would unmatter be more useful to conceiving New Energy than antimatter? If yes, then how?

It is our hope that perhaps some of these questions may be found interesting to motivate further study of elementary particles.

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