Essay

The Brilliance and Poverty of Standard Model: Theory Crisis and the Selection of a Development Course

Alexander G. Kyriakos*
Saint-Petersburg State Institute of Technology, St.-Petersburg, Russia

Abstract

For the last 30 years, theoretical physicists talk about the crisis of the fundamental theory - the Standard Model (SM) theory and try to build the theory "beyond the SM". Recent experimental results confirm the existence of a crisis in the SM but do not confirm the theories "beyond the SM." The present note is devoted to the issue of selection of a path of the development of theoretical physics.

Keywords: Quantum field theory, Standard Model, crisis, development course.

The quantum field theory (QFT), called Standard Model (SM), is the contemporary theory of elementary particles and their interactions. This is very remarkable, but strange theory.

From one side, its formulas are confirmed by experiments in the majority of the cases with the very high accuracy. Since in the natural sciences the experimental confirmation is the criterion of the truth of theory, unambiguously the majority of formulas of SM is completely accurate. Therefore the SM can be considered the pride of theoretical physicists and experimenters, who work in the area of elementary particles.

From the other side, in the recent decades arrived the understanding that the SM is not perfect. In this very effective theory are two grave disadvantages:

1) In SM there are at least 18 parameters, which can not be calculated, but are introduced in theory "by hand" as experimental data. Thus, the need of their calculations exists. Special difficulty the calculations of the masses of particles cause. In SM the particles' mass are originally equal into zero. But the special mathematical apparatus - "the mechanism of Higgs" - is here developed, which describes the procedure of acquisition of mass by the particles. The experiments did not yet confirm this "mechanism", bringing into question the SM theory.

2) Structure of SM as theory differs essentially from the classical scheme of the construction of axiomatic theories.

As examples of successful physical axiomatic theories serve, e.g., the Newton mechanic and classical electrodynamics. In these theories on the basis of several postulates (or, which is the same, axioms) all formulas, necessary for calculating of the physical values in these area of science, are derived.

At the same time, the structure of quantum theories, in particular of SM, is non-axiomatic.
A characteristic feature of these theories is the selection of procedures for calculating the required quantities, in each case based on detached and randomly selected postulates and definitions. Richard Feynman called these theories "Babylon theories" and the axiomatic theory - the "Greek theory" (Feynman, 1964; Kyriakos, 2010).

* Correspondence: AlexanderG.Kyriakos, Saint-Petersburg State Institute of Technology, St.-Petersburg, Russia. Present address: Athens, Greece, E-mail: a.g.kyriak@hotmail.com

Briefly and meaningfully about this peculiarity of QFT spoke one of the creators of SM, the Nobel price laureate Murray Gell-Mann(Gell-Mann, 1981):

"*Quantum mechanics, that misterious, confusing discipline, which none of us really understands but which we know how to use. It works perfectly, as far as we can tell, in the describing physical reality, but it is a 'counter-intuitive discipline', as social scientists would say. Quantum mechanics is not a theory, but rather a framework, within which we believe any correct theory must fit.*"

It is necessary to recognize that such structure of theory is completely acceptable for the calculation applications. But from the other side this structure does not give the possibility to answer all questions.

Among these, for example, are: what is the origin of the mass of particles; why fundamental particles are point; why the wave function has not a physical sense, and many others.

The understanding of the fact that SM '*is not a theory, but rather a framework, within which we believe any correct theory must fit*', cause the desire to construct the completely axiomatic theory of elementary particles.

In particular, as such theory was planned the theory of superstring, but absence of predictions brings to question about its truth. (About the situation in the superstring theory and SM see, e.g., (Woit, 2007).

If we assume that there is an axiomatic theory of elementary particles, then which it must be?
Obviously, it must contain the limited number of the axioms, which, as in the case of, e.g., geometry of Euclid, Newton mechanics or Maxwell-Lorentz's electrodynamics will give all necessary results of theory as theorems.

At the same time, all mathematical results of this theory must completely coincide or be equivalent to corresponding mathematical results of the Standard Model, which are strictly checked by experiment.

The axiomatic theory must either remove the restrictions in quantum field theory, or prove conclusively their need. For example, such theory must not only confirm the uncertainty principle of Heisenberg, but also it must find the reasons for its existence. It cannot deny the faithfulness of the statistical interpretation of wave function, but it must give its physical interpretation. Axiomatic theory must explain the origin of the mass of particles, but it must show that their calculation can be formulated in the form of the Higgs mechanism (even if Higgs's boson will not be found, the mathematician description of the Higgs mechanism can be exist in the theory in order to explain the appearance of masses of gauge fields in the electro-weak theory). And the like.

It occurs that such theory can be actually built. The 'Prespacetime Journal' http://prespacetime.com/index.php/pst) is the first place, where its last version is published in a complete form (a short English version see (Kyriakos, 2009)).

How does this theory differ from the SM? First of all, it is axiomatic theory.

In order not to violate the principle of superposition, physicists would for long time consider that all fundamental theories must be linear. Specifically, on this base the quantum field theory was built. But, strictly speaking, in nature all processes are nonlinear.

Nonlinearity is the basic feature of the proposed axiomatic theory – nonlinear theory of elementary particles (NTEP). In the same time, SM is the linear approximation of this nonlinear theory. It appears that this nonlinearity is the peculiarity of physics of elementary particles. It appears also that all difficulties of the existing theory of elementary particles are connected with the nonlinearity, since we are attempted to describe the nonlinear world as linear. Taking into account nonlinearity the proposed theory answers the questions, which in SM cause difficulties. But at the same time it doesn't come into conflict with any SM result, which is strictly checked experimentally.

The proposed theory based on the fact that the wave functions of elementary particles are special nonlinear wave fields. In the normalized form they can be interpreted statistically, as in SM. These fields are nonpoint, but they can be recorded as point, disrupting in no way the idea SM for point particles.

For these fields is valid the uncertainty principle as for any wave packets; but at the same time, nonlinear "packets", as soliton, have not spreading, since they are monochromatic.

This theory describes the appearance of masses of particles, without requiring the presence of the vacuum of Higgs; instead it is sufficient here the usual physical vacuum, in particular, electromagnetic. But at the same time, in the nonlinear theory mathematics of spontaneous symmetry breakdown can be recorded similarly to Higgs's mechanism. And the like.

The primary attention of physicists is riveted now to the search of the Higgs boson - the particle, whose existence is necessary for the completion of Standard Model. Physicists hope that this will make it possible to begin the study of the new, deeper level of the structure of our world "Beyond Standard Model". But last results indicate the serious difficulties in achieving these goals.

Specially for the search of Higgs's boson and supersymmetrical particles was built LHC (Large Hadron Collider, Europe), which cost many billion dollars.

Early results (2001), obtained on LEP (Europe) and last results (2011), obtained on the Tevatron into Fermilab (Fermi National Accelerator Laboratory, USA) and on LHC excluded the existence of the standard Higgs boson and supersymmetrical particles over a wide range of the masses.
In short, the general results of Higgs searches presented at the Lepton Photon science meeting in Mumbai are the following **(**News, Sci-Tech, 2011):

> "*Results from the Large Hadron Collider have disappointed theorists on the lookout for Higgs boson and has them rethinking that the basic idea of supersymmetry might be wrong. Researchers failed to find evidence of so-called "supersymmetric" particles, which many physicists had hoped would plug holes in the current theory.*
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> *According to Dr Tara Shears of Liverpool University, a spokesman for the LHCb experiment: "It does rather put supersymmetry on the spot".*
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> *The theory of supersymmetry,… which was developed 20 years ago, can help to explain why there is more material in the Universe than we can detect – so-called "dark matter"…*
>
> *Dr Joseph Lykken of Fermilab…: "There's a certain amount of worry that's creeping into our discussions," he told BBC News. The worry is that the basic idea of supersymmetry might be wrong: "It's a beautiful idea. It explains dark matter, it explains the Higgs boson, it explains some aspects of cosmology; but that doesn't mean*

> *it's right". "It could be that this whole framework has some fundamental flaws and we have to start over again and figure out a new direction," he added*."

(For addition information see (Combination of Higgs searches, 2011; Ghosh, 2011; Shears, 2011a,b; Gibbs, 2011)).

To the end of 2011, as it is assumed, the LHC will give the end results. In the case if LHC does not find the Higgs boson, it will mean that the mass production mechanism is realized in nature by another method. Then the question arises, how it should the modern theory of elementary particles be rebuilt?

Judging by the statements of theoretical physicists, they believe that the refinement of the theory must be done in the same way, as the development of SM and that success will be achieved by further complicating the existing theory.

But maybe they make a big mistake. There is reason to believe that the theory does not need to be complicated but restructured. Maybe it is time to replace the "Babylon theory" with the "Greek theory"?

The proposed nonlinear theory of elementary particles makes it possible to complete the construction of the theory of elementary particles and to facilitate the creation of physics "beyond Standard Model", since originally it does not contain the Higgs boson and it does not need supersymmetry and other super-ideas. At the same time the nonlinearity points the direction, in which efforts should be undertaken to better understand the existing microworld.

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