Essay

Naturalness, Fine Tuning & Recent Situation In Theoretical Physics

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Abstract

Do the results from LHC mean end of theoretical physics as a predictive discipline? Should we accept multiverse? Should we give up the notion of naturalness and accept fine tuning? To my opinion the situation in fundamental physics should be looked from a wider perspective than that given by last forty year. Physics is in crisis. The history of science is not steady linear evolution but a continual fight between mediocrists and visionaries. Mediocrists quite often win in the short run but lose in the long run.

Key Words: naturalness, fine tuning, multiverse, superstring theory, revolution.

There has been a considerable amount of discussion in blogs about the recent situation in fundamental physics. Do the results from LHC mean end of theoretical physics as a predictive discipline? Should we accept multiverse? Should we give up the notion of naturalness and accept fine tuning? These are interesting questions.

Phil Gibbs answered affirmatively to these questions in his blog post, Lubos wrote in more skeptic tone about these topics, and Peter Woit touched these questions in his comments about talks held in "Prospects in Theoretical Physics" - a program for graduate students and postdocs in Princeton. I wrote a couple of comments about the situation to the blog of Phil Gibbs and combine them below to a more polished commentary.

To my opinion the situation in fundamental physics should be looked from a wider perspective than that given by last forty - not very successful - years of theoretical high energy physics. Physics is definitely in crisis. Multiverse scenario and the view about necessity of fine tuning are conclusions from sticking to certain basic dogmas and refusal to admit that some of them might be badly wrong. I do not believe in all these dogmas and therefore do not share these pessimistic conclusions. I tend to see the recent situation as an ego catastrophe (we failed to find *the* theory so that there can be is no theory) which is outcome of accepting quite too many ad hoc assumptions as final truths. The situation can be also seen as the final collapse of reductionist view about physics.

Alternative for multiverse

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I believe that standard model symmetries have fundamental meaning being selected by their very special mathematical and physical character. GUT approach denied this possibility and led theoreticians on wrong track leading to standard SUSY and eventually to M-theory landscape.

Also, the fact that the observed space-time is 4-dimensional probably contains a very important message. But the idea of 4-dimensional space-time became old-fashioned as superstring revolutions appeared. Sociological factors played a key role in the process. The attitude that thousands of brilliant theoreticians cannot be wrong allowed the situation to develop to a catastrophe made manifest by the findings at LHC.

Even in this situation we are told that we should continue to follow the leaders and now give up even the belief that theoretical physics can explain and predict - the very motivation of superstring theory originally. This is apparently because few generations of theoretical particle physicists became victims of mass psychosis.

Standard model symmetries and space-time dimension would be forced by the existence of geometry for infinite-dimensional space - "world of classical worlds" (WCW) consisting of 3-surfaces defining the analog of Wheeler's superspace. WCW geometry would realize a generalization of Einstein's geometrization program to a geometrization of the entire quantum physics rather than only the classical physics.

In the case of much simpler loop spaces the mere existence of this Käahler geometry fixes it uniquely for given group G defining the loop group (the existence of Riemann connection requires infinite-dimensional Kac-Moody group as isometries as shown by Freed). Standard model symmetries fix WCW (equivalently, the imbedding space $H = M^4 \times CP_2$ containing space-times as 4-surfaces) and the conjecture is that the mathematical existence of WCW Kahler geometry implies the same WCW. In accordance with the vision about physics as generalized number theory, standard model symmetries would have also number theoretical interpretation in terms of classical number fields. For instance, color group would correspond to isometries of CP_2 and subgroup of automorphisms of octonions.

Concerning the fine tuning of coupling parameters, I believe that fine tuning of dynamical parameters is a basic aspect of quantum evolution leading to life as we identify it, but that standard model symmetries and space-time dimension are mathematical necessities rather than outcomes of evolution in some region of multiverse.

p-Adic length scale hypothesis and selection of preferred p-adic primes provides a realization of the evolution selecting preferred mass scales for elementary particles. One should therefore accept the obvious: superstring model describes physics of 2-D space-time but, as it has become clear , the attempts to deduce real physics from it are doomed to fail. Nature does not love tricks. Super-conformal symmetry remains the genuine contribution of string models to physics and the natural next step is to finally generalize this symmetry to four dimensions.

Reductionism as the basic cause of the catastrophe

I have spent much time during last decades in trying to understand why we have gradually ended up with this dead end and why the professionals are not able to see that there is no way out except radical rethinking of fundamentals. The history of physics is history of bold and often wrong generalizations. The naive length scale reductionism is one of the most influential of these wrong assumptions. It has been raised to a level of dogma and together with materialistic world view more or less defines nowadays what it is to be scientific.

Fractality is very natural candidate for replacing the reductionism and quantum theory strongly encourages to give up materialism but still taken as givens by particle physicists. Reductionism is indeed responsible for many far reaching and probably wrong dogmas in present day physics.

Reductionism forces us to believe that the strange findings at RHIC and LHC about heavy ion collisions and proton heavy ion collisions are consistent with QCD although here we would have the new physics that we are so desperately searching for. This relates also to naturalness. To my opinion, the attempt to understand mass ratios of various fermion generations group theoretically is doomed to fail. If one accepts the notion of length scale hierarchy implied by fractality there is no need to extend standard model symmetries. The fact that separate B and L conservation is consistent with experimental facts provides an additional strong constraint.

Length scale reductionism also forces us to believe that biology and brain science are just complexity, consciousness is just an epiphenomenon, and free will is an illusion. Theoretical physicists lose a huge treasure trove of anomalies which could help to achieve the sought for unification. As a consequence of this isolation from experiential reality, theoretical physicists have divided into half-religious sects such as super-stringers and loop gravitists. Feynman has talked about general relativists gathering to their yearly meetings and discussing again and again the same old dead ideas. Sadly, Feynman's characterization seems to apply quite well also to Strings 2013 and Loops 2013.

Length scale reductionism guides us to search dark matter from elementary particle length scales. This direction might be completely wrong: TGD suggests generalization of quantum theory by introducing the hierarchy of effective Planck constants and in this framework dark matter as quantum coherent phases would emerge in long length scales.

Ironically, already Tesla made observations, which one might be interpret as indications for the existence of something behaving much like dark matter in TGD sense. Tesla spoke of "cold electricity" not seen in ampere-meter but as a child of his time assigned with it what he called aether particles. Did Tesla discover the dark matter for more than century ago? One cannot exclude this possibility since his experiments typically used high voltages, low frequencies, and using sudden pulses resulting in switching on of electrical circuits and in this manner testing the boundaries of Maxwell's theory in long rather than short scales (as particle physics does).

In this context one must mention also the strange quantum like effects of ELF radiation on vertebrate brain and the fact that cell membrane resting potential corresponds to an electric field above the dielectric breakdown in air. Tesla's vision about future technology was also surprisingly far reaching and he also saw a possible connection with the energy technology and biology: his ideas are still revolutionary. To me the example of Tesla demonstrates that the

history of science is not steady linear evolution but a continual fight between mediocrists and visionaries. Mediocrists quite often win in the short run but lose in the long term.

Reference

1. http://matpitka.blogspot.com/2013/07/about-naturality-fine-tuning-and-recent.html