Essay

Do We Need a Theory of Everything?

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Abstract

Eventually people who do TOE must take also consciousness seriously and this leads to the fundamental questions about quantum measurement theory. What is interesting is that Weinberg has changed his views about Copenhagen interpretation better known as "shut-up-and-calculate" dogma. I will say something about Nicolai's views, the comments by Weinberg, and Lisa Randall's interview with New Scientist in this essay.

Key Words: Theory of Everything, Higgs Boson, New Scientist, Lisa Randall.

There is an interview of Lisa Randall in New Scientist about building of theories of everything. Phil Gibbs wrote a nice commentary of the interview, and this is my view on the subject. Quantum gravity and TOE relate very closely and there is a very nice critical article about the recent situation in quantum gravity from the perspective of particle physics by Nicolai.

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The views of Nicolai about quantum gravity as seen from particle physics perspective

Part of the Nicolai's message is that the best manner to make progress in quantum gravity is to understand why standard model gauge group is so special. To this question the existing approaches have not answered or not even tried to answer. Separation of quantum gravity from other interactions is the worst thing to do. The next worst thing to do is to see recent day physics as nothing but low energy phenomenology, which happens to described by a more or less random gauge group applying in this particular corner of the multiverse. I cannot but agree with Nicolai.

As Nicolai expresses it, in standard model the fine tuning of Higgs mass in order to sail through the extremely narrow strait between the Scylla of vacuum instability and the Kharybdis of Landau pole causing Higgs self coupling to become infinite. This feat requires a correlation between Planck scale physics and TeV scale physics so that low energy physics becomes very relevant for understanding of Planck length scale physics. Nicolai suggests that some kind of

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negative feedback making it possible to sail through this strait, and suggests that conformal invariance is the symmetry (broken in quantum theory automatically) making this feedback possible. Usually supersymmetry is though to be the stabilizer but LHC has posed very severe limits on N=1 SUSY. This is of course only the simplest option and TGD leads to its own view about SUSY.

In TGD framework p-adic physics is what causes the correlation between various length scales. The standard reductionistic vision about the reduction of physics to Planck length scale is replaced with fractality meaning that there is entire infinite hierarchy of physics which are fractal variants of each other. The 3-surfaces representing particles can have arbitrarily large size scale - not only Planck scale as in standard dogma. Also the hierarchy of effective Planck constants and hierarchy of size scales associated with causal diamonds define length scale hierarchies. This strongly correlates the physics in long length scales with the physics in short length scales.
Nicolai suggests that conformal invariance acts as stabilizer. Super-conformal invariance generalized by replacing 2-D basic objects with 3-D light-like surfaces is indeed a basic pillar of TGD. In fact, the notion of complex structure generalizes from 2-D case to 4-D space-time level. For Euclidian regions it means 4-D complex structure and for Minkowskian regions to what I have christened as Hamilton-Jacobi structure. Rather remarkably, the preferred extremal property can be formulated without any reference to Kähler action and also minimal surface equations and Einstein-Maxwell equations with cosmological term hold true with G and Lambda coming as predictions.

Full D=4 generalized super-conformal symmetry applies to purely right handed neutrinos delocalized along entire space-time surfaces. Ordinary 2-D super-conformal invariance applies at string world sheets at which other spinor modes are localized. These infinite-D symmetries are crucial for the very mathematical existence of the "world of classical worlds" and therefore also for the physics. Conformal invariance generalizes scale invariants so that very strong correlation between physics in ultrashort and long length scales is expected.

Is something wrong with Copenhagen interpretation?
A second interesting comment came from Weinberg as discussed by Lubos. At the age about 80 years he has been able to change his views about "interpretations" of QM and admits that there is something wrong here. The history of physics shows that single anomaly or even paradox is infinitely more valuable than tons of data. Therefore standard TOErs make a fatal error when they pretend that Copenhagen interpretation is the final one. At some day we must include conscious observer as part of the physical system, and the interpretational problems of QM give strong clue how to do it.

The interpretational problems of TGD forced to take quantum measurement theory seriously. This leads to radically news about basic ontology forcing to give up the materialistic dogma seeing consciousness as one particular property of physical state. The basic paradox of state function can be solved without totally giving up the notion of objective reality defined as "solution of field equations" but accepting that the defining property of consciousness is that it replaces this reality with a new one. Zero energy ontology is one crucial implication of this

picture. Also a radically new view about time explaining the different character of subjective time and geometric time of physicist emerges.

Questions posed to Lisa Randall about unification
Also some comments relating to the questions posed to Lisa Randallare in order.

1. The first three questions can be lumped together. *Is TOE the dream of every physicist and isn't it a myth? Isn't beautiful mathematics supposed to lead to the truth? Isn't it then a problem that our best theories are so messy?*

TOE of is a must for every theoretician with imagination and the passion to understand. What TOE means depends on the mathematics available (besides mathematical abilities of the TOEr;-)). Mathematics evolves so that TOEing poses evolutionary pressures also on mathematics itself.

First example from TGD: The geometrization program of Einstein generalizes to infinite-D context and leads to the notion of "world of classical worlds", whose very existence as Kähler geometry requires the existence of infinite-D isometry group (the property of being union of infinite-D symmetric spaces) and strongly suggests the uniqueness of the geometry (already for loop spaces Kähler geometry is unique). This is extremely abstract mathematics but leads to the vision that infinite-dimensional existence and therefore also physics is unique, an encouraging news for a TOEr. What is amusing is that in this approach holography reduces to general coordinate invariance and Bohr orbitology usually regarded as approximation generalizes and becomes an exact part of quantum theory. In infinite-D context also Born rules are the only possibility for purely mathematical reasons. Also Fermi statistics finds a geometrization.

Second example from TGD: The idea about number theoretical universality of physics is very powerful guideline in attempts to fuse real and p-adic number based mathematics to something more general. The problems are very concrete: for instance, how to integrate in p-adic context?! This mathematics will certainly be beautiful and abstract but the need for it is forced by physics at the concrete experimental level (in TGD framework the original motivation comes from mass calculations based on p-adic thermodynamics plus super-conformal invariance). Number theoretical vision involves naturally also quaternions and octonions and they relate very intimately to standard model symmetries. Standard modely looks messy only if one has no idea about the meaning of the underlying symmetries and sees the group as just one choice among infinity of other choices.

2. *Was the discovery of Higgs a surprise?*

Whether Higgs exists or not in TGD Universe has been one of the key questions from the very beginning of TGD, and I have considered very many scenarios. It is now clear that Higgs like state is there and is indeed possible in TGD Universe and even that Higgs vacuum expectation has a space-time correlate in TGD Universe. This conclusion came only during last year when I realized the solutions of the modified Dirac equation are localized at 2-D string world sheets for fermion modes which are not pure right-handed neutrinos - this from the condition that spinor modes have well-defined em charge. If string world sheet is minimal surface in space-time, it is

not in general minimal surface in the imbedding space and CP_2 part of its second fundamental form defines a dimensional parameter whose value for the ends of braid strands carrying fermion number could correspond to Higgs vacuum expectation at QFT limit.

The story Higgs taught to me how valuable experimental input is for theoretician, and how important it is to see how theory-dependent our interpretations of data really are. What we are doing is explaining the data in terms of Higgs: we do not see a particle carrying a label "Higgs"! Higgs mechanism could well be the only possible description of massivation in QFT context but is just a mimicry. For instance, the proportionality of Higgs-fermion couplings to fermion mass follows automatically if coupling is derivative coupling so that the assumption about Higgs vacuum expectation only effectively explains fermion masses! The predictive description must be in terms of a microscopic theory and if this theory has QFT limit then Higgs mechanism is the phenomenological parametrization this limit. Nothing more!

3. *What would an extra dimension look like?*

This question is a teaser to Lisa Randall who has been proposing large extra dimensions now excluded by LCH. In TGD framework extra dimensions are not additional space-time dimensions but dimensions of the imbedding space containing space-time surfaces as 4-D sub-manifolds. This is very important distinction between TGD and string models. 3-branes (4-D surfaces) in M-theory are analogous to space-time surface but the dynamics is totally different. The new dimensions in TGD framework are neither large nor have Planck scale. The size scale of CP_2 is about 10^4 Planck lengths and roughly corresponds to the unification scale for GUTs.
This prediction comes from p-adic mass calculations: the prediction for electron mass assuming that it corresponds to Mersenne prime M_{127} fixes the size scale of CP_2, and the overall success of calculations supports this identification of electron's p-adic length scale (largest non-super-astrophysical Mersenne prime length scale is in question, Gaussian Mersennes give rise to additional length scales and four of them are between 10 nm and 2.5 micrometers, the biological most important length scales).

4. *What if we not see any new physics at LHC?*

It is quite well possible that we have been seen it for years but our theoretical conditioning - forced by methods comparable to those applied by Pavlov to his poor dogs - prevents to realize that we see it. The too high rate for the decays of Higgs to gamma pairs could be due to an additional wide resonance decaying to gamma pairs. Fermi satellite has reported 135 GeV bump which the existing paradigm wants to interpret as dark matter particle and this leads to problems. Perhaps the most important finding was made by RHIC for seven years ago: the production of charged particle pairs for which members tend to have parallel or antiparallel momenta as if they were produced in decays of string like objects. This is not at all consistent with perturbative QCD predicting QCD plasma but people soon introduced the notion of color glass phase to save QCD. My personal bet is that M_{89} hadron physics (as I call it) with general mass scale 512 times higher than that for ordinary hadron physics is doing its best to inform the stubborn theoreticians about its presence.

Reference

1. http://matpitka.blogspot.com/2013/01/do-we-need-theory-of-everything.html