Report

Indications of New Physics Predicted by TGD

Matti Pitkänen [1]

Abstract

TGD predicts a lot of physics in LHC scales. Two scaled up copies of hadron physics, higher families of gauge bosons and Higgs particles, and fundamental sfermions identifiable as bound states of fermions and right handed neutrino or antineutrino or their pair giving rise to leptoquarks states in quark sector, are suggestive. The predictive power of TGD approach comes from the p-adic length scale hypothesis allow one to predict the masses of new states from known ones by simple scaling argument. One knows precisely what to search for unlike in the case of a typical model containing large number of unknown parameters. The key prediction are two spectroscopies of new hadrons rather than a couple of some exotic particles and sooner or later their existence should become manifest. In this report I summarize the recent indications for the existence of these states. In particular, the identification of the recently reported bump at 750 GeV as f_0 exotic meson of M_{89} hadron physics, of the reported 2 TeV bump as pion of $M_{G,79}$ physics, and of the reported 4 TeV bump as Higgs of M_{79} electroweak physics assignable to the second generation of weak gauge bosons. The existence of M_{89} neutral pion with mass around 67.5 GeV is now a rather firm prediction.

1 Some almost predictions of TGD

TGD predicts a lot of new physics at LHC energy scale.

1. TGD suggests the existence of two scaled up copies of the ordinary hadron physics labelled by Mersenne prime $M_{107} = 2^{107} - 1$ [4]. The first copy would corresponds to M_{89} with mass spectrum of ordinary hadrons scale by factor $2^9 = 512$ and second one to Gaussian Mersenne $M_{G,179} = (1+i)^{79} - 1$ with mass spectrum of ordinary hadrons scaled by 2^{14}. The signature of the this new physics is the existence of entire hadronic spectroscopy of new states rather than just a couple of exotic elementary particles. If this new physics is there it is eventually bound to become visible as more information is gathered. If this new physics is there it is eventually bound to become visible as more information is gathered. What is especially interesting that in heavy ion collisions at RHIC and in proton heavy ion collisions at LHC dark variants of M_{89} hadrons with Compton length scaled up by $h_{eff}/n = n$ to hadronic or even nuclear dimensions could have been produced. This might be the case in all collisions of ordinary hadrons.

2. TGD also suggests [3,4] the existence of copies of various gauge bosons analogous to higher fermion generations assigned to the genus $g = 0, 1, 2$ of boundary topology of partonic 2-surface: genus is actually the of partonic 2-surface whose light-like orbit is the surface at which the induced metric changes its signature from Minkowskian to Euclidian. Copies of gauge bosons (electroweak bosons and gluons) and Higgs correspond to octet representations for the dynamical "generation color" group SU(3) assignable to 3 fermion generations. The 3 gauge bosons with vanishing "color" are expected to be the lightest ones: for them the opposite throats of wormhole contact have same genus. The orthogonality of charge matrices for bosons implies that the couplings of these gauge bosons (gluons and electroweak bosons) to fermions break universality meaning that they depend on fermion generations. There are indications for the breaking of the universality. TGD differs from minimal supersymmetric extension of standard model in that all these Higgses are almost eaten by weak gauge bosons so that only the neutral Higgses remain.

[1]Correspondence: Matti Pitkänen `http://tgdtheory.fi/`. Address: Karkinkatu 3 I 3, 03600, Karkkila, Finland. Email: matpitka6@gmail.com.

One can ask whether the three lightest copies of weak and color physics for various boson families could correspond M_{89}, $M_{G,79}$ and M_{61}.

3. TGD SUSY is not $\mathcal{N} = 1$ [5]. Instead superpartners of particle is added by adding right handed neutrino or antineutrino or pair of them to the state. In quark sector one obtains leptoquark like states and the recent indications for the breaking of lepton universality has been also explained in terms of leptoquarks which indeed have quantum numbers of bound states of quark and right-handed neutrino also used to explain the indications for the breaking of lepton universality.

2 Indications for the new physics

During last years several indications for the new physics suggested by TGD have emerged. Recently the first LHC Run 2 results were announced and there was a live webcast (see `https://webcast.web.cern.ch/webcast/play.php?event=442432`).

1. The great news was the evidence for a two photon bump at 750 GeV about which there had been rumors. Lubos told earlier about indications for diphoton bump around 700 GeV. This mass differs only few percent from the naive calling estimate for the mass of ρ and ω mesons of M_{89} hadron physics for which masses for the simplest option are obtained by using p-adic length scale hypothesis by scaling with the factor $2^{(107-89)/2} = 512$ the masses of these mesons for ordinary M_{107} hadron physics.

   There is however a problem: these mesons do not decay to gamma pairs! The effective interaction Lagrangian for photon and ρ is product of Maxwell action with the divergence of ρ vector field. ρ is massive. Could the divergence be non-vanishing and could the large mass of ρ make the decay rate high enough? No. The problem is that the divergence should vanish for on mass shell states also for massive ρ. Also off mass shell states with unphysical polarization of ρ near resonance are excluded since the propagator should eliminate time-like polarizations in the amplitude. Scalar, pseudoscalar, or spin 2 resonance is the only option.

   If the scaling factor is the naive 512 so that M_{89} pion would have mass about 70 GeV, there are several meson candidates. The inspection of the experimental meson spectrum (see `http://fafnir.phyast.pitt.edu/exotica/mesons/mesonSpec.html`) shows that there is quite many resonances with desired quantum numbers. The scaled up variants of neutral scalar mesons $\eta(1405)$ and $\eta(1475)$ consisting of quark pair would have mases 702.5 GeV and 737.5 GeV and could explain both 700 GeV and 750 bump. There are also neutral exotic mesons which cannot be quark pairs but pairs of quark pairs (see `https://en.wikipedia.org/wiki/Exotic_meson`) $f_0(400)$, $f_0(980)$, $f_2(1270)$, $f_0(1370)$, $f_0(1500)$, $f_2(1430)$, $f_2(1565)$, $f_2(1640)$, $f_?(1710)$ (the subscript tells the total spin and the number inside brackets gives mass in MeVs) would have naively scaled up masses 200, 490, 635, 685, 725, 750, 715, 782.5, 820, 855 GeV. The charged exotic meson $a_0(1450)$ scales up to 725 GeV state.

2. There is a further mystery involved. Matt Strassler (see `http://profmattstrassler.com/2015/12/18/so-what-is-it/`) emphasizes the mysterious finding fact that the possible particle behind the bump does not seem to decay to jets: only 2-photon state is observed. As if the particle would not have any direct decay modes to quarks, gluons and other elementary particles. If the particle consists of quarks of M_{89} hadron physics it could decay to mesons of M_{89} hadron physics but we cannot directly observe them. Is this enough to explain the absence of ordinary hadron jets: are M_{89} jets somehow smoothed out as they decay to ordinary hadrons? Or is something more required? Could they decay to M_{89} hadrons leaking out from the reactor volume before a transition to ordinary hadrons?

   The TGD inspired idea that M_{89} hadrons are produced at RHIC in heavy ion collisions and in proton heavy ion collisions at LHC as dark variants with large value of $h_{eff} = n \times h$ with scaled up Compton length of order hadron size or even nuclear size conforms with finding that the decay of string like objects identifiable as M_{89} hadrons in TGD framework explains the unexpected properties of what was expected to be simple quark gluon plasma analogous to blackbody radiation. Could dark M_{89} eta mesons decaying only via digamma annihilation to ordinary particles be in question? Large h_{eff} states are produced at quantum criticality (they are responsible for quantal long range correlations) and the criticality would correspond to the phase transition fron confined to de-confined phase (at criticality confinement in the same or larger scale but with much longer Compton wavelength!). They have life times scaled up by h_{eff}/h factor: could this imply the leak out? Note that in TGD inspired biology dark EEG photons would have energies in bio-photon energy range (visible and UV) and would be exactly analogous to dark M_{89} hadrons.

3. Lubos mentions in his posting `http://tinyurl.com/p7muf9p` several excesses, which could be assigned with the above mentioned states. The bump at 750 GeV could correspond to scaled up copy of $\eta(1475)$ or - less probably - $f_0(1500)$. Also the bump structure around 700 GeV for which there are indications (see `http://tinyurl.com/jjuuuzj`) could be explained as a scaled up copy of $\eta(1405)$ with mass 702.5 GeV or $f_0(1370)$ with mass around 685 GeV. Lubos mentions also a 662 GeV bump (see `http://cds.cern.ch/record/2014119/files/HIG-15-001-pas.pdf`). If it turns out that there are several resonances in 700 TeV region (and also elsewhere) then the only reasonable explanation relies on hadron like states since one cannot expect a large number of Higgs like elementary particles. One can of course ask why the exotic states should be seen first.

4. Remarkably, for the somewhat ad hoc scaling factor $2 \times 512 \sim 10^3$ one does not have any candidates so that the M_{89} neutral pion should have the naively predicted mass around 67.5 GeV. Old Aleph anomaly [1] had mass 55 GeV. This anomaly did not survive. I found from my old writings [5] that Delphi and L3 have also observed 4-jet anomaly with dijet invariant mass about 68 GeV: M_{89} pion? There is indeed an article about search of charged Higgs bosons in L3 (see `http://arxiv.org/pdf/hep-ex/0105057.pdf`) telling about an excess in $c\overline{s}\tau^-\overline{\nu}_\tau$ production identified in terms of H^+H^- annihilation suggesting charged Higgs mass 68 GeV. TGD based interpretation would in terms of the annihilation of charged M_{89} pions.

   The gammas in 130-140 GeV range detected by Fermi telescope [**?**]estonia (see `http://arxiv.org/pdf/1205.1045.pdf`) were the motivation for assuming that M_{89} pion has mass twice the naively scaled up mass. The digammas could have been produced in the annihilation of a state with mass 260 GeV. The particle would be the counterpart of the ordinary η meson $\eta(548)$ with scaled up mass 274 GeV thus decaying to two gammas with energies 137 GeV.

   Also scaled up eta prime should be there. Also an excess in the production of two-jets above 500 GeV dijet mass has been reported (see `http://tinyurl.com/o6hmry4`) and could relate to the decays of $\eta'(958)$ with scaled up mass of 479 GeV! Also digamma bump should be detected.

5. What about M_{89} kaon? It would have scaled up mass 250 GeV and could also decay to digamma. There are indications for a Higgs like state with mass of 250 GeV from ATLAS (see `http://atlas.ch/news/2011/simplified-plots.html`! It would decay to 125 GeV photons - the energy happens to be equal to Higgs mass. There are thus indications for both pion, kaon, all three scaled up η mesons, kaon, and η' with predicted masses! The low lying M_{89} meson spectroscopy could have been already seen!

6. Lubos (see `http://tinyurl.com/hweqnnu`) tells that ATLAS sees charged boson excess manifesting via decay to tb in the range 200-600 TeV. Here Lubos takes the artistic freedom to talk about charged Higgs boson excess since Lubos still believes in standard SUSY predicting copies several Higgs doublets. TGD does not allow them. In TGD framework the excess could be due to the presence of charged M_{89} mesons: pion, kaon, ρ, ω.

7. A smoking gun evidence would be detection of production of pairs of M_{89} nucleons with masses predicted by naive scaling to be around 470 GeV. This would give rise to dijets above 940 GeV cm energy with jets having total quantum numbers of ordinary nucleons. Each M_{89} nucleon consisting of 3 quarks of M_{89} hadron physics could also transform to ordinary quarks producing 3 ordinary hadron jets.

Is there any evidence for $M_{G,79}$ hadron physics? Tommaso Dorigo (see `http://tinyurl.com/ngdhwhf`) told about indications for a neutral di-boson bump at 2 TeV (see `http://arxiv.org/pdf/1512.03371v1.pdf`). The mass of M_{79} pion is predicted to be 2.16 TeV by a direct scaling of the mass 135 MeV of the ordinary neutral pion!

What about higher generations of gauge bosons?

1. There has been also a rumour about a bump at 4 TeV. By scaling Higgs mass 125 GeV by 32 one obtains 4 TeV! Maybe the Higgs is there but in different sense than in standard SUSY! Could one have copy of weak physics with scale up gauge boson masses and Higgs masses waiting for us! Higgs would be second generation Higgs associated with second generation of weak bosons analogous to that for fermions predicted by TGD? Actually one would have octet associated with dynamical "generation color" symmetry SU(3) but neutral members of the octet are expected to be the lightest states. This Higgs would have also only neutral member after massivation and differ from SUSY Higgs also in this respect. The scaled up weak boson masses would be by scaling with factor 32 from 80.4 GeV for W and 91 GeV for Z would be 2.6 TeV and 2.9 TeV respectively. Lubos (see `http://tinyurl.com/zjbdn7a`) mentions also 2.9 GeV dilepton event: decay of second generation Z^0?!

2. There is already evidence for second generation gauge bosons from the evidence for the breaking of lepton universality. The couplings of second generation weak bosos depend on fermion generation because their charge matrices must be orthogonal to those of the ordinary weak bosons. The outcome is breaking of universality in both lepton and quark sector. An alternative explanation would be in terms leptoquarks (see `http://tinyurl.com/oat538m`), which in TGD framework are super partners of quarks identifiable as pairs of right-handed neutrinos and quarks.

We are living exciting times! If TGD is right, experimenters and theorists are forced to change their paradigm completely. Instead of trying to desperately to identify elementary particle predicted by already excluded theories like SUSY they must realize that there is entire zoo of hadron resonances whose existence and masses are predicted by scaled up hadron physics. Finding a needle in haystack is difficult. In the recent situation one does not even know what one is searching for! Accepting TGD framework one would know precisely what to search for. The enormous institutional inertia of recent day particle physics community will not make the paradigm shift easy. The difficult problem is how to communicate bi-directionally with the elite of particle physics theorists, which refuses to take seriously anyone coming outside the circles.

References

[1] Min De A. Exotic searches at LEP. Available at: `http://arxiv.org/pdf/hep-ex/0106097`, 2011.

[2] Fermi 130 GeV gamma-ray excess and dark matter annihilation in sub-haloes and in the Galactic centre. Available at: `http://arxiv.org/pdf/1205.1045.pdf`, 2012.

[3] Pitkänen M. Construction of elementary particle vacuum functionals. In *p-Adic Physics*. Onlinebook. Available at: `http://tgdtheory.fi/public_html/padphys/padphys.html#elvafu`, 2006.

[4] Pitkänen M. New Particle Physics Predicted by TGD: Part I. In *p-Adic Physics*. Onlinebook. Available at: `http://tgdtheory.fi/public_html/padphys/padphys.html#mass4`, 2006.

[5] Pitkänen M. SUSY in TGD Universe. In *p-Adic Physics*. Onlinebook. Available at: http://tgdtheory.fi/public_html/padphys/padphys.html#susychap, 2012.