Indications for the new physics predicted by TGD

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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 allowing 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 article I summarize the recent indications for the existence of these states. In particular, the identification of the recently reported bump at 750 GeV as $\eta(755\ GeV)$ 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 and there is indeed a bump associated 68 GeV mass too and in fact all light scalar mesons as wellas some excitations of eta meson can be found in the spectrum reported bumps with predicted masses.

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 $M_{107} = 2^{107} - 1$ [**?**]. 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. 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 [**?**, K1] 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.

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 $\mathcal{N}=1$ [K3]. 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. 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 719.4 GeV and 755.2 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 204.8, 501.8, 650.2, 701.4, 768.0, 732.2, 801.3, 840.0, 875.5 GeV. Thus f_0 meson consisting of two quark pairs would be also a marginal candidate. The charged exotic meson $a_0(1450)$ scales up to 742.4 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. Situation might of course change when data are analyzed. Jester (`http://resonaances.blogspot.fi/2015/12/750-and-what-next.html`) in fact reports that 1 sigma evidence for $Z\gamma$ decays has been observed around 730 GeV. The best fit to the bump has rather large width, which means that there must be many other decay channels than digamma channels. If they are strong as for TGD model, one can argue that they should have been 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 $\eta(1405)$ 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 [**?**]ad mass 55 GeV. This anomaly did not survive. I found from my old writings [**?**]hat 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 $c\bar{s}\tau^-\overline{\nu}_\tau$ 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 [E1] (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. An alternative identification of the galactic gamma rays in terms of gamma ray pairs resulting in the annihilation of two dark matter particles nearly at rest. It has been found that this interpretation cannot be correct (see `http://tinyurl.com/zve4fap`).

   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 and kaon and η' with predicted masses! The low lying M_{89} meson spectroscopy could have been already seen!

6. Lubos mentions (see `http://tinyurl.com/hzxsnmy`) also indications for 285 GeV bump decaying to gamma pair. The mass of the eta meson of ordinary hadron physics is .547 GeV and the scaling of eta mass by factor 512 gives 280.5 GeV : the error is less than 2 per cent.

7. Lubos tells (see `http://tinyurl.com/jpunanb`) about 3 sigma bump at 1.650 TeV assigned to Kaluza-Klein graviton in the search for Higgs pairs hh decaying to $b\bar{b}$ $+b\bar{b}$. Kaluza-Klein gravitons are rather exotic creatures and in absence of any other support for superstring

model they are not the first candidate coming into my mind. I do not know how strong the evidence for spin 2 is but I dare to consider the possibility of spin 1 and ask whether M_{89} hadron physics could allow an identification for this bump.

(a) Very naively the scaled up J/Psi of the ordinary M_{107} hadron physics having spin $J = 1$ and mass equal to 3.1 GeV would have 512 times higher mass 1.585 TeV: error is about 4 per cent. The effective action would be based on gradient coupling similar in form to Zhh coupling. The decays of scaled up Ψ/J could take place via $hh \rightarrow b\bar{b}b + b\bar{b}$ also now.

(b) This scaling might be too naive: the quarks of M_{89} hadron physis might be same as those of ordinary hadron physics so that only the color magnetic energy would be scaled up by factor 512. c quark mass is equal 1.29 GeV so that the magnetic energy of ordinary J/Psi would be equal to .52 GeV. If so, M_{89} version of J/Psi would have mass of only 269 GeV. Lubos tells also about evidence for a 2 sigma bump at 280 GeV identified as CP odd Higgs - this identification of course reflects the dream of Lubos about standard SUSY at LHC energies. However, the scaling of η meson mass 547.8 MeV by 512 gives 280.4 GeV so that the interpretation as η meson proposed already earlier is convincing. The naive scaling might be the correct thing to do also for mesons containing heavier quarks.

8. In his latest posting Lubos (see `http://tinyurl.com/z8np2lc`) tells about an excess (I am grateful for Lubos for keeping book about the bumps: this helps enormously), which could have interpretation as the lightest M_{89} vector meson - ρ_{89} or ω_{89}. Mass is the predicted correctly with 5 per cent accuracy by the familiar p-adic scaling argument: multiply the mass of ordinary meson with 512.

   This 375 GeV excess might indeed represent the lightest vector meson of M_{89} hadron physics. ρ and ω of standard hadron physics have mass 775 MeV and the scaled up mass is about 397 GeV, which is about 5 per cent heavier than the mass of $Z\gamma$ excess.

   The decay $\rho \rightarrow Z + \gamma$ describable at quark level via quark exchange diagram involving emission of Z and γ. The effective action would be proportional to $Tr(\rho * \gamma * Z)$, where the product and trace are for antisymmetric field tensors. This kind effective action should describe also the decay to gamma pair. By angular momentum conservation the photons of gamma pairs should be in relative $L = 1$ state. Since Z is relativistic, $L = 1$ is expected to be favored also for $Z + \gamma$ final state. Professional could immediately tell whether this is correct view. Similar argument applies to the decay of ω which is isospin singlet. For charged ρ also decays to $W\gamma$ and WZ are possible. Note that the next lightest vector meson would be K* with mass 892 MeV. $K*_{89}$ should have mass 457 GeV.

9. 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.

10. 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 [K2]. The couplings of second generation weak bosons 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.

3. New evidence for the existence of this kind of weak boson has emerged (see http://tinyurl.com/gqrg9ztl). If I understood correctly, the average angle between the decay products of B meson is not quite what it is predicted to be. This is interpreted as an indication that Z' type boson appears as an intermediate state in the decay.

4. Lubos Motl told in his blog (see http://tinyurl.com/jpunanb) about direct evidence for Z′ boson now: earlier the evidence was only indirect: breaking of universality and anomaly in angle distribution in B meson decays. Z′ bump has mass around 3 TeV. TGD predicts 2.94 TeV mass for second generation Z breaking universality (mass would differ by scaling factor 32 from that of ordinary Z). The decay width would be by direct scaling .08 TeV and is is larger than deviation .06 TeV from 3 TeV. Lubos reported half year ago (see http://tinyurl.com/zqsdpvw about excess at 2.9 GeV which is also consistent with TGD prediction.

We are living exciting times! Evidence for three new branches of physics predicted by TGD is accumulating! As such each bump is not convincing but when large number of bumps has just the predicted masses, situation changes. 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.

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