125 GeV Standard Model Higgs

by Frank Dodd (Tony) Smith Jr.

Abstract:

In July 2012 the LHC announced observation of a 125 GeV state

of the Standard Model Higgs boson.

Therefore, I lost a bet to Tommaso Dorigo and had to revise my E8 Physics model:

Now it has no Tquark mesons (I was wrong about having a quantum protectorate

that extended Tquark lifetime enough to permit meson formation)

and

my calculated low mass state Higgs mass of 145 GeV is now seen to be only

a tree level value that goes to 0.86 x 145 = 125 GeV effective mass seen by the LHC.

In view of the detailed LHC histograms for the Higgs to ZZ to 4l Golden Channel,

I remain in favor of a Standard Model Higgs with 3 Mass States:

125 GeV (effective mass) ; around 200 GeV ; around 250 GeV.

(References are included in the body of the paper and in linked material.)

125 GeV Standard Model Higgs (low mass state)

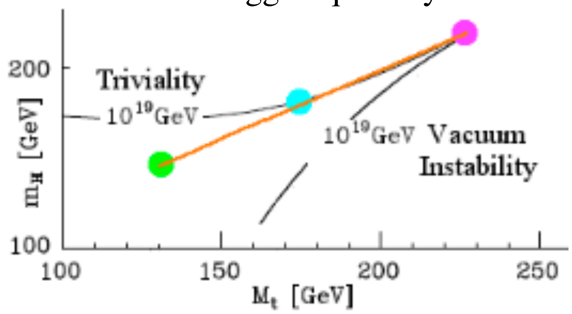
200 GeV midHiggs and 240 GeV highHiggs

Frank Dodd (Tony) Smith, Jr. - July 2012

This paper is about LHC results announced through 4 July 2012 (it supercedes my earlier papers).

The LHC has observed a 125 GeV (about 133 proton masses) state of the Standard Model Higgs boson.

In my E8 Physics model the Higgs/Tquark system has 3 mass states



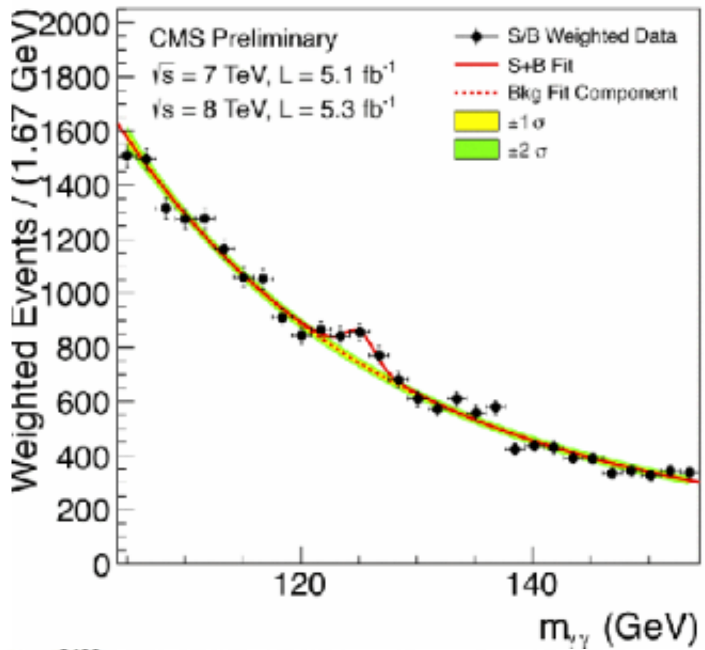
with the low-mass Higgs state calculated in my E8 Physics model at tree level to be near 145 GeV.
The 125 GeV observed peak is at about 0.86 times the 145 GeV tree-level calculation.
The factor of 0.86 = cos(pi/6) comes into play when you consider that the Higgs is part of a Tquark condensate system as indicated in these diagrams (which are explained in detail in Appendix I hereinbelow):

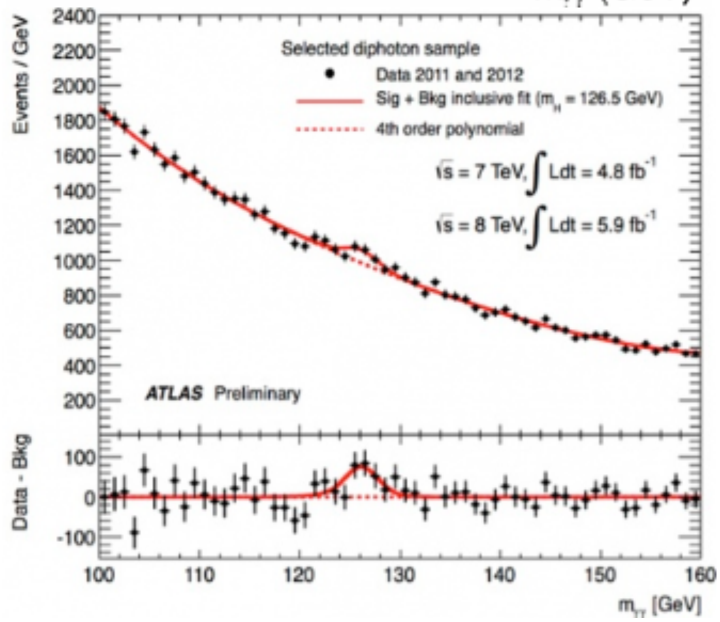
```
              mass = 145
         T ----------- Tbar                Effective Higgs in CP2 ISS
          \     |     /                      |
           \    |    /                       |     Higgs
mass = 145  \   |   /  mass = 145            |  Effective Mass =
             \  |  /                         |  = 145 x cos(pi/6)= 145 x 0.86 = 125
              \ | /                          |
              Higgs                       Higgs in M4 spacetime
```

The 3-state Higgs-Tquark system also has, near the Higgs Vacuum Expectation Value around 240 GeV, a high-mass state at a critical point with respect to Vacuum Instability and Triviality,
as well as a mid-mass state around 200 GeV at which the system renormalization path enters conventional 4-dim Physical Spacetime, departing from the Triviality boundary at which an (4+4)-dim Klauza-Klein spacetime is manifested.

Here are some details about the LHC observation at 125 GeV and related results:

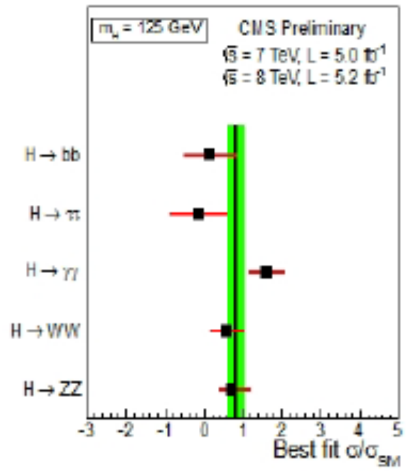
The digamma histograms for CMS and ATLAS





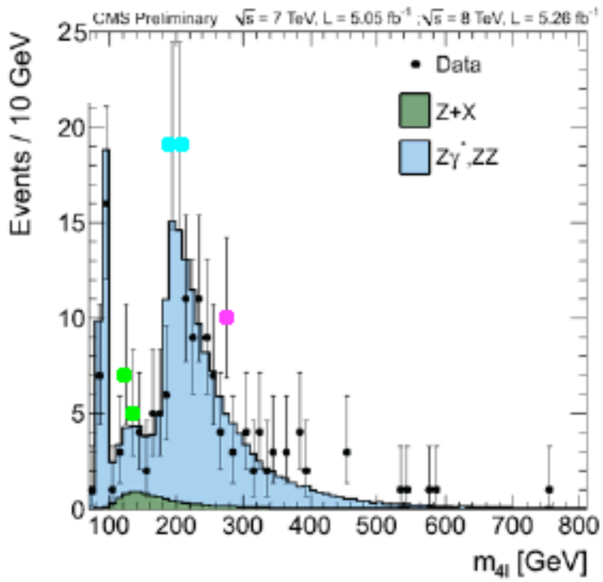
clearly show only one peak below 160 GeV and it is around 125 GeV.

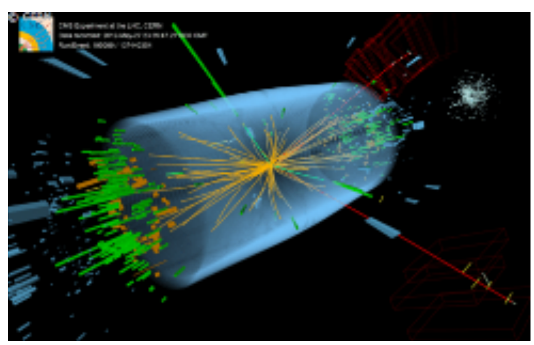
CMS shows the cross sections for Higgs at 125 GeV



to be substantially consistent with the Standard Model for the WW and ZZ channels,
a bit low for tau-tau and bb channels (but that is likely due to very low statistics there),
and a bit high for the digamma channel (but that may be due to phenomena related
to the Higgs as a Tquark condensate).

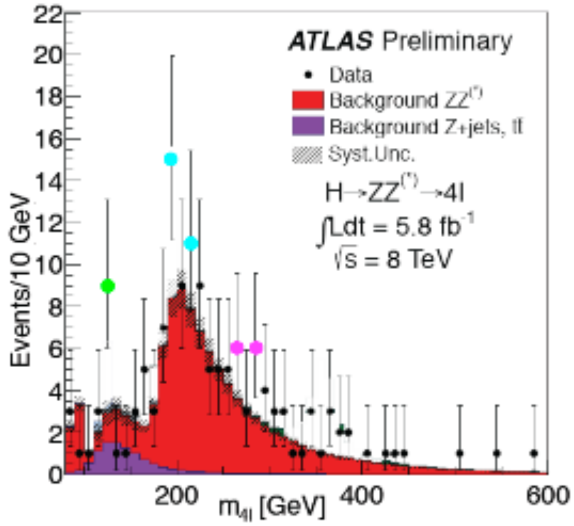
A CMS histogram (some colors added by me) for the Golden Channel Higgs to ZZ to 4l shows the peak around 125 GeV (green dots - lowHiggs mass state. An image of one of the events is shown next to the histogram.

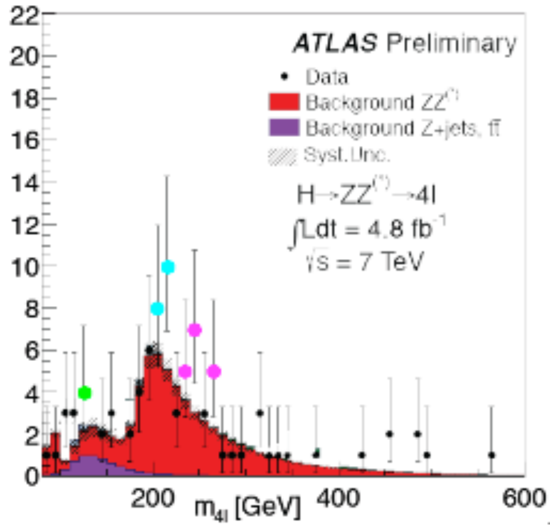


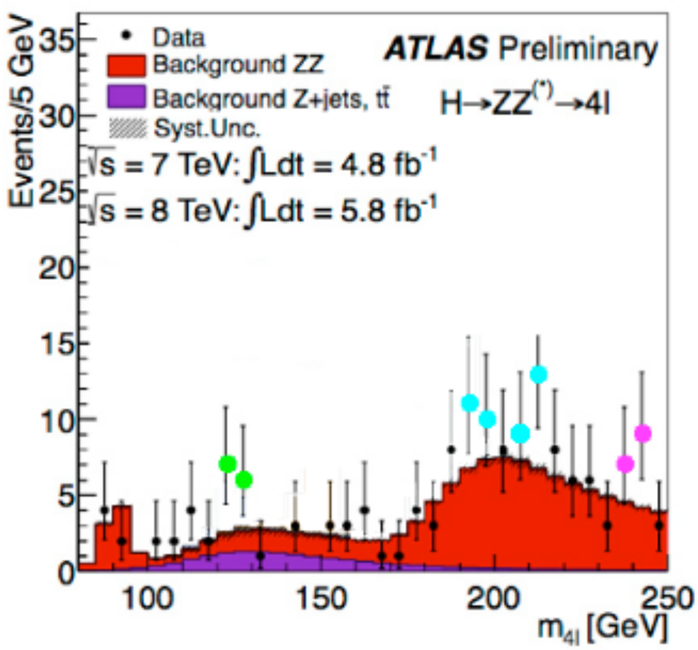


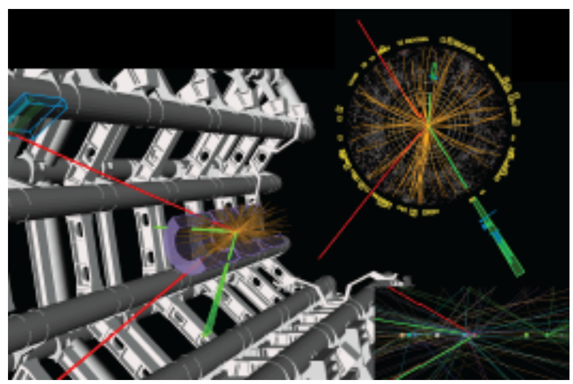
The CMS histogram also indicates other excesses
around 190-210 GeV (cyan dots - midHiggs mass state)
and around 280 GeV (magenta dot - highHiggs mass state).

Some ATLAS ZZ to 4l histograms (some colors added by me) show the peak around 125 GeV (green dots - lowHiggs mass state. An image of one of the events is shown next to the third histogram.









The ATLAS histograms also indicate other excesses
around 190-210 GeV (cyan dots - midHiggs mass state)
and around 235-280 GeV (magenta dots - highHiggs mass state - note that some of these are omitted in the histogram combining 7 TeV and 8 TeV because it only covers up to 250 GeV).

The midHiggs and highHiggs excesses may go away with more data (as did the 137 GeV digammma excesses) or
further data may confirm one or both of them
but
either way we now know that the plain vanilla Standard Model is what Nature likes.

Non-Standard-Model Higgs beyond those 3 mass states clearly are not needed or used by Nature.

Neither do Tquark mesons exist, confirming that Tquarks decay too rapidly (due to high mass and lack of any collective quantum protectorate for individual Tquarks) to form mesons.

Also neither needed nor observed are any conventional 1-1 fermion-boson SuperSymmetric particles or any exotic phenomena such as Technicolor, extra Z bosons, etc.

With the Standard Model firmly confirmed, what should physicists do in the future ?

Here are a few things to think about:

Study the High Energy Massless Realm well above Electroweak Symmetry Breaking:
What happens to Kobayashi-Maskawa mixing in a Realm with no mass ?
How do you tell a muon from an electron if they are both massless ?
Build a Muon Collider to find out.

If conventional 1-1 fermion-boson SuperSymmetry is not Nature's Way,
can we get the nice cancellations from a more Subtle SuperSymmetry ?
For that, my model uses a Triality-related symmetry between fermions and gauge bosons
based on its 8-dim Kaluza-Klein structure.

What about Dark Matter and Dark Energy?
My model uses the Spin(2,4) = SU(2,2) Conformal Group of Irving Ezra Segal to account for both,
but it is experimental observation that counts.
My favourite experimental approach is that of Paul A. Warburton at University College London
using terahertz frequency Josephson Junctions.

Since the Higgs came from Solid State Physics ideas of people like Anderson,
look closely at Solid State Nanostructures
(such as Nickel/Palladium that seems to be useful in Cold Fusion)
to see whether they can show new ways
to visualize the workings of High-Energy Physics of the Standard Model plus Gravity.

Appendix I: low-mass state Higgs calculations:

The calculations produce ratios of masses, so that only one mass need be chosen to set the mass scale.
In the E8 model, the value of the fundamental mass scale vacuum expectation value v = <PHI> of the Higgs scalar field is set to be the sum of the physical masses of the weak bosons, W+, W-, and Z0,
such that, in accord with ratios calculated in the E8 model, the electron mass will be 0.5110 MeV.
Effectively, the electron mass of 0.5110 MeV is the only input into the calculated particle masses.

The relationship between the Higgs mass and v is given by the Ginzburg-Landau term from the Mayer Mechanism as (1/4) Tr ([PHI , PHI] - PHI)^2
or, in the notation of hep-ph/9806009 by Guang-jiong Ni

(1/4!) lambda PHI^4 - (1/2) sigma PHI^2 where the Higgs mass M_H = sqrt(2 sigma)

Ni says:

"... the invariant meaning of the constant lambda in the Lagrangian is not the coupling constant, the latter will change after quantization ... The invariant meaning of lambda is nothing but the ratio of two mass scales: lambda = 3 (M_H / PHI)^2 which remains unchanged irrespective of the order ...".
Since <PHI>^2 = v^2,
and assuming at tree-level that lambda = 1 (a value consistent with the Higgs Tquark condensate model of Michio Hashimoto, Masaharu Tanabashi, and Koichi Yamawaki in their paper at hep- ph/0311165),
we have, at tree-level

$$M_H^2 / v^2 = 1 / 3$$

As described above, in the E8 model

v is set to be 252.514 GeV M_H = v /sqrt(3) = 145.789 GeV

This is a tree-level calculation in (4+4)-dim Kaluza-Klein with a 4-dim M4 Minkowski Physical Spacetime at each point of which there lives a 4-dim CP2 Internal Symmetry Space (ISS).
A Non-Condensate Higgs is represented by a Higgs at a point in M4
that is connected to a Higgs representation in CP2 ISS by a line whose length represents the Higgs mass

```
            Higgs                    Higgs in CP2 ISS
              |                           |
              |                           |
              |                           |
              | mass = 145                | Non-Condensate Higgs Mass = 145
              |                           |
              |                           |
              |                           |
            Higgs                    Higgs in M4 spacetime
```

of the tree-level calculation set out above.
However, in my E8 Physics model, the Higgs has beyond-tree-level structure due to a Tquark condensate

```
           mass = 145
       T ----------- Tbar          Effective Higgs in CP2 ISS
        \      |      /                   |
         \     |     /                    |
mass = 145 \   |    /   mass = 145        | Higgs Effective Mass =
            \  |   /                      | = 145 x cos(pi/6)= 145 x 0.86 = 125
             \ |  /                       |
            Higgs                    Higgs in M4 spacetime
```

in which the Higgs at a point in M4 is connected to a T and Tbar in CP2 ISS
so that the vertices of the Higgs-T-Tbar system are connected by lines forming an equilateral triangle whose line lengths represent the tree-level calculated mass. Therefore:
The effective length from the Higgs in M4 to the Effective Higgs in CP2 ISS (the mass observed by LHC) is the altitude of the equilateral triangle: 145 x cos(pi/6) = 125 GeV.

Appendix II: some comments on my earlier work:

My father was in the mining business. He told me
"never trust any geological model until you drill a hole and look to see what is really under the ground".
I am a lawyer. To try a case,
I have to have a working model of the facts to the extent that I know them at the time,
but to be ready to change that model immediately when new facts emerge
(as they often do quite unexpectedly).

Around 1981, I started to try to build a realistic physics model based on those principles.

I started with N = 8 supergravity, but its naive 1-1 supersymmetry gave it too many particles
and its SO(8) did not really fit the Standard Model gauge groups.

Then I tried to build a model around Division Algebras and Spin(8)
with 3 generations of fermions and of W/Z bosons,
but experiment said that 3 generations of W/Z was wrong,
so I changed it to a model based on F4.

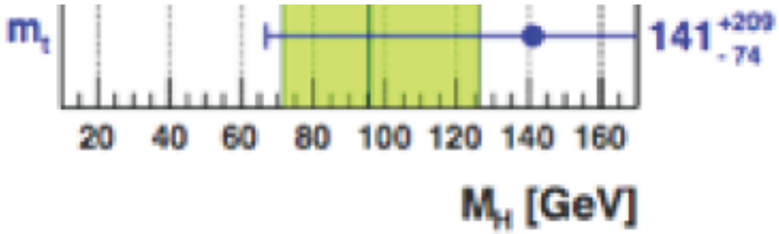
F4 was better than Spin(8), but it ran aground due to lack of complex structure,
which led me to build an E6 model.

The E6 model was pretty nice (it can be seen as a bosonic string model
with fermions coming from orbifolding), but it only had local Lagrangian structure
and did not seem to give a natural Algebraic Quantum Field Theory (AQFT).

To get an AQFT, I needed to use the 8-periodicity of Real Clifford Algebras.
Since E6 sits inside E8 which lives inside the Clifford Algebra Cl(16),
E8 and Clifford Algebra is the basic structure of my present model,
which has a lot of complicated details that give results
that look roughly consistent with experiments up to the LHC Higgs search.

My Higgs sector is based on Higgs as a Tquark condensate
with 3 mass states for the Higgs and for the Tquark.
Since a Tquark condensate involves a quantum protectorate
to allow it to be stable beyond the very short basic Tquark lifetime,
I had in my model T0 and T0c mesons in which a low-mass-state Tquark,
stabilized by the condensate quantum protectorate,
combined with an Up or Charm (anti)quark,
producing mesons with mass around 125 GeV or so.

The low-mass-state Higgs in my model was around 145 GeV or so,
which is roughly where Gfitter says the Higgs should be if the Tquark mass is not fixed



which is the case of my E8 Physics model with 3 mass states for the Tquark.

Therefore, with the 2011 LHC results, I was happily identifying
the 125 GeV digamma bump with my lowTquark T0 meson and
the 137 GeV digamma bump with my lowHiggs.

The fact that the 2011 LHC WW cross section (for both CMS and ATLAS) was low
(something natural for a T0 meson but not good for Standard Model Higgs)
made me confident enough to bet with Tommaso Dorigo that the 125 GeV bump
would not be Higgs.

The 4 July 2012 LHC results told me that I lost the bet because
the 137 GeV bump went away in both CMS and ATLAS with the new data
and
as to the 125 GeV bump, even though
the Tevatron announced on 2 July 2012 that it saw a low WW cross section
and ATLAS on 4 July 2012 was still reporting a low WW cross section
in agreement with CMS 2011 and ATLAS 2011,
CMS showed a high WW cross section in agreement with a Standard Model Higgs.

CMS was able to find the correct result that ATLAS and the Tevatron missed
because, as Tommaso said, by
CMS "... having put together more advanced multivariate search techniques
and having analyzed in time for the announcement not just the two main channels
but all the five important final states (W boson pairs, b-quark pairs, and tau-lepton pairs
in addition to the two ... main channels ... [digamma and Higgs to ZZ to 4l])...".

Not only was my bet lost,
but my model was shown to have errors, so I have had to revise it in at least two ways:

1 - There is no quantum protectorate extension of the life of the Tquark,
so there are no Tquark mesons.

2 - The LHC indeed found the Higgs at 125 GeV, which is about 0.86 times the value calculated in my model. Since the high digamma strength in the 2012 LHC data could be due to the Higgs being connected with a Tquark condensate, it seems that
the 125 GeV Higgs is really basically a plain vanilla Standard Model Higgs-Tquark Condensate.

It is easy to do 1
(just as it was easy to get rid of high-generation W/Z bosons many years ago)
but

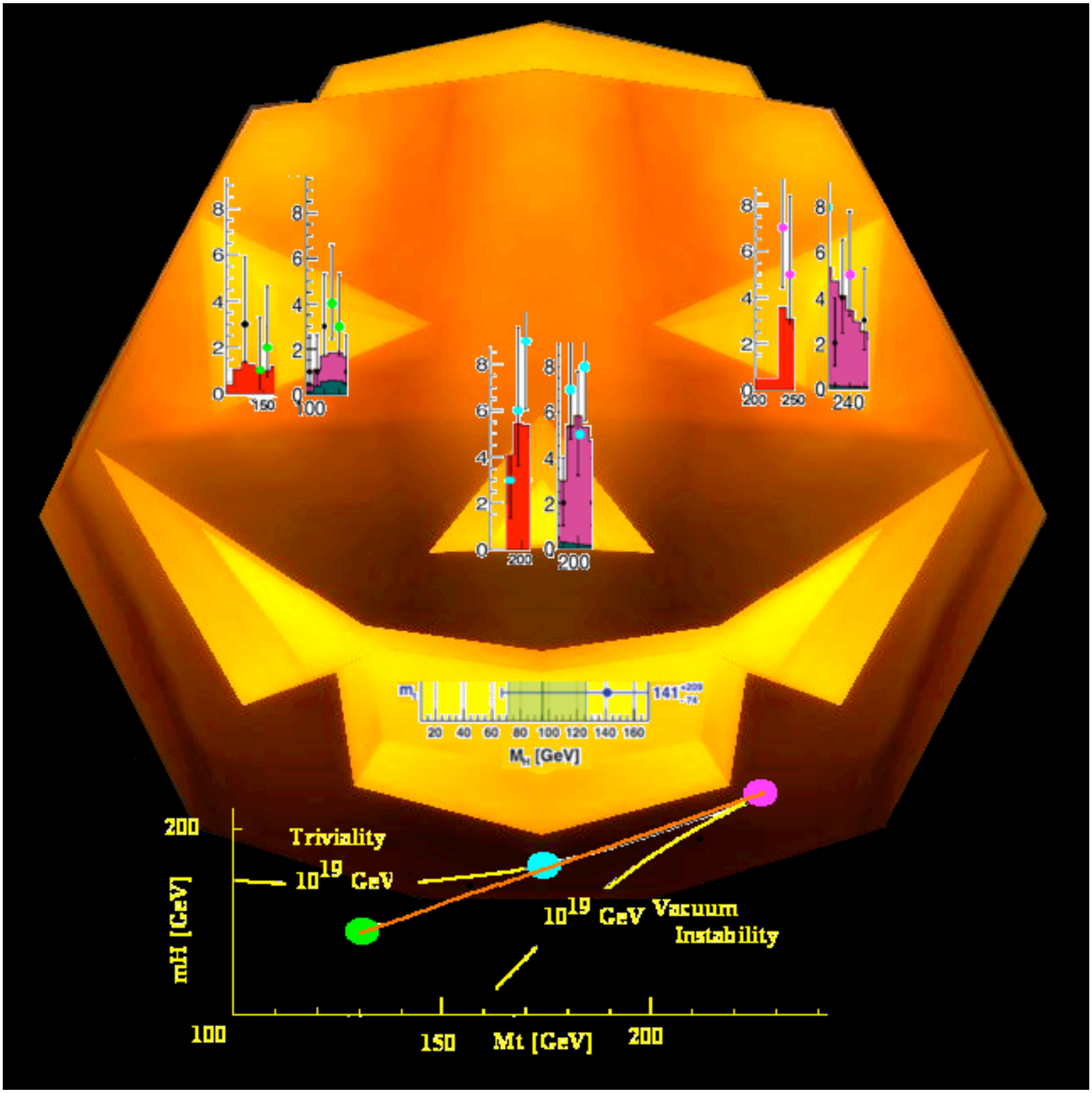
it will take some work and rethinking to take care of 2,
so
thanks to LHC observations for telling me to get to work
to try to get my model into better shape.

This is why I like physics:
You can use your imagination to devise models that (in your eyes) are beautiful
but
Nature (not the magazine) is always the boss,
telling you though experiments like the LHC how dumb you were to do
some of the things that you thought were so smart,
and
then you get a chance to correct your dumb mistakes and try to do something better.

It is a life-long process that goes on as long as you have fun playing the game:
Even if I get 1 and 2 done, that will not be the end of the road.

My model still has 3 Higgs mass states,
and the LHC will have to say whether or not the two higher mass state exist or not.

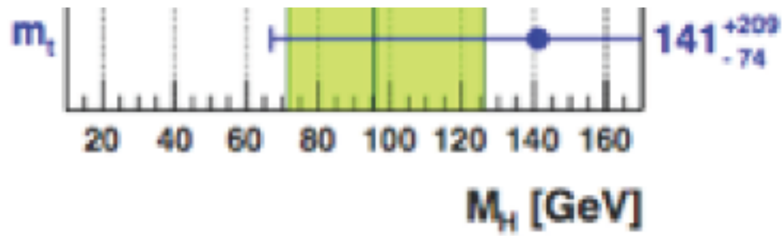
If the LHC eventually confirms the two higher mass Higgs states,
then the Pumpkin Chart that I made based on LHC data as of Halloween 2011 will be confirmed



Here is how the Great Pumpkin of the Halloween 2011 Data shows the True State of Physics:

Using the ideas of - African IFA Divination; Clifford Algebra Cl(8)xCl(8) = Cl(16); Lie Algebra E8 ; Hua Geometry of Bounded Complex Domains; Mayer Geometric Higgs Mechanism; Batakis 8-dim Kaluza-Klein structure of hep-ph/0311165 by Hashimoto et al; Segal Conformal Gravity version of the MacDowell-Mansouri Mechanism; Real Clifford Algebra generalized Hyperfinite II1 von Neumannn factor AQFT; and Joy Christian EPR Geometry - my E8 Physics model has been developed with a 3-state Higgs system in which the Higgs is related to the Primitive Idempotents of the real Clifford Algebra Cl(8).

The Pumpkin Mouth Plot shows that the Electroweak Gfitter best fit for a floating Tquark mass as is required in my 3-State Higgs-Tquark System



is for a Higgs state with central value of 141 GeV and upper bound 141+209 = 350 GeV.

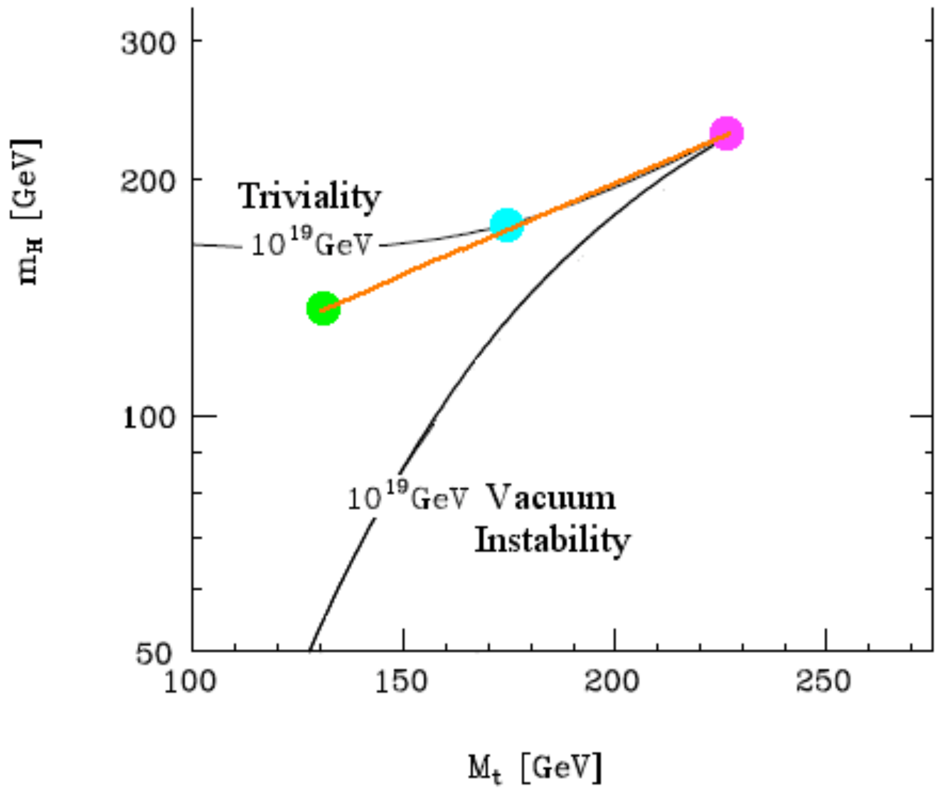
The Pumpkin Eye-Nose-Eye Plots are for data (about 5/fb) taken by Halloween 2011:

Green Eye: ATLAS-CMS ZZ-4l plots of Halloween 2011 excesses seen in 120-145 GeV Higgs range;

Cyan Nose: ATLAS-CMS ZZ-4l plots of Halloween 2011 excesses seen around 200 GeV;

Magenta Eye: ATLAS-CMS ZZ-4l plots of Halloween 2011 excesses seen around 250 GeV.

According to hep-ph/0307138 by C. D. Froggatt:
"... the top quark mass is the dominant term in the SM fermion mass matrix ... [so]... it is likely that its value will be understood dynamically ... the self-consistency of the pure SM up to some physical cut-off scale /\ imposes constraints on both the top quark and Higgs boson masses.
The first constraint is the so-called triviality bound: the running Higgs coupling constant lambda(mu) should not develop an Landau pole for mu < /\ .
The second is the vacuum stability bound: the running Higgs coupling constant lambda(mu) should not become negative leading to the instability of the usual SM vacuum.
These bounds are illustrated in Fig. 3 ... we shall be interested in the large cut-off scales /\ = 10^19 GeV, corresponding to the Planck scale [I have edited this sentence to restrict coverage to a Planck scale SM cut-off and have edited Fig. 3 and added material relevant to my E8 Physics model with 3 Higgs-Tquark states]
...
The upper part of each curve corresponds to the triviality bound.
The lower part of each curve coincides with the vacuum stability bound and
the point in the top right-hand corner, where it meets the triviality bound curve, is the quasi-fixed infra-red fixed point for that value of /\ . ...



... Fig. 3: SM bounds in the (Mt , MH) plane ...”.

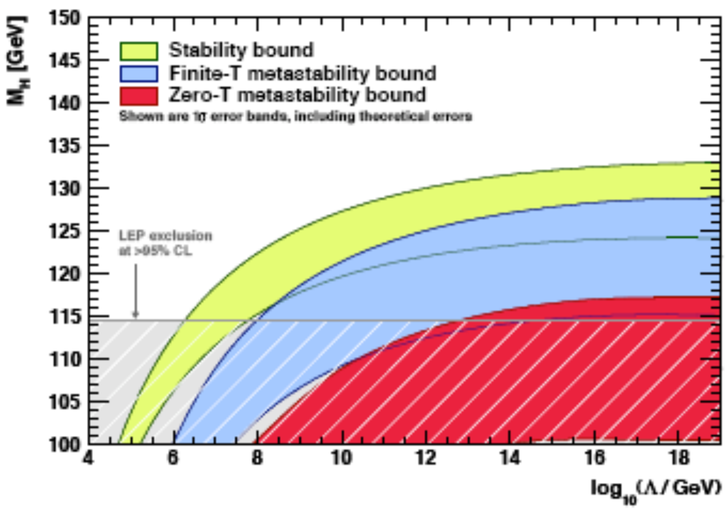
The Magenta Dot is the high-mass state of a 220 GeV Truth Quark and a 240 GeV Higgs.
It is at the critical point of the Higgs-Tquark System with respect to Vacuum Instability and Triviality.
It corresponds to the description in hep-ph/9603293 by Koichi Yamawaki of the Bardeen-Hill-Lindner model
That high-mass Higgs is around 250 GeV in the range of the Higgs Vacuum Instability Boundary
which range includes the Higgs VEV.

The Gold Line leading down from the Critical Point roughly along the Triviality Boundary line is based on Renormalization Group calculations with the result that MH / MT = 1.1 as described by Koichi Yamawaki in hep-ph/9603293 .

The Cyan Dot where the Gold Line leaves the Triviality Boundary to go into our Ordinary Phase is the middle-mass state of a 174 GeV Truth Quark and Higgs around 200 GeV. It corresponds to the Higgs mass calculated by Hashimoto, Tanabashi, and Yamawaki in hep-ph/0311165 where they show that
for 8-dimensional Kaluza-Klein spacetime with the Higgs as a Truth Quark condensate
172 < MT < 175 GeV and 178 < MH < 188 GeV.
That mid-mass Higgs is around the 200 GeV range of the Higgs Triviality Boundary. The physical meaning of the Triviality Bound is described by Pierre Ramond in his book Journeys Beyond the Standard Model (Perseus Books 1999) where he says at pages 175-176:
“... for a ... (large) Higgs mass, we expect the standard model to enter a strong coupling regime ... losing ... our ability to calculate ... it is natural to think ... that the Higgs actually is a composite ... The resulting bound ... is sometimes called the triviality bound. The reason for this unfortunate name (the theory is anything but trivial) stems from lattice studies where the coupling is assumed to be finite everywhere; in that case the

coupling is driven to zero, yielding in fact a trivial theory. In the standard model ... the coupling ... is certainly not zero. ...”.

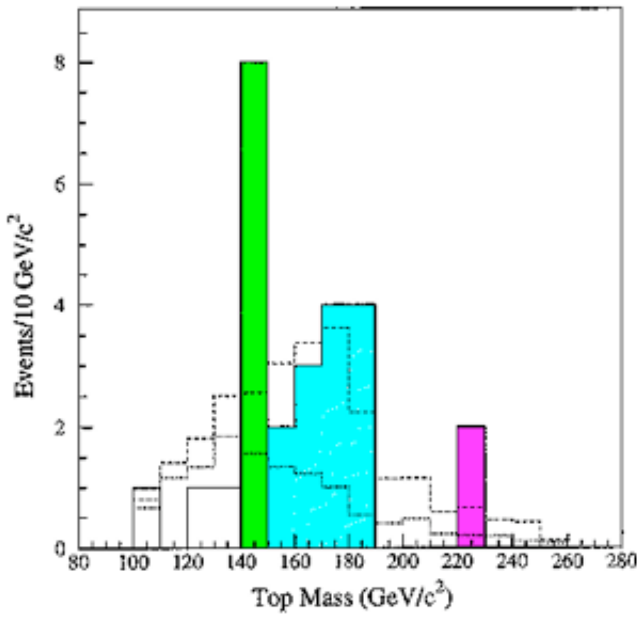
The Green Dot  where the Gold Line terminates in our Ordinary Phase is the low-mass state of a 130 GeV Truth Quark and a tree-level 145 GeV Higgs with Effective Higgs mass of 125 GeV.
Its location is determined by E8 Physics calculation of the tree-level 145 GeV Higgs state
which is the Higgs state that is necessary for agreement with arXiv 0960.0954
by Ellis et al who require a Higgs with 135 < MH < 158 GeV, saying:
“... the Standard Model may survive all the way to the Planck scale
for an intermediate range of Higgs masses ...
We evaluate ... on the basis of a global fit to the Standard Model made using the Gfitter package ...
a global fit to electroweak precision data within the SM ... favors MH < 158 GeV ...
Lower bounds on the Higgs mass due to absolute vacuum stability .. and finite-temperature ...
and zero-temperature metastability ... includ[ing] theoretical uncertainties ...

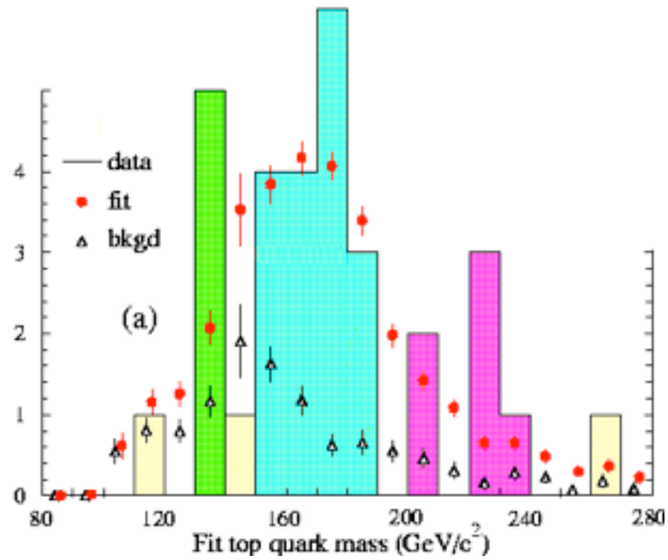


...[“allow (as Tommaso Dorigo said in an entry of 23 July 2009 on his blog) the SM to be valid for all energies up to the Planck scale (set at 2 x 10^18 GeV) only if the Higgs boson has a mass above 135 GeV or so”]...”. In short, it is the
tree-level Higgs state mass of 145 GeV that allows the Standard Model to be valid up to the Planck scale
and
the Effective Higgs mass of 125 GeV that is observed by the LHC.

As to the 3 mass states of the Tquark:

Back in the 1990s Fermilab CDF saw (left image below) 3 peaks for the Truth Quark Mass.
but they ignored the high mass (magenta) peak and dismissed the low mass (green) peak as a "statistical fluctuation",
and insisted that the medium mass (cyan) peak was the Single Mass State of the Truth Quark.





Even when the independent Fermilab detector D0 (right image above) saw the same 3 peaks including a similar tall low mass (green) peak
(very unlikely that an independent detector would produce a similar "statistical fluctuation" in the same place)

Fermilab continued to ignore the low mass (green) and high mass (magenta) peaks
and to insist that the Truth Quark had only a Single Mass State, at the middle mass (cyan) peak.
For the better part of two decades, up to the present, Fermilab designed experiments and analysis based on their Single Mass State model of the Truth Quark.
Detailed study of their results continued to point to the Truth Quark having 3 Mass States
and I have consistently pointed out that Fermilab's own experiments are in line with the 3 Mass State model.

References:
my web site - its mirror site
