From E8 Root Vector Geometry to the LHC

Frank Dodd (Tony) Smith, Jr. - 2017 - viXra 1701.0496

Abstract

This paper is intended to be a only rough semi-popular overview of how the 240 Root Vectors of E8 can be used to construct a useful Lagrangian describing Gravity and Dark Energy plus the Standard Model.
For details and references, see viXra/1602.0319.
The 240 Root Vectors of E8 represent the physical forces, particles, and spacetime that make up the construction of a realistic Lagrangian describing the Octonionic Inflation Era followed by a Quaternionic M4 x CP2 Kaluza-Klein Era in which the HIggs emerges by the Mayer mechanism and 2nd and 3rd Generation Fermions appear. By generalizations of the Nambu-Jona-Lasinio models, the Higgs is seen to be a Truth Quark-AntiQuark Condensate giving 3 Mass States of the Higgs and 3 Mass States of the Truth Quark.
My analysis of Fermilab and LHC observation data indicates that Fermilab has observed the 3 Truth Quark Mass States and LHC has observed the 3 Higgs Mass States.
The Lagrangian, which is fundamentally classical, is constructed from E8 only and E8 lives in Cl(16) = Cl(8) x Cl(8) which corresponds to two copies of an E8 Lattice.
A seperate paper discusses using a third copy of an E8 Lattice in connection with construction of a realistic Algebraic Quantum Field Theory related to the Leech Lattice.

Table of Contents

The **240 root vectors of E8** are of equal length in 8 dimensions
as they form the 240-vertex Witting-Gossett polytope
so
you can in 8 dimensions visualize how they group together

If you look at the 240 vertices as points on an 8-dim sphere
then
you can pick one point as the North Pole
and
see where the other points fall at their angle of latitude:

1 is at North Pole

56 nearest neighbors of the North Pole
are at North Temperate Latitude

126 2nd nearest neighbors of the North Pole
are at the Equator

56 3rd nearest neighbors of the North Pole
are at South Temperate Latitude

1 4th nearest neighbor of the North Pole
is Anitpodal at the South Pole

Therefore you see that the 240 break down into 1 + 56 + 126 + 56 + 1
but
what you need to see next is which root vector corresponds to which physics thing.

Geometry of the E8 Lie Group gives you some ideas:

56 + 56 = 112 Temperate North and South is the D8 = Spin(16) subgroup of E8
and they correspond to Gravity + Dark Energy and the Standard Model gauge groups
and to 8-dimensonal Spacetime position and momentum.

Each 56 breaks down into 24 + 32.

North Temperate 24 = D4 Lie Algebra = Spin(2,6) which contains Conformal Spin(2,4)
which gives Gravity plus Conformal Dark Energy
as well as Ghosts of Standard Model Gauge Bosons

South Temperate 24 = D4 Lie Algebra = Spin(8) which contains SU(4)
which gives SU(3) of the Color Force
which is the Global Group of Kaluza-Klein Internal Symmetry Space CP2
and CP2 = SU(3) / SU(2) x U(1) contains groups of Weak and Electromagnetic Forces
as well as Ghosts of Gravity and Dark Energy

Symmetric space D8 / D4(gravity) x D4(standard model) is 112-28-28 = 64-dim
and it corresponds to 64 = 8-dim position x 8-dim momentum of 8-dim Spacetime
which
8-dim Spacetime reduces to 4+4 dim M4 x CP2 Kaluza-Klein spacetime

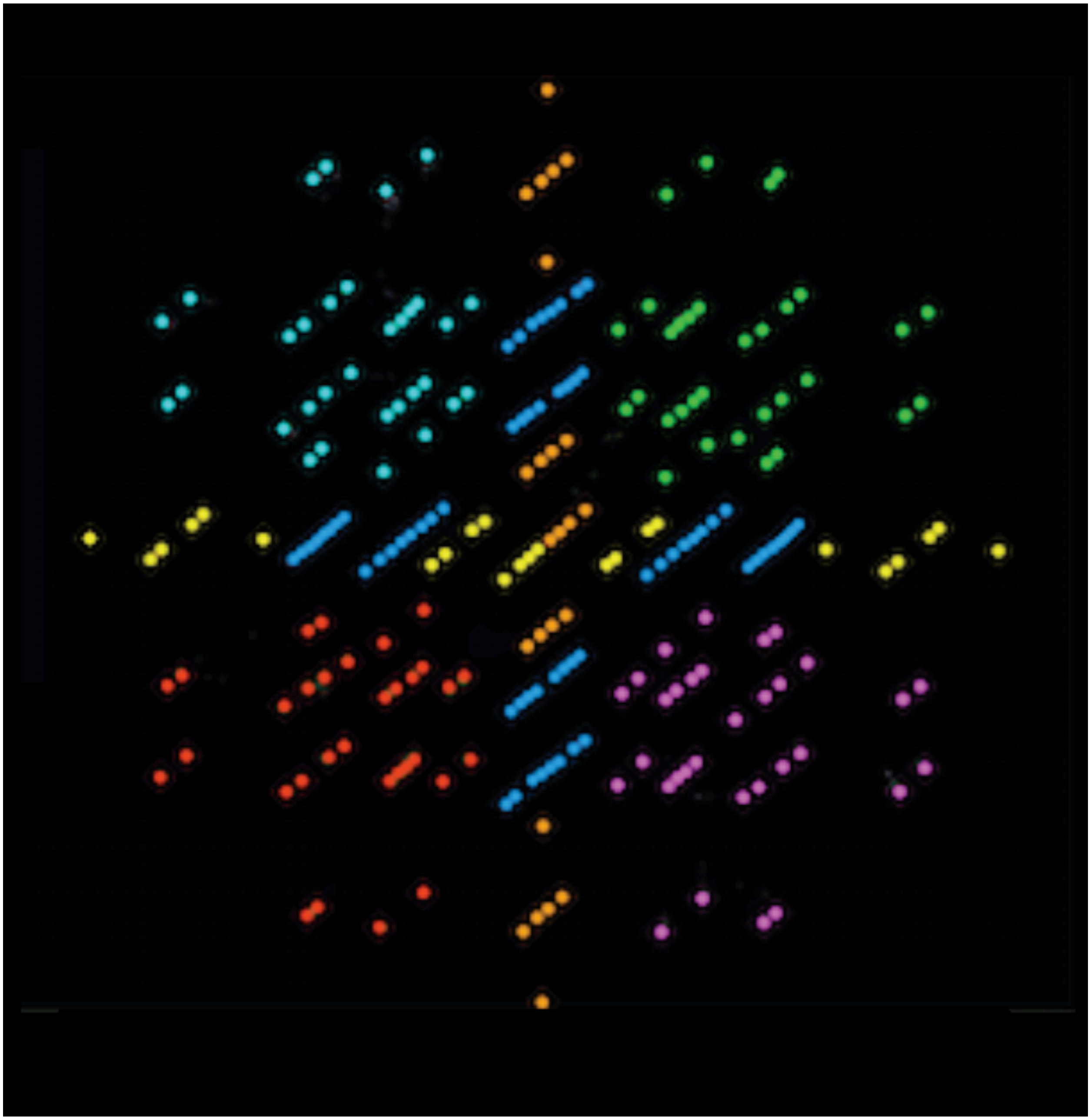
Symmetric space E8 / D8 is 128-dim Rosenfeld OctoOctonionic Projective Plane
which is
1 + 126 + 1 of the North Pole, Equator, and South Pole

The 128 are the 8 Spacetime components of Fermions: 8 Particles and 8 AntiParticles
for 8x8 = 64 Particle components + 8x8 = 64 AntiParticle components.
1 at North Pole = time component of Neutrino
1 at South Pole = time component of AntiNeutrino
126 at Equator = other components of Leptons and Quarks = root vectors of E7

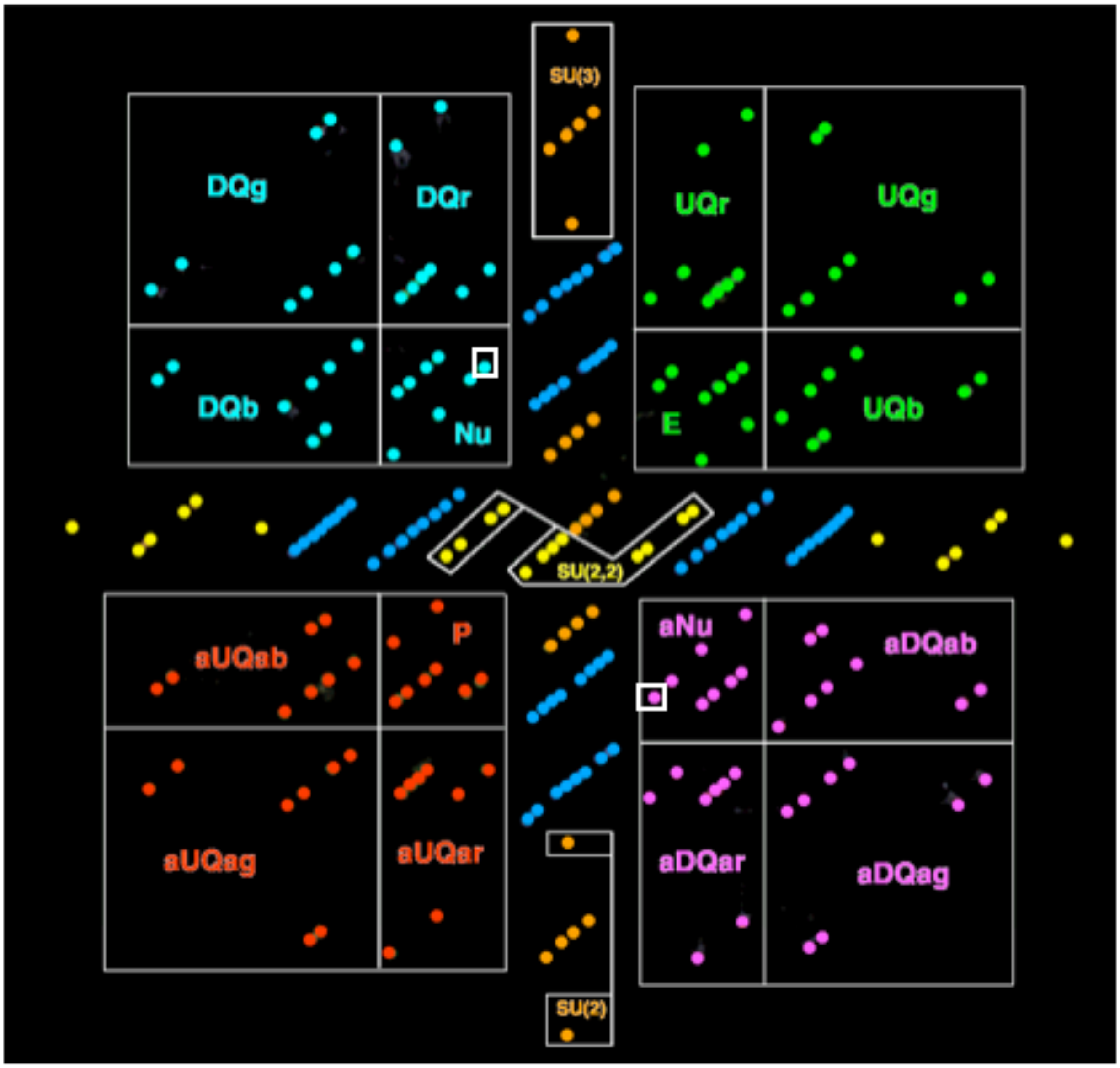
Symmetric space E7 / D6xSU(2) = 64-dim Rosenfeld QuaterOctonionic Projective Plane
corresponds to 8 components of (electron + rgb up quarks) = 8x4 = 32
plus 8 components of (positron + rgb up antiquarks) = 8x4 = 32
D6 x SU(2) has 60+2 = 62 root vectors so if you add 1+1 North and South Poles
you get 64 corresponding to 8 components of (neutrino + rgb down quarks) = 8x4 = 32
plus 8 components of (antineutrino + rgb down antiquarks) = 8x4 = 32

**2-dim projection of 240 E8 Root Vectors
gives useful visualization of
which root vector corresponds to which physics thing**

In 2-dim Projection the Root Vectors no longer have the same distance from origin



but in this particular 2-dim projection the physical interpretations of each Root Vector becomes clear:

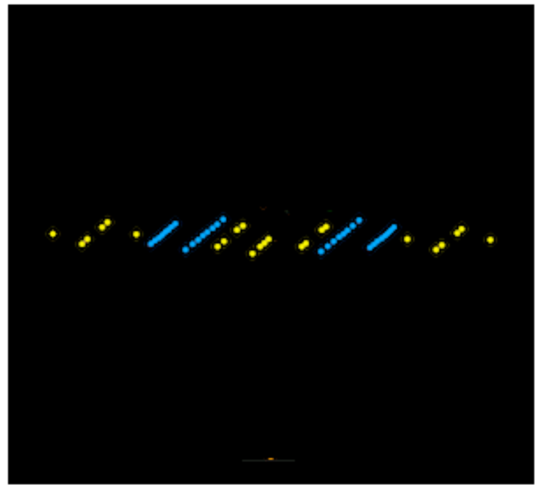


E = electron, UQr = red up quark, UQg = green up quark, UQb = blue up quark
Nu = neutrino, DQr = red down quark, DQg = green down quark, DQb = blue down quark
P = positron, aUQar = anti-red up antiquark,
aUQag = anti-green up antiquark, aUQab = anti-blue up antiquark
aNu = antineutrino, aDQar = anti-red down antiquark
white boxes enclose time components of neutrino and antineutrino
aDQag = anti-green down antiquark, aDQab = anti-blue down antiquark
Each Lepton and Quark has 8 components with respect to 4+4 dim Kaluza-Klein
6 orange SU(3) and 2 orange SU(2) represent Standard Model root vectors
24-6-2 = 16 orange represent U(2,2) Conformal Gravity Ghosts
12 yellow SU(2,2) represent Conformal Gravity SU(2,2) root vectors
24-12 = 12 yellow represent Standard Model Ghosts
32+32 = 64 blue represent 4+4 dim Kaluza-Klein spacetime position and momentum

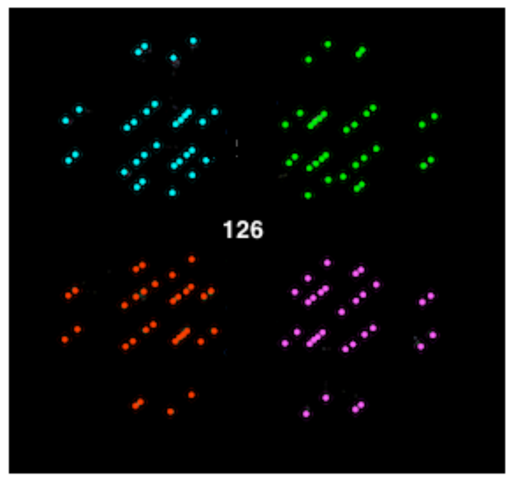
Here is how the 2-dim physical interpretations correspond
to the 8-dim Sphere Latitude decomposition:

1 is at North Pole

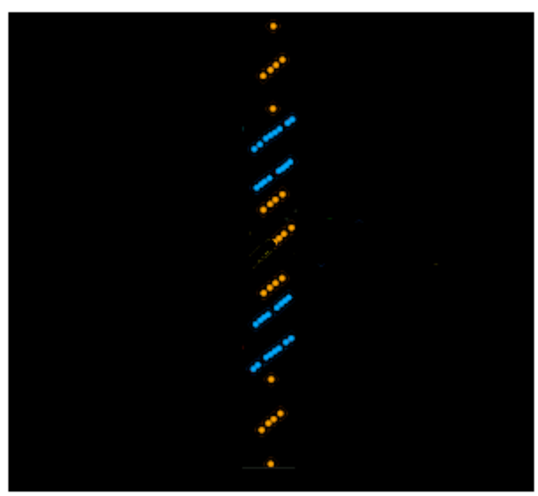
56 nearest neighbors of the North Pole
are at North Temperate Latitude



126 2nd nearest neighbors of the North Pole
are at the Equator



56 3rd nearest neighbors of the North Pole
are at South Temperate Latitude



1 4th nearest neighbor of the North Pole
is Anitpodal at the South Pole

Recipe for constructing Lagrangian from E8 Root Vectors

My favorite Fundamental Structure of Physics is the Lagrangian.
In his Dirac Lecture, Steven Weinberg says "... Lagrangian density ...
you can think of it as the density of energy.
Energy is the quantity that ... tells us how the system evolves. ...".

The Lagrangian Density contains Boson terms and Fermion terms.
To get the full Lagrangian, you integrate those terms over Spacetime.

The Code or Recipe just says:

put
the Gravity + Dark Energy Gauge Bosons and Standard Model Ghosts
and
the Standard Model Gauge Bosons and Gravity-Dark Energy Ghosts
into the Lagrangian Density Boson terms in accord with the standard way of constructing physics boson terms

and

put
the Fermion Particles and AntiParticles
into the Lagrangian Density Fermion terms in accord with the standard way of constructing physics fermion terms

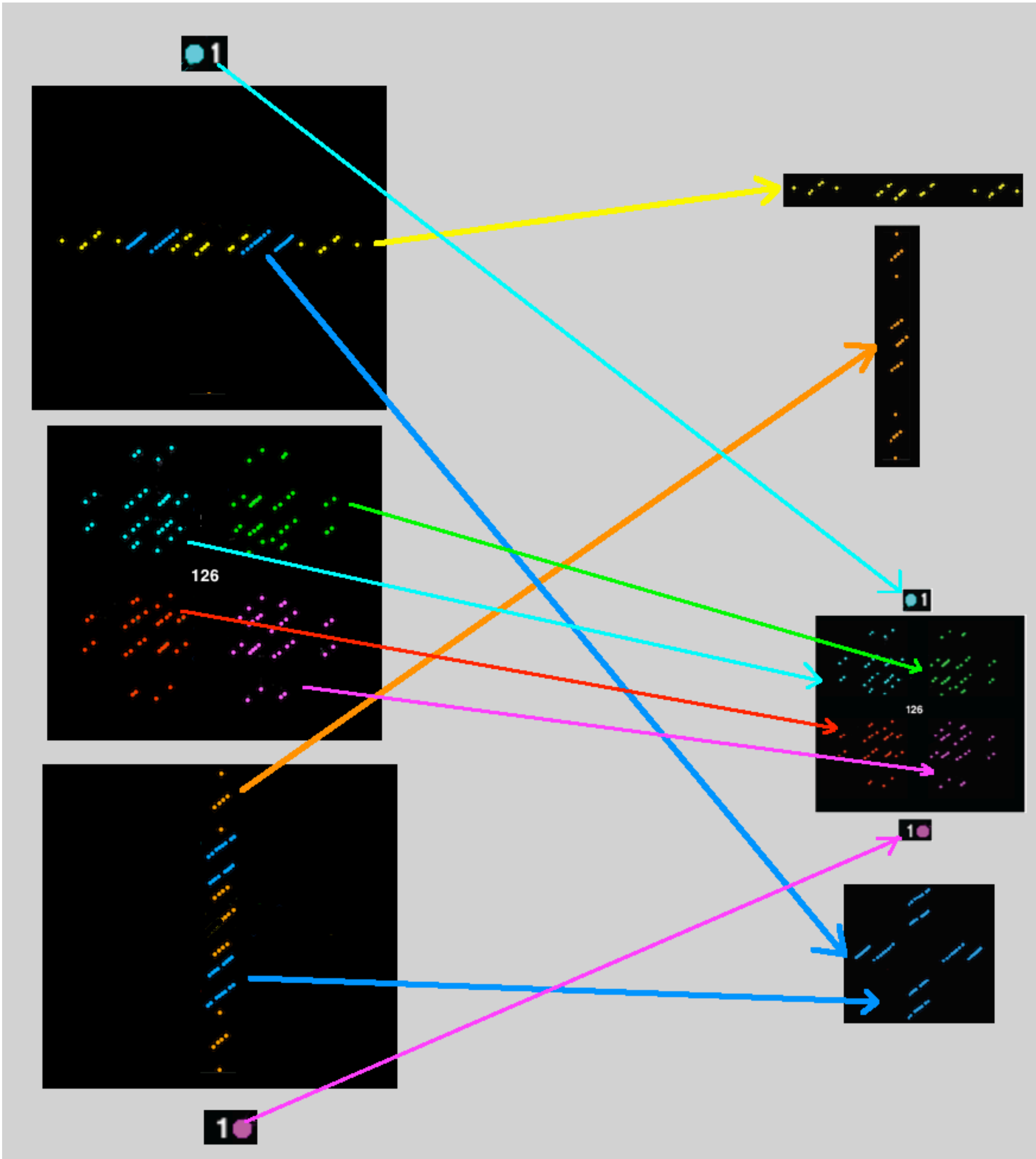
and

put the Spacetime Root Vectors
into the Spacetime Base Manifold over which the Lagrangian Density is integrated.

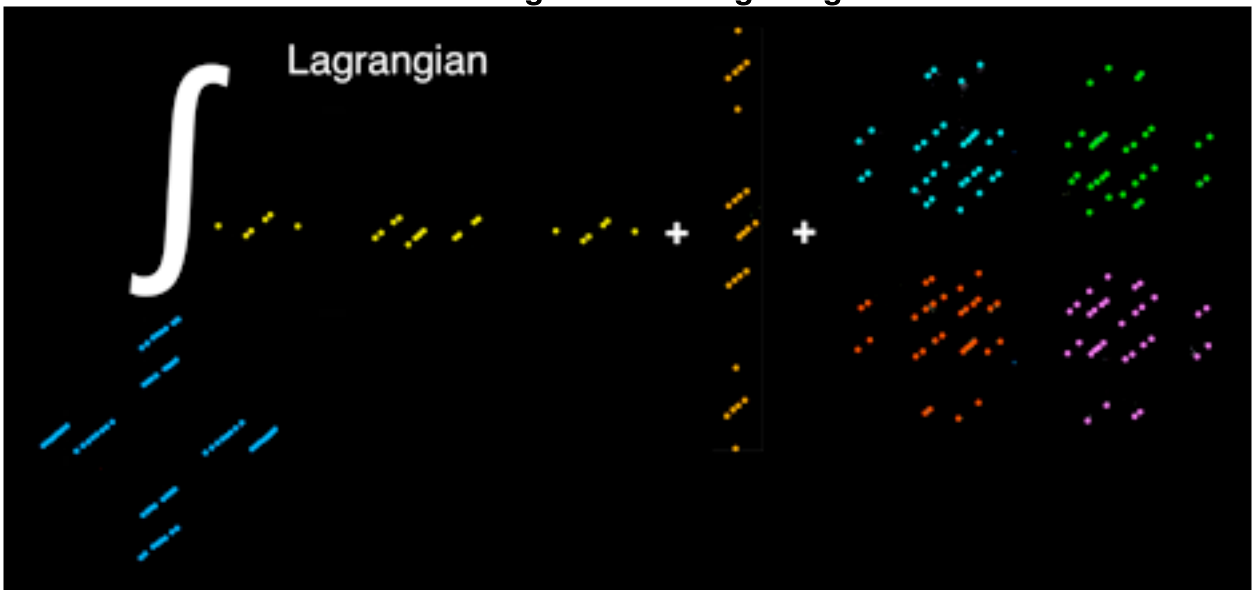
In terms of the preceding pictures of physics of E8 Root Vectors
the Code or Recipe gives a Lagrangian that is a realistic physics model.

Of course, to completely carry out the Code or Recipe you need to write out
the Lagrangian terms in the math language of conventional physics
and that is described in some of the long papers I have written
(see my web site and my viXra papers).

Here I am just trying to show the basic underlying structure of E8 Geometry
so I am not writing down the extensive details in this paper.

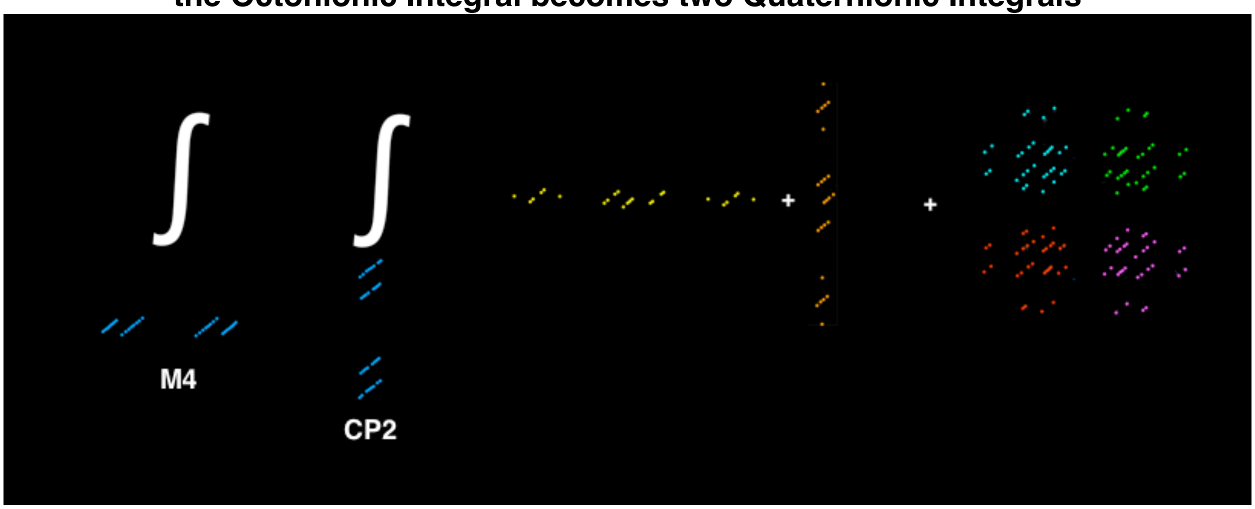

1
126
1
126
1
1

The fundamental Lagrangian formed by this structure is an Octonionic structure over 8-dim Spacetime and is effective during the Initial Big Bang and Inflation.

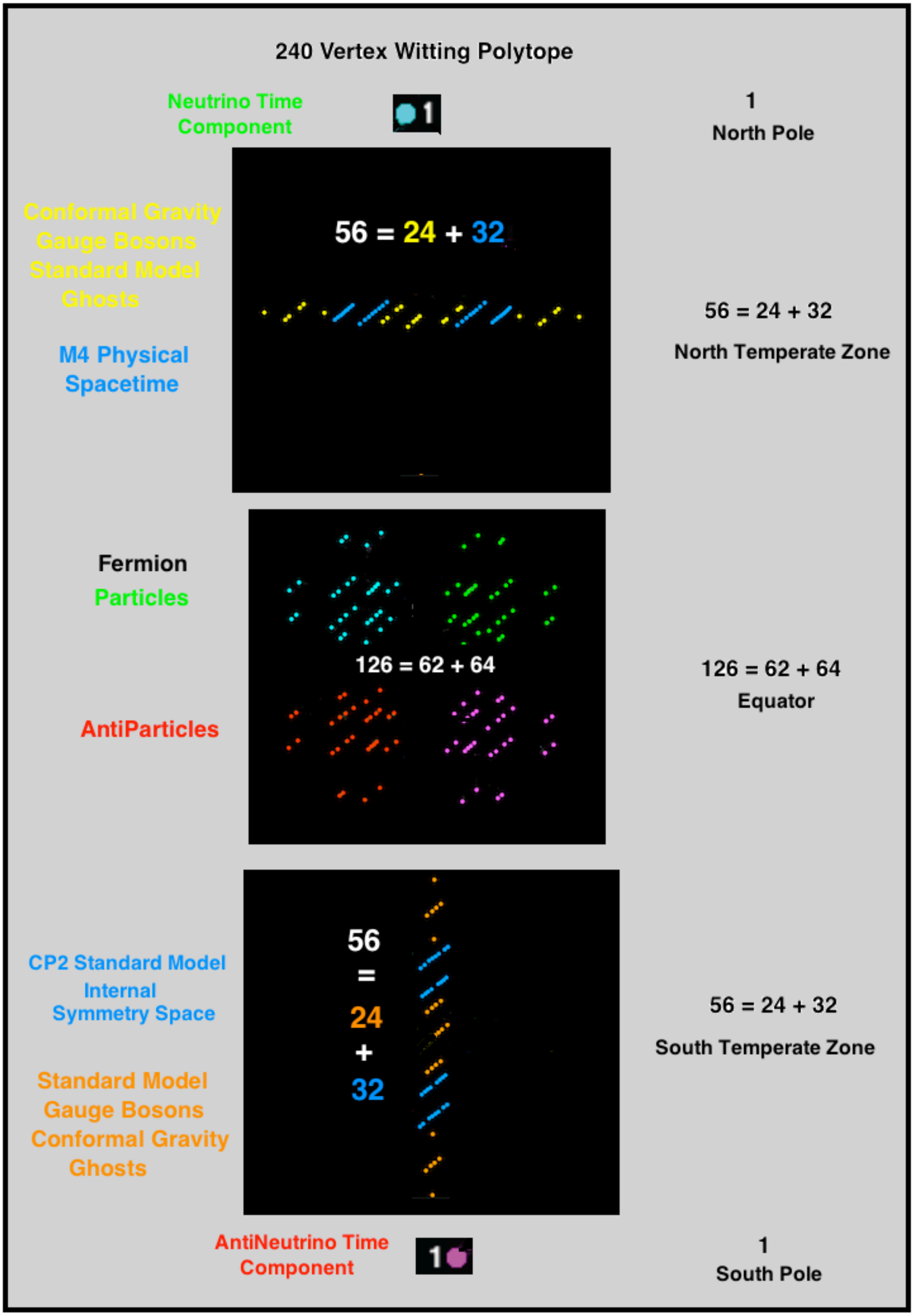


Since Octonionic Quantum Field Theory is NOT Unitary, Particle / AntiParticle Creation occurs during Inflation.

Inflation Ends when a preferred Quaternionic Subspacetime freezes out, converting 8 dim Spacetime into 4+4 dim M4 x CP2 Spacetime where M4 = Physical Minkowski Spacetime and CP2 = SU(3) / U(2) Internal Symmetry Space and the Octonionic Integral becomes two Quaternionic Integrals



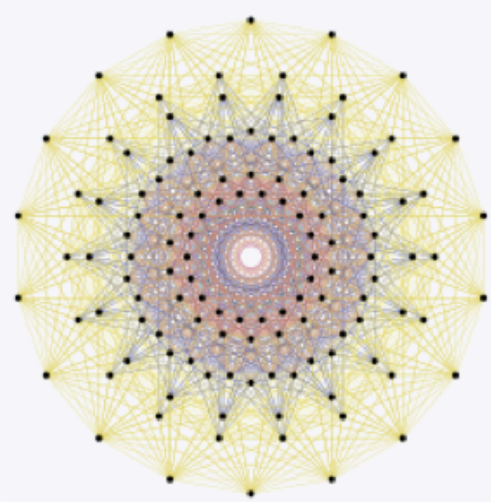
Here is how the Witting 240-Polytope splits into two 600-Cells:


240 Vertex Witting Polytope
Neutrino Time Component
1
1
North Pole
56 = 24 + 32
Conformal Gravity Gauge Bosons Standard Model Ghosts
M4 Physical Spacetime
56 = 24 + 32
North Temperate Zone
Fermion Particles
126 = 62 + 64
AntiParticles
126 = 62 + 64
Equator
56 = 24 + 32
CP2 Standard Model Internal Symmetry Space
Standard Model Gauge Bosons Conformal Gravity Ghosts
56 = 24 + 32
South Temperate Zone
AntiNeutrino Time Component
1
1
South Pole

In more detail, start with the North Pole.

Then the North Pole has 56 nearest neighbors that live on a North Temperate Zone
which is a fixed Latitude Angle from the North Pole
and is a 6-dim sphere Latitude subset of the 7-dim sphere.
The 56 are of two kinds:
32 describing half of 8-dim Spacetime
for 4-dim Minkowski Physical Spacetime and
24 describing Gauge Bosons and Ghosts for Gravity and the Standard Model.
The 32 Spacetime-type vertices live on the Equator of the 6-dim sphere and
are distributed on that 5-dim sphere as one half of the 64 vertices of a hypercube in 6-dim space.
12 of the 24 live on a North Temperate Latitude of the 6-dim sphere
The other 12 of the 24 live on a South Temperate Latitude of the 6-dim sphere.

Then there are 126 next-nearest neighbors to the North Pole.
They live on the Equator of the 7-dim sphere
and are distributed on that 6-dim sphere as the Root Vectors of the E7 Lie Algebra



126 vertices of 2_{31} represent the root vectors of E_7

They correspond to 126 of the 128 components of 8+8 Fermion Particles+AntiParticles.

Then are the 56 nearest neighbors of the South Pole that of a South Temperate Zone
which is a fixed Latitude Angle from the South Pole
and is a 6-dim sphere Latitude subset of the 7-dim sphere.
The 56 are of two kinds:
32 describing half of 8-dim Spacetime
for 4-dim CP2 Standard Model Internal Symmetry Space and
24 describing Gauge Bosons and Ghosts for the Standard Model and Gravity.
The 32 Spacetime-type vertices live on the Equator of the 6-dim sphere and
are distributed on that 5-dim sphere as the other half of the 64 vertices of a hypercube in 6-dim space.
12 of the 24 live on a North Temperate Latitude of the 6-dim sphere
The other 12 of the 24 live on a South Temperate Latitude of the 6-dim sphere.

Then there is finally the South Pole.The 240-Polytope decomposes into two 120-vertex 600-Cells

The 240-Polytope splits into two 120-vertex 600-Cells:

Sadoc and Mosseri in their book "Geometrical Frustration" (Cambridge 1999, 2006), say: "...

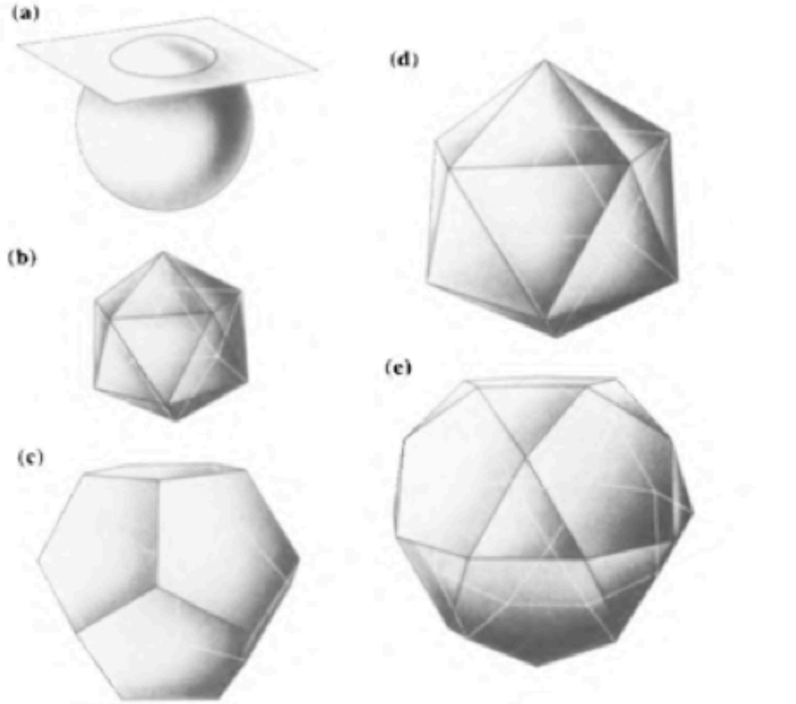


Fig. A5.1. The {3, 3, 5} polytope. Different flat sections in S^3 (with one site on top) give the following successive shells; (a) an icosahedral shell formed by the first 12 neighbours, (b) a dodecahedral shell, (c) a second and larger icosahedral shell, (d) an icosidodecahedral shell on the equatorial sphere. Then other shells are symmetrically disposed in the second 'south' hemi-hypersphere, relative to the equatorial sphere (e).

...

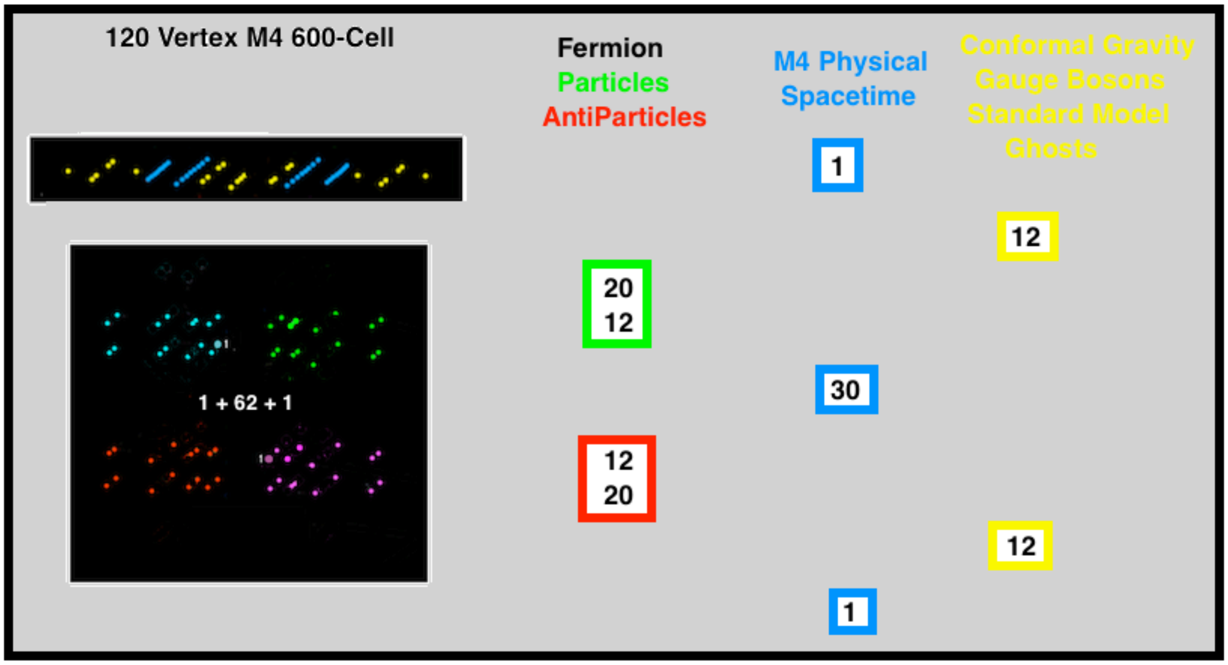
Table A5.1. *Sections of the {3, 3, 5} polytope (with an edge length equal to $2\tau^{-1}$) beginning with a vertex*

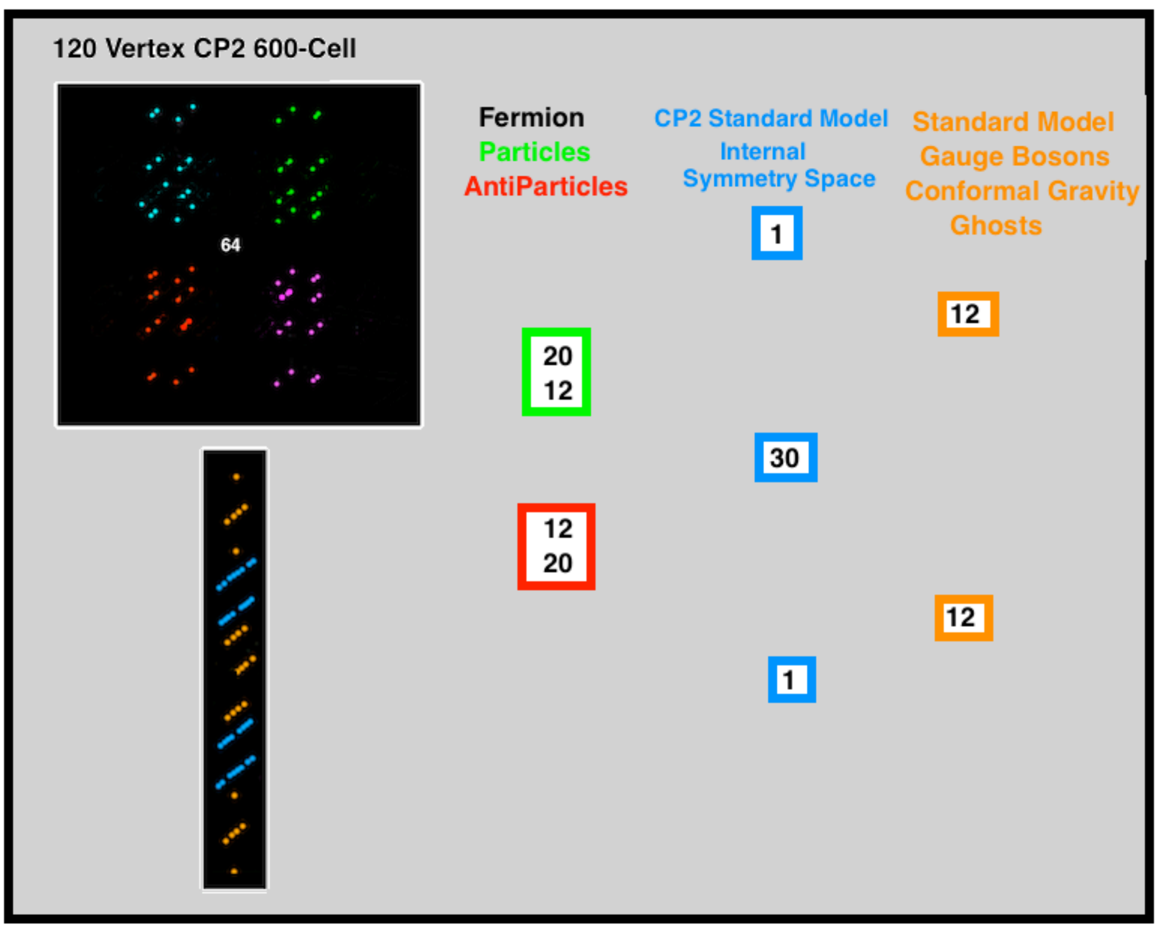
Section	x_0	$(x_1, x_2, x_3)^1$	Vertex number	Shape
0	2	(0, 0, 0)	1	point
1	τ	$(1, 0, \tau^{-1})$	12	icosahedron
2	1	(1, 1, 1) $(\tau, \tau^{-1}, 0)$	20	dodecahedron
3	τ^{-1}	$(\tau, 0, 1)$	12	icosahedron
4	0	(2, 0, 0) $(\tau, 1, \tau^{-1})$	30	icosidodecahedron
5	$-\tau^{-1}$	$(\tau, 0, 1)$	12	icosahedron
6	-1	(1, 1, 1) $(\tau, \tau^{-1}, 0)$	20	dodecahedron
7	$-\tau$	$(1, 0, \tau^{-1})$	12	icosahedron
8	-2	(0, 0, 0)	1	point

[1]Cyclic permutation with all possible changes of signs. $\tau = (1 + \sqrt{5})/2$.

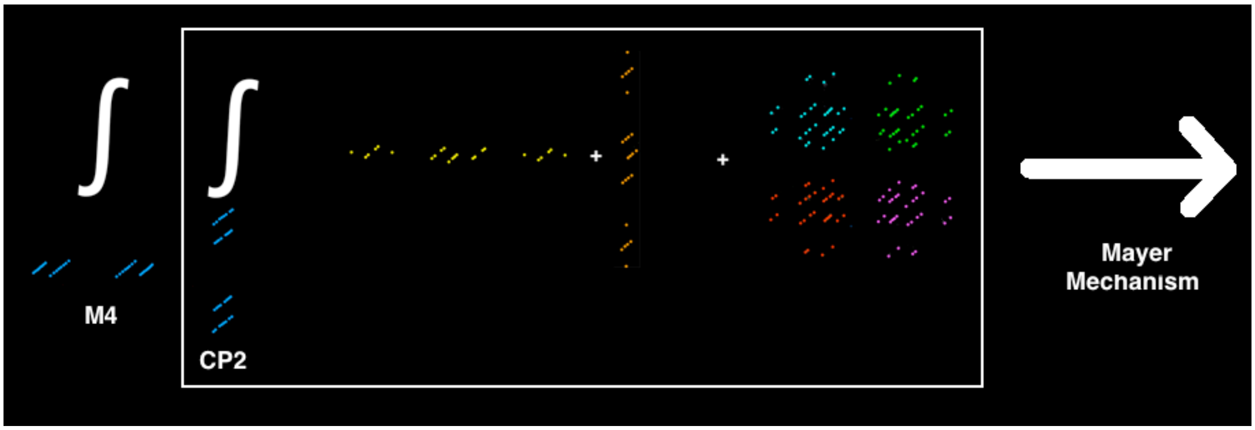
...".

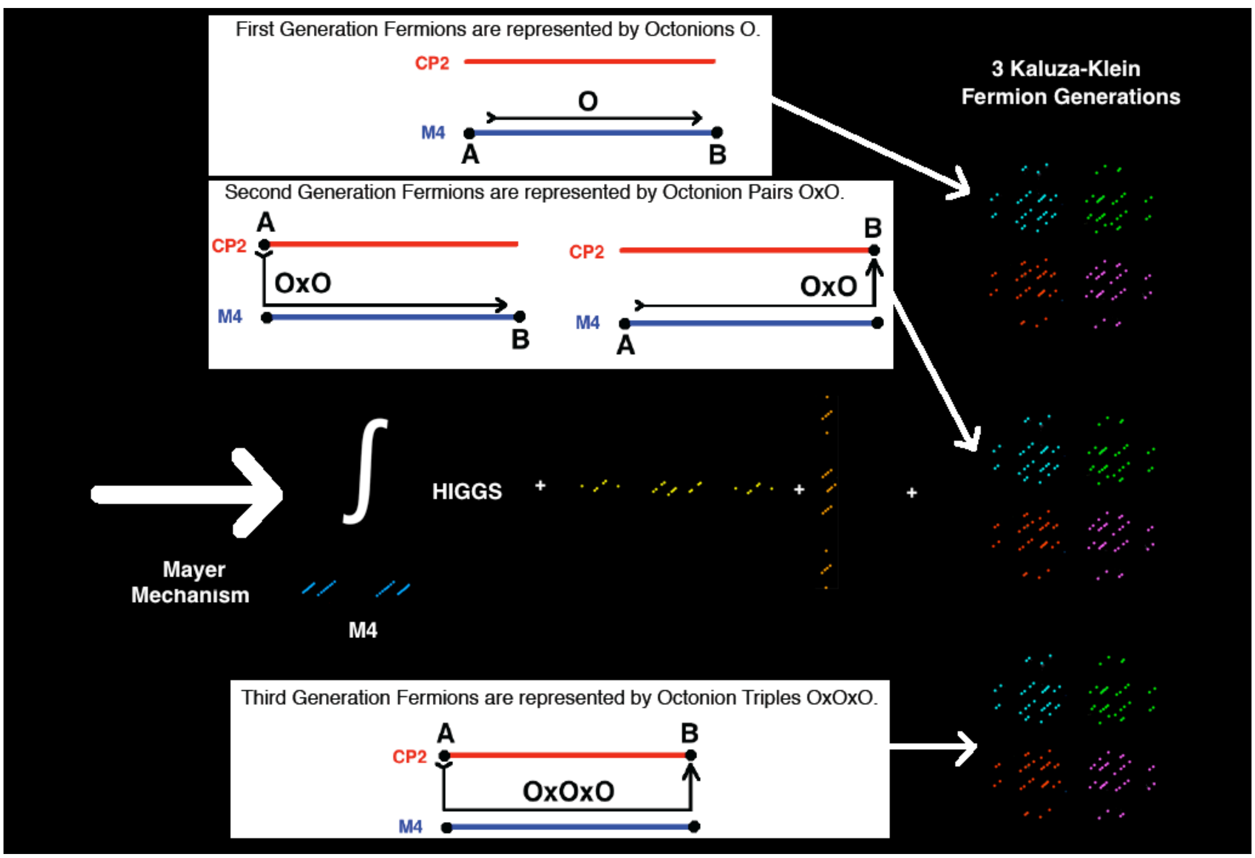
One 600-Cell represents M4 and the other 600-Cell represents CP2:



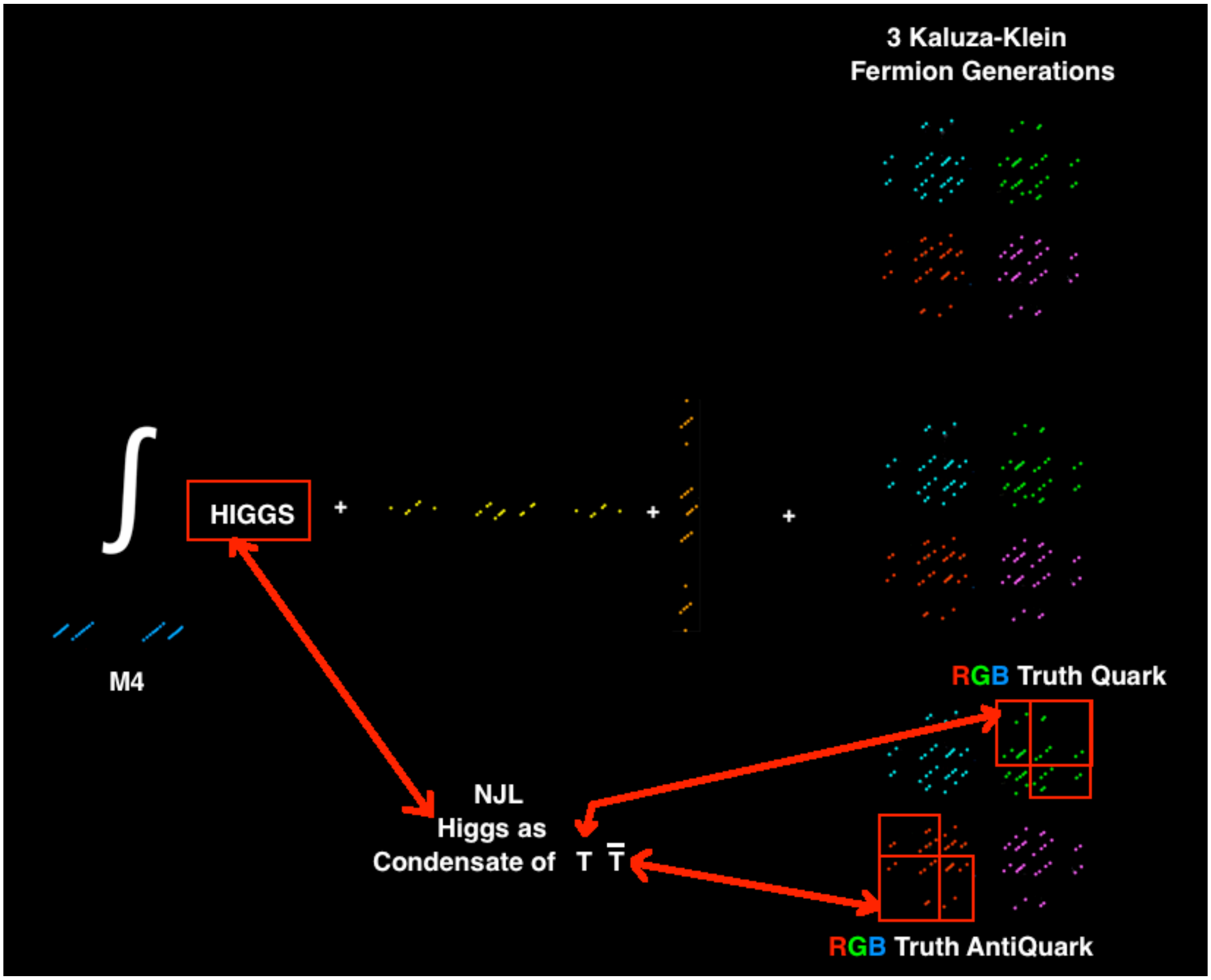


**Splitting Octonionic Spacetime into Quaternionic M4 x CP2 Kaluza-Klein over CP2 produces
Higgs by the Mayer Mechanism and
Second and Third Generation Fermions**



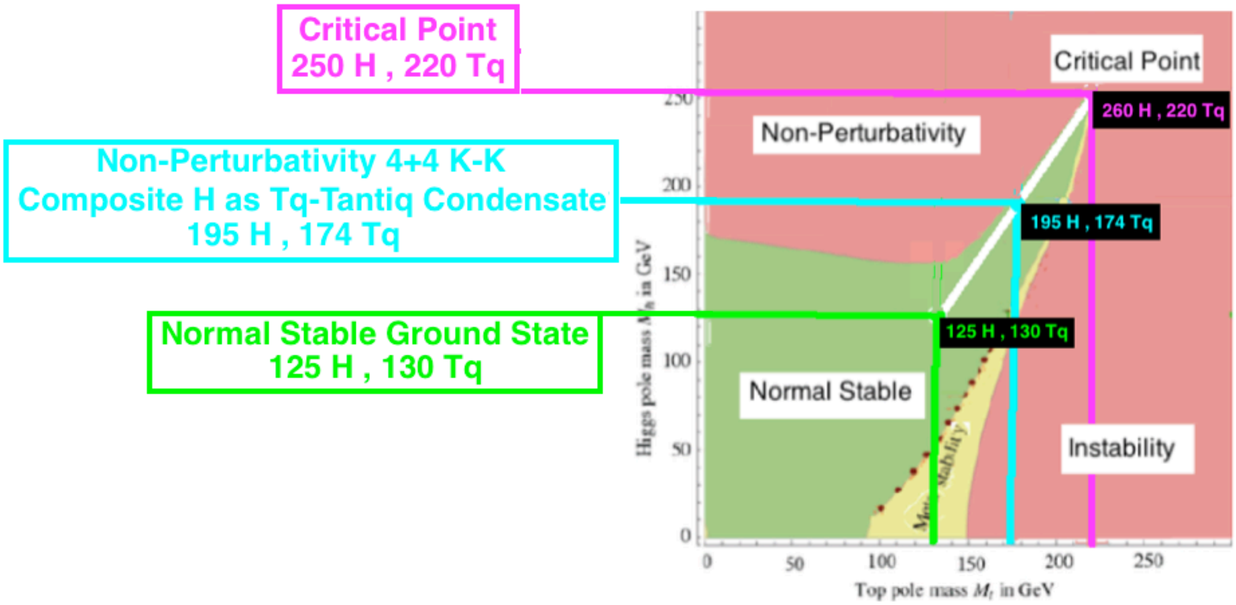


By generalizations of the Nambu-Jona-Lasinio mechanism
Higgs is a Fermion Particle-AntiParticle Condensate
which, since the Truth Quark is by far the most massive Fermion,
effectively means that Higgs is a Truth Quark - Truth AntiQuark Condensate.

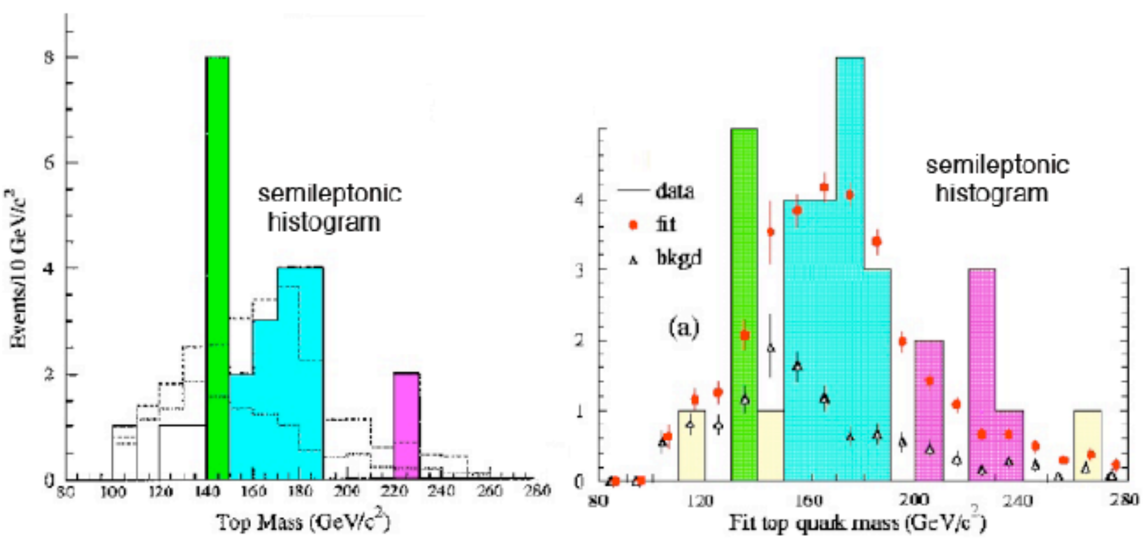


When Octonionic M(1,9) Spacetime is reduced
to Cf6 x CP2 Kaluza-Klein and then to M4 x CP2 Kaluza-Klein
the Higgs is produced by the Mayer-Trautman mechanism
and the Second and Third generations of Fermions appear.

The Higgs is seen to be related to Tquark-Tantiquark Condensate
by a phase diagram with Normal Stable, Vacuum Instability, and Non-Perturbativity - Triviality - (4+4)-dim Kaluza-Klein Higgs Compositeness plus Critical Point, showing 3 Mass States of Nambu-Jona-Lasinio type Higgs-Tquark Systems:

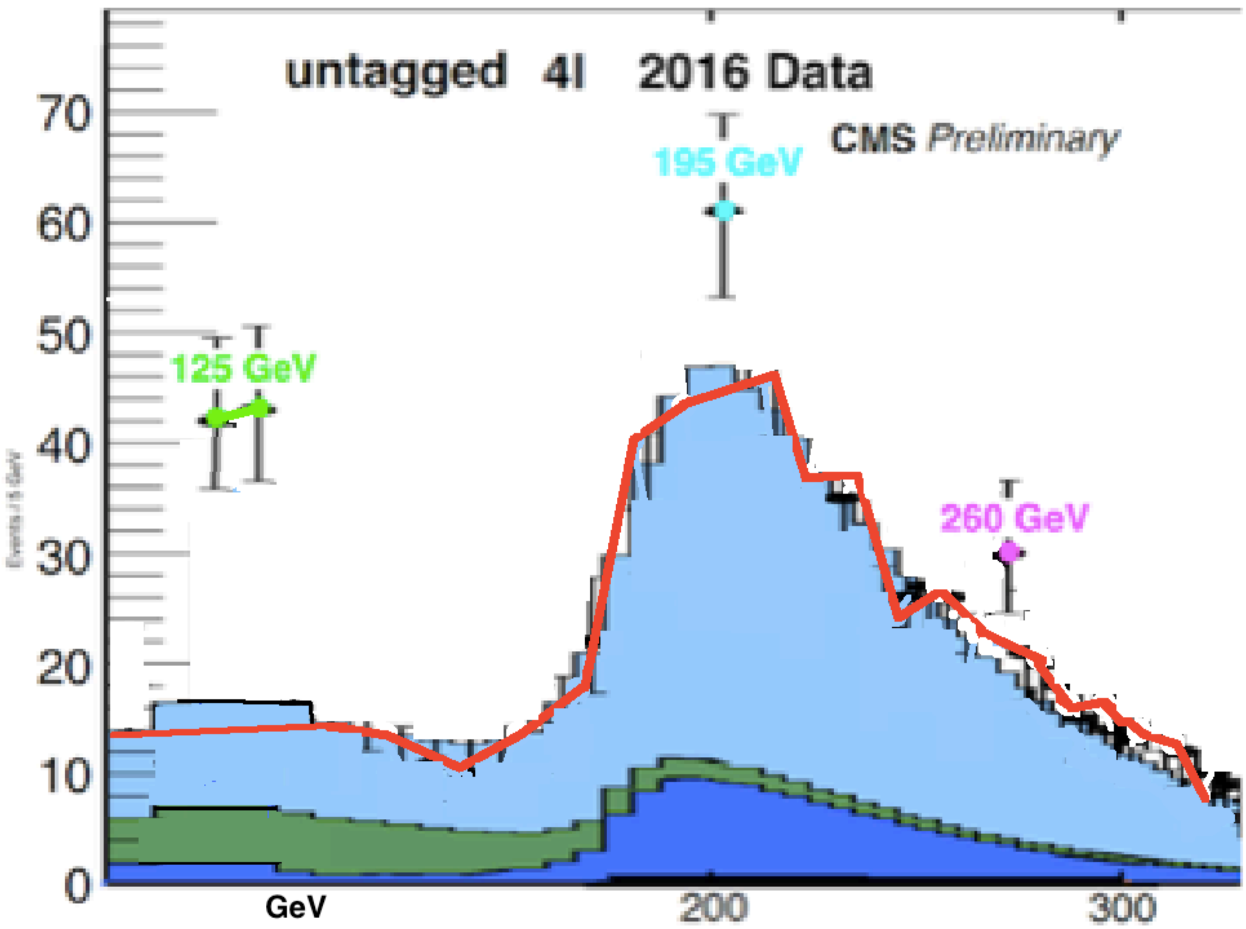


Semileptonic histograms of CDF and D0 from the 1990s
show 3 Truth Quark Mass States



CDF (FERMILAB-PUB-94/097-E) D0 (hep-ex/9703008)

Higgs -> ZZ -> 4l channel histogram of CMS from CMS PAS HIG-17-012 (some adjacent 5 GeV histogram bins combined by me to form 10 GeV bins) **shows 3 Higgs Mass States**



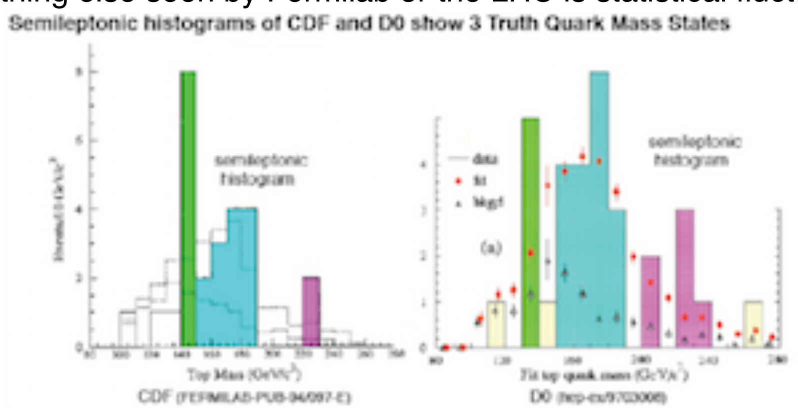
The CMS observation of 260 GeV for the high-mass Higgs state is somewhat higher than the theoretical value given by Koichi Yamawaki in hep-ph/9603293 where he says: "... the four-fermion theory in the presence of gauge interactions (... gauged Nambu-Jona-Lasinio (NJL) ... model) can become renormalizable and nontrivial ...
The Higgs boson was predicted as a tbar-t bound state ... Its mass was ... calculated by BHL ... [Bardeen-Hill-Lindner] ... through the full RG equation ... the result being ... MH = mt x 1.1 at 10^19 GeV ...[which gives]... MH = 239 +/- 3 GeV ...".

The CMS observation of 195 GeV for the middle-mass Higgs state is also somewhat higher than the theoretical value given by Hashimoto, Tanabashi, and Yamawaki in hep-ph/0311165 where they say:
"... We perform the most attractive channel (MAC) analysis in the top mode standard model with TeV-scale extra dimensions for ...[Kaluza-Klein type]... dimension... D=8 ... m_t = 172-175 GeV and m_H=176-188 GeV ...".

In both cases
the CMS observed mass is about 10-20 GeV higher than the theoretical mass which is close enough to show that the theory is fundamentally realistic.

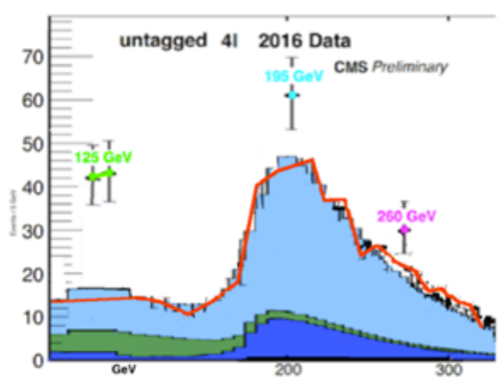
Consensus 1-state Higgs and Tquark give Metastable Universe
but
E8 3-state Higgs and Tquark gives Stable Universe at Low Energy
and 8-dim Kaluza-Klein Compositeness at Medium Energy
and Full Electroweak Symmetry at High Energy

The Consensus View of experimental results of the LHC and Fermilab is
that there is only one Higgs state and it is the 125 GeV state and
everything else seen by the LHC is statistical fluctuation
and
that there is only one Tquark state and it is the 174 GeV state and
everything else seen by Fermilab or the LHC is statistical fluctuation.



1990s Analyses of Tquark mass states by Fermilab led to a **Fermilab Consensus:**
there is only one Tquark mass state;
it is the 174 GeV central (cyan) peak; and
the green and magenta peaks predicted by E8 physics are statistical fluctuations.
Therefore later Fermilab analyses experiments ignored the green and magenta peaks.

If LHC follows the Fermilab practice of ignoring the unconventional peaks



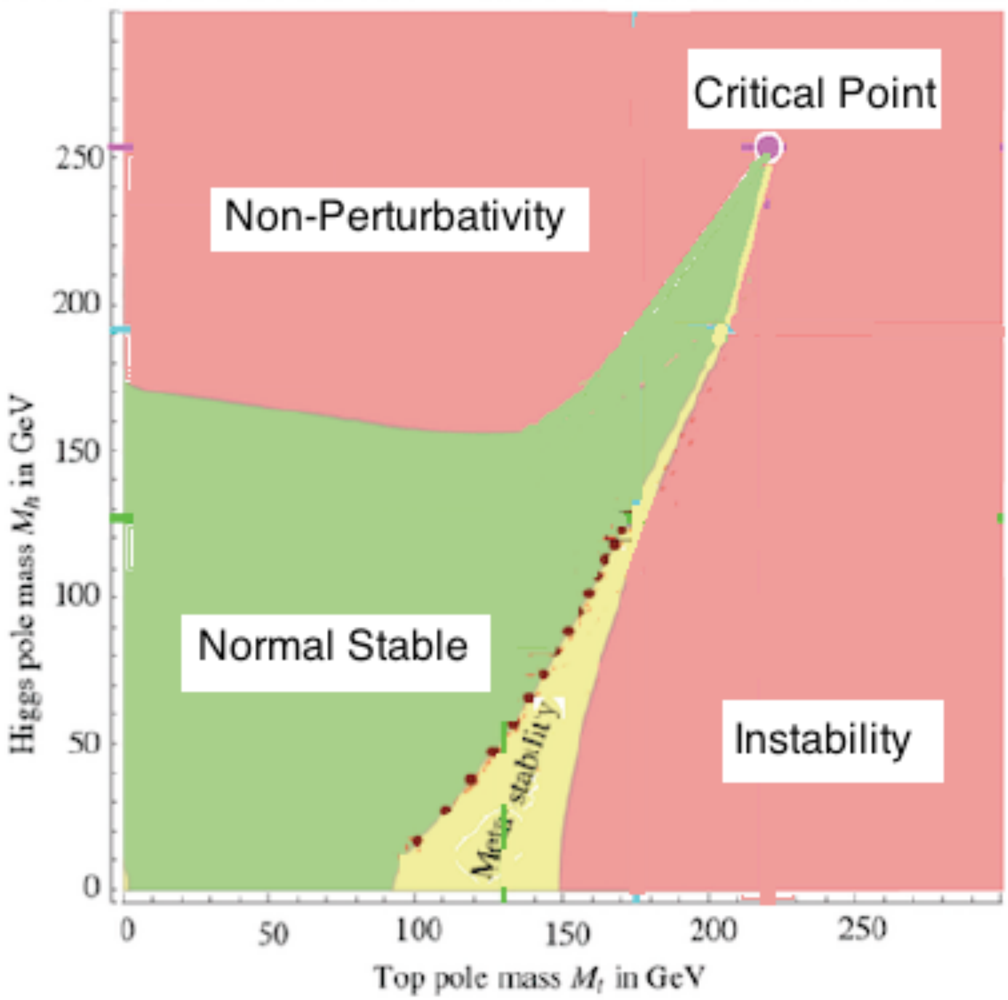
and declares the 195 GeV and 260 GeV Higgs peaks to be statistical fluctuations
(perhaps by using inappropriate Look Elsewhere Effect)

What will it mean for physics ?

It means that every physics student has been since the 1990s and will be from now on taught that the Standard Model has only one Higgs mass state (125 GeV) and one Tquark mass state (174 GeV).

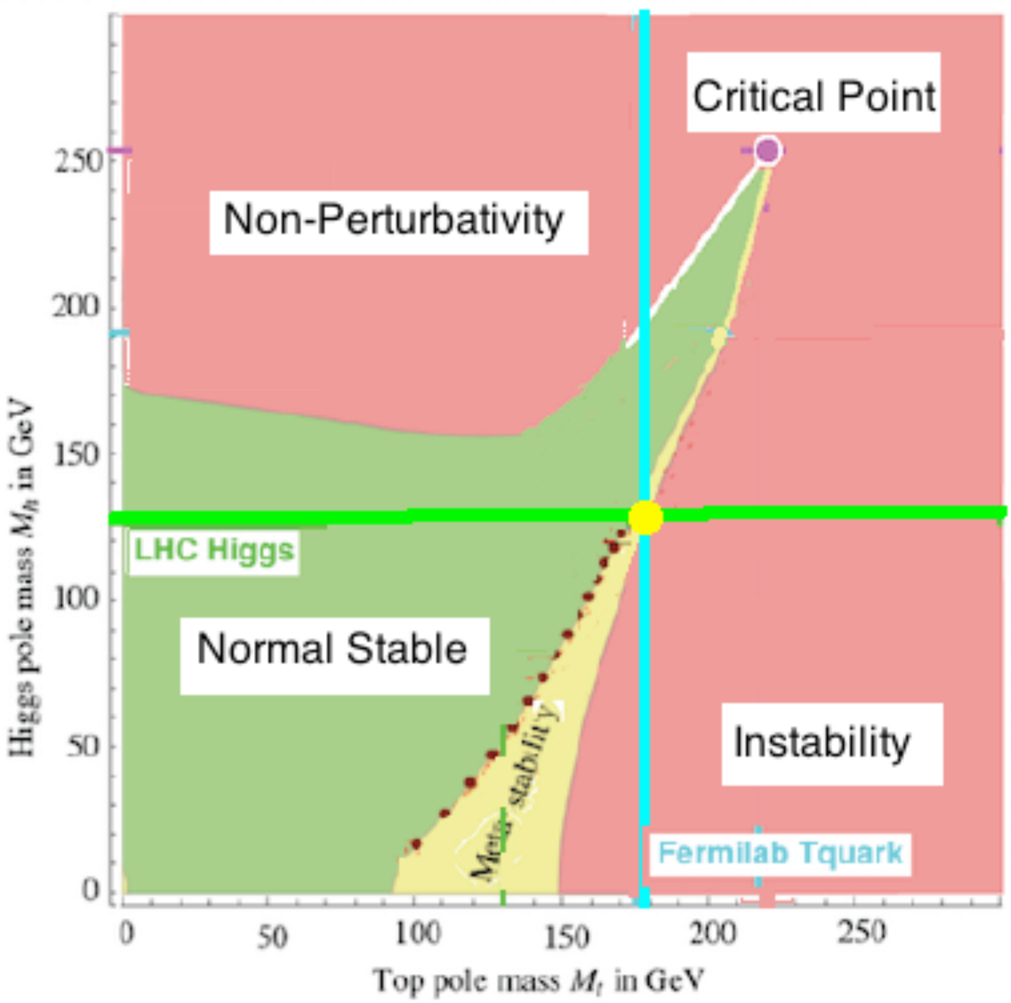
WHAT IS WRONG WITH THAT ?
WHAT REAL DIFFERENCE WOULD IT MAKE TO FOLLOW THE CONSENSUS ?

If you use the Standard Model to plot Higgs mass against Tquark mass you get this phase diagram:



Where is the Consensus View on the Phase Diagram ?

The Consensus View of one Higgs at 125 GeV and one Tquark at 174 GeV gives a METASTABLE UNIVERSE that might destroy itself at any moment:



How about the E8 physics model with 3-state Higgs and 3-state Tquark ?

In the E8 physics 3-state model there are 3 intersections:

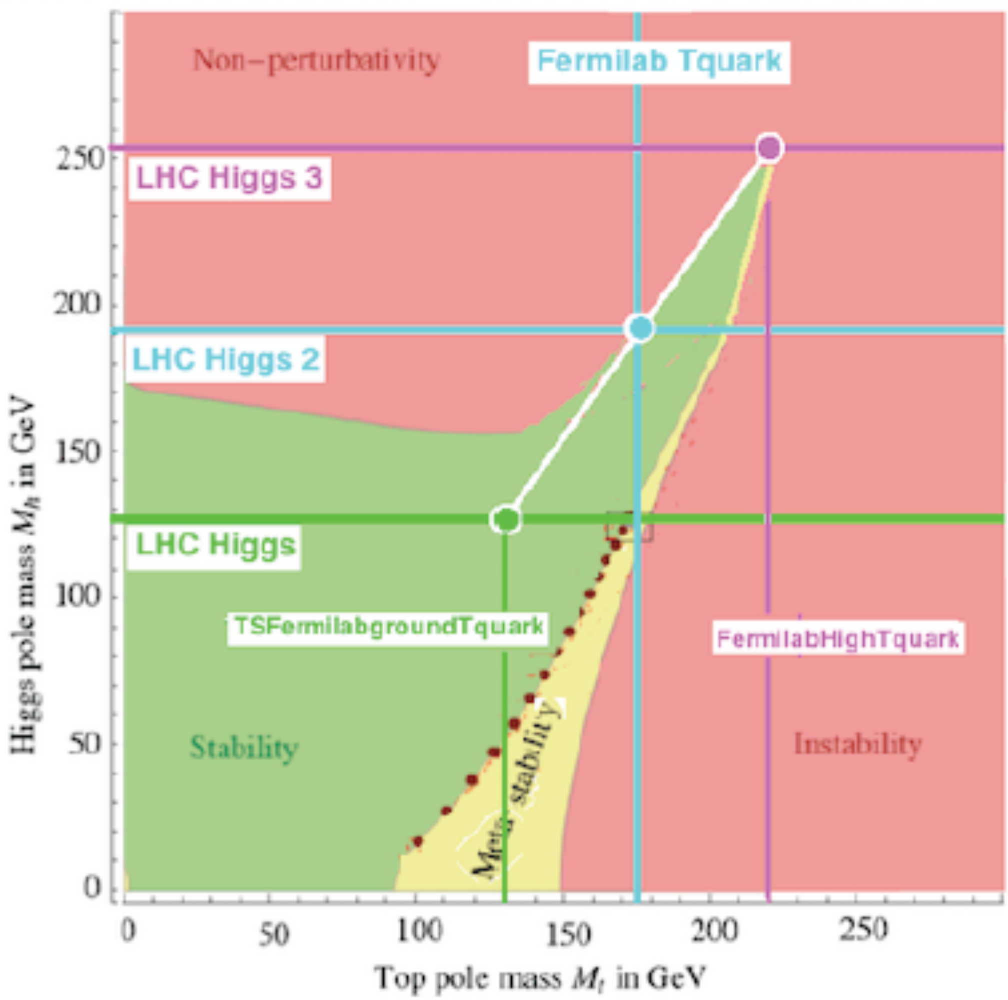
low mass H with low mass Tq
medium mass H with medium mass Tq
high mass H with high mass Tq

Those 3 intersections are, respectively:

in the Normal Stable region - with STABLE Universe

on the boundary line of non-perturbativity - at which Higgs compositeness
and 8-dim Kaluza-Klein spacetime structure become manifest
(see hep-ph/0311165 by Hashimoto, Tanabashi, and Yamawaki)

at the critical point - beyond which Electroweak Symmetry is NOT broken
and W and Z bosons stay massless

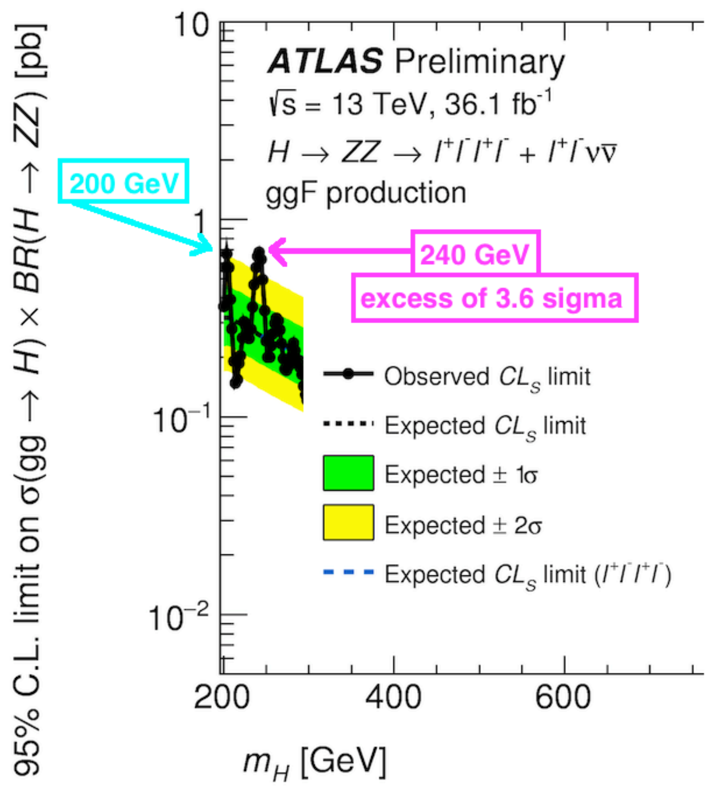


**ATLAS may have seen two of the three Higgs Mass States,
thus supporting the STABLE Universe of the E8-Cl(16) model NJL Sector:**

ATLAS, for the Full 2016 36.1 fb-1 of data in the Higgs -> ZZ* -> 4l channel,
on 5 July 2017 released **ATLAS-CONF-2017-058** saying:
"... A search for heavy resonances decaying into a pair of Z bosons leading to l+ l- l+ l-
... final state... where l stands for either an electron or a muon, is presented.
[that includes the Higgs -> ZZ* -> 4l channel]
The search uses proton–proton collision data at a centre-of-mass energy of 13 TeV
corresponding to an integrated luminosity of 36.1 fb-1 collected with the ATLAS detector
during 2015 and 2016 at the Large Hadron Collider ...

excess ...[is]... observed in the data for m4l around 240 ... GeV ...
with a local significance of 3.6 sigma

estimated under the asymptotic approximation,
assuming the signal comes only from ggF production ...
The excess at 240 GeV is observed mostly in the 4e channel ...
Figure 6 presents the expected and observed limits at 95% confidence level
on sigma x BR(H->ZZ) of a narrow-width scalar for the ggF ... production modes,
as well as the expected limits [figure truncated to relevant 140 - 300 GeV range]...



...".

E8-Cl(16) Physics Model (viXra 1602.0319) NJL Sector has 3 Higgs mass states being around 125 GeV (observed) and 200 and 250 GeV.

240 GeV is close enough to 250 GeV that the ATLAS 3.6 sigma peak should not be suppressed by LEE.

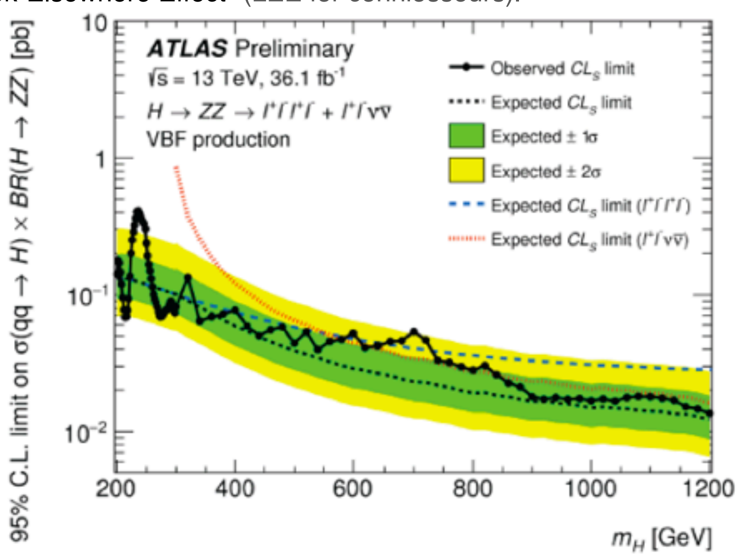
On 27 July 2017 Tommaso Dorigo posted this on his blog:

"... **An ATLAS 240 GeV Higgs-Like Fluctuation Meets Predictions From Independent Researcher**

A new **analysis by the ATLAS** collaboration, based of the data collected **in 13 TeV proton-proton collisions delivered by the LHC in 2016**, finds

an excess of X-->4 lepton events at a mass of 240 GeV, with a local significance of 3.6 standard deviations.

The search, which targeted objects of similar phenomenology to the 125 GeV Higgs boson discovered in 2012, is published in ATLAS CONF-2017-058.
Besides the 240 GeV excess,
another one at 700 GeV is found, with the same statistical significance.
3.6 standard deviations correspond to a "one-in-six-thousand" chance to observe data at least as discrepant with the background model as what is observed, if they do come from background only.
So it is something interesting, as one may entertain the hypothesis that the data do contain some extra signal in it, causing the observation. However, in general such fluctuations are common in collider data.
Physicists have learnt to "derate" the computed significances of bumps appearing in new particle searches - equivalently, to increase the estimate of the probability (p-value) of seeing the data if coming from background-only fluctuations - by considering the number of independent places where a bump was sought for in the first place. The p-value-enhancing factor is commonly called "trials factor" and the effect addressed to as "Look-Elsewhere Effect" (LEE for conniosseurs).



Above: as a function of the reconstructed mass of the hypothetical particle decaying into four leptons, ATLAS plots the upper limit on the particle's production rate. The green+yellow band shows the range of values that the expected limit should take in the absence of any new particle, with green meaning "the central 68% quantiles" and yellow meaning "the central 95% quantiles". Whatever is above the curve is a significant-ish excess. The black points show the observed limit, which has a upward spike at 240 GeV due to the presence of an excess of events with that mass.

The two bumplets found by ATLAS have a "trial-factor-corrected" significance of just over 2 standard deviations (a few-in-hundred chance), so they appear insignificant. However, in case you have **a model which predicts in advance the mass at which the particle signal should be found, the local significance (3.6 sigma in this case) should be the one to look at**. And 3.6 sigma is a quite serious business: the number is called "strong evidence" by ATLAS itself when it refers to H->bb decays neatly evidenced in the same dataset through a careful new analysis (one which I have not had an occasion to talk about here, unfortunately).

Incidentally, 3.6 sigma are also about the significance of the 750 GeV X->gamma gamma bump found by ATLAS 2 years ago - you know, the one that caused 600 theoretical papers to flood the Cornell Arxiv in the matter of a few months. So you see: 3.6 sigmas can both be the first hint of a real signal -
the 125 GeV H->bb one nobody doubts about - or a fluctuation that should not be taken too seriously and which is destined to die away, as the 750 GeV fairy.
Today, the 240 GeV ATLAS signal looks intriguing, for a couple of reasons.
One is that an independent researcher, who has a past involvement in experimental physics research but is now doing totally different things, has predicted such a particle in a toy model he put together several years ago. The guy is Tony Smith (Frank D. Smith his registered name), a long-time follower of this blog. His toy model is described in a vixra paper he wrote in February last year.
(see http://vixra.org/abs/1602.0319 and http://vixra.org/abs/1610.0318)
The other is that Tony himself points out that CMS also seems to have been seeing slight excesses more or less where he predicted them, in their 4-lepton mass distribution. Being a CMS member, I will not comment on that statement, as CMS has not issued any on the matter. Whether the 240 GeV Higgs will join the 750 GeV one in the trash bin or whether instead it will grow to become an astounding new find, confirming Tony's model, is a topic on which I accept bets. Not from Tony himself though, as I won two with him already and I don't want to look like I exploit his perseverance in pursuit of exotic new physics signals - he is sort of a friend now.
But if you believe this will become the next big LHC discovery,
and are willing to bet $500 on it, drop me a line!

COMMENTS
...
Well, I hope some real theorist who can write real arxiv papers picks it up as a possible divertissement - Tony has tried to publish in the arxiv but as far as I remember he is sort of banned there.
Cheers,
T.
Tommaso Dorigo | 07/28/17 | 1:42 PM ...”.