Outline of E8 Physics:

1 - Empty set grows by Clifford Process to arbitrarily large Cl(16N) which factors by periodicity to N-fold tensor product of Cl(16) = Cl(8)xCl(8) with each local Cl(16) containing an E8 that describes physics of that local region

2 - E8 has Chirality because E8 contains only one set of Cl(16) half-spinors

3 - E8 D8 part = 120 = 112 + 8 = 64 + (24+4) + (24+4)

4 - 64 + 64 E8 spinor part as anticommuting Fermions

5 - Spacetime emerges like condensation by all E8 regions consistently aligning their local 8-dim Octonionic spacetimes with 8-dim position and momentum described by 64-dim D8 / D4xD4 (blue dots) where D8 is a 120-dim subalgebra of 248-dim E8

6 - 8-dim Lorentz structure satisfies Coleman-Mandula because the fermionic fundamental spinor representations of the E8 model are built with respect to Lorentz, spinor, etc representations based on 8-dim Spin(1,7) spacetime

7 - Fundamental High-Energy E8 Lagrangian for Octonionic 8-dim SpaceTime is UltraViolet Finite

8 - High-Energy Octonionic Physics is NOT Unitary due to Octonion Non-Associativity so the initial Inflationary Phase of Our Universe produces many particles

9 - World-Lines as Strings of 26-dim String Theory and Quantum Consciousness

10 - 8-dim SpaceTime breaks into (4+4)-dim Quaternionic Kaluza-Klein

11 - Schwinger Sources with symmetry from inherited from Monster Group
have
Kerr-Newman Black Hole structure size about 10^(-24) cm
and
Geometry of Bounded Complex Domains and Shilov boundaries

12 - Combinatorics of (4+4)-dim Kaluza-Klein structure contributes to Fermion mass ratios for 2nd and 3rd generations

13 - Kobayashi-Maskawa mass formulas

14 - neutrino masses beyond tree level

15 - Higgs-Tquark system with 3 mass states and Higgs as Tquark condensate

16 - Proton-Neutron mass difference

17 - Pion as sine-Gordon breather structure

18 - Planck mass as superposition condensate of Fermions

19 - Segal-type Conformal gravity with conformal generator structure giving
Dark Energy, Dark Matter, and Ordinary Matter ratio

20 - Dark Energy explanations for Pioneer Anomaly and Uranus spin-axis tilt
Conformal Dark Energy can explain the Pioneer Anomaly

21 - Dark Energy experiment by BSCCO Josephson Junctions and geometry of 600-cell

22 - Real Clifford Algebra periodicity allows construction of Algebraic Quantum Field
Theory as a generalization of II1 hyperfinite von Neumann factor algebra

23 - maximal contraction of E8 = semidirect product A7 x h92
gives a creation/annihilation algebra
where h92 = 92+1+92 = 185-dim Heisenberg algebra and A7 = 63-dim SL(8)

24 - AQFT and Third Grothendieck Universe

This is a 24-point Outline of E8 Physics
and so contains almost no technical details or references to papers, books, or images.
Such details and references can be found on my web sites at
http://www.valdostamuseum.com/hamsmith/
http://www.tony5m17h.net/
and my papers on viXra listed at
http://vixra.org/author/frank_dodd_tony_smith_jr
which papers include
http://vixra.org/abs/1310.0182
and the 11,445 page pdf file (about 313 MB) at
http://vixra.org/abs/1311.0094

Overview of E8 Physics:

Frank Dodd Tony Smith Jr - 2013

1 - Empty set grows by Clifford Process to arbitrarily large Cl(16N) which factors by periodicity to N-fold tensor product of Cl(16) = Cl(8)xCl(8) with each local Cl(16) containing an E8 that describes physics of that local region

1 = Cl(0) = 1
ø

1 1 = Cl(1) = 2
ø (ø)

1 2 1 = Cl(2) = 4
ø (ø) (ø (ø))
((ø))

1 4 6 4 1 = Cl(4) = 16
ø (ø) (ø (ø)) ((ø) ((ø)) (ø (ø))) (ø (ø) ((ø)) (ø (ø)))
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1 16 120 560 1820 4368 8008 11440 12870 11440 8008 4368 1820 560 120 16 1

= Cl(16) = 2^16 = 65,536 = ((64+64) + (64+64)) x ((64+64) + (64+64))

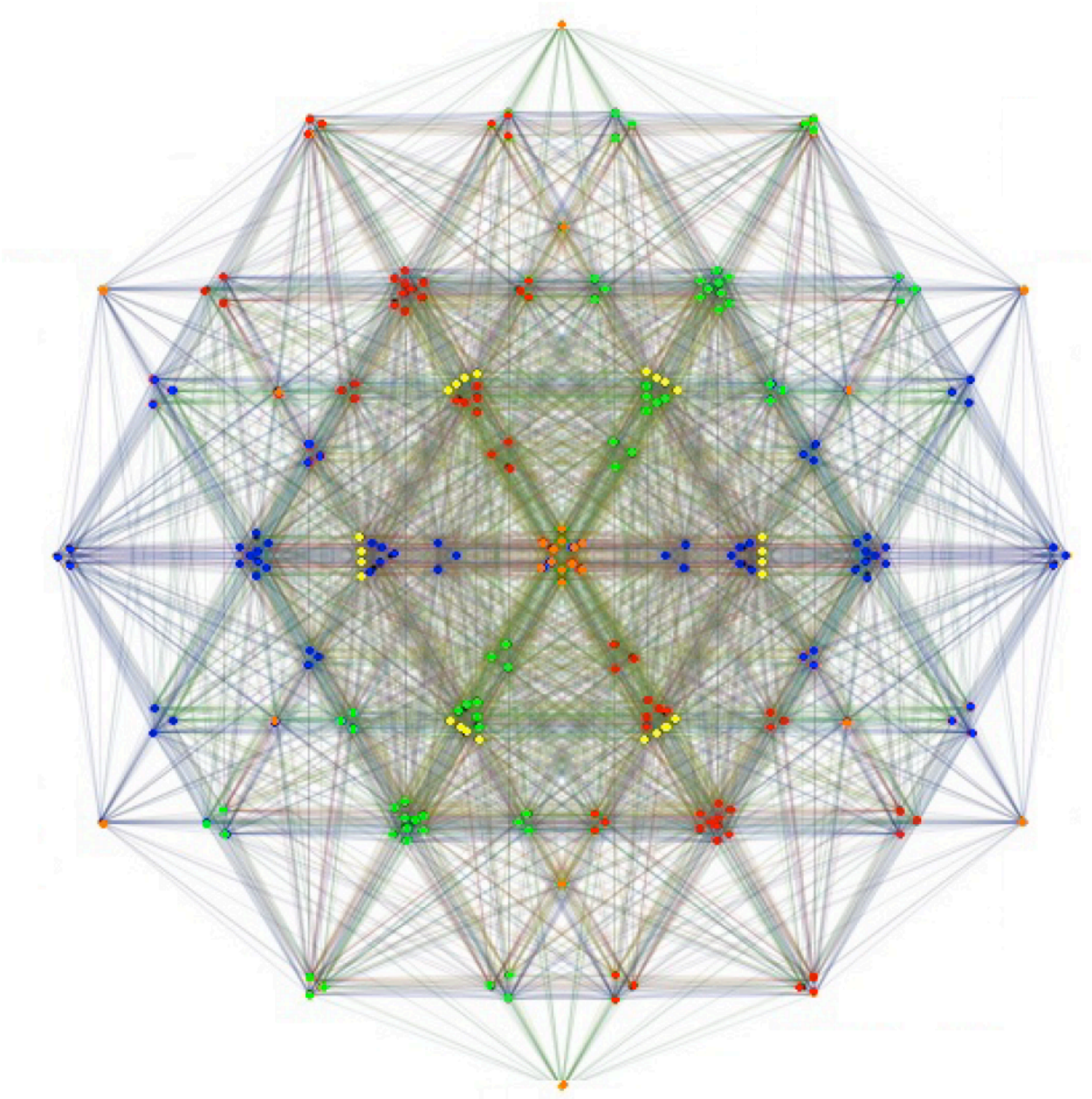
120 + 64 + 64 = E8

E8 root vectors = 112 + 64 + 64

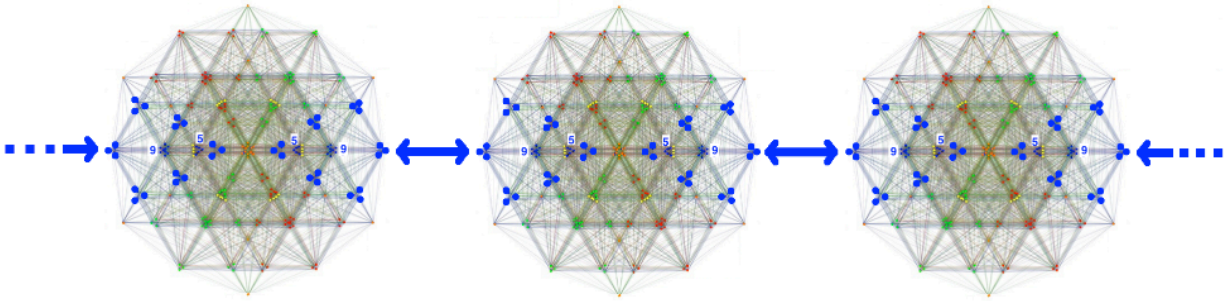
2 - E8 has Chirality because E8 contains only one set of Cl(16) half-spinors

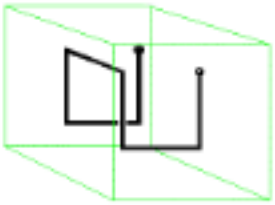
3 - E8 D8 part = 120 = 112 + 8 = 64 + (24+4) + (24+4)
(24+4) = D4 producing Conformal Gravity
(24+4) = D4 producing Standard Model SU(3)

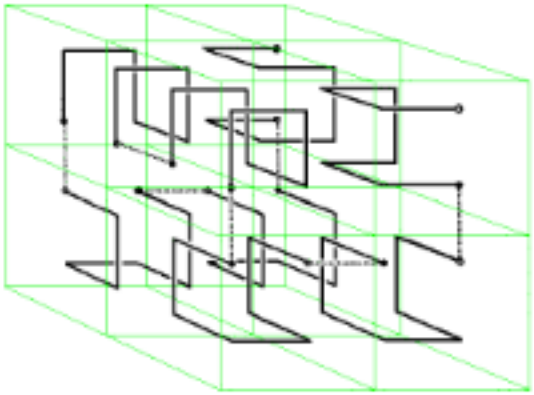
4 - 64 + 64 E8 spinor part as anticommuting Fermions
8 components of 8 Particles and 8 components of 8 AntiParticles of the First Generation
In Cl(8): F4 = V8 + BV23 + S+8 + S-8 with anticommutator structure for S+8 + S-8
In Cl(8) x Cl(8) = Cl(16): E8 = BV120 + S+64 + S-64
where S+64 = S+8 x S+8 and S-64 = S-8 x S-8 inherit anticommutator structure from F4

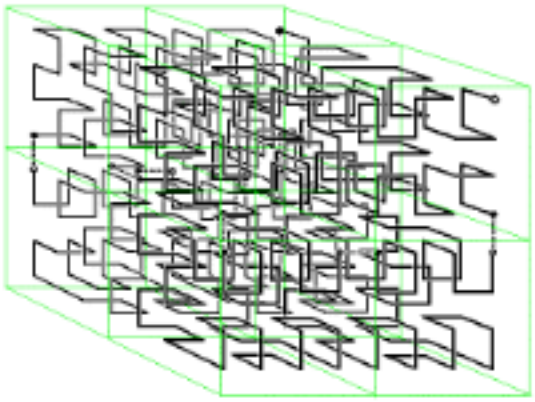


5 - Cl(16) x ... x Cl(16) where each Cl(16) contains E8 produces Emergent Spacetime
with all E8 local 8-dim Octonionic spacetimes consistently aligned
with 8-dim position and momentum described by 64-dim D8 / D4xD4 (blue dots)









6 - 8-dim Lorentz structure satisfies Coleman-Mandula because the fermionic fundamental spinor representations of the E8 model are built with respect to Lorentz, spinor, etc representations based on 8-dim Spin(1,7) spacetime.

7 - Fundamental High-Energy E8 Lagrangian for Octonionic 8-dim SpaceTime
is UltraViolet Finite because:

$$\int_{\text{8-dim SpaceTime}} \text{Gauge Boson Term} \;+\; \text{Fermion Particle-AntiParticle Term}$$

.

Gauge Boson Term has total weight 28 x 1 = 28
16 generators for U(2,2) of Conformal Gravity
+
12 generators for U(3) and U(2) Standard Model
=
28 D4 Gauge Bosons
each with 8-dim Lagrangian weight = 1

Fermion Particle-AntiParticle Term also has total weight 8 x (7/2) = 28
8 Fermion Particle/Antiparticle types
each with 8-dim Lagrangian weight = 7/2

8 - High-Energy Octonionic Physics is NOT Unitary due to Octonion Non-Associativity
so the initial Inflationary Phase of Our Universe produces many particles.

As 8-dimensional Spacetime remains Octonionic throughout Inflation, the paper gr-qc/0007006 by Paola Zizzi shows that "... during inflation, the universe can be described as a superposed state of quantum ... [qubits].
The self-reduction of the superposed quantum state is ... reached at the end of inflation ...[at]... the decoherence time ... [Tdecoh = 10^9 Tplanck = 10^(-34) sec] ... and corresponds to a superposed state of ... [10^19 = 2^64 qubits]. ...
This is also the number of superposed tubulins-qubits in our brain ...
leading to a conscious event. ...".

If at each of the 64 doubling stages of Zizzi inflation the 2 particles of a pair produced 8+8 = 16 fermions, then at the end of inflation non-unitary processes would have produced about 2 x 16^64 = 4 x (2^4)^64 = 4 x 10^77 fermion particles.
Each of the 10^77 fermions had energy of 10^14 GeV so that collisions among them would for each fermion produce jets containing 10^12 particles of energy 100 GeV so that the total number of particles at the End of Inflation was about 10^89.

The Zizzi Inflation phase of our universe ends with decoherence "collapse" of the 2^64 Superposition Inflated Universe into Many Worlds of the Many-Worlds Quantum Theory, only one of which Worlds is our World which therefore carries only a tiny fraction of the entropy of the 2^64 Superposition Inflated Universe.

9 - World-Lines as Strings of 26-dim String Theory

26-dim Bosonic String Theory = 26-dim traceless part J3(O)o

a	O+	Ov
O+*	b	O-
Ov*	O-*	-a-b

Octonionic Ov contains Quaternionic Associative Subspace D3 brane
Compactify CoAssociative Subspace of Ov into CP2 Internal Symmetry Space
D3 + CP2 = D7 brane

Orbifold by Z2 the 1-dim Real Subspace of Ov to discretize time into Tz2
D7 brane + Tz2 = D8 brane

Give D8 branes Planck-Scale Lattice Structure as superpositons of 8 types of E8 Lattice
denoted by 1E8, iE8, jE8, kE8, EE8, IE8, JE8, KE8

Orbifold by Oct16 the O+ to get 8 components of 8 Fermion Particles

Orbifold by Oct16 the O- to get 8 components of 8 Fermion AntiParticles

Stack D8 branes to get SpaceTime with Strings = World-Lines
with
a and b representing
ordering of D8 brane stacks and Bohm-type Quantum Potential

Gauge Bosons from 1E8 and EE8 parts of a D8 give U(2) ElectroWeak Force

Gauge Bosons from IE8, JE8, and KE8 parts of a D8 give SU(3) Color Force

Gauge Bosons from 1E8, iE8, jE8, and kE8 parts of a D8 give U(2,2) Conformal Gravity.

The 8x8 matrices for collective coordinates linking one D8 to the next D8
give Position x Momentum

Green, Schwartz, and Witten say in their book "Superstring Theory" vol. 1 (Cambridge 1986)
"... For the ... closed ... bosonic string .... The first excited level ... consists of ...
the ground state ... tachyon ... and ... a scalar ... 'dilaton' ... and ...
SO(24) ... little group of a ...[26-dim]... massless particle ... and ...
a ... massless ... spin two state ...".

Closed string tachyons localized at orbifolds of fermions produce virtual clouds of particles / antiparticles that dress fermions.

Dilatons are Goldstone bosons of spontaneously broken scale invariance that (analagous to Higgs) go from mediating a long-range scalar gravity-type force to the nonlocality of the Bohm-Sarfatti Quantum Potential.

The SO(24) little group is related to the Monster automorphism group that is the symmetry of each cell of Planck-scale local lattice structure.

The massless spin two state is what I call the Bohmion:
the carrier of the Bohm Force of the Bohm-Sarfatti Quantum Potential.
Peter R. Holland says in his book "The Quantum Theory of Motion" (Cambridge 1993)
"... the total force ... from the quantum potential ... does not ... fall off with distance ... because ... the quantum potential ... depends on the form of ...[the quantum state]... rather than ... its ... magnitude ...".

Quantum Consciousness is due to Resonant Quantum Potential Connections among Quantum State Forms. The Quantum State Form of a Conscious Brain is determined by the configuration of a subset of its 10^18 Tubulin Dimers
with math description in terms of a large Real Clifford Algebra.

First consider Superposition of States involving one tubulin
with one electron of mass m and two different position states separated by a .
The Superposition Separation Energy Difference is the gravitational energy

$$E_{electron} = G m^2 / a$$

For any single given tubulin a = 1 nanometer = 10^(-7) cm so that for a single Electron

$$T = h / E_{electron} = (Compton / Schwarzschild) (a / c) = 10^{26} sec = 10^{19} years$$

Now consider the case of N Tubulin Electrons in Coherent Superposition
Jack Sarfatti defines coherence length L by $L^3 = N a^3$ so that
the Superposition Energy E_N of N superposed Conformation Electrons is

$$E_N = G M^2 / L = N^{(5/3)} E_{electron}$$

The decoherence time for the system of N Tubulin Electrons is

$$T_N = h / E_N = h / N^{(5/3)} E_{electron} = N^{(-5/3)} 10^{26} sec$$

So we have the following rough approximate Table of Decoherence Times T_N

Time T_N	Number of Tubulins
$10^{(-5)}$ sec	10^{18}
$5 \times 10^{(-4)}$ sec (2 kHz)	10^{17}
$25 \times 10^{(-3)}$ sec (40 Hz)	10^{16}
$100 \times 10^{(-3)}$ sec (EEG alpha)	4×10^{15}
$500 \times 10^{(-3)}$ sec (Libet)	1.5×10^{15}

10 - 8-dim SpaceTime breaks into (4+4)-dim Quaternionic Kaluza-Klein

248 E8 = 120 D8 ⊕ 128 D8 Half Spinor

28 D4

D4 contains U(2,2)
U(2,2) = Spin(2,4)
Conformal Gravity

28 D4'

D4' contains U(4)
U(4) contains SU(3)

(8v , 8v)

M4 x CP2

CP2 = SU(3) / U(2)
U(2) = SU(2) x U(1)

(8s , 8s)

{ nu, ruq, guq, buq,
e, rdq, gdq, bdq }

(8c , 8c)

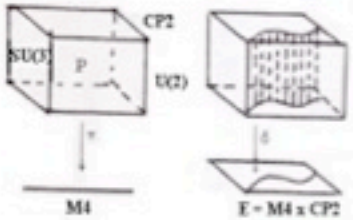
{ $\overline{nu}$, $\overline{ruq}$, $\overline{guq}$, $\overline{buq}$,
$\overline{e}$, $\overline{rdq}$, $\overline{gdq}$, $\overline{bdq}$ }

Generations:	Propagator Origin		Propagator Destination
1	M4	→	M4
2	M4	→	CP2
	CP2	→	M4
3	CP2	→	CP2

Lagrangian: $\int$ gauge term + fermion term

KKspacetime

Higgs-Mayer:



Kobayashi-Nomizu:

THEOREM 11.7. *Assume in Theorem 11.5 that* $\mathfrak{k}$ *admits a subspace* $\mathfrak{m}$ *such that* $\mathfrak{k} = \mathfrak{j} + \mathfrak{m}$ *(direct sum) and* $\mathrm{ad}(J)(\mathfrak{m}) = \mathfrak{m}$, *where* $\mathrm{ad}(J)$ *is the adjoint representation of* J *in* $\mathfrak{k}$. *Then*

(1) *There is a 1:1 correspondence between the set of K-invariant connections in P and the set of linear mappings* $\Lambda_{\mathfrak{m}}: \mathfrak{m} \to \mathfrak{g}$ *such that*

$$\Lambda_{\mathfrak{m}}(\mathrm{ad}(j)(X)) = \mathrm{ad}(\lambda(j))(\Lambda_{\mathfrak{m}}(X)) \quad \text{for } X \in \mathfrak{m} \text{ and } j \in J;$$

the correspondence is given via Theorem 11.5 by

$$\Lambda(X) = \begin{cases} \lambda(X) & \text{if } X \in \mathfrak{j}, \\ \Lambda_{\mathfrak{m}}(X) & \text{if } X \in \mathfrak{m}. \end{cases}$$

(2) *The curvature form* Ω *of the K-invariant connection defined by* $\Lambda_{\mathfrak{m}}$ *satisfies the following condition:*

$$2\Omega_{\mathfrak{m}}(\tilde{X}, \tilde{Y}) = [\Lambda_{\mathfrak{m}}(X), \Lambda_{\mathfrak{m}}(Y)] - \Lambda_{\mathfrak{m}}([X, Y]_{\mathfrak{m}}) - \lambda([X, Y]_{\mathfrak{j}})$$
$$\text{for } X, Y \in \mathfrak{m},$$

The Higgs and the T-quark form a system in which the Higgs is effectively a T-quark condensate.

11 - Schwinger Sources with symmetry from inherited from Monster Group
have
Kerr-Newman Black Hole structure size about 10^(-24) cm
and
Geometry of Bounded Complex Domains and Shilov boundaries

The E8 Lagrangian for Octonionic (4+4)-dim Kaluza-KleinSpaceTime is

$\int$ Gauge Boson Term + Fermion Particle-AntiParticle Term + Higgs Term 4D PhyST

Consider the Fermion Term.
E8 Physics constructs the Lagrangian integral such that
the mass m emerges as the integral over the Schwinger Source spacetime region
of its Kerr-Newman cloud of virtual particle/antiparticle pairs plus the valence fermion
so that the volume of the Schwinger Source fermion defines its mass, which, being
dressed with the particle/antiparticle pair cloud, gives quark mass as constituent mass.

Fermion Schwinger Sources correspond to the Lie Sphere Symmetric space
Spin(10) / Spin(8)xU(1)
which has local symmetry of the Spin(8) gauge group
from which the first generation spinor fermions are formed as +half-spinor and -half-spinor spaces
and Bounded Complex Domain D8 of type IV8 and Shilov Boundary Q8 = RP1 x S7

Consider the Gauge Boson Term
The process of breaking Octonionic 8-dim SpaceTime
down to Quaternionic (4+4)-dim M4 x CP2 Kaluza-Klein
creates differences in the way gauge bosons "see" 4-dim Physical SpaceTime

There 4 equivalence classes of 4-dimensional Riemannian Symmetric Spaces
with Quaternionic structure consistent with 4-dim Physical SpaceTime:

S4 = 4-sphere = Spin(5) / Spin(4) where Spin(5) = Schwinger-Euclidean version of the Anti-DeSitter subgroup of the Conformal Group that gives MacDowell-Mansouri Gravity

CP2 = complex projective 2-space = SU(3) / U(2) with the SU(3) of the Color Force

S2 x S2 = SU(2)/U(1) x SU(2)/U(1) with two copies of the SU(2) of the Weak Force

S1 x S1 x S1 x S1 = U(1) x U(1) x U(1) x U(1) = 4 copies of the U(1) of the EM Photon
(1 copy for each of the 4 covariant components of the Photon)

The Gravity Gauge Bosons (Schwinger-Euclidean versions) live in
a Spin(5) subalgebra of the Spin(6) Conformal subalgebra of D4 = Spin(8).
They "see" M4 Physical spacetime as the 4-sphere S4
so that their part of the Physical Lagrangian is

$$\int_{S4} \text{Gravity Gauge Boson Term} \quad .$$

an integral over SpaceTime S4.
The Schwinger Sources for GRb bosons are the Complex Bounded Domains and
Shilov Boundaries for Spin(5) MacDowell-Mansouri Gravity bosons.
However, due to Stabilization of Condensate SpaceTime
by virtual Planck Mass Gravitational Black Holes,
for Gravity, the effective force strength that we see in our experiments
is not just composed of the S4 volume and the Spin(5) Schwinger Source volume,
but is suppressed by the square of the Planck Mass.
The unsuppressed Gravity force strength is the Geometric Part of the force strength.

The Standard Model SU(3) Color Force bosons live in
a SU(3) subalgebra of the SU(4) subalgebra of D4 = Spin(8).
They "see" M4 Physical spacetime as the complex projective plane CP2
so that their part of the Physical Lagrangian is

$$\int_{CP2} \text{SU(3) Color Force Gauge Boson Term} \quad .$$

an integral over SpaceTime CP2.
The Schwinger Sources for SU(3) bosons are the Complex Bounded Domains and
Shilov Boundaries for SU(3) Color Force bosons.
The Color Force Strength is given by
the SpaceTime CP2 volume and the SU(3) Schwinger Source volume.
Note that since the Schwinger Source volume is dressed with the particle/antiparticle
pair cloud, the calculated force strength is
for the characteristic energy level of the Color Force (about 245 MeV).

The Standard Model SU(2) Weak Force bosons live in
a SU(2) subalgebra of the U(2) local group of CP2 = SU(3) / U(2)
They "see" M4 Physical spacetime as two 2-spheres S2 x S2
so that their part of the Physical Lagrangian is

$$\int_{S2xS2} \text{SU(2) Weak Force Gauge Boson Term} \quad .$$

an integral over SpaceTime S2xS2.
The Schwinger Sources for SU(2) bosons are the Complex Bounded Domains and
Shilov Boundaries for SU(2) Weak Force bosons.
However, due to the action of the Higgs mechanism,
for the Weak Force, the effective force strength that we see in our experiments
is not just composed of the S2xS2 volume and the SU(2) Schwinger Source volume,
but is suppressed by the square of the Weak Boson masses.
The unsuppressed Weak Force strength is the Geometric Part of the force strength.

The Standard Model U(1) Electromagnetic Force bosons (photons) live in
a U(1) subalgebra of the U(2) local group of CP2 = SU(3) / U(2)
They "see" M4 Physical spacetime as four 1-sphere circles S1xS1xS1xS1 = T4
(T4 = 4-torus) so that their part of the Physical Lagrangian is

$$\int_{T4} \text{(U(1) Electromagnetism Gauge Boson Term} \quad .$$

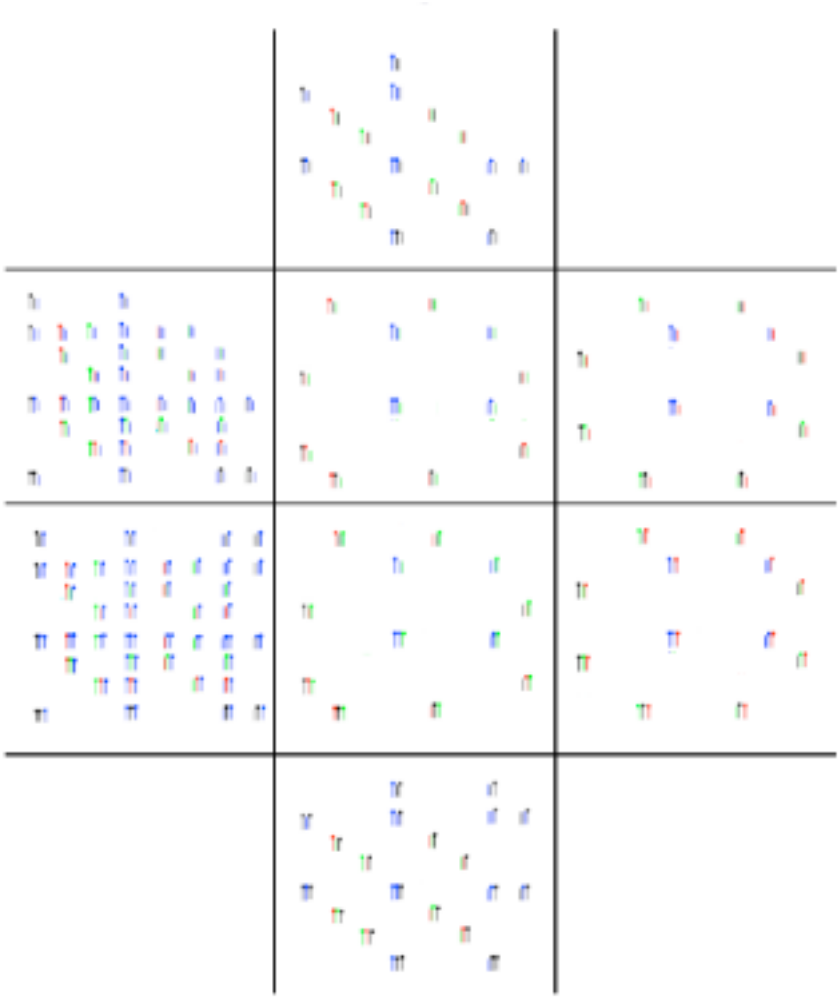
an integral over SpaceTime T4.
The Schwinger Sources for U(1) photons
are the Complex Bounded Domains and Shilov Boundaries for U(1) photons.
The Electromagnetic Force Strength is given by
the SpaceTime T4 volume and the U(1) Schwinger Source volume.

12 - Combinatorics of (4+4)-dim Kaluza-Klein structure contributes to Fermion mass ratios for 2nd and 3rd generations. For example:

Blue Down Quark is 1 out of 8
Blue Up Quark is 1 out of 8

Blue Strange Quark is 3 out of 8x8 = 64
Blue Charm Quark is 17 out of 8x8 = 64

Blue Beauty Quark is 7 out of 8x8x8 = 512
Blue Truth Quark is 161 out of 8x8x8 = 512



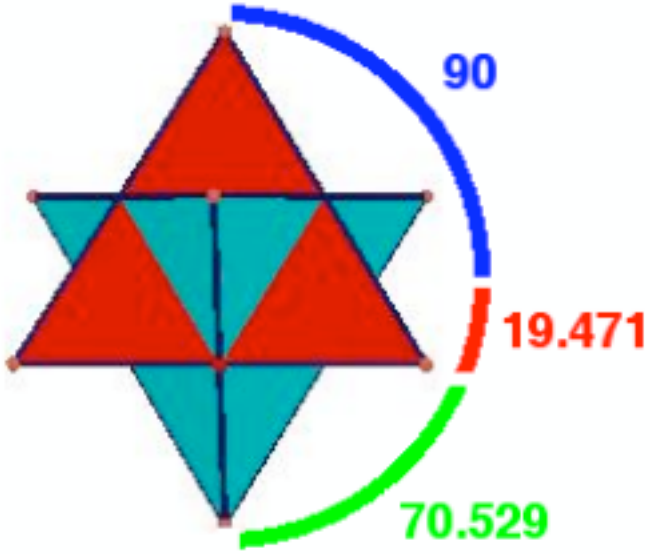
The E8 Physics calculation results are:

Since calculations are for ratios of particle masses and force strengths,
the Higgs mass and the Geometric Part of the Gravity force strength are set so that the ratios agree with conventional observation data.

Particle/Force	Tree-Level	Higher-Order
e-neutrino	0	0 for nu_1
mu-neutrino	0	9 x 10^(-3) eV for nu_2
tau-neutrino	0	5.4 x 10^(-2) eV for nu_3
electron	0.5110 MeV	
down quark	312.8 MeV	charged pion = 139 MeV
up quark	312.8 MeV	proton = 938.25 MeV neutron - proton = 1.1 MeV
muon	104.8 MeV	106.2 MeV
strange quark	625 MeV	
charm quark	2090 MeV	
tauon	1.88 GeV	
beauty quark	5.63 GeV	
truth quark (low state)	130 GeV	(middle state) 174 GeV (high state) 218 GeV
W+	80.326 GeV	
W-	80.326 GeV	
W0	98.379 GeV	Z0 = 91.862 GeV
Mplanck	1.217x10^19 GeV	
Higgs VEV (assumed)	252.5 GeV	
Higgs (low state)	126 GeV	(middle state) 182 GeV (high state) 239 GeV
Gravity Gg (assumed)	1	
(Gg)(Mproton^2 / Mplanck^2)		5 x 10^(-39)
EM fine structure	1/137.03608	
Weak Gw	0.2535	
Gw(Mproton^2 / (Mw+^2 + Mw-^2 + Mz0^2))		1.05 x 10^(-5)
Color Force at 0.245 GeV	0.6286	0.106 at 91 GeV

13 - Kobayashi-Maskawa mass formulas

In E8 Physics the KM Unitarity Triangle angles can be seen on the Stella Octangula



The Kobayashi-Maskawa parameters are determined in terms of
the sum of the masses of the 30 first-generation fermion particles and antiparticles,
denoted by

Smf1 = 7.508 GeV,

and the similar sums for second-generation and third-generation fermions,
denoted by

Smf2 = 32.94504 GeV and Smf3 = 1,629.2675 GeV.

The resulting KM matrix is:

	d	s	b
u	0.975	0.222 0.00249	-0.00388i
c	-0.222 -0.000161i	0.974 -0.0000365i	0.0423
t	0.00698 -0.00378i	-0.0418 -0.00086i	0.999

14 - neutrino masses beyond tree level

The heaviest mass state nu_3 is for a neutrino whose propagation
begins and ends in CP2 internal symmetry space, lying entirely therein.
In E8 Physics the mass of nu_3 is zero at tree-level
but it picks up a first-order correction by
propagating entirely through internal symmetry space,
merging with a virtual electron through the weak and electromagnetic forces,
effectively acting not merely as a point
but as a point plus an electron loop at both beginning and ending points.

Calculation along those lines produce these results

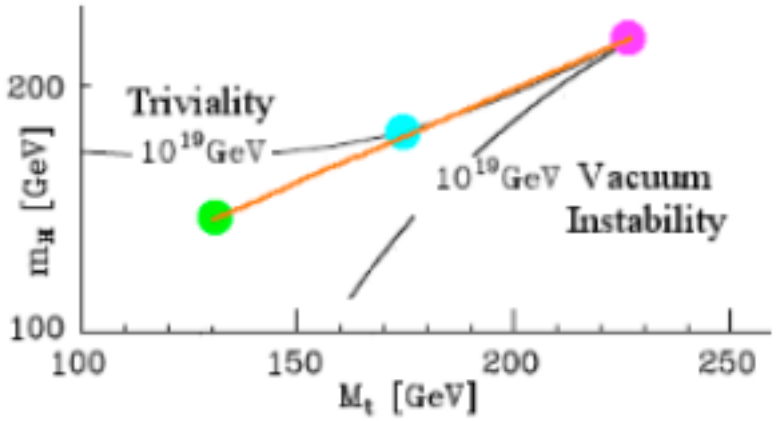
for masses

Particle	Tree-Level	Higher-Order
e-neutrino	0	0 for nu_1
mu-neutrino	0	9 x 10^(-3) eV for nu_2
tau-neutrino	0	5.4 x 10^(-2) eV for nu_3

and for mixing matrix

	nu_1	nu_2	nu_3
nu_e	0.853	0.493	0.056 - 0.157 i
nu_m	-0.388 - 0.096 i	0.592 - 0.056 i	0.697
nu_t	0.320 - 0.096 i	0.632 - 0.056 i	0.697

15 - Higgs-Tquark system with 3 mass states and Higgs as Tquark condensate

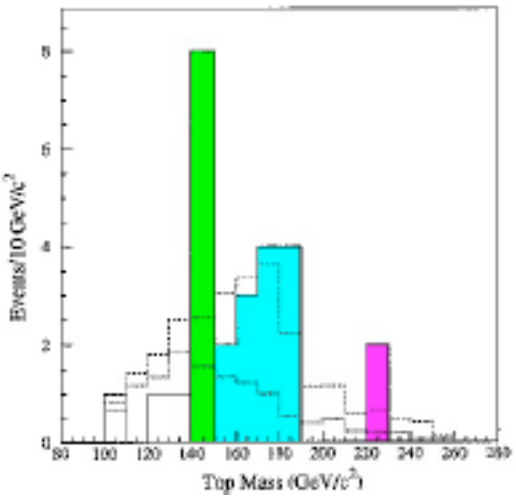


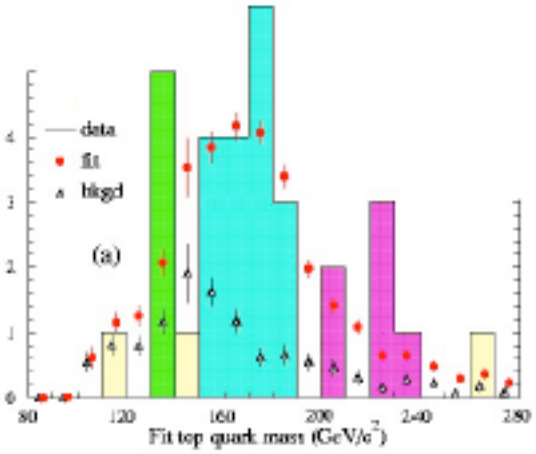
The Magenta Dot is the high-mass state of a 220 GeV Truth Quark and a 240 GeV Higgs. It is at the critical point of the Higgs-Tquark System with respect to Vacuum Instability and Triviality. It corresponds to the description in hep-ph/9603293 by Koichi Yamawaki of the Bardeen-Hill-Lindner model. That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

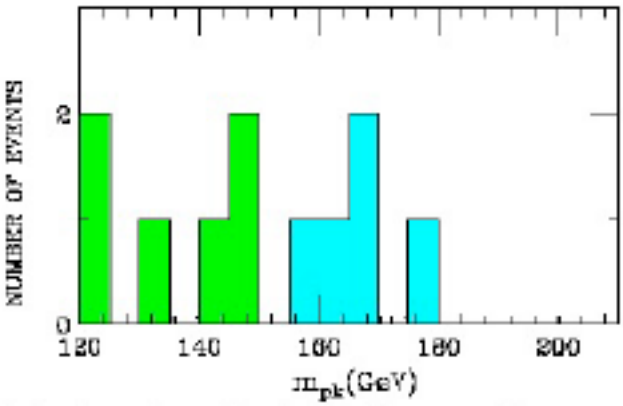
The Gold Line leading down from the Critical Point roughly along the Triviality Boundary line is based on Renormalization Group calculations with the result that MH / MT = 1.1 as described by Koichi Yamawaki in hep-ph/9603293 .

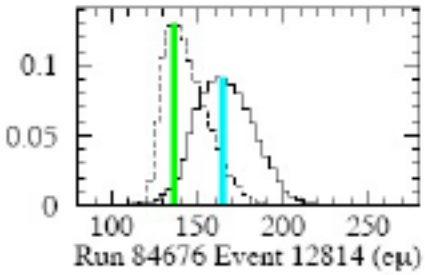
The Cyan Dot where the Gold Line leaves the Triviality Boundary to go into our Ordinary Phase is the middle-mass state of a 174 GeV Truth Quark and Higgs around 200 GeV. It corresponds to the Higgs mass calculated by Hashimoto, Tanabashi, and Yamawaki in hep-ph/0311165 where they show that for 8-dimensional 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 at which the composite nature of the Higgs as T-Tbar condensate in (4+4)-dim Kaluza-Klein becomes manifest.

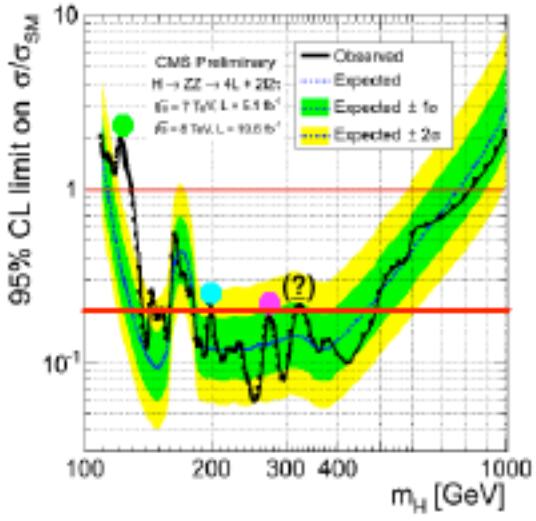
The Green Dot where the Gold Line terminates in our Ordinary Phase is the low-mass state of a 130 GeV Truth Quark and a 126 GeV Higgs.


Events/10 GeV/c²
Top Mass (GeV/c²)


data
fit
bkgd
(a)
Fit top quark mass (GeV/c²)


NUMBER OF EVENTS
m_pk(GeV)


Run 84676 Event 12814 (eμ)


CMS Preliminary
Observed
Expected
Expected ± 1σ
Expected ± 2σ
95% CL limit on σ/σ_SM
(?)
m_H [GeV]

16 - Proton-Neutron mass difference

An up valence quark, constituent mass 313 Mev, does not often swap places with a 2.09 Gev charm sea quark,
but a 313 Mev down valence quark can more often swap places with a 625 Mev strange sea quark.
Therefore the Quantum color force constituent mass of the down valence quark is heavier by about
(ms - md) (md/ms)^2 a(w) |Vds| = 312 x 0.25 x 0.253 x 0.22 Mev = 4.3 Mev,
(where a(w) = 0.253 is the geometric part of the weak force strength and |Vds| = 0.22 is the magnitude of the K-M parameter mixing first generation down and second generation strange)
so that the Quantum color force constituent mass Qmd of the down quark is

$$Qmd = 312.75 + 4.3 = 317.05 \text{ MeV}.$$

Similarly, the up quark Quantum color force mass increase is about
(mc - mu) (mu/mc)^2 a(w) |V(uc)| = 1777 x 0.022 x 0.253 x 0.22 Mev =
= 2.2 Mev, (where |Vuc| = 0.22 is the magnitude of the K-M parameter mixing first generation up and second generation charm)
so that the Quantum color force constituent mass Qmu of the up quark is

$$Qmu = 312.75 + 2.2 = 314.95 \text{ MeV}.$$

Therefore, the Quantum color force Neutron-Proton mass difference is
mN - mP = Qmd - Qmu = 317.05 Mev - 314.95 Mev = 2.1 Mev.

Since the electromagnetic Neutron-Proton mass difference is roughly

$$mN - mP = -1 \text{ MeV}$$

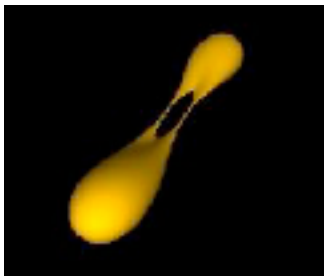
the total theoretical Neutron-Proton mass difference is

$$mN - mP = 2.1 \text{ Mev} - 1 \text{ Mev} = 1.1 \text{ Mev},$$

an estimate that is fairly close to the experimental value of 1.3 Mev.

17 - Pion as sine-Gordon breather structure

When a quark Kerr-Newman Black Hole and antiquark KNBH form a pion



the resulting toroidal black hole remains a torus. The torus is an event horizon and therefore is not a 2-spacelike dimensional torus,
but is a (1+1)-dimensional torus with a timelike dimension
that can can carry a Sine-Gordon Breather that is equivalent to the massive Thirring model. The soliton and antisoliton of a Sine-Gordon Breather correspond to the quark and antiquark that make up the pion.

Using the E8 Physics constituent mass of the Up and Down quarks and antiquarks, about 312.75 MeV, as the soliton and antisoliton masses, and setting Coleman's parameter B^2 = pi and using the DHN formula, the mass of the charged pion is calculated to be

(312.75 / 2.25) MeV = 139 MeV

which is close to the experimental value of about 139.57 MeV.

The value B^2 = pi (or, using Coleman's eq. (5.14), the Thirring coupling constant g = 3 pi) is used because B^2 = pi is where
the First-order weak coupling expansion coincides with the DHN formula.

18 - Planck mass as superposition condensate of Fermions

At a single spacetime vertex, a Planck-mass black hole is the Many-Worlds quantum sum of all possible virtual first-generation particle-antiparticle fermion pairs allowed by the Pauli exclusion principle to live on that vertex.
Once a Planck-mass black hole is formed, it is stable in the E8 model.
Less mass would not be gravitationally bound at the vertex.
More mass at the vertex would decay by Hawking radiation.

There are 8 fermion particles and 8 fermion antiparticles
for a total of 64 particle-antiparticle pairs.
Of the 64 particle-antiparticle pairs, 12 are bosonic pions.

A typical combination should have about 6 pions so
it should have a mass of about .14x6 GeV = 0.84 GeV.
Just as the pion mass of .14 GeV is less than the sum of the masses of a quark and an antiquark, pairs of oppositely charged pions may form a bound state of less mass than the sum of two pion masses.
If such a bound state of oppositely charged pions has a mass as small as .1 GeV, and if the typical combination has one such pair and 4 other pions, then the typical combination could have a mass in the range of 0.66 GeV.
Summing over all 2^64 combinations,
the total mass of a one-vertex universe should give a Planck mass roughly around

$$0.66 \times 2^{64} = 1.217 \times 10^{19} \text{ GeV}.$$

The value for the Planck mass given in by the 1998 Particle Data Group is
1.221×10^{19} GeV.

19 - Segal-type Conformal gravity with conformal generator structure giving Dark Energy, Dark Matter, and Ordinary Matter ratio

Gravity and the Cosmological Constant come from the MacDowell-Mansouri Mechanism and the 15-dimensional Spin(2,4) = SU(2,2) Conformal Group, which is made up of:

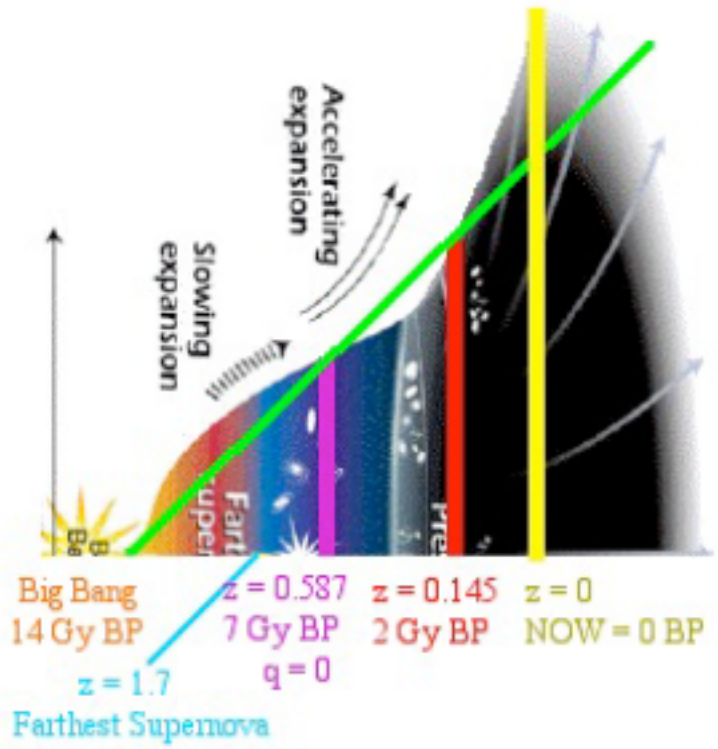
3 Rotations;
3 Boosts;
4 Translations;
4 Special Conformal transformations; and
1 Dilatation.

The Cosmological Constant comes from
the 10 Rotation, Boost, and Special Conformal generators
of the Conformal Group Spin(2,4) = SU(2,2),
so the fractional part of our Universe of the Cosmological Constant
should be about 10 / 15 = 67% for tree level.

Black Holes, including Dark Matter Primordial Black Holes, are curvature singularities in our 4-dimensional physical spacetime,
and since Einstein-Hilbert curvature comes from the 4 Translations
of the 15-dimensional Conformal Group Spin(2,4) = SU(2,2)
through the MacDowell-Mansouri Mechanism (in which the generators corresponding to the 3 Rotations and 3 Boosts do not propagate),
the fractional part of our Universe of Dark Matter Primordial Black Holes
should be about 4 / 15 = 27% at tree level.

Since Ordinary Matter gets mass from the Higgs mechanism
which is related to the 1 Scale Dilatation
of the 15-dimensional Conformal Group Spin(2,4) = SU(2,2),
the fractional part of our universe of Ordinary Matter
should be about 1 / 15 = 6% at tree level.

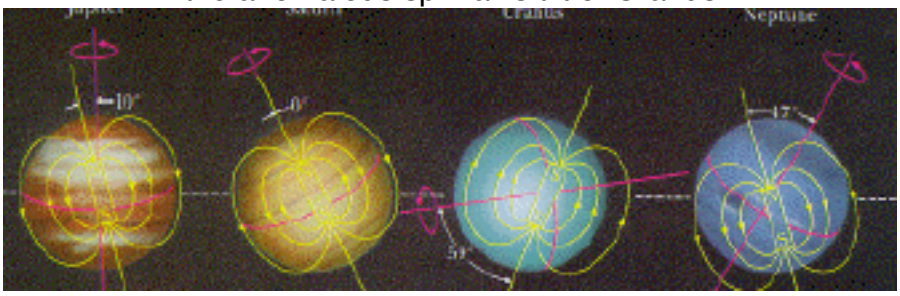
However, as Our Universe evolves the Dark Energy, Dark Matter, and Ordinary Matter densities evolve at different rates, so that the differences in evolution must be taken into account from the initial End of Inflation to the Present Time.



The result can be compared with data from WMAP and Planck:

evolution E8 calculation: DE : DM : OM = 75 : 20 : 05
WMAP: DE : DM : OM = 73 : 23 : 04
Planck: DE : DM : OM = 69 : 26 : 05
basic E8 Conformal calculation: DE : DM : OM = 67 : 27 : 06

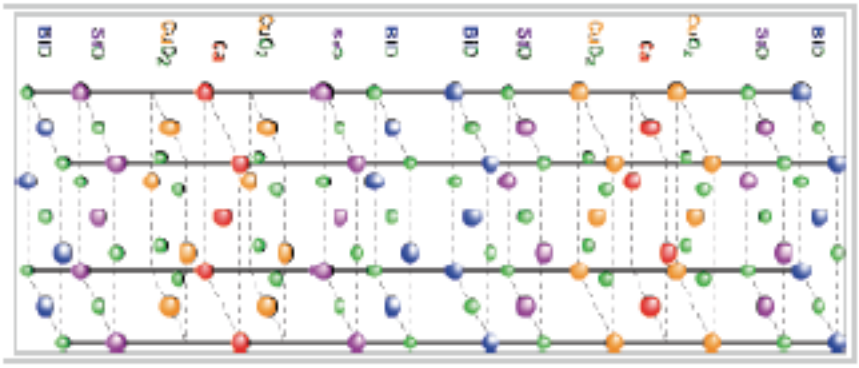
20 - Dark Energy explanations for Pioneer Anomaly and Uranus spin-axis tilt
Conformal Dark Energy can explain the Pioneer Anomaly
and
the anomalous spin-axis tilt of Uranus



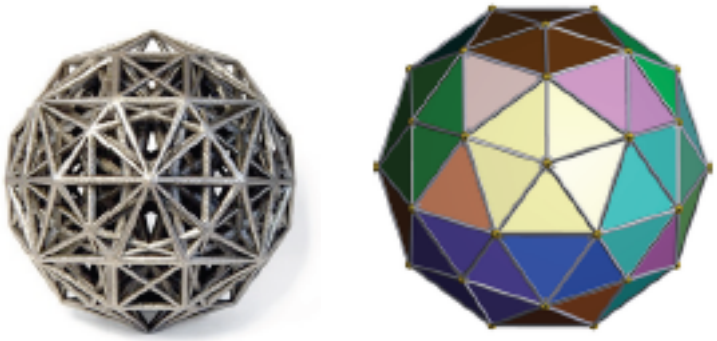
by taking the orbit of Uranus as a boundary between an outer region in which Conformal Gravity is fully effective and an inner region in which the Conformal degrees of freedom are frozen out, similarly to the 2-phases-of-gravity proposal of Irving Ezra Segal.

21 - Dark Energy experiment by BSCCO Josephson Junctions and geometry of 600-cell

The Energy Gap of our Universe as superconductor condensate spacetime is from 3 x 10^(-18) Hz (radius of universe) to 3 x 10^43 Hz (Planck length). Its RMS amplitude is 10^13 Hz = 10 THz = energy of neutrino masses = = critical temperature Tc of BSCCO superconducting crystals.
Neutrino masses are involved because their mass is zero at tree level and their masses that we observe come from virtual graviphotons becoming virtual neutrino-antineutrino pairs.



BSCCO superconducting crystals are natural Josephson Junctions.
Dark Energy accumulates in the superconducting layers of BSCCO.
The basic idea of Dark Energy from BSCCO Josephson Junctions is based on the 600-cell each of whose 720 edge-lines would be made of a single BSCCO crystal. It may be useful to use a Jitterbug-type transformation between a 600-cell configuration and a configuration based on icosahedral 120-cells which also have 720 edge-lines:



22 - Real Clifford Algebra periodicity allows construction of Algebraic Quantum Field Theory as a generalization of II1 hyperfinite von Neumann factor algebra

Since the E8 classical Lagrangian is Local, it is necessary to patch together Local Lagrangian Regions to form a Global Structure describing a Global E8 Algebraic Quantum Field Theory (AQFT).
This is done by using Clifford Algebras to embed E8 into Cl(16) and using a copy of Cl(16) to represent each Local Lagrangian Region, and then taking the tensor products of the copies of Cl(16).
Due to Real Clifford Algebra 8-periodicity, Cl(16) = Cl(8)xCl(8) , and any Real Clifford Algebra, no matter how large, can be embedded in a tensor product of factors of Cl(8), and therefore of Cl(8)xCl(8) = Cl(16).

Just as the completion of
the union of all tensor products of 2x2 complex Clifford algebra matrices
produces the usual Hyperfinite II1 von Neumann factor
that describes
creation and annihilation operators on fermionic Fock space over C^(2n)

the completion of the union of all tensor products of Cl(16) = Cl(8)xCl(8)
produces a generalized Hyperfinite II1 von Neumann factor
that gives a natural

E8 Physics Algebraic Quantum Field Theory.

23 - maximal contraction of E8 = semidirect product A7 x h92
gives a creation/annihilation algebra
where h92 = 92+1+92 = 185-dim Heisenberg algebra and A7 = 63-dim SL(8)

A Fundamental Building Block of E8 Physics AQFT is the
Maximal Contraction of E8
which can be written
as a 5-Graded Lie Algebra with structure

$$28 + 64 + (SL(8,R) + 1) + 64 + 28$$

The Central Even Grade 0 = SL(8,R) + 1
The 1 is an anticommuting scalar and SL(8,R) has bosonic commutators.
As Polar Coordinates, SL(8,R) represents a local 8-dim spacetime
as SL(8,R) = Spin(8) + Traceless Symmetric 8x8 Matrices.

Odd Grades -1 and +1 each = 64 = 8x8 = Creation/Annihilation Operators
for
8 components of 8 fundamental fermions with fermionic anticommutators.

Even Grades -2 and +2 each = Creation/Annihilation Operators
for
28 Gauge Bosons with bosonic commutators.

24 - AQFT and Third Grothendieck Universe

Three Grothendieck Universes:

1 - Empty Set - the seed from which everything grows.

2 - Hereditarily Finite Sets - computer programs, discrete lattices, discrete Clifford algebras, cellular automata, Feynman Checkerboards.

3 - Completion of Union of all tensor products of Cl(16) real Clifford algebra which gives a generalized hyperfinite II1 von Neumann factor algebra that, through its Cl(16) structure, contains math structures that are sufficient to describe E8 Physics.