

High Energy Particle Physics

Outline of E8 Physics

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This is a 24-point Outline of E8 Physics. For details see 377-page viXra 1310.0182. For more details and supplemental material see 11,445-page viXra 1311.0094.

Comments: 27 Pages.

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Submission history

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- 17 - Pion as sine-Gordon breather structure
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- 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

$$\begin{matrix} 1 \\ \emptyset \end{matrix} = Cl(0) = 1$$

$$\begin{matrix} 1 & 1 \\ \emptyset & (\emptyset) \end{matrix} = Cl(1) = 2$$

$$\begin{matrix} 1 & 2 & 1 \\ \emptyset & (\emptyset) & (\emptyset (\emptyset)) \\ & ((\emptyset)) & \end{matrix} = Cl(2) = 4$$

$$\begin{matrix} 1 & 4 & 6 & 4 & 1 \\ \emptyset & (\emptyset) & (\emptyset (\emptyset)) & ((\emptyset) ((\emptyset)) (\emptyset (\emptyset))) & (\emptyset (\emptyset) ((\emptyset)) (\emptyset (\emptyset))) \\ & ((\emptyset)) & (\emptyset ((\emptyset))) & (\emptyset ((\emptyset)) (\emptyset (\emptyset))) & \\ & (((\emptyset))) & (\emptyset (\emptyset (\emptyset))) & (\emptyset (\emptyset) (\emptyset (\emptyset))) & \\ & ((\emptyset (\emptyset))) & ((\emptyset) ((\emptyset))) & (\emptyset (\emptyset) ((\emptyset))) & \\ & & ((\emptyset) (\emptyset (\emptyset))) & & \\ & & (((\emptyset)) (\emptyset (\emptyset))) & & \end{matrix} = Cl(4) = 16$$

$$\begin{matrix} 1 & 16 & 120 & 560 & 1820 & 4368 & 8008 & 11440 & 12870 & 11440 & 8008 & 4368 & 1820 & 560 & 120 & 16 & 1 \end{matrix}$$

$$= Cl(16) = 2^{16} = 65,536 = ((64+64) + (64+64)) \times ((64+64) + (64+64))$$

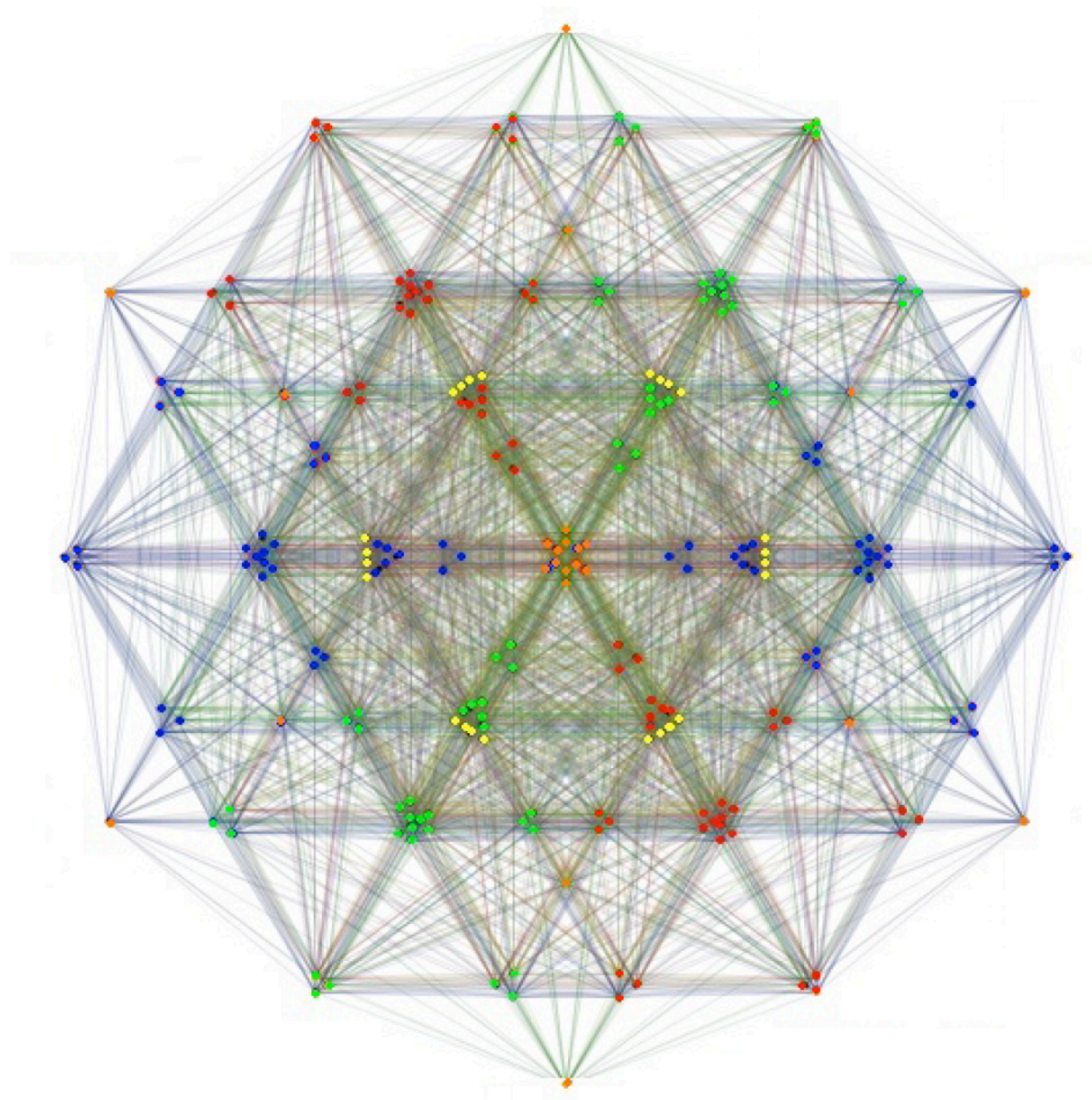
$$120 + 64 + 64 = E8$$

$$E8 \text{ root vectors} = 112 + 64 + 64$$

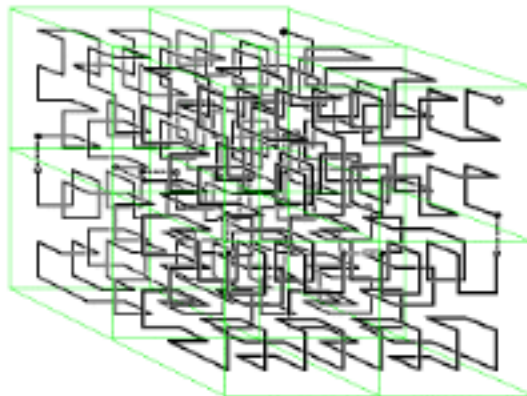
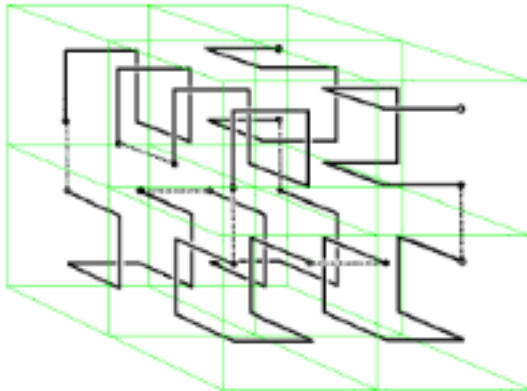
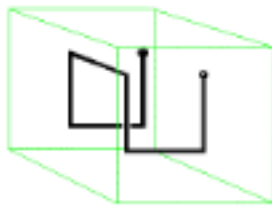
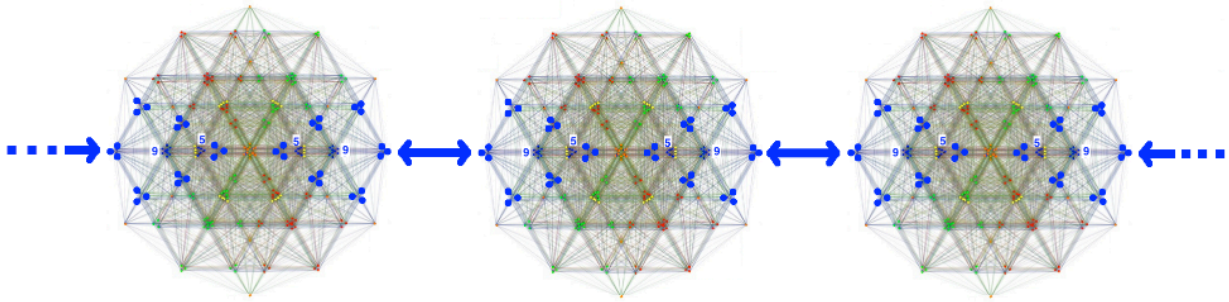
2 - E8 has Chirality because E8 contains only one set of Cl(16) half-spinors

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 $S+64 = S+8 \times S+8$ and $S-64 = S-8 \times S-8$ inherit anticommutator structure from F4



5 - $Cl(16) \times \dots \times Cl(16)$ where each $Cl(16)$ contains E_8 produces Emergent Spacetime with all E_8 local 8-dim Octonionic spacetimes consistently aligned with 8-dim position and momentum described by 64-dim $D_8 / D_4 \times D_4$ (blue dots)



6 - 8-dim Lorentz structure satisfies Coleman-Mandula because the fermionic fundamental spinor representations of the E_8 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 $28 \times 1 = 28$
 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 $8 \times (7/2) = 28$
 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 $2 \times 16^{64} = 4 \times (2^4)^{64} = 4 \times 10^{77}$ 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 $J_3(O)$

a	O_+	O_v
O_+^*	b	O_-
O_v^*	O_-^*	-a-b

Octonionic O_v contains Quaternionic Associative Subspace D3 brane
Compactify CoAssociative Subspace of O_v into CP^2 Internal Symmetry Space
 $D3 + CP^2 = D7$ brane

Orbifold by Z_2 the 1-dim Real Subspace of O_v to discretize time into Tz_2
 $D7$ brane + $Tz_2 = D8$ brane

Give $D8$ branes Planck-Scale Lattice Structure as superpositions of 8 types of E_8 Lattice
denoted by $1E_8, iE_8, jE_8, kE_8, EE_8, IE_8, JE_8, KE_8$

Orbifold by Oct_{16} the O_+ to get 8 components of 8 Fermion Particles

Orbifold by Oct_{16} 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 $1E_8$ and EE_8 parts of a $D8$ give $U(2)$ ElectroWeak Force

Gauge Bosons from $IE_8, JE_8,$ and KE_8 parts of a $D8$ give $SU(3)$ Color Force

Gauge Bosons from $1E_8, iE_8, jE_8,$ and kE_8 parts of a $D8$ give $U(2,2)$ Conformal Gravity.

The 8×8 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 (analogous 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

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

For any single given tubulin $a = 1$ nanometer = 10^{-7} cm so that for a single Electron
 $T = h / E_{\text{electron}} = (\text{Compton} / \text{Schwarzschild}) (a / c) = 10^{26} \text{ sec} = 10^{19} \text{ years}$

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

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

The decoherence time for the system of N Tubulin Electrons is

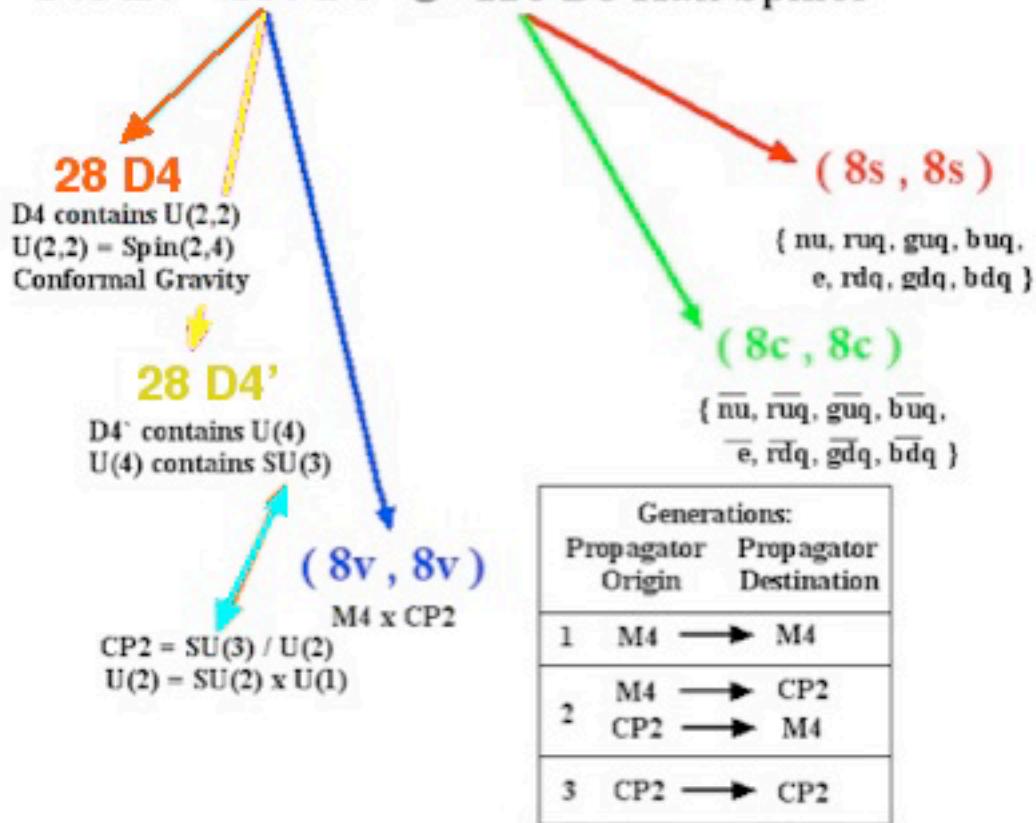
$$T_N = h / E_N = h / N^{5/3} E_{\text{electron}} = N^{-5/3} 10^{26} \text{ sec}$$

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

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

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

$$248 E8 = 120 D8 \oplus 128 D8 \text{ Half Spinor}$$



Lagrangian: $\int_{\text{KKspacetime}} \text{gauge term} + \text{fermion term}$

Higgs-Mayer:

Kobayashi-Nomizu:

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

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

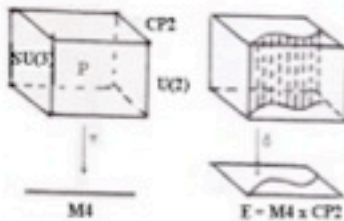
$\Lambda_m(\text{ad}(j)(X)) = \text{ad}(j)(\Lambda_m(X))$ for $X \in \mathfrak{m}$ and $j \in J$;
the correspondence is given via Theorem 11.5 by

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

(2) The curvature form Ω of the K -invariant connection defined by Λ_m satisfies the following condition:

$$2\Omega_m(X, Y) = [\Lambda_m(X), \Lambda_m(Y)] - \Lambda_m([X, Y]_{\mathfrak{m}}) - \lambda([X, Y]_{\mathfrak{j}})$$

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

$$\int_{4D \text{ PhyST}} \text{Gauge Boson Term} + \text{Fermion Particle-AntiParticle Term} + \text{Higgs Term}$$

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

$$\text{Spin}(10) / \text{Spin}(8) \times \text{U}(1)$$

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 $D_4 = \text{Spin}(8)$. They "see" M4 Physical spacetime as the 4-sphere S^4 so that their part of the Physical Lagrangian is

$$\int_{S^4} \text{Gravity Gauge Boson Term}$$

an integral over SpaceTime S^4 .

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 S^4 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 $D_4 = \text{Spin}(8)$. They "see" M4 Physical spacetime as the complex projective plane CP^2 so that their part of the Physical Lagrangian is

$$\int_{CP^2} \text{SU(3) Color Force Gauge Boson Term}$$

an integral over SpaceTime CP^2 .

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 CP^2 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

$$\int_{S^2 \times S^2} \text{SU(2) Weak Force Gauge Boson Term}$$

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

$$\int_{T^4} \text{(U(1) Electromagnetism Gauge Boson Term)}$$

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

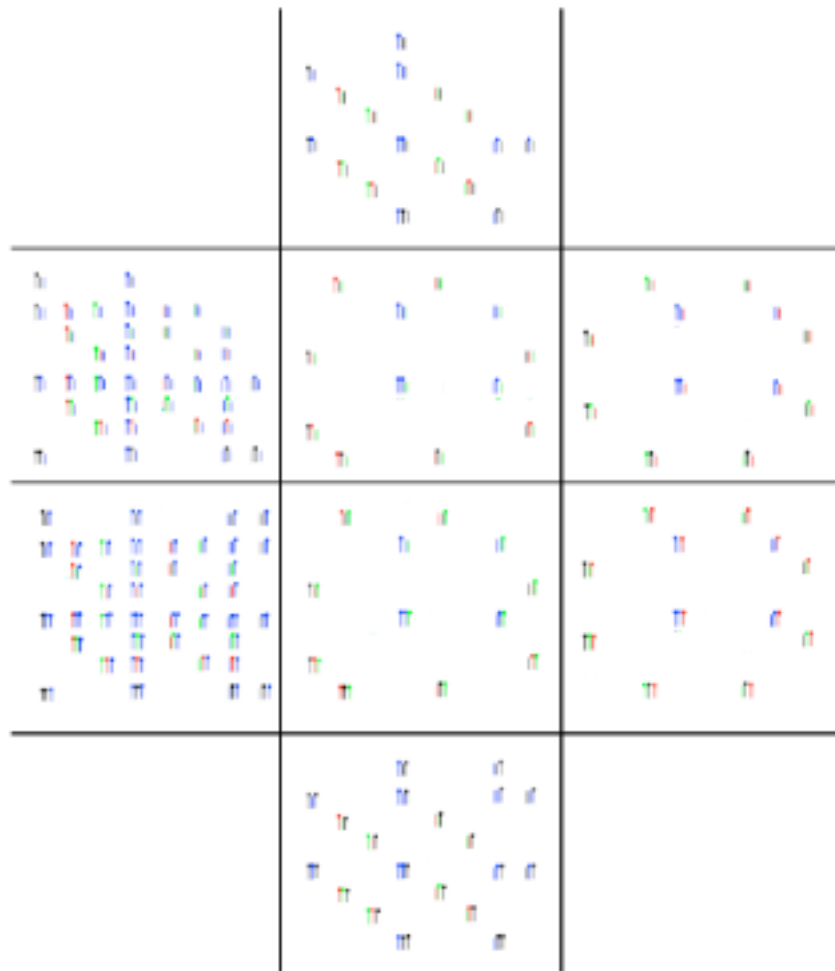
Blue Up Quark is 1 out of 8

Blue Strange Quark is 3 out of $8 \times 8 = 64$

Blue Charm Quark is 17 out of $8 \times 8 = 64$

Blue Beauty Quark is 7 out of $8 \times 8 \times 8 = 512$

Blue Truth Quark is 161 out of $8 \times 8 \times 8 = 512$



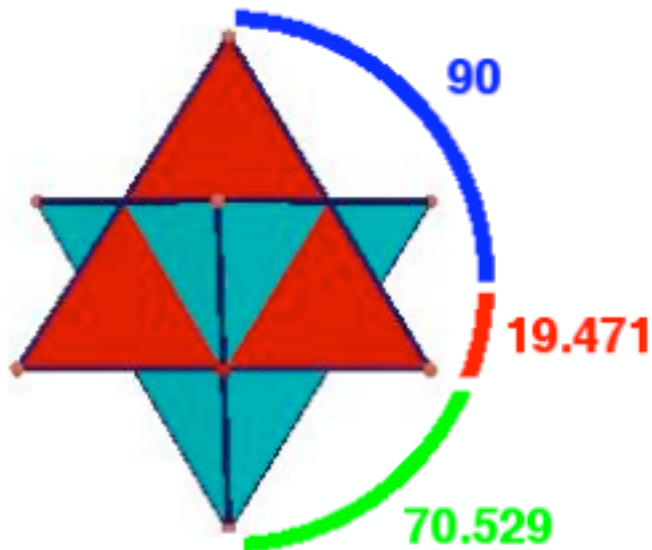
The E8 Physics calculation results are:

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

$$S_{mf1} = 7.508 \text{ GeV},$$

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

$$S_{mf2} = 32.94504 \text{ GeV} \text{ and } S_{mf3} = 1,629.2675 \text{ GeV}.$$

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 ν_3 is for a neutrino whose propagation begins and ends in CP2 internal symmetry space, lying entirely therein. In E8 Physics the mass of ν_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

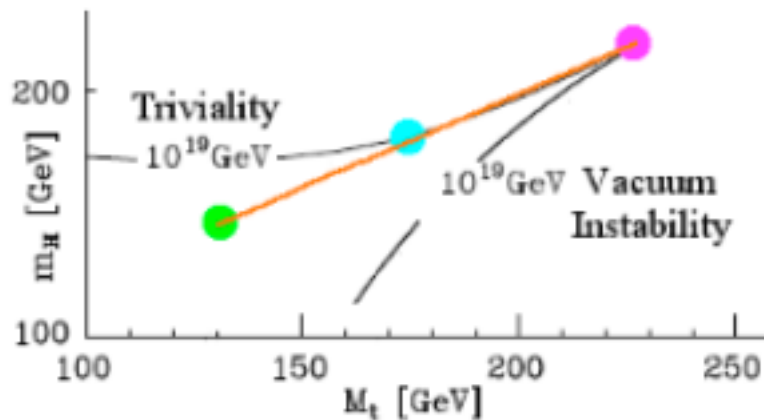
Particle	Tree-Level	Higher-Order
e-neutrino	0	0 for ν_1
mu-neutrino	0	9×10^{-3} eV for ν_2
tau-neutrino	0	5.4×10^{-2} eV for ν_3


and for mixing matrix

$\nu_1 \ \nu_2 \ \nu_3$


ν_e	0.853	0.493	$0.056 - 0.157 i$
ν_m	$-0.388 - 0.096 i$	$0.592 - 0.056 i$	0.697
ν_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




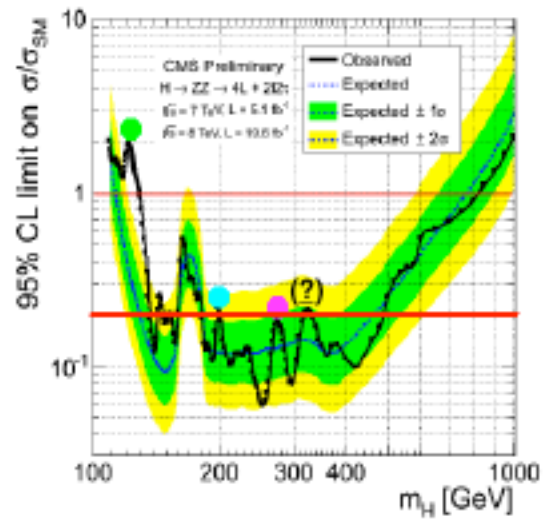
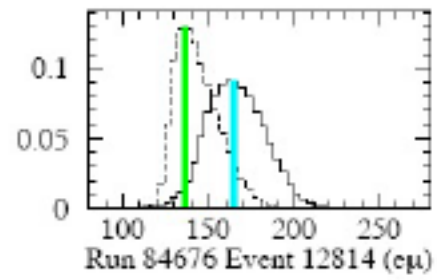
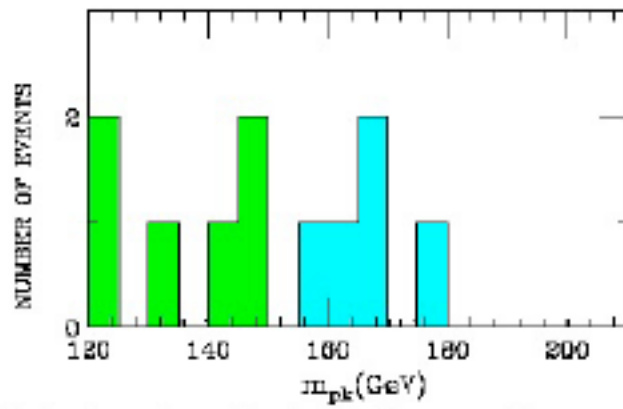
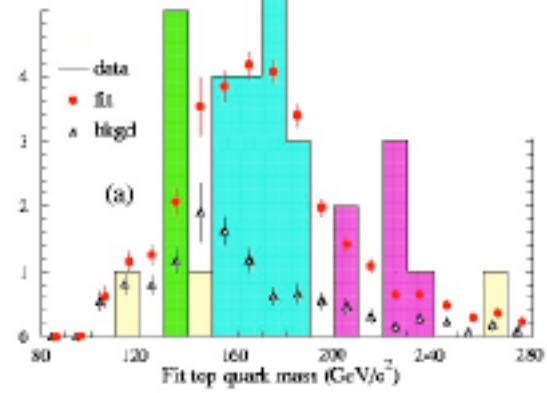
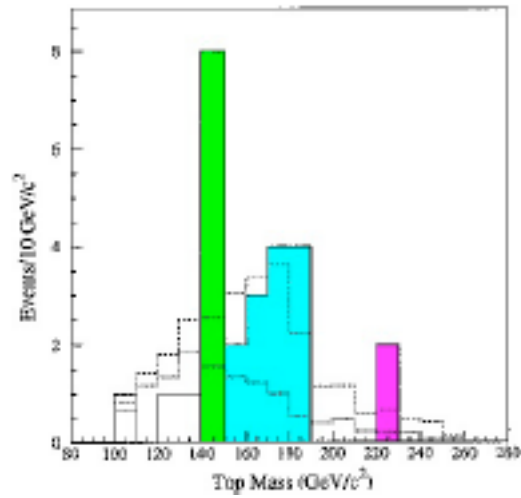
The Magenta Dot  is the high-mass state of a 220 GeV Truth Quark and a 240 GeV Higgs. It is at the critical point of the Higgs-Tquark System with respect to Vacuum Instability and Triviality. It corresponds to the description in hep-ph/9603293 by Koichi Yamawaki of the Bardeen-Hill-Lindner model. That 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 $M_H / M_T = 1.1$ 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 $172 < M_T < 175$ GeV and $178 < M_H < 188$ 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.



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

$(m_s - m_d) (m_d/m_s)^2 a(w) |V_{ds}| = 312 \times 0.25 \times 0.253 \times 0.22 \text{ Mev} = 4.3 \text{ Mev}$,
(where $a(w) = 0.253$ is the geometric part of the weak force strength and $|V_{ds}| = 0.22$ is the magnitude of the K-M parameter mixing first generation down and second generation strange)

so that the Quantum color force constituent mass Q_{md} of the down quark is

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

Similarly, the up quark Quantum color force mass increase is about
 $(m_c - m_u) (m_u/m_c)^2 a(w) |V_{uc}| = 1777 \times 0.022 \times 0.253 \times 0.22 \text{ Mev} = 2.2 \text{ Mev}$,
(where $|V_{uc}| = 0.22$ is the magnitude of the K-M parameter mixing first generation up and second generation charm)

so that the Quantum color force constituent mass Q_{mu} of the up quark is

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

Therefore, the Quantum color force Neutron-Proton mass difference is
 $m_N - m_P = Q_{md} - Q_{mu} = 317.05 \text{ Mev} - 314.95 \text{ Mev} = 2.1 \text{ Mev}$.

Since the electromagnetic Neutron-Proton mass difference is roughly

$$m_N - m_P = -1 \text{ MeV}$$

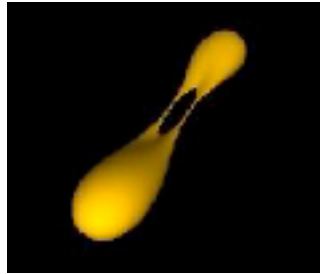
the total theoretical Neutron-Proton mass difference is

$$m_N - m_P = 2.1 \text{ Mev} - 1 \text{ Mev} = 1.1 \text{ Mev,}$$

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 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

$$(312.75 / 2.25) \text{ MeV} = 139 \text{ MeV}$$

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 $.14 \times 6 \text{ GeV} = 0.84 \text{ GeV}$. Just as the pion mass of $.14 \text{ GeV}$ 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 $.1 \text{ GeV}$, 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 $1.221 \times 10^{19} \text{ GeV}$.

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:

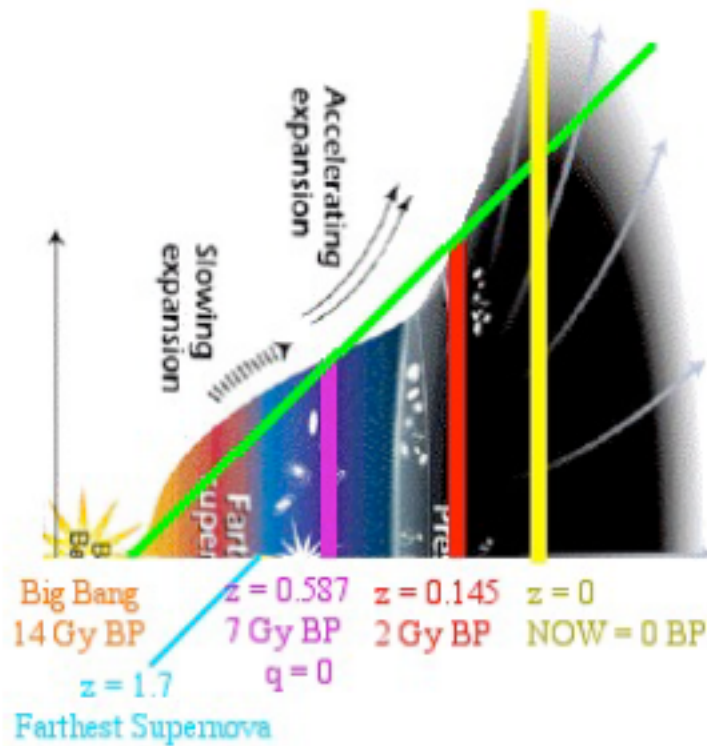
- 3 Rotations;
- 3 Boosts;
- 4 Translations;
- 4 Special Conformal transformations; and
- 1 Dilatation.

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

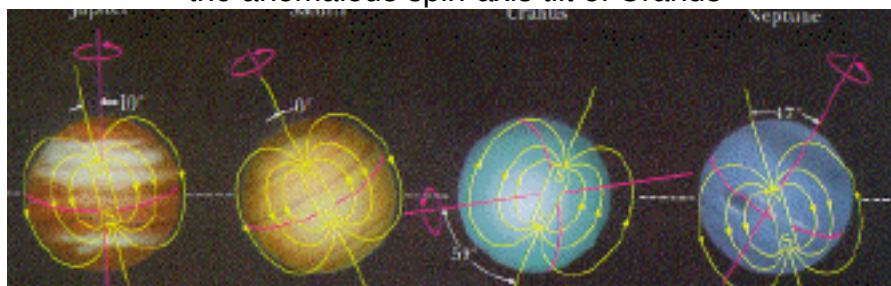
Planck: DE : DM : OM = 69 : 26 : 05

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

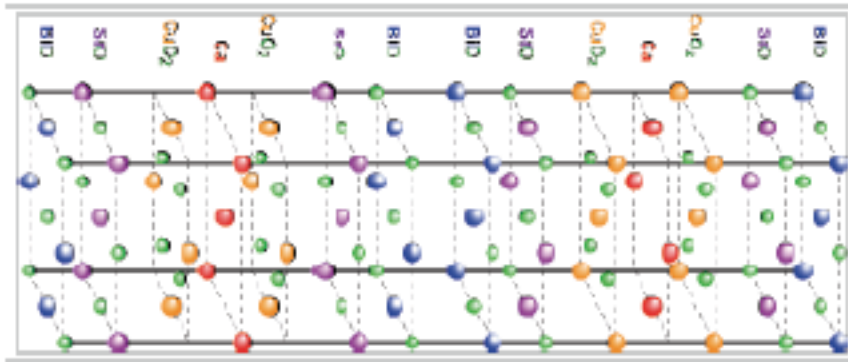
the anomalous spin-axis tilt of Uranus



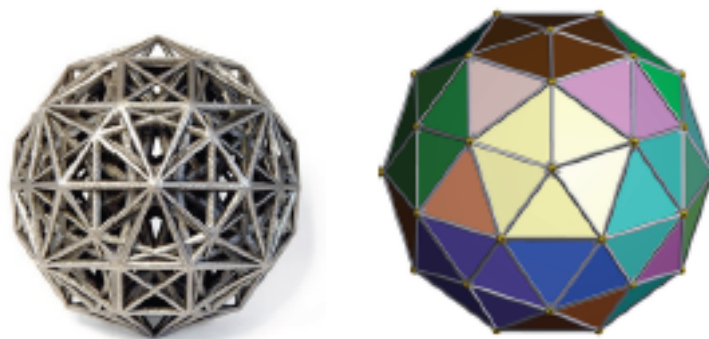
by taking the orbit of Uranus as a boundary between an outer region in which Conformal Gravity is fully effective and an inner region in which the Conformal degrees of freedom are frozen out, similarly to the 2-phases-of-gravity proposal of Irving Ezra Segal.

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 $3 \times 10^{(-18)}$ Hz (radius of universe) to 3×10^{43} Hz (Planck length). Its RMS amplitude is 10^{13} Hz = 10 THz = energy of neutrino masses = = critical temperature T_c 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, $Cl(16) = Cl(8) \times Cl(8)$, and any Real Clifford Algebra, no matter how large, can be embedded in a tensor product of factors of $Cl(8)$, and therefore of $Cl(8) \times Cl(8) = Cl(16)$.

Just as the completion of the union of all tensor products of 2×2 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 $Cl(16) = Cl(8) \times Cl(8)$ produces a generalized Hyperfinite II1 von Neumann factor that gives a natural

E8 Physics Algebraic Quantum Field Theory.

23 - maximal contraction of $E_8 = \text{semidirect product } A_7 \times h_{92}$
gives a creation/annihilation algebra
where $h_{92} = 92 + 1 + 92 = 185$ -dim Heisenberg algebra and $A_7 = 63$ -dim $SL(8)$

A Fundamental Building Block of E_8 Physics AQFT is the
Maximal Contraction of E_8

which can be written
as a 5-Graded Lie Algebra with structure

$$28 + 64 + (SL(8, \mathbb{R}) + 1) + 64 + 28$$

The Central Even Grade $0 = SL(8, \mathbb{R}) + 1$

The 1 is an anticommuting scalar and $SL(8, \mathbb{R})$ has bosonic commutators.

As Polar Coordinates, $SL(8, \mathbb{R})$ represents a local 8-dim spacetime

as $SL(8, \mathbb{R}) = Spin(8) + \text{Traceless Symmetric } 8 \times 8 \text{ Matrices}$.

Odd Grades -1 and $+1$ each = $64 = 8 \times 8 = \text{Creation/Annihilation Operators}$
for

8 components of 8 fundamental fermions with fermionic anticommutators.

Even Grades -2 and $+2$ each = $\text{Creation/Annihilation Operators}$
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 II_1 von Neumann factor algebra that, through its $Cl(16)$ structure, contains math structures that are sufficient to describe E_8 Physics.

High Energy Particle Physics

Spinor Doubling and Evolution of Our Universe

Authors: [Frank Dodd Tony Smith Jr](#)

Spinors and their doubling up to $Cl(16)$ 64+64-dim half-spinors can be seen as an alternate (but substantially equivalent) way to look at E8 Physics which is outlined in vixra 1312.0036 as being based on a $Cl(k) \rightarrow Cl(Cl(k))$ Clifford process. For details about E8 Physics see 377-page viXra 1310.0182 and 11,445-page viXra 1311.0094.

Comments: 7 Pages.

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Spinor Doubling and Evolution of Our Universe

Frank Dodd Tony Smith Jr - 2013

E8 Physics based on a $Cl(k) \rightarrow Cl(Cl(k))$ Clifford Algebra process (vixra 1312.0036) can also be described based on

Spinors and their doubling up to $Cl(16)$ 64+64-dim half-spinors:

In the beginning there was $Cl(0)$ spinor fermion void



from which emerged $2 = \sqrt{2^2} = 1+1$ $Cl(2)$ half-spinor fermions/antifermions



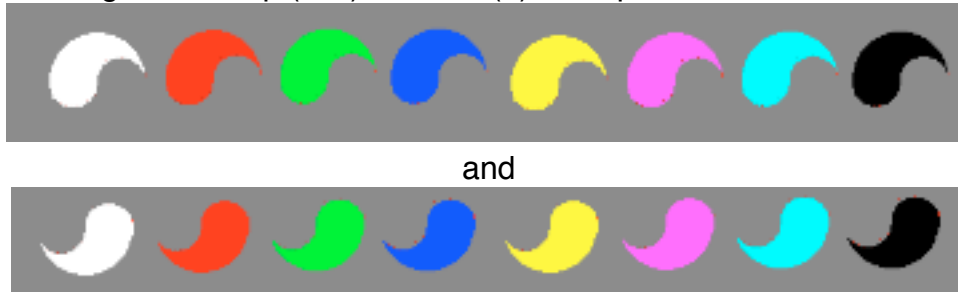
from which emerged $4 = \sqrt{2^4} = 2+2$ $Cl(4)$ half-spinor fermions/antifermions



from which emerged $8 = \sqrt{2^6} = 4+4$ $Cl(6)$ half-spinor fermions/antifermions



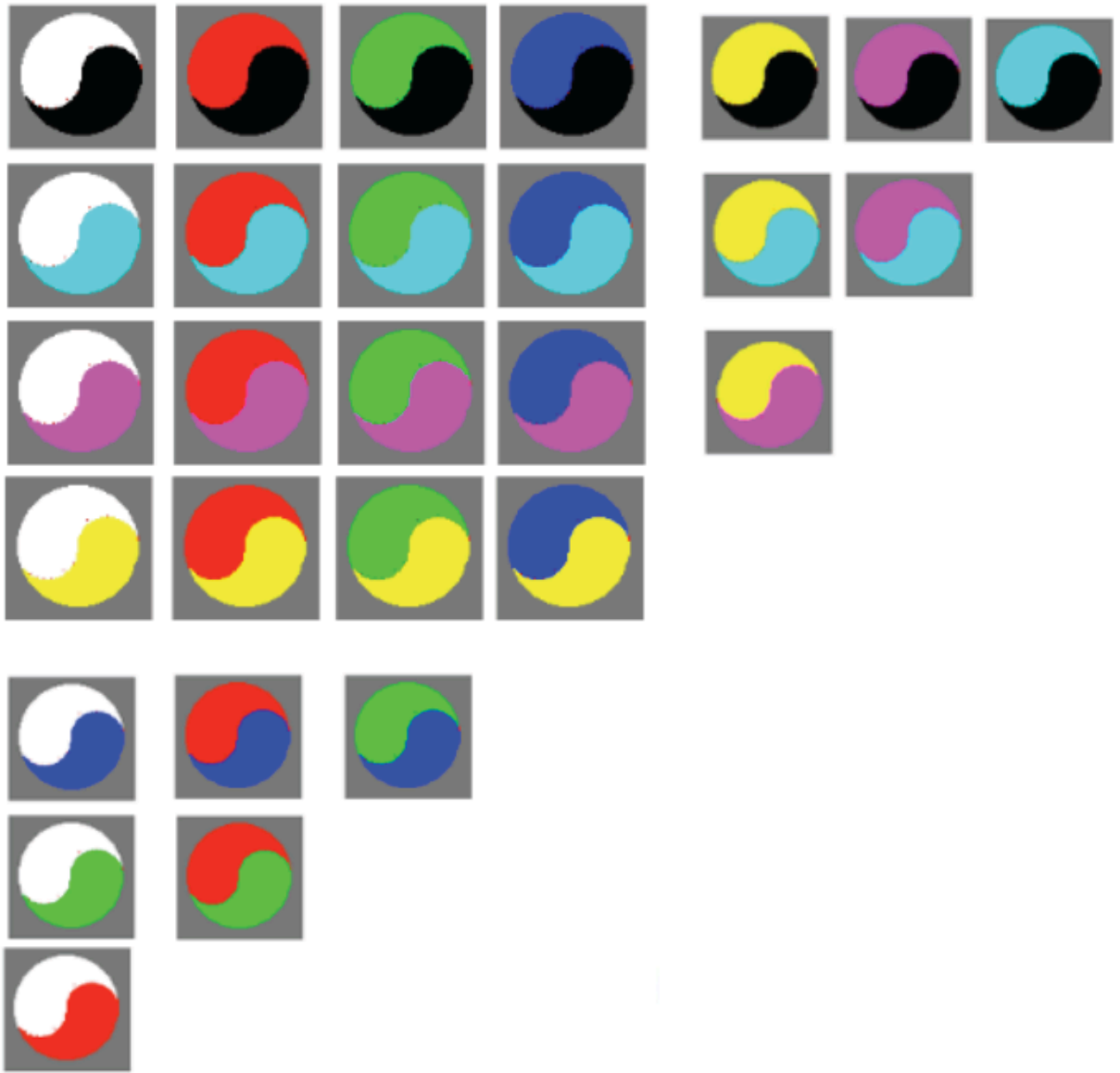
from which emerged $16 = \sqrt{2^8} = 8+8$ $Cl(8)$ half-spinor fermions/antifermions



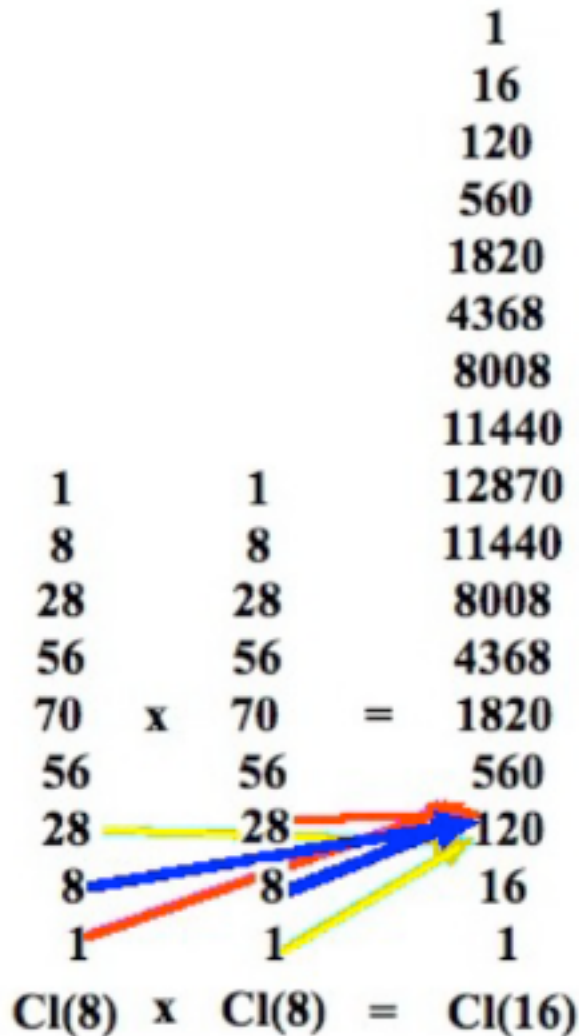
8 half-spinor fermions and 8 half-spinor antifermions are isomorphic by $Cl(8)$ Triality to each other and to the 8 $Cl(8)$ vectors



so that the 28 antisymmetric pairs of half-spinors are the 28 $Cl(8)$ bivectors of a D_4 Lie Algebra:



By Real Clifford Algebra Periodicity, the tensor product $Cl(8) \times Cl(8) = Cl(16)$:



Spinors: $(\boxed{8s \times 8s} + \boxed{8c \times 8c})$
 $(8s+8c) \times (8s+8c) = \quad + \quad (8s \times 8c + 8c \times 8s)$

$256 = \sqrt{2^{16}} = 128 + 128$ $Cl(16)$ half-spinor generation/antigeneration

128 $Cl(16)$ generation = $64 + 64$ quarter-spinor fermions/antifermions

$120 + 64 + 64 = E8$

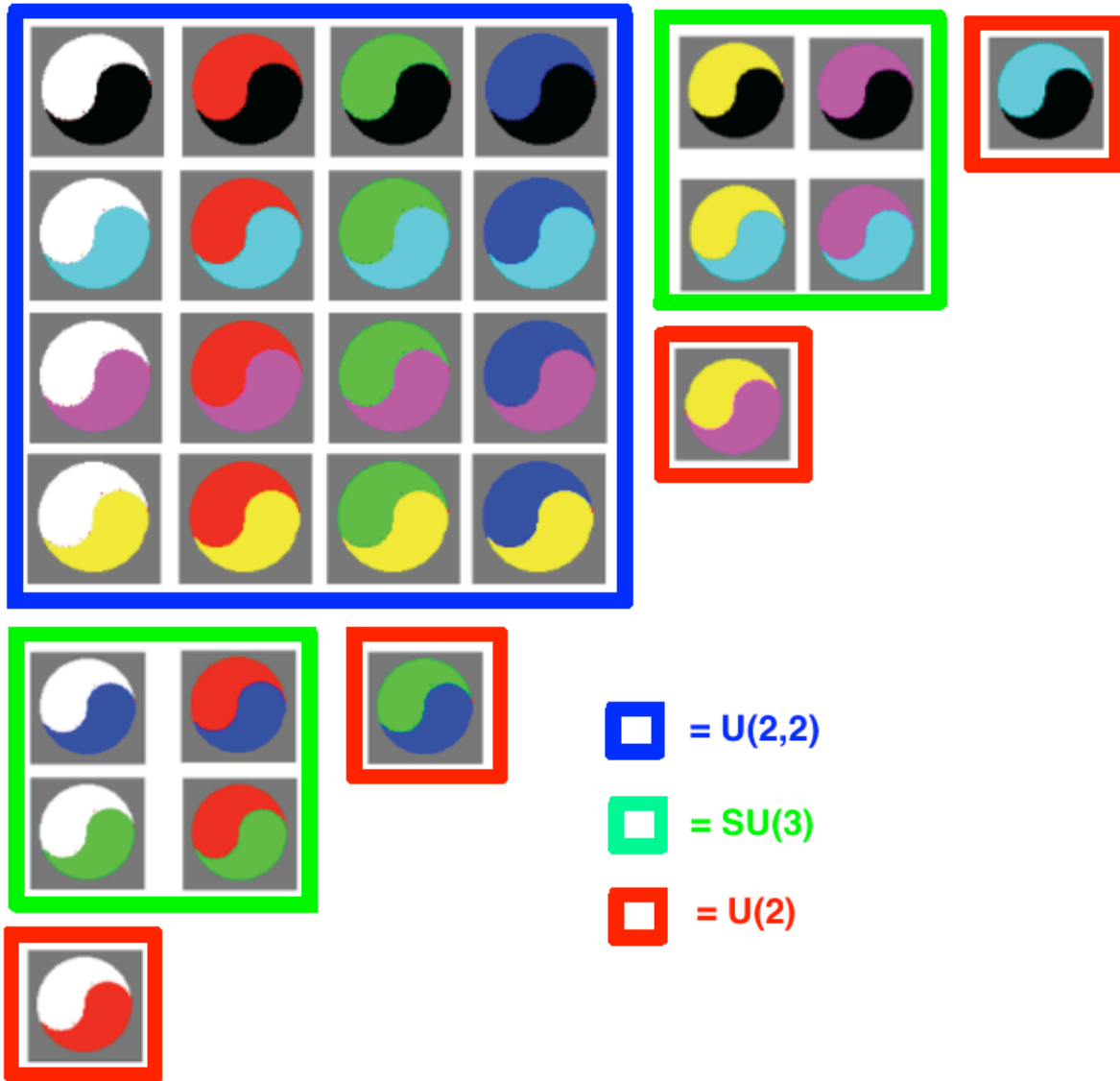
$E8$ root vectors = $112 + 64 + 64$

$E8$ contains $120 = D8 = 8 \times 8 + 1 \times 28 + 28 \times 1$

$D8$ contains $28 + 28 = D4 \times D4$

one $D4$ gives Gravity - other $D4$ gives the Standard Model

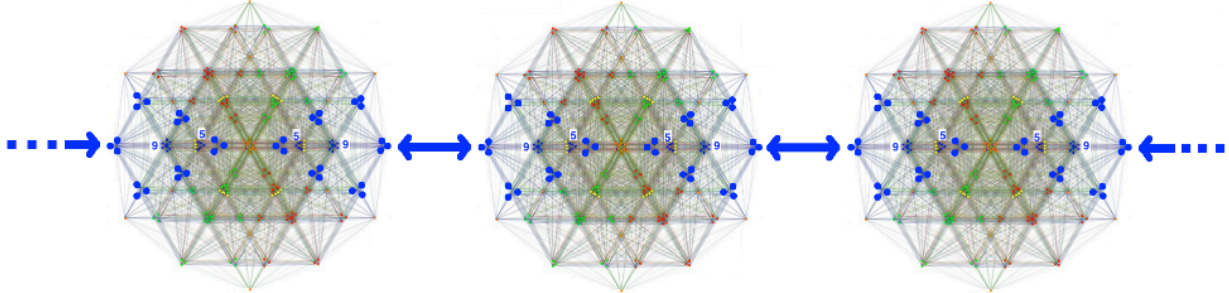
D4 acting on M4 of M4xCP2 4+4 = 8-dim Kaluza-Klein for Gravity:



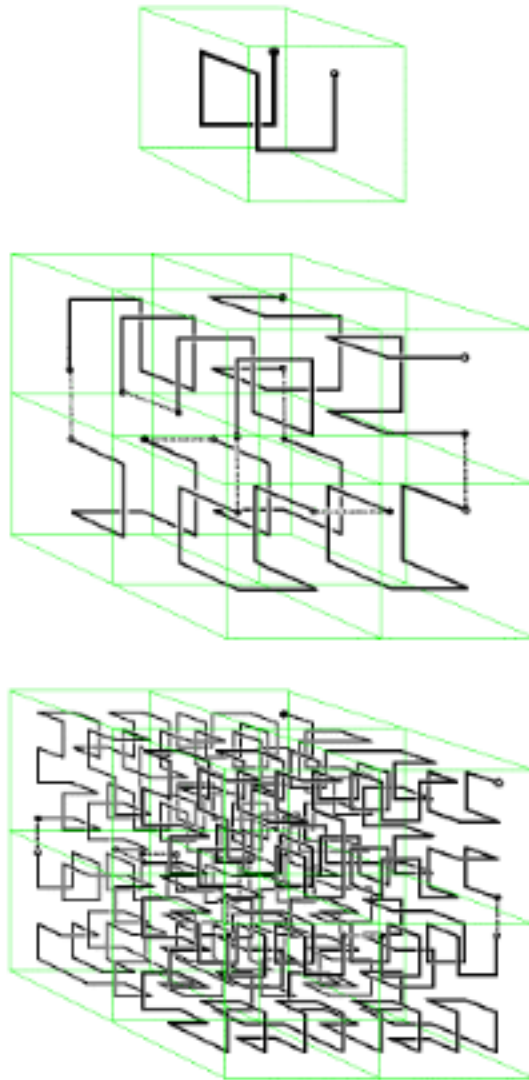
16-dim $U(2,2)$ contains 15-dim $SU(2,2) = Spin(2,4)$ Conformal Group Algebra acting as Gauge Group Algebra on 4-dim M4 physical spacetime of 4+4 Kaluza-Klein that gives Gravity by the MacDowell-Mansouri mechanism and also contains 1-dim $U(1)$ Propagator Phase.

$D4 / U(2+2) = 12$ -dim rank 2 Symmetric Space corresponding to $SU(3)$ and $U(2)$ but not directly acting on M4 of M4xCP2 Kaluza-Klein.

One $Cl(16)$ containing one E_8 gives a Lagrangian description of only one local spacetime neighborhood. To get a realistic global spacetime structure, take the tensor product $Cl(16) \times \dots \times Cl(16)$ with all E_8 local 8-dim Octonionic spacetimes consistently aligned as described by 64-dim $D_8 / D_4 \times D_4$ (blue dots)



which then fill up spacetime according to Gray Code Hilbert's curves:



As our Universe evolves, there are some Special Times in its history:

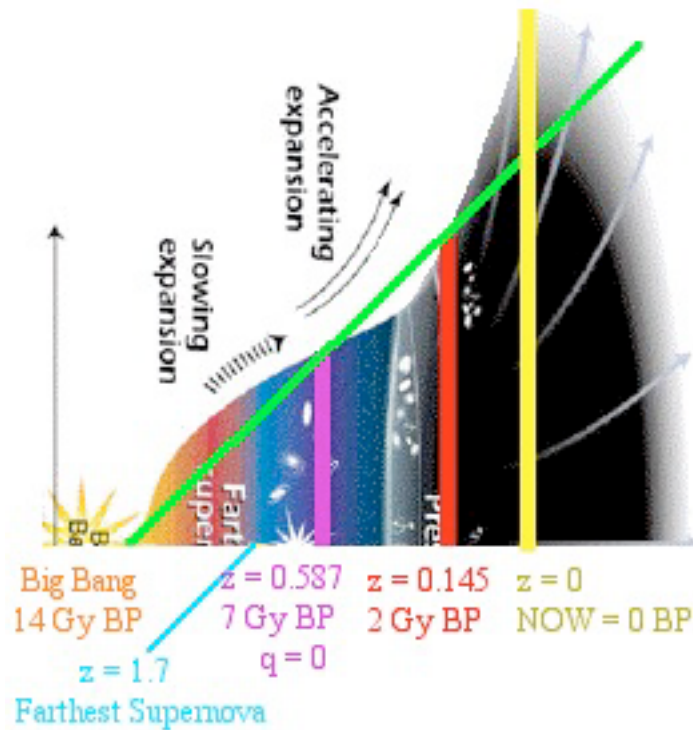
1 - the Big Bang Beginning of Non-Unitary Octonionic Inflation (about 13.7 Gy BP) during which Non-Unitary processes produce about 10^{89} particles;

2 - the End of Inflation = Beginning of Unitary Quaternionic Expansion that initially is Decelerating (beginning of green line also about 13.7 Gy BP);

3 - the End of Deceleration ($q=0$) = Inflection Point =
= Beginning of Accelerating Expansion (purple vertical line at about 7 Gy BP);

4 - the Last Intersection of the Accelerating Expansion of our Universe of Linear Expansion (green line) with the Third Intersection (at red vertical line at about 2 Gy BP);

5 - Now.



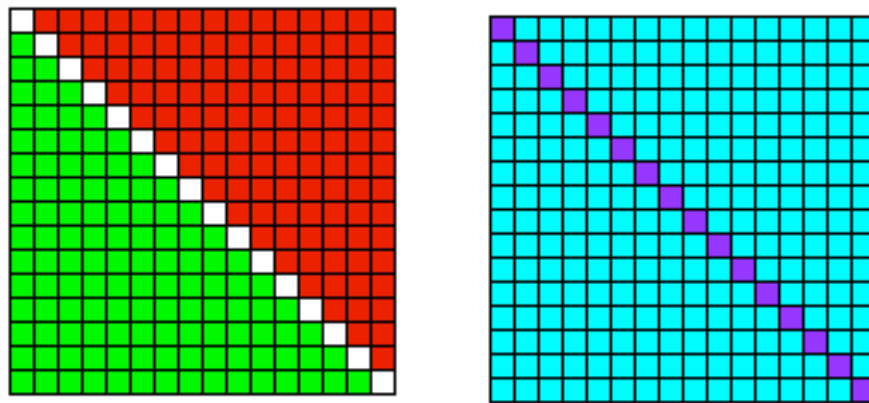
In E8 Physics the Conformal Group structure and the history of our Universe give the ratio Dark Energy : Dark Matter : Ordinary Matter that is roughly

$$DE : DM : OM = 75 : 20 : 05$$

The African IFA Divination based on $16 \times 16 = 256$ elements (tony5m17h.net/VoudouFA.html)
 It corresponds mathematically to the $Cl(8)$ Real Clifford Algebra
 with graded structure $256 = 1 + 8 + 28 + 56 + 70 + 56 + 28 + 8 + 1$
 and algebraic structure of $M(16, \mathbb{R}) = 16 \times 16$ Matrices of Real Numbers.

Here is how E8 Physics of Gravity and the Standard Model is encoded in IFA:

$$256\text{-dim } 16 \times 16 = \\ = 120\text{-dim Antisymmetric } 16 \times 16 + 136\text{-dim Symmetric } 16 \times 16$$



For Antisymmetric 16×16 each red entry above the diagonal is the negative of the corresponding green entry below the diagonal and the 16 diagonal entries are zero so the number of Antisymmetric entries is 120 corresponding to the D_8 Lie Algebra.

For Symmetric 16×16 each cyan entry above the diagonal is equal to the corresponding cyan entry below the diagonal and the 16 diagonal entries are non-zero so the number of Symmetric entries is $120 + 16 = 136$.

8 of the 136 Symmetric entries of the IFA $Cl(8)$ 16×16 Matrix do not correspond to E8 but

the other $136 - 8 = 128 = 64 + 64$ correspond to 128-dim half-spinor of D_8 .

Since 248-dim $E_8 = 120\text{-dim } D_8 + 128\text{-dim half-spinor of } D_8$
 by E_8 / D_8 rank 8 Type EVIII space (OxO)P2 the Octo-Octonionic Projective Plane

256-dim IFA $Cl(8)$ contains $120 + 128 = 248\text{-dim } E_8$

and

encodes the structure of E8 Physics of Gravity and the Standard Model.

African IFA to RigVeda-Pachisi

From its home in Africa the IFA Information System spread, like humanity itself,



throughout the Earth. Some of its descendant systems, such as

128-element Shinto Divination

64-element I Ching

16-element Ilm Al Raml

are straightforward subsets of 256-element IFA

but

the Rig Veda and its related game Pachisi has a more intricate relationship to IFA.

Within its African home IFA was never written down but was oral tradition

but

when humans left Africa they had less of the direct contact with their Ancestral Home that is useful for preservation of oral tradition.

India was settled from Africa via the Arabian Sea in very early times.

(map adapted from "Past Worlds, The Times Atlas of Archaeology" (Crescent Books 1995))



Indian priests of IFA chose to put the IFA Information System into writing, so they developed Sanskrit from the African Geez language.

In a 16 October 2010 post to his blog at bafsudralam.blogspot.com Clyde Winters said:

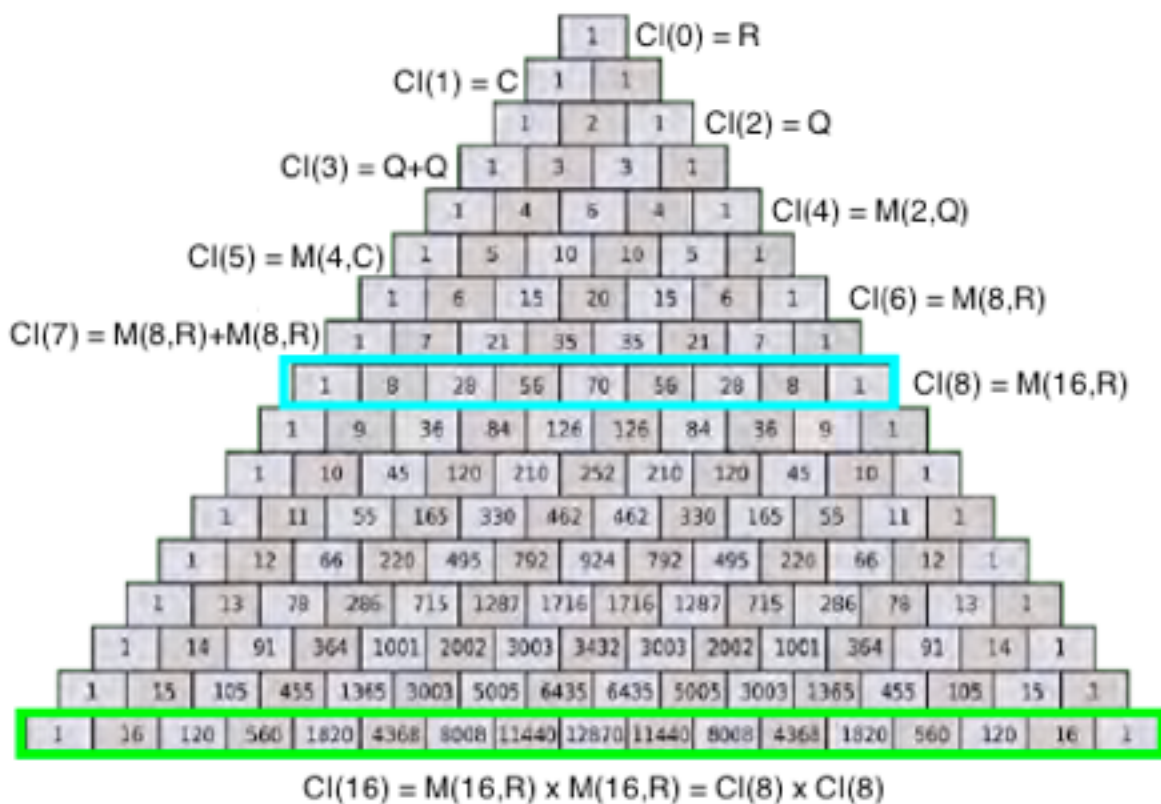
"... The Naga were Semitic speaking people from Ethiopia ...

The major gift of the Naga to India was the writing system: Deva-Nagari.

Nagari is the name for the Sanskrit script ... the ancient Ethiopic and Sanskrit writing are one and the same ... the name Nagari for Sanskrit betrays the Ethiopia origin of this form of writing. In Geez, the term nagar means 'speech, to speak'. ...".

Feuerstein, Kak, and Frawley, in their book In Search of the Cradle of Civilization (Quest 1995), say "... The principal and, taken in its totality, the oldest of the four Vedic hymnbodies is the Rig-Veda. ... The Sanskrit word ric, which for euphonic reasons is changed to rig, means literally "praise". ... The Sanskrit word veda means literally "knowledge" or "wisdom". ... **The Rig-Veda is the oldest book in the Sanskrit language ... More than that, if we are correct, it is the oldest book in the world ...**".

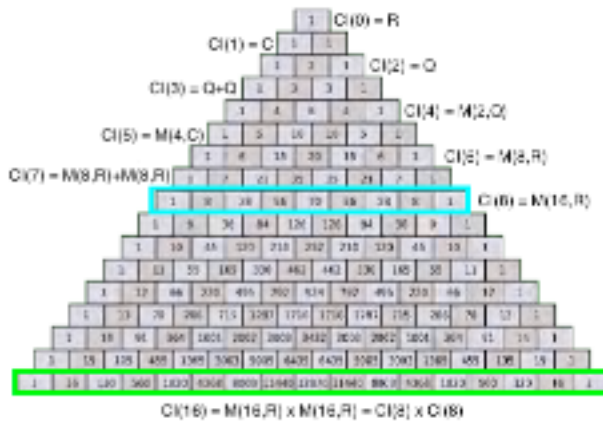
The Indian National Science Academy web site insaindia.org says "... The Vedic Civilization ... evolved around ... the Vedas ... Vedic meters ... permutations and combinations of long and short sounds ... led ... to discover[y] of the Meru Prastara ...



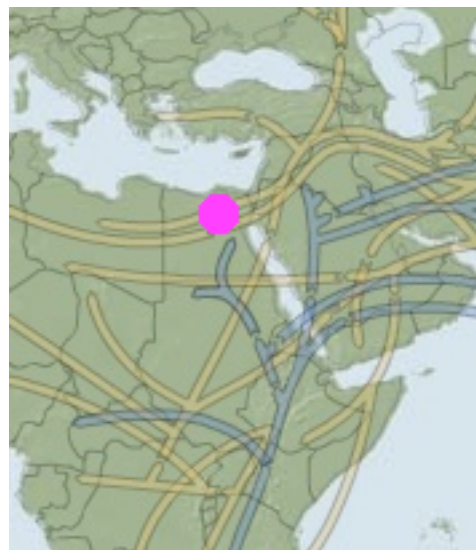
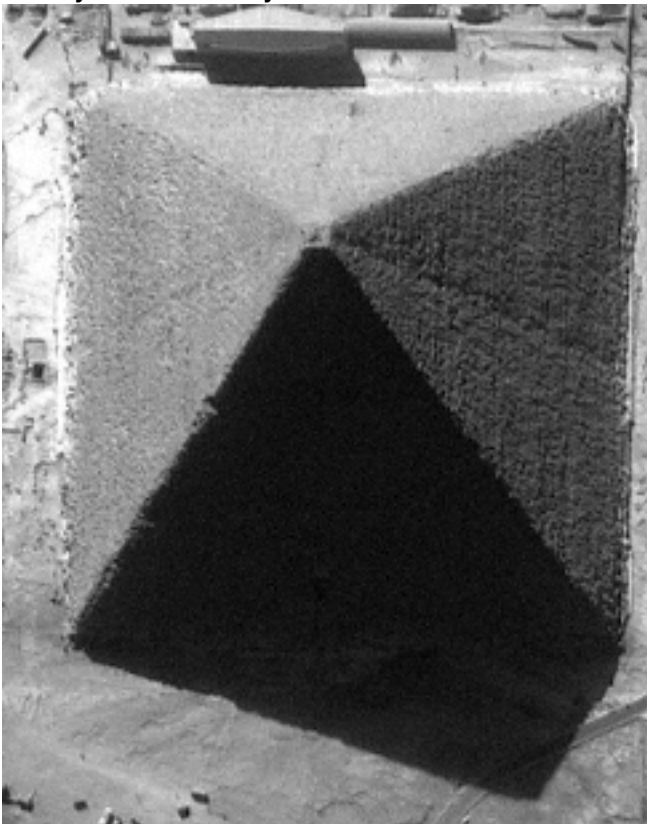
now known as Pascal's Triangle ...".

The row I have outlined in cyan contains the $1+8+28+56+70+56+28+8+1 = 256 = 16 \times 16$ elements of the CI(8) Real Clifford Algebra of African IFA divination. The other rows contain the 2^N elements of CI(N) where N is the second number from the left in each row, so that the Meru Prastara describes all Real Clifford Algebras CI(N), with the figure above showing CI(0) through CI(16) which I have outlined in green.

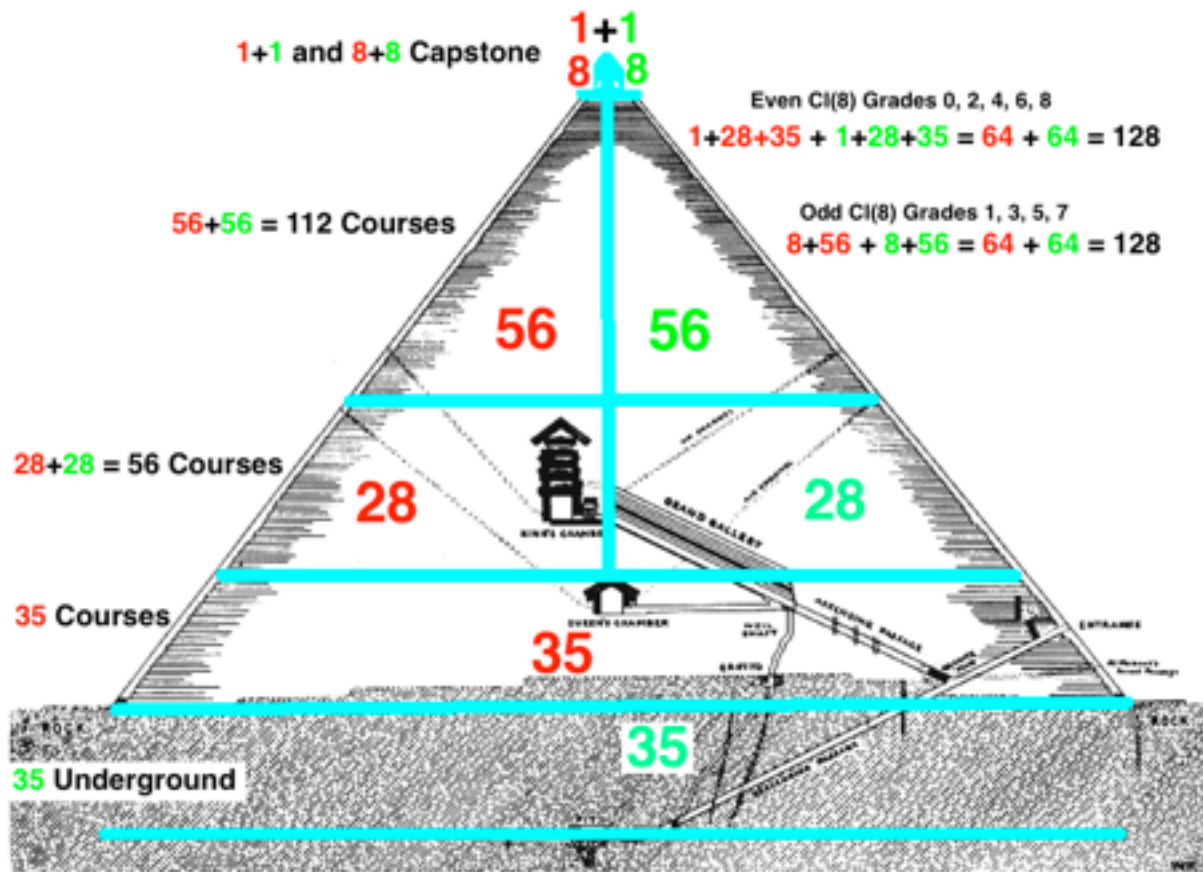
The Golden Ratio structure and pyramidal shape show that the representation of Ancient African IFA by the Meru Prastara of African Migrants to India 50,000 years ago (about 4 Vedic Semi-Precession periods of 4800 + 3600 + 2400 + 1200 = 12,000 years with the 4th 1200 year Dark Iron Kali Yuga ending about 2012 / 2013 to be followed by a Bright Golden 4800 year Satya Yuga of reconciliation of technology and spirituality)



corresponds to its representation by the Great Pyramid of Giza of African Nile Migrants of 40,000 years ago



The migration from Africa to the Mouth of the Nile about 40,000 years ago can be seen in terms of the chronology of the Egyptian historian Manetho who lived about 2,000 years ago in which the African Nile migration would be seen as occurring about 36,525 years ago, when the Geminga SuperNova Shock Wave hit Earth



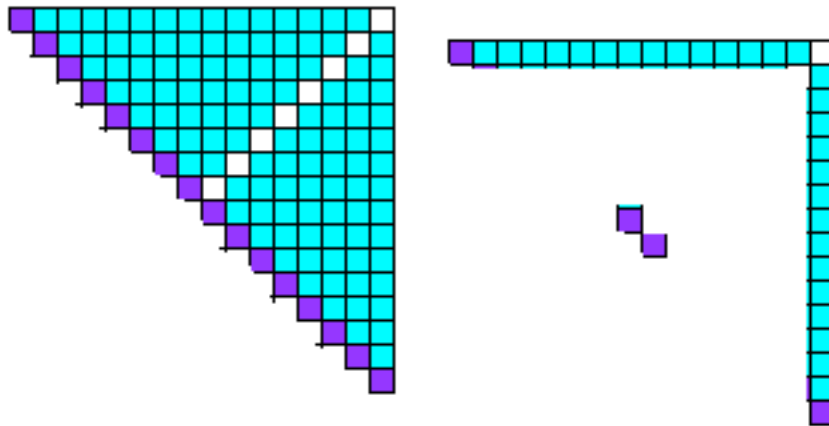
$$1 + 8 + 28 + 56 + (35 + 35) + 56 + 28 + 8 + 1$$

(image adapted from David Davidson image -
 for a larger version of this image go to tony5m17h.net/GreatPyrCl8.png
 or valdostamuseum.com/hamsmith/GreatPyrCl8.png)

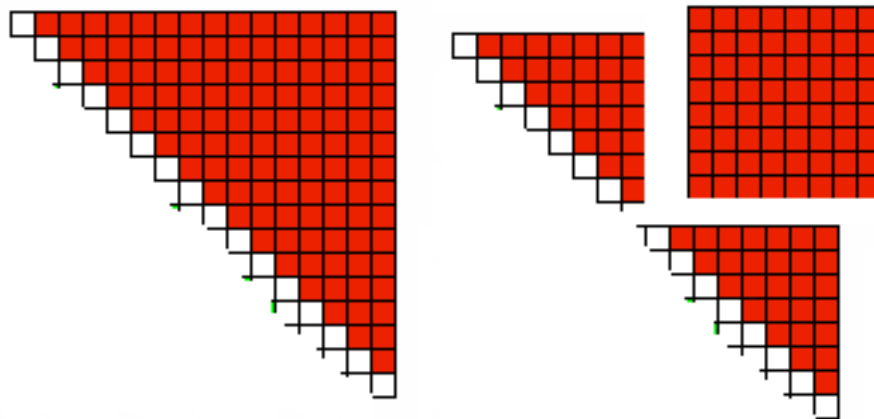
**Here is how the structure of the IFA Information System
has been simplified for transmission to Pachisi:**

First, due to the diagonal-reflection symmetry of Antisymmetric and Symmetric matrices, only the upper triangular parts of the matrices need to be preserved:

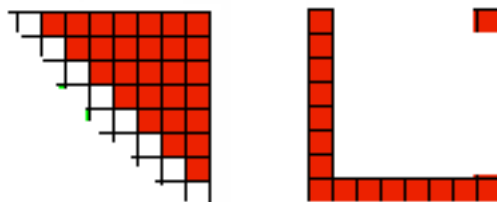
The Symmetric part was simplified by ignoring the part of $Cl(8)$ not in E_8 and then using only 32 entries (from outer shell and diagonal) of those 128 entries



The Antisymmetric part was first cut into 3 sections

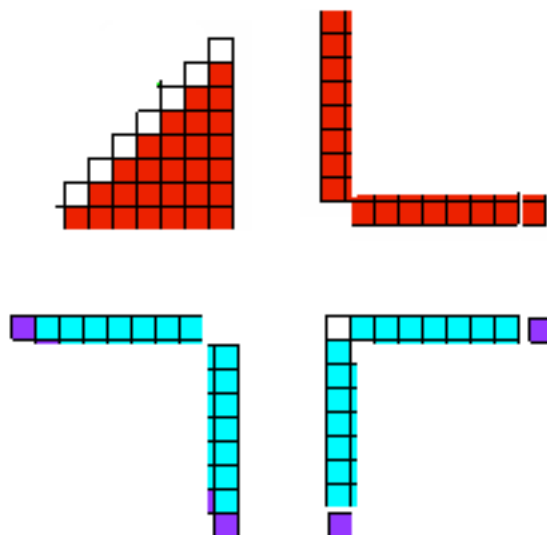


two similar triangular each with 28 entries and one square with 64 entries.
Using only one of the two similar 28-entry triangles plus 16 from the square (outer shell)

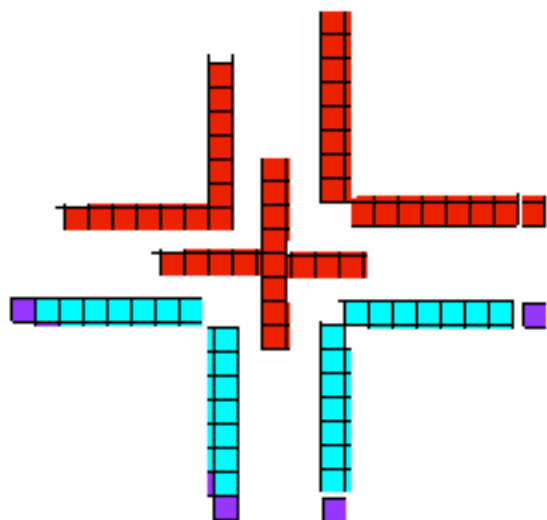


reduced the 120 Antisymmetric entries to $28 + (64-49) = 28+16 = 44$ entries

thus reducing 248-dim E8 to $28 + 16 + 32 = 76$ entries.
 Since most of the IFA E8 structures are outer boundaries of square regions
 it is natural to construct Pachisi as a boundary-progression board game
 so the 30-entry Symmetric outer shell is broken into two parts which,
 when added to the 28-entry and 15-entry Antisymmetric parts,
 naturally fit together in this configuration

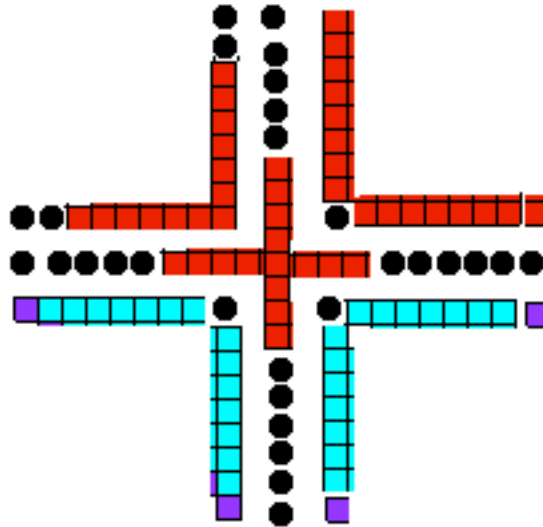


with 3 quadrants that look like a boundary-progression board game
 but with one triangular quadrant that looks out of place. To make the board look more
 nearly consistent, move the interior 15 elements of the triangle to the interior of the
 board to get



with $8+8+8+8+8+8+7+6 = 61$ outer plus 15 inner = 76 entries

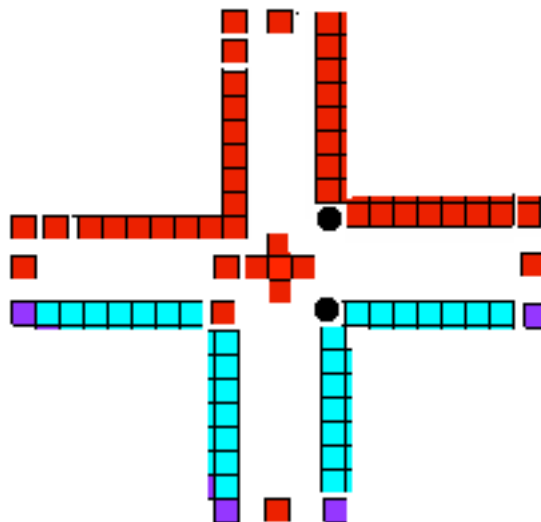
In order to fill out the Pachisi board 29 more entries are needed as filler



to get the total of 105 entries on the full game board for Pachisi.

RigVeda-Pachisi to Tarot

Tarot was developed from Pachisi by getting rid of 26 filler entries and using the 15 inner entries: 4 to complete the exterior arms of D4; 4 to bridge between arms; 1 as an inner corner; and 6 in central configuration, with the remaining 2 filler entries used for the U(1) of D5 / D4xU(1) and E6 / D5xU(1). The red entry at the corner of the left-side blue pair of arms corresponds to the Antisymmetric U(1) in the $U(2,2) = U(1) \times Spin(2,4)$ subalgebra of the D4 which physically represents the propagator phase of Fermions from the Symmetric sector.



Tarot has $105 - 27 = 78$ cards, corresponding to the 78-dim E6 Lie Algebra.

Tarot to Lull

Ramon Lull (1232-1316) of Mallorca lived in a time and place of a unique confluence of Islamic, Christian, and Jewish mystical ideas on a Mediterranean island between Iberia and Africa

so

he was exposed to ideas including

Islamic 16-element IIm al Raml derived from African 256-element IFA,

Christian-Crusader Troubadour 78-element Tarot,

Jewish Urim v'Thummim system revealed to Moses for decoding the 72 letters

on the 12 stones of the Breastplate of Judgment,

and

he was able to travel easily to Africa, the home of 256-element IFA.

According to Anthony Bonner's book Doctor Illuminatus (Princeton 1993):

"... In the history of Western mysticism,

there is nothing quite like ...[Lull's Quaternary Phase (1274-89)]...

with its curious blend of Troubadour, Franciscan, and Islamic influences,

mixed with Lull's own special outlook based on the Art ...".

"Lull's own special outlook" may have been to see that

72 letters of the Urim v'Thummim Breastplate are contained in the 78-element Tarot

the 78-element Tarot fits inside the 256-element IFA D4 Real Clifford Algebra as

$$1 + 8 + 28 + \dots + 8 + 1$$

fits inside

$$256 = 1 + 8 + 28 + 56 + 70 + 56 + 28 + 8 + 1$$

and as

$$(8+8) + (8+8)$$

fits inside

$$256 = (8+8) \times (8+8)$$

Troubadours propagated songs, poetry, and games such as Tarot.

Ramon Lull (1232-1316) of Mallorca studied the Islamic 16-element IIm al Raml,

the Troubadour 78-element Tarot,

and the 256-element IFA

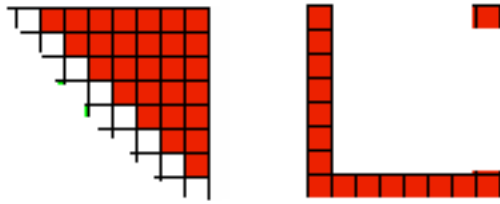
and

found a structure that he summarized in Wheel Diagrams with 16 vertices

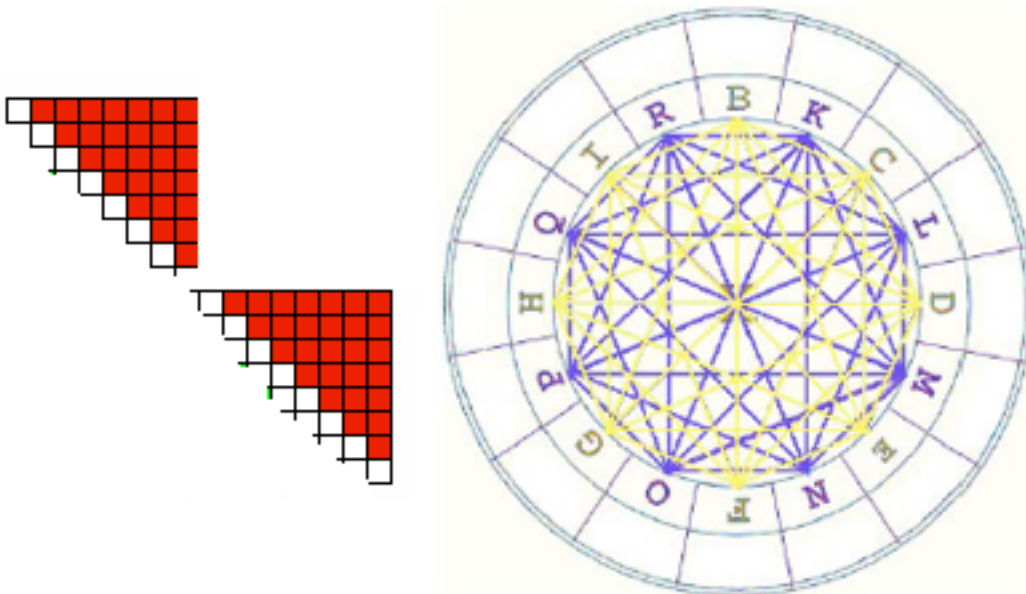
connected to each other by lines such as (some images adapted from lullianarts.net web site)

Of the 120-dim Antisymmetric Part of 16x16 Real matrices

the 78-dim Tarot contains only a 16-dim partial boundary of its 64-dim $U(8)$ square and one 28-dim D_4 triangle plus a single 1-dim $U(1)$ from $D_5 / D_4 \times U(1)$

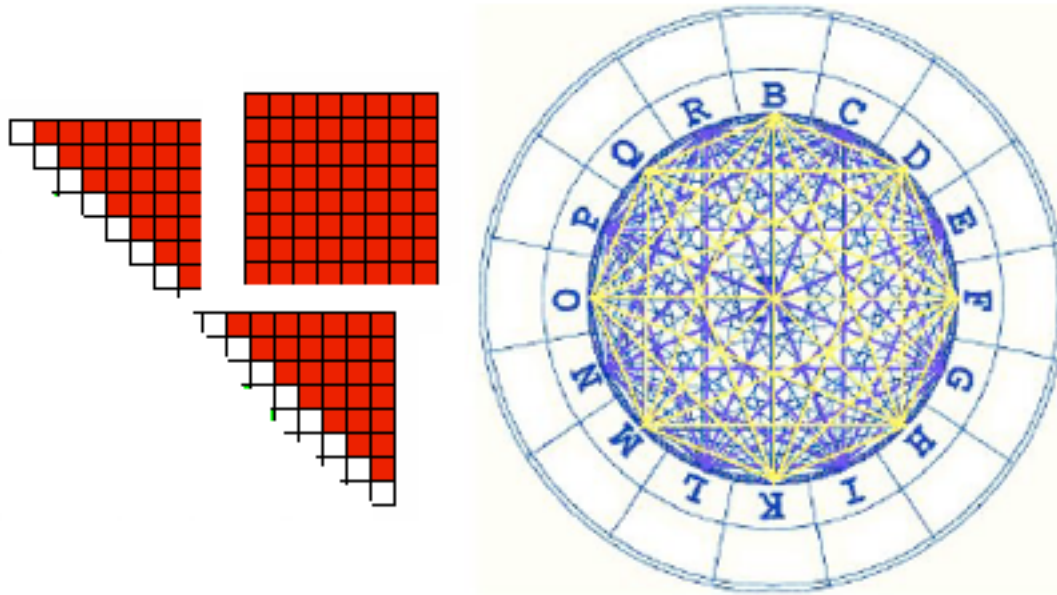


Lull expanded that 45-dim part of the Tarot to include the second D_4 triangle and to represent them in his Wheel Diagram X as two sets of 8 vertices, for a total of 16 vertices, around the X-Wheel within which each set of 8 vertices was connected with the other 7 of that set by 28 lines, each line representing one generator of each of the two copies of 28-dim



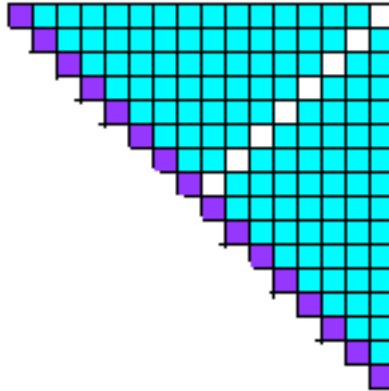
The 28 gold lines represent the D_4 containing $U(2,2)$ that gives Conformal Gravity and the 28 purple lines represent second D_4 containing the $SU(3)$ that when combined with Kaluza-Klein Internal Symmetry Space $CP^2 = SU(3) / U(2)$ gives by the Batakis mechanism the Standard Model Gauge Groups $SU(3) \times SU(2) \times U(1)$.

Lull further expanded the 16-dim square-partial-boundary to full square 64-dim size by adding the 64 blue lines that connect a vertex of one D4 with a vertex of the other D4



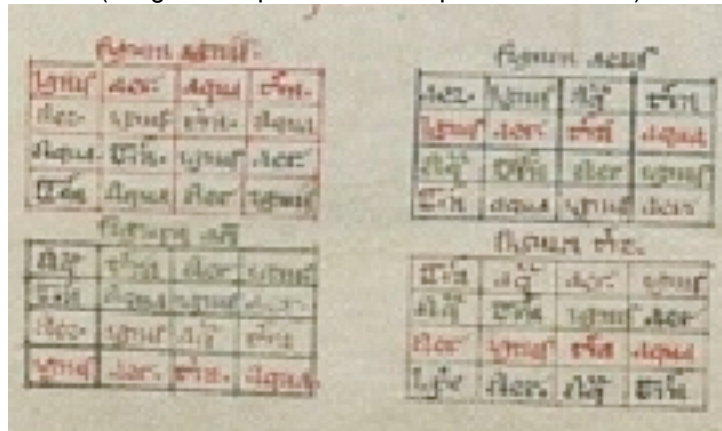
Adding in 64 blue lines gives $28+28+64 = 120$ lines of the Lullian A-wheel that represents the Spin(16) bivector Lie Algebra D8 of the Clifford Algebra $Cl(16) = Cl(8) \times Cl(8)$

As to **the 136-dim Symmetric part of 16x16 Real matrices**
 the 78-dim Tarot does not contain any of the 8 antidiagonal elements
 but contains a single 1-dim U(1) from E6 / D5xU(1)
 plus 16 of 64 entries in each of two 64-element triangular blocks



Physically one of the 64-element blocks of the Symmetric Part of Tarot corresponds to the 8 components (with respect to 8-dim Kaluza-Klein spacetime) of the 8 First-Generation Fundamental Fermion Particles and the other 64-element block corresponds to the components of the Fermion Antiparticles.

Ramon Llull's 64-element Elemental Figure is effectively an 8x8 matrix corresponding to
 (image from quiseestullus.narpan.net web site)



the Fermion Particle and Fermion Antiparticle 64-element Symmetric Tarot blocks
 thus
 constructing a $64+64 = 128$ -dimensional D8 half-Spinor space
 that when combined with the 120-dimensional D8 of the Lullian A-Wheel produces
 $120\text{-dim D8} + 128\text{-dim D8 half-Spinor} = 248\text{-dim E8 Lie Algebra}$

In his time around 1300 A.D. Ramon Llull could not use the language of 2000 A.D. math and physics to explain his Tarot-type model to the world. As Anthony Bonner' said in his book Doctor Illuminatus (Princeton 1993):

"... Even ...[Llull's]... disciple, le Myesier, complained ... about "the confusion caused by the meanings of the alphabet of the Ars demonstrativa and its sixteen figures, which confound the mind." ...

Llull ... tr[ie]d to persuade the Parisian schoolmen ...[by]... us[ing] the bizarre vocabulary more sparingly, and modify[ing] the Art itself so that it would not look so alarming. ... Towards the beginning of 1290 in Montpellier, therefore, Llull set about ... beginning a new phase of the Art ...

As a result of the "weakness of human intellect", the number of figures [wa]s reduced and the algebraic notation vanishe[d] ...

Llull's last works were written in December 1315 in Tunis, at which point he disappears from history. ... he must have died sometime between then and March 1316

...

the Dominican inquisitor general of Aragon, Nicholas Eymerich (1320-99), began a campaign against the doctrines of Ramon Llull ...[that]... culminated ... in two events: The first was the publication in January ... 1376 ... of the Directorium inquisitorum, his notorious manual on inquisitorial methods ... it contained a list of a hundred errors of Ramon Llull ... on February 6, a papal bull was promulgated censuring Llull and condemning twenty of his books ... Llull's followers ... won in 1416 ... the promulgation by the Papal Court ... invalidating the bull of forty years earlier. ... Veneration of Llull was ... permitted within the Franciscan Order and locally in Majorca ... his feast day was set on 3 July ...

The second condemnation of Llullist doctrines came from ... the Faculty of Theology of the University of Paris. In 1390 ... the Faculty of Theology publish[ed] an edict prohibiting the teaching of Llullist doctrines. ...[It]... cut off ... considerable interest in Llull in Paris ...".

In short:

Ramon Llull expanded the 78-dim Tarot outline structure to the old full 256-dim IFA
including the E8 Lie Algebra and the realistic structure of E8 Physics
but
he was 600 years ahead of rediscovery of his mathematics
and
700 years ahead of the time of detailed experimental confirmation
with the result that
the Paris-based Establishment of his time ignored and attacked his work
even when he tried to dumb it down to their level.

Llull to Cartan-Dirac-Riesz-E8Physics

Llull's description of the D8 Lie Algebra of dimension $120 = 8(16-1)$ remained undeveloped and unappreciated for 600 years until Killing and Cartan classified Lie Groups.

Roger Penrose in his book "The Road to Reality" (Knopf 2004) said:

"... classification ...[of]... Lie groups ... started with Wilhelm Killing ... whose basic papers appeared in 1888-1890, and was essentially completed in 1894 ... by ... Elie Cartan ... It turns out that there are four families, known as A_m , B_m , C_m , D_m ... of respective dimension $m(m+2)$, $m(2m+1)$, $m(2m+1)$, $m(2m-1)$, called the classical groups ... and five exceptional groups known as E_6 , E_7 , E_8 , F_4 , G_2 , of respective dimension 78, 133, 248, 52, 14. ...".

The connection of the 248-dim Lie Algebra E_8 with the Clifford Algebra $Cl(16)$ and its 120-dim bivector algebra D8 and 128-dim half-spinor space only became clear in the 1900s based on the work of Cartan as further developed by Jovet, Sauter, and Riesz mathematically and applied by Dirac to physics.

Pertti Lounesto in his article on "History of Clifford Algebras"

in the book "Clifford Numbers and Spinors" by Marcel Riesz (Kluwer 1993) said:

"... E. Cartan 1908 ... identified the Clifford algebras $Cl(p,q)$ as matrix algebras with entries in R [Real Numbers], C [Complex Numbers], H [Quaternions], $R+R$, $H+H$ and found a periodicity of 8 ...

Cartan also observed spinor modules of orthogonal Lie algebras in 1913 ...

Jovet 1930 and Sauter 1930 replaced column spinors by square matrices in which only the first column was non-zero -

thus spinor spaces became minimal left ideals in a matrix algebra.

Riesz 1947 used primitive idempotents of Clifford algebras to construct spinor spaces as minimal left ideals in Clifford algebras ...".

Roger Penrose in his book "The Road to Reality" (Knopf 2004) said:

"... One reason that Clifford Algebras are important is for their role in defining spinors. In physics, spinors made their appearance in Dirac's equation for the electron (Dirac 1928), the electron's state being a spinor quantity ...".

In the 1900s, Irving Ezra Segal showed the connection between the Conformal Group and the Dark Energy of Gravity; MacDowell and Mansouri showed how gauging the Conformal Group produces Gravity; and the Dirac Equation was generalized to the Standard Model. During the 2000s Dark Energy was observed by WMAP and Planck and the LHC discovered a Higgs state, confirming the basic Standard Model structure so

**it is only now (the 2000s) that the formal Written Human Culture
has caught up with the informal Oral Ancient African Culture
and the 700-year old model of Ramon Llull
in understanding a realistic Unified Theory of the Laws of Nature.**