Real Clifford Algebras and Our Universe:
VOID to Cl(16) Lagrangian to Cl(1,25) AQFT

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Abstract

This paper is an outline of basic ideas of Cl(16) and Cl(1,25) Physics.
For details see my papers listed at
http://vixra.org/author/frank_dodd_tony_smith_jr
including http://vixra.org/abs/1903.0485
about the Nambu-Jona-Lasinio Higgs-Truth Quark System

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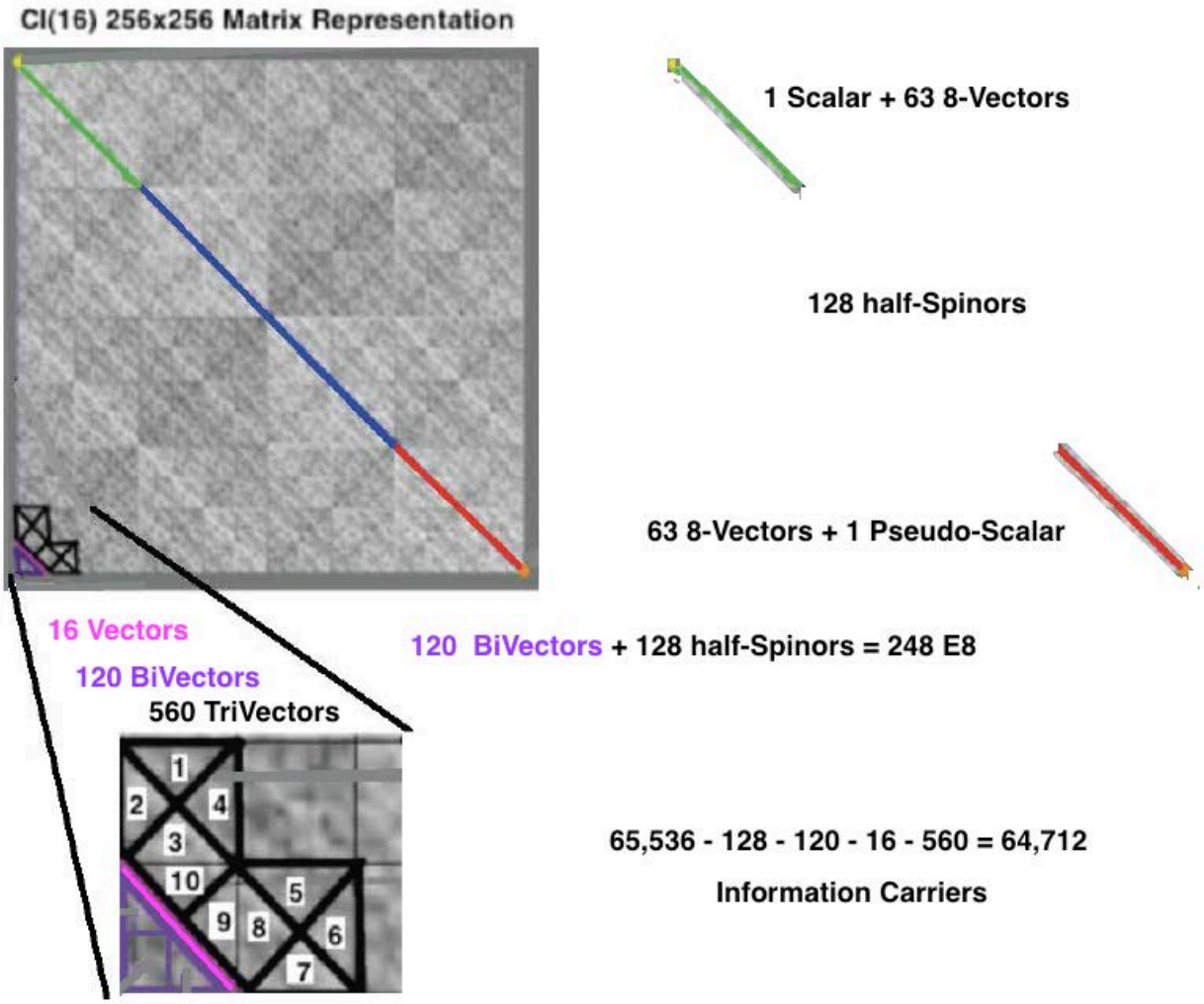
VOID to Cl(16) - Octonionic Lagrangian

The **Real Clifford Algebra Cl(16)** is the culmination of David Finkelstein's process of Iteration of Clifford Algebras that began when Our Universe emerged from an Empty Set Void in its Parent Universe by Quantum Fluctuation:

Cl(Void) = Clifford Algebra of Void = 0
Cl(0) = 2^0 dimensions = 1
Cl(1) = 2^1 = 2
Cl(2) = 2^2 = 4
Cl(4) = 2^4 = 16
Cl(16) = 2^16 = 65,536 = 256x256 Real Matrices M(256,R):

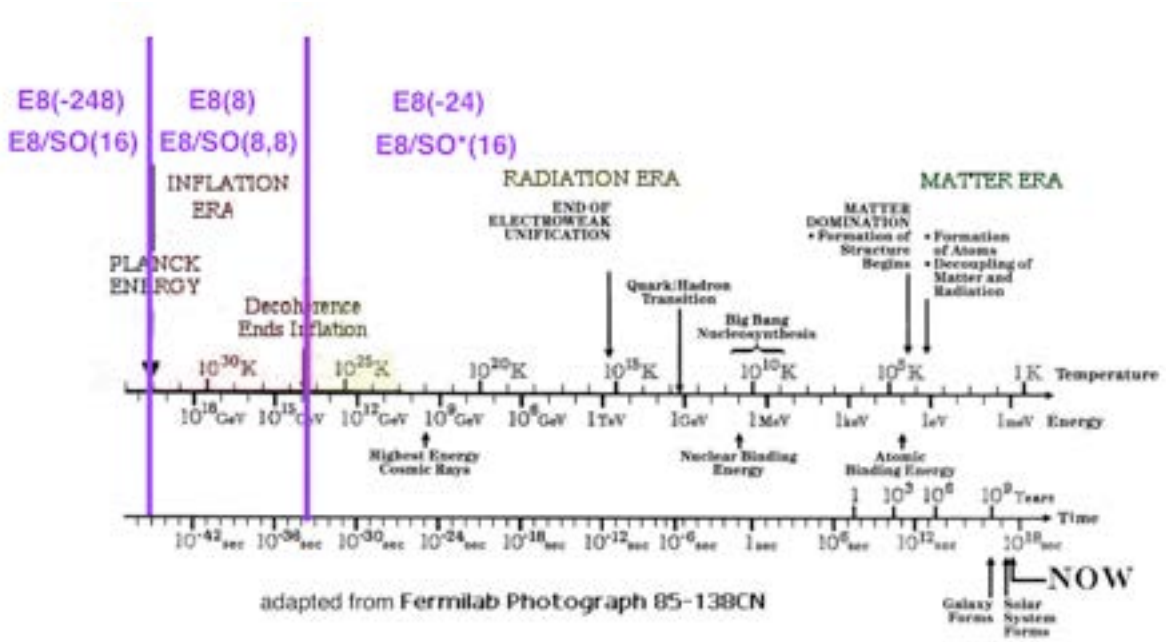
Cl(16) BiVectors + Cl(16) half-Spinors = 248-dim E8



65,536 - 128 - 120 - 16 - 560 = 64,712

Information Carriers

E8 has 3 Real Forms

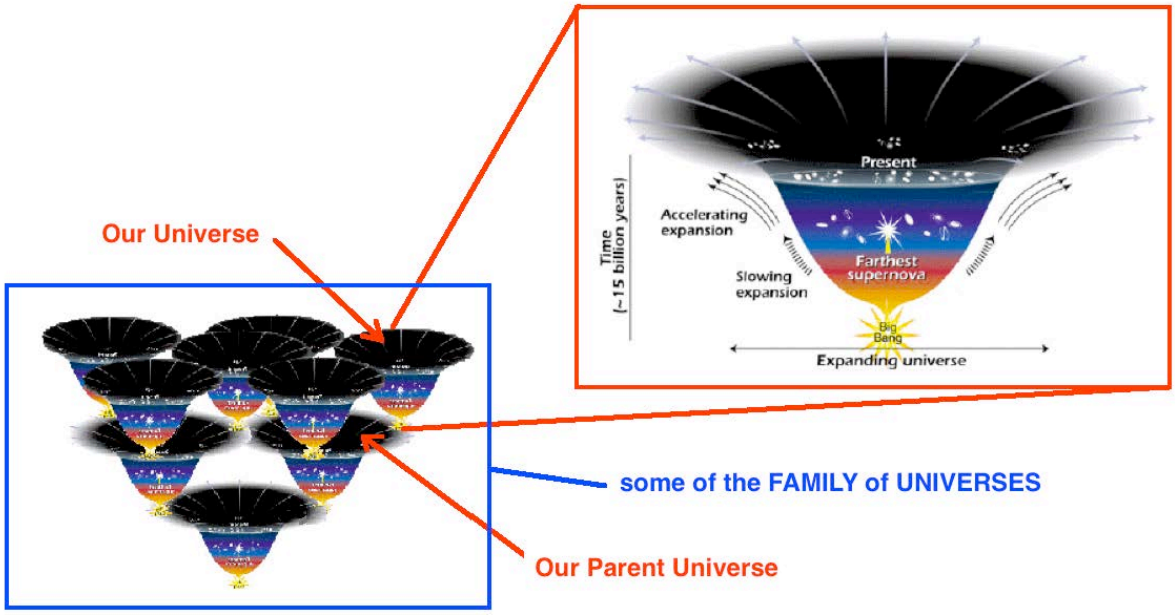


The compact form ... E8(-248) ... has symmetric space **E8/SO(16)**
for Clifford Iteration from VOID to Cl(16)

The split form, EVIII (or E8(8)) ... has symmetric space **E8/SO(8,8)**
for Octonionic Inflation

EIX (or E8(-24)) ... has symmetric space **E8 / Sk(8,H) = E8 / SO*(16)**
for Quaternionic Expansion

First Stage of the Evolution of Our Universe - from VOID to Cl(16) -
was when Our Universe emerged from a VOID in Our Parent Universe



in a **Finkelstein Cliifford Iteration Big Bang leading to Cl(16)**

which contains E8 as 120 BiVectors + 128 half-Spinors = 248-dim E8

E8 is a recipe for a Lagrangian of
8-dimensional Spacetime = Shilov Boundary of Cl(16) Vectors
and
First-Generation Fermions = Cl(16) half-Spinors
and
Gauge Bosons and Ghosts = 28+28 of 120 Cl(16) BiVectors

64 = 120-28-28 of 120 Cl(16) BiVectors = A7+R = Unimodular Gravity =
= Central grade-0 Element of Maximal Contraction of E8

Maximal Contraction of E8 was shown by Rutwig Campoamor-Stursberg in Acta Physica Polonica B 41 (2010) 53-77 , “Contractions of Excep tional Lie Algebras and SemiDirect Products” , to be semi-direct product H92 x A7+R where H92 is (8+28+56 +1+ 56+28+8)-dim Heisenberg Creation/Annihilation Algebra and
E8 Max Contraction has graded structure 8 + 28 + 56 + 64 + 56+ 28 + 8

grade -3 = Creation of 1 fermion (tree-level massless neutrino)
with 8 SpaceTime Components for a total of 8 fermion component creators

grade -2 = Creation of 8+3+1 = 12 Ghosts for Standard Model
and 16 Conformal U(2,2) Bosons for MacDowell-Mansouri Gravity

grade -1 = Creation of 7 massive Dirac fermion
each with 8 SpaceTime Components for a total of 56 fermion component creators

grade 0 = A7+R = 63 +1= 64-dim
Creation/Annihilation of 8-dim SpaceTime of HyperVolume Elements

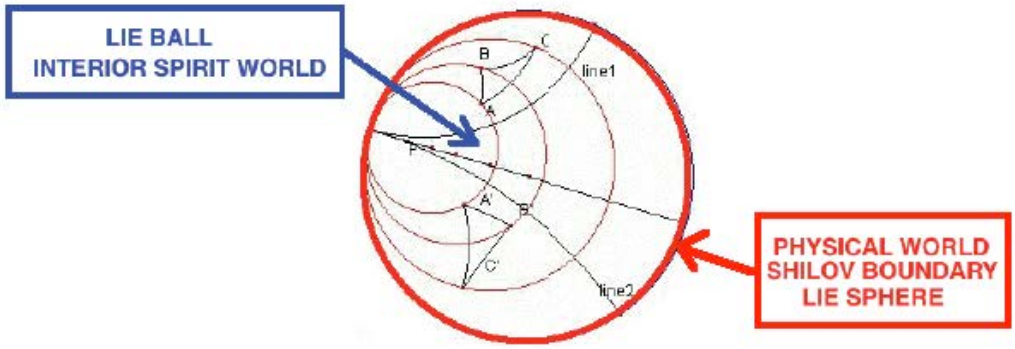
grade 1 = Annihilation of 7 massive Dirac fermions
each with 8 SpaceTime Components for a total of 56 fermion component annihilators

grade 2 = Annihilation of 8+3+1 = 12 Bosons for Standard Model
and 16 Conformal U(2,2) Ghosts for MacDowell-Mansouri Gravity

grade 3 = Annilation of 1 fermion (tree-level massless neutrino)
with 8 SpaceTime Components for a total of 8 fermion component annihilators

Cl(16) Physical Interpretation - Vectors
Spacetime as Shilov Boundary described by Hua

16 Vectors = 16-dim Lie Ball Spin(10) Spin(8) x U(1)
with Bounded Complex Domain of Hua Type IV(8)
whose Lie Sphere Shilov Boundary is 8-dim Spacetime
that is the Base Manifold for the Cl(16) Lagrangian



The 8-dim Spacetime has a Kaluza-Klein M4 x CP2 structure
with CP2 = SU(3) / SU(2)xU(1) Internal Symmetry Space
and M4 = Minkowski Physical Spacetime that is seen by Gauge Groups as

S4 by Gravity
CP2 by Color Force
S2xS2 by Weak Force
T4 = S1xS1xS1xS1 by Electromagnetism

Loo-Keng Hua in his book Harmonic Analysis of Functions of Several Complex Variables in the Classical Domains describes the structure of Bounded Complex Domains and their Shilov Boundaries such as:

Weak Force
SU(2) for Spin(5) / SU(2)xU(1) - Type IV Domain with Shilov Boundary = RP^1xS^2
Color Force
SU(3) for SU(4) / SU(3)xU(1) - Type I Domain B^6 (ball) with Shilov Boundary S^5
Gravity
Spin(5) for Spin(7) / Spin(5)xU(1) - Type IV Domain with Shilov Boundary RP^1xS^4

Hua calculated their Poisson Kernels and Bergman Kernels
that act as Green's Function Propagators for Schwinger Sources.

Note - Hua uses the term "Characteristic Manifold" for "Shilov Boundary".

Cl(16) Physical Interpretation - BiVectors + half-Spinors = E8

For Cl(8) Triality gives
8-dim Vectors V = 8-dim +half-Spinors S+ = 8-dim -half-Spinors S-
which are also the off-diagonal terms of 26-dim traceless J3(O)o
that defines the structure of 26-dim Cl(1,25) Strings=World-Lines Theory
of Cl(16) TriVectors = 10 copies of 56-dim Fr3(O) Freudenthal Algebra each
of which is a complexification of the 27-dim J3(O) Jordan Algebra.

For Cl(16) = tensor product Cl(8)xCl(8) the Relation is a bit more complex.
Cl(16) contains E8 which is a recipe for a Lagrangian
with base manifold 8-dimSpacetime = Shilov Boundary of Cl(16) Vectors
and with these Lagrangian Density terms:

Gauge Bosons = 28 of 120 Cl(16) BiVectors
Ghosts = 28 of 120 Cl(16) BiVectors
First-Generation Fermion Particles = Cl(16) ++quarter-Spinors
First-Generation Fermion AntiParticles = Cl(16) --quarter-Spinors

The Cl(16) Relation is between

Components of 28 Gauge Bosons of the 120-dim BiVectors
8x28 = 224 each with Lagrangian weight 1
for total of 224
and
Components of 28 Ghosts of the 120-dim BiVectors
8x28 = 224 each with Lagrangian weight 1
for total of 224
and
Components of ++quarter-Spinor Fermion Particles
8x8 = 64 each with Lagrangian weight 7/2
for a total of 32x7 = 224
and
Components of --quarter-Spinor Fermion AntiParticles
8x8 = 64 each with Lagrangian weight 7/2
for a total of 32x7 = 224

The Lagrangian weight equality between
Gauge Bosons plus Ghosts and Particles plus AntiParticles
gives UltraViolet Finiteness by a Subtle Version of SuperSymmetry

Cl(16) Physical Interpretation - half-Spinors
First-Generation Fermions

1 Scalar + 63 8-Vectors = 8 spacetime components of 8 fermion particles with the 1 Scalar being the time component of the neutrino.

alf-

1 Pseudo-Scalar + 63 8-Vectors = 8 spacetime components of 8 fermion anti-particles with the 1 Pseudo-Scalar being the time component of the anti-neutrino.

1 Scalar + 63 8-Vectors + 63 8-Vectors + 1 Pseudo-Scalar = 128
= half-Spinors of Cl(16)
128 = E8 / D8 Symmetric Space

E8 is made up of Bosonic D8 and half-Spinor 128
Lie Algebras are usually represented by Bosonic commutators
B**osonic D8 part of E8 is represented by commutator**s
and half-spinor 128 can be represented by commutators
but
half-Spinor 128 can also be represented by anti-commutators
and therefore **half-Spinor 128 can physically represent Fermions**.

> This property of E8 is inherited from F4, for which this property was shown by Pierre Ramond in hep-th/0112261, because 52-dim F4 lives in Cl(8) as 8-dim Vector spacetime + 28-dim BiVector Gauge Bosons + 16-dim Spinors and 8-Periodicity of Real Clifford Algebras shows that the tensor product Cl(8) x Cl(8) = Cl(16) so the F4 parts of Cl(8)xCl(8) = Cl(16) give E8 with the half-Spinor part of E8 inheriting from the Spinor parts of the F4s the property of being representable by Fermionic anti-commutators.

The **half-Spinor Fermions are physically not point particle**s
because as soon as they appear in Spacetime
the Tachyons of World-Line = String Theory of Cl(16) Fr3(O) TriVectors
form a particle-antiparticle cloud around the original Valence Particle so
that **they become Schwinger Sources**
whose Green's Function Propagator is determined by Bergman Kernel of Hua Domains of Gauge Forces.

Hua's calculations applied to Schwinger Sources allowed
Armand Wyler to calculate their properties with realistic results:

Calculation Results

Here is a summary of Cl(16) Physics model calculation results. Since ratios are calculated, values for one particle mass and one force strength are assumed. Quark masses are constituent masses. Most of the calculations are tree-level, so more detailed calculations might be even closer to observations.

Dark Energy : Dark Matter : Ordinary Matter = 0.75 : 0.21 : 0.04

Fermions as Schwinger Sources have geometry of Complex Bounded Domains with Kerr-Newman Black Hole structure size about 10^(-24) cm.

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) 220 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)	**125 GeV**	**(middle state) 195 GeV** **(high state) 250 GeV**

Particle/Force	Tree-Level	Higher-Order
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

Kobayashi-Maskawa parameters for W+ and W- processes are:

	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

The phase angle d13 is taken to be 1 radian.

Coleman-Mandula

Lagrangian has 8-dim Lorentz structure satisfying Coleman-Mandula because its Fermionic fundamental spinor representations are built with respect to spinor representations for 8-dim Spin(1,7) spacetime - see Steven Weinberg, “The Quantum Theory of Fields” Volume III

Chirality

Lagrangian is Chiral because
E8 contains Cl(16) half-spinors (64+64) for a Fermion Generation
but does not contain Cl(16) Mirror Fermion AntiGeneration half-spinors.

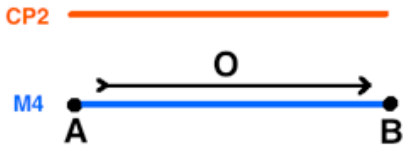
Fermion +half-spinor Particles with high enough velocity
are seen as left-handed.
Fermion -half-spinor AntiParticles with high enough velocity
are seen as right-handed.

3 Generations

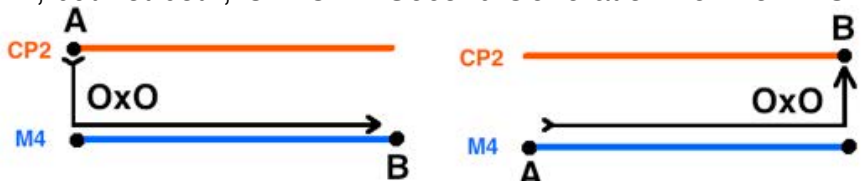
When 8-dim Octonionic Symmetry of Spacetime breaks down below Planck Energy to (4+4)-dim Quaternionic M4 x CP2 Kaluza-Klein with CP2 = SU(3) / SU(2) x U(1) the Higgs and Second and Third Generation Fermions emerge.

In Kaluza-Klein M4 x CP2 there are 3 possibilities for a Fermion represented by an Octonion O basis element to go from point A to point B:

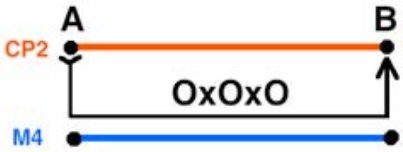
1 - A and B are both in M4: First Generation Fermion = Octonion O



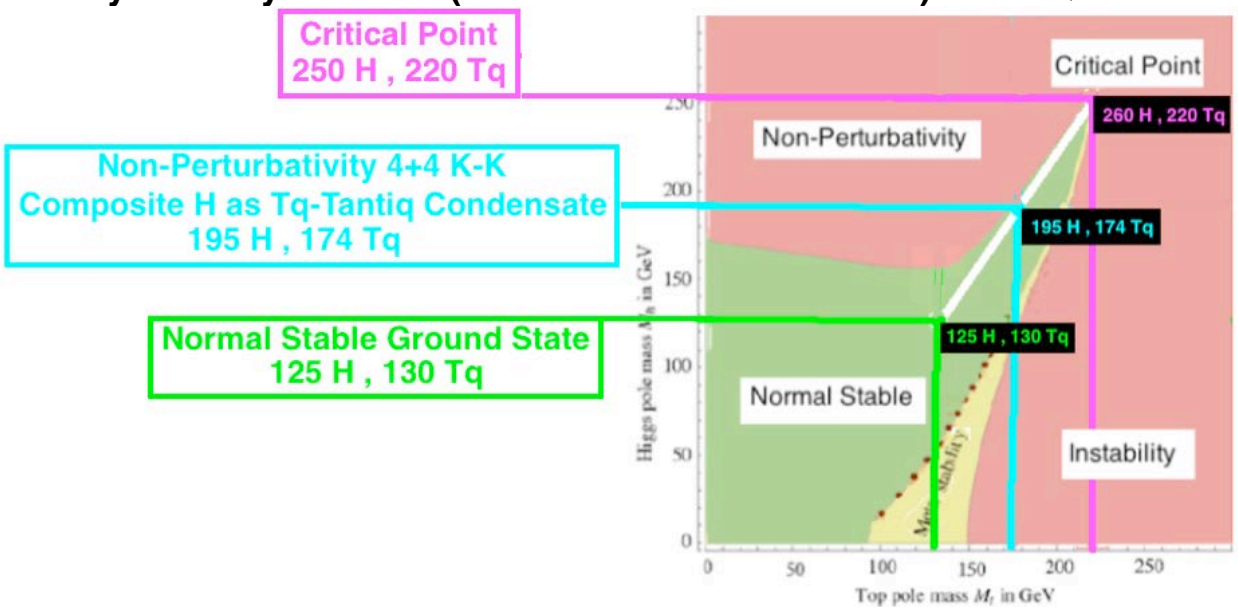
2 - Either A or B, but not both, is in CP2: Second Generation Fermion = OxO Pair



3 - Both A and B are in CP2: Third Generation Fermion = OxOxO Triple of Octonions



The HIggs and the Truth Quark form a Nambu-Jona-Lasinio System with 3 Mass States and the Higgs as Fermion Condensate dominated by the very massive (relative to other Fermions) Truth Quark



Spin-Statistics

Lagrangian obeys Spin-Statistics because the CP2 part of M4xCP2 Kaluza-Klein has index structure Euler number 2+1 = 3 and Atiyah-Singer index -1/8 which is not the net number of generations because CP2 has no spin structure but you can use a generalized spin structure (Hawking and Pope (Phys. Lett. 73B (1978) 42-44)) to get (for integral m) the generalized CP2 index n_R - n_L = (1/2) m (m+1)

Prior to Dimensional Reduction from Octionionic Spacetime:

m = 1, n_R - n_L = (1/2)x1x2 = 1 for 1 generation

After Reduction to Quaternionic 4+4 Kaluza-Klein:

m = 2, n_R - n_L = (1/2)x2x3 = 1 for 3 generations

Hawking and Pope say: "Generalized Spin Structures in Quantum Gravity ...what happens in CP2 … one could replace the electromagnetic field by a Yang-Mills field whose group G had a double covering G~. The fermion field would have to occur in representations which changed sign under the non-trivial element of the kernel of the projection … G~ -> G while the bosons would have to occur in representations which did not change sign …".

For E8 physics gauge bosons are in the 28+28=56-dim D4xD4 subalgebra. D4 = SO(8) is the Hawking-Pope G with double covering G~ = Spin(8). The 8 fermion particles / antiparticles are D4 half-spinors represented within E8 by anti-commutators and so do change sign
while the 28 gauge bosons are D4 adjoint represented within E8 by commutators and so do not change sign.

E8 Lagrangian inherits from F4 the property whereby its Spinor Part need not be written as Commutators but can also be written in terms of Fermionic AntiCommutators - see Pierre Ramond hep-th/0112261
- also, F4 lives in Cl(8) as Vectors + BiVectors + Spinors
and by 8-Periodicity Cl(16) = tensor product Cl(8) x Cl(8)
and E8 lives in Cl(16) as BiVectors + half-Spinors.

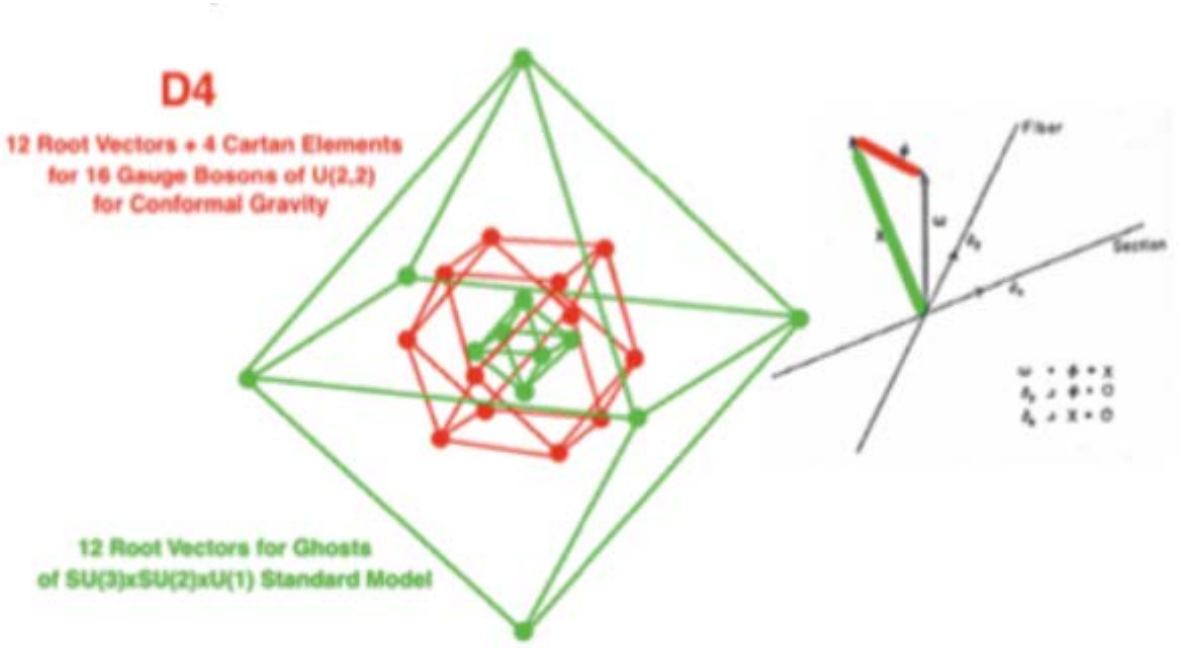
Cl(16) Physical Interpretation - BiVectors
Gauge Bosons and Ghosts and Unimodular Spacetime

120 BiVectors = D8 subalgebra of E8

D8 is made up of two copies of 28-dim D4 plus 64-dim A7+R

One D4 contains 16-dim U(2,2) of Conformal Gravity+Dark Energy

28-16 = 12-dim = Ghosts of SU(3)xSU(2)xU(1) of the Standard Model



Jean Thierry-Mieg in J. Math. Phys. 21 (1980) 2834-2838 said:
"... The ghost and the gauge field:
The single lines represent a local coordinate system
of a principal fiber bundle of base space-time.
The double lines are 1 forms.
The connection of the principle bundle w is assumed to be vertical.
Its contravariant components PHI and X are recognized, respectively,
as the Yang-Mills gauge field and the Faddeev-Popov ghost form ...".

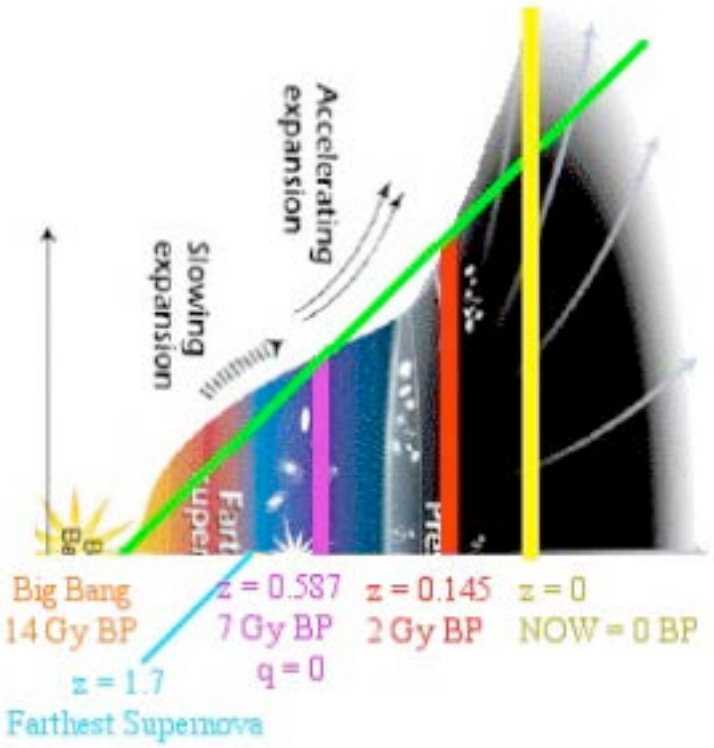
The ratio **Dark Energy : Dark Matter : Ordinary Matter**
comes from the structure of the Conformal Group SU(2,2) = Spin(2,4)
whose 15 generators are:

10 = 6 Lorentz + 4 Special Conformal for Dark Energy
4 = Translations for Primordial Black Hole Dark Matter
1 = Dilation for Higgs Ordinary Matter

giving a tree-level ratio of

10 : 4 : 1 = 0.667 : 0.267 : 0.067

Taking Account of differences between Radiation and Matter Eras
in the Evolution of Our Universe



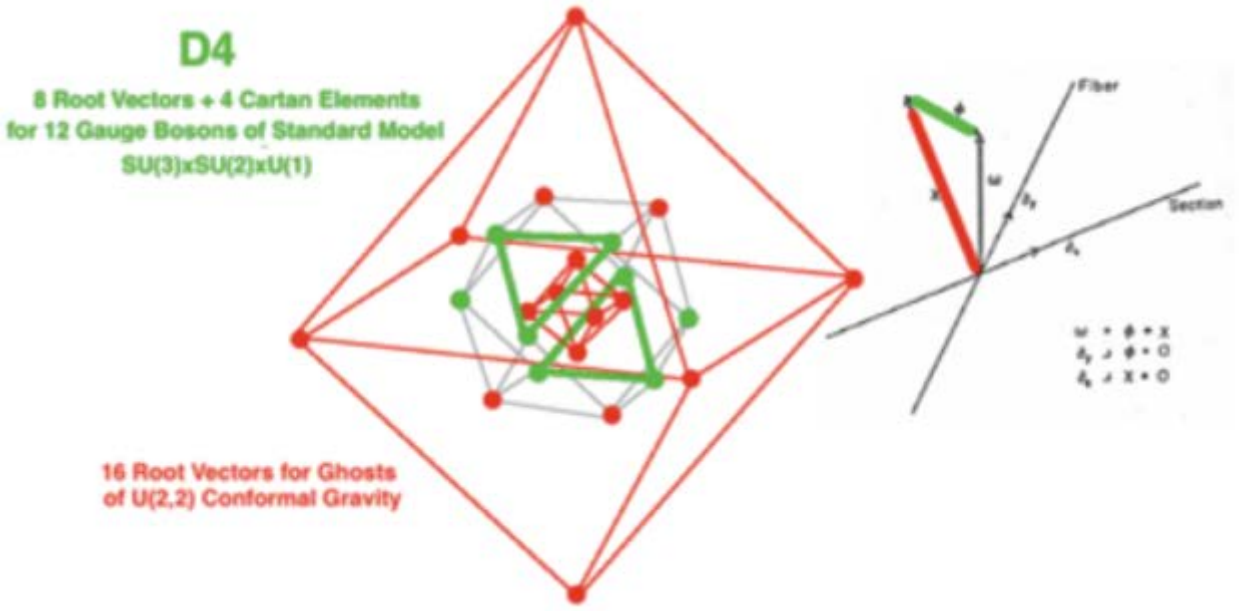
gives

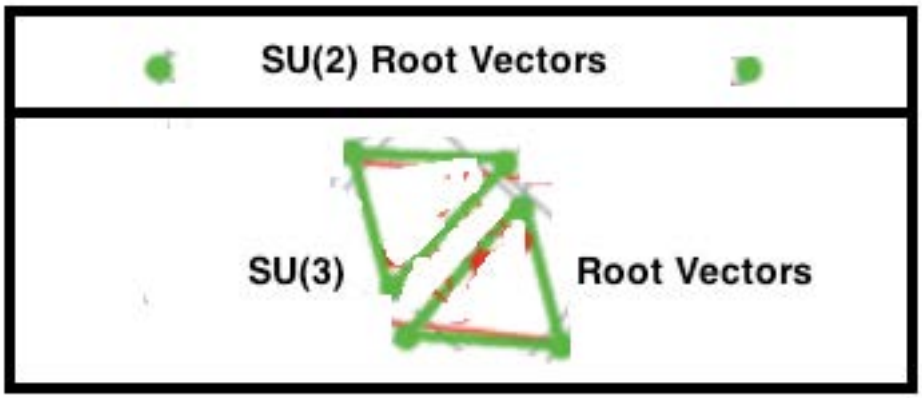
Dark Energy : Dark Matter : Ordinary Matter =

= 0.75 : 0.21 : 0.04

Other D4 contains SU(3) of Standard Model with SU(2)xU(1) from CP2

28 - 12(SU(3)xSU(2)xU(1)) = 16-dim = Ghosts of Gravity+Dark Energy





A7+R = D8 / D4 x D4 Symmetric Space

Rutwig Campoamor-Stursberg in Acta Physica Polonica B 41 (2010) 53-77 ,
“Contractions of Exceptional Lie Algebras and SemiDirect Products” , showed that
the E8 Maximal Contraction of E8 = semi-direct product H92 x A7+R
where H92 is (8+28+56 +1+ 56+28+8)-dim Heisenberg Creation/Annihilation Algebra
and E8 Max Contraction has graded structure 8 + 28 + 56 + 64 + 56+ 28 + 8

grade -3 = Creation of 1 fermion (tree-level massless neutrino)
with 8 SpaceTime Components for a total of 8 fermion component creators

grade -2 = Creation of 8+3+1 = 12 Ghosts for Standard Model
and 16 Conformal U(2,2) Bosons for MacDowell-Mansouri Gravity

grade -1 = Creation of 7 massive Dirac fermion
each with 8 SpaceTime Components for a total of 56 fermion component creators

grade 0 = A7+R = 63 +1= 64-dim
Creation/Annihilation of 8-dim SpaceTime of HyperVolume Elements
A7 = Unimodular Relativity
Bradonjic and Stachel in arXiv 1110.2159 said: "... in ... Unimodular relativity ... the metric tensor ... break[s up] ... into the conformal structure represented by a conformal metric ... with det = -1 and a ... volume element ... at each point of space-time ... [that]... may be the remnant, in the ... continuum limit, of a more fundamental discrete quantum structure of space-time itself ...".
Frampton, Ng, and Van Dam in J. Math. Phys. 33 (1992) 3881-3882 said:
"... Because of the existence of topologically nontrivial solutions, instantons, of the classical field equations associated with quantum chromodynamics (QCD), the quantized theory contains a dimensionless parameter ø ($0 < ø < 2\pi$) ... Since ø multiplies an expression odd in CP, QCD predicts violation of ... CP ... symmetry unless the phase ø takes one of the special values ... 0 (mod π) ... this fine tuning is the strong CP problem ... the quantum dynamics of ... unimodular gravity ... may lead to the relaxation of ø to ø = 0 (mod π) without the need ... for ... the axion ...".

grade 1 = Annihilation of 7 massive Dirac fermions
each with 8 SpaceTime Components for a total of 56 fermion component annihilators

grade 2 = Annihilation of 8+3+1 = 12 Bosons for Standard Model
and 16 Conformal U(2,2) Ghosts for MacDowell-Mansouri Gravity

grade 3 = Annilation of 1 fermion (tree-level massless neutrino)
with 8 SpaceTime Components for a total of 8 fermion component annihilators

Conformal Unimodular Relativity is consistent
with Conformal Gravity+Dark Energy

Cl(16) Physical Interpretation - TriVectors
World-Lines = Strings Bohm Quantum Potential
Schwinger Sources

560 TriVectors of Cl(16) represent 10 copies of 56-dim Fr3(O)

56-dim Fr3(O) = Freudenthal Algebra of Zorn vector-matrices

$$\begin{matrix} a & & & & d & S+ & V \\ & & & & S+^* & e & S- \\ & & & & V^* & S-^* & f \end{matrix}$$

$$\begin{matrix} d' & S'+^* & V'^* \\ S'+ & e' & S'-^* \\ V' & S'- & f' \end{matrix} \qquad b$$

where a, b, d, e, and f are real numbers; **S+**, **V**, **S-**, **S'+**, **V'**, and **S'-** are Octonions; and * denotes conjugation.

$$\begin{matrix} d & S+ & V \\ S+^* & e & S- \\ V^* & S-^* & f \end{matrix}$$

is 27-dim J3(O) = 3x3 Hermitian Octonion Matrices whose traceless part is 26-dim J3(O)o that describes

26D String Theory with Strings = World-Lines and

V = 8-dim Spacetime
the 8-real-dim space RP1 x S7 that is the Shilov Boundary of the 16-real-dim IV(8,2) Bounded Domain (tube type) of the BDI Symmetric Space Spin(10) / Spin(8) x U(1)

S+ = 8 +half-Spinor Fermion Particles
the real part RP1 x S7 of the Complex Shilov Boundary S of the 32-real-dim V non-tube type.bounded Domain (CxO)P2 of the EIII Symmetric Space E6 / Spin(10) x U(1).

S- = 8 - half-Spinor Fermion AntiParticles
RP1 x S7 in the Complex part of the Shilov Boundary S of the 32-real-dim V non-tube type bounded Domain (CxO)P2 of the EIII Symmetric Space E6 / Spin(10) x U(1)

Fr3(O) has two copies of J3(O)
and is a Complexification of J3(O)o and of 26D String Theory
so
Fr3(O) is the structural basis for E8 World-Lines = Strings Theory

Strings = World-Lines of Particles interact by entire fine-grained histories.

Andrew Gray (quant-ph/9712037v2) said:
"... A new formulation of quantum mechanics ... assign[s] ... probabilities ... to entire fine-grained histories ... [It] is fully relativistic and applicable to multi-particle systems ... [and]... makes the same experimental predictions as quantum field theory ... consider space and time cut up into small volume elements ... and then take the limit as ... volume ... ---> 0 ... get the final amplitude ... by considering all possible distributions at a time t earlier ... the interference factor ... is a measure of how much interference between the different possible histories that contain the distribution of interest there is at each time ... This result is the ... Feynman amplitude squared times the product of all the interference factors ...".

Luis E. Ibanez and Angel M. Uranga in "String Theory and Particle Physics" said:
"... As a string evolves in time, it sweeps out a two-dimensional surface in spacetime, known as the worldsheet, which is the analog of the ... worldline of a point particle ... for the bosonic string theory ... the classical string action is the total area spanned by the worldsheet ... This is the ... Nambu– Goto action ...".
The Gray Fine-Grained History Quantum Theory with World-Line = String is equivalent

to the Nambu-Goto action of 26D String Theory. Ibanez and Uranga also said:
"... The string groundstate corresponds to a 26d spacetime tachyonic scalar field T(x). This tachyon ... is ... unstable ...
The massless two-index tensor splits into irreducible representations of SO(24) ...
Its trace corresponds to a scalar field, the dilaton ϕ, whose vev fixes the string interaction coupling constant gs ...
the antisymmetric part is the 26d 2-form field BMN ...
The symmetric traceless part is the 26d ... GMN ...".
Closed string tachyons localized at orbifolds of fermions produce virtual clouds of particles / antiparticles that dress fermions as Schwinger Sources
The antisymmetric 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 symmetric traceless part is the Quantum Bohmion.

Cl(1,25) AQFT
Quantum Consciousness

The 560 TriVectors of Cl(16) are 10 copies of 56 = Fr3(O)
Fr3(O) is Complexification of J3(O)
V = Fr3(O) Spacetime is a Superposition of 8 E8 8-dim Spacetime Lattices
(7 being Integral Domains)
Each Fermion Type propagates within its own E8 Lattice within the Superposition which accounts for 8 of the 10 copies of Fr3(O)
The other 2 copies of Fr3(O) correspond to the 2 diagonal elements d and f which describe the 10-dim R(1,9) space that is Conformal over 8-dim R(0,8) space which has Clifford Algebra Cl(0,8) = Cl(1,7) of RP1 x S7

The two copies of J3(O)o within each Fr3(O) correspond to Real and Imaginary 26D String Theories where
the Real Part represents the Shilov Boundary
of the Bulk Complex Bounded Domain.

The Clifford Algebra of 26D String Theory is Cl(1,25)

Cl(1,25) = M(2,Cl(0,24)) = 2x2 matrices with entries in Cl(0,24) =
= Conformal Structure over Cl(0,24)

Cl(0,24) = Cl(0,8) x Cl(0,16)

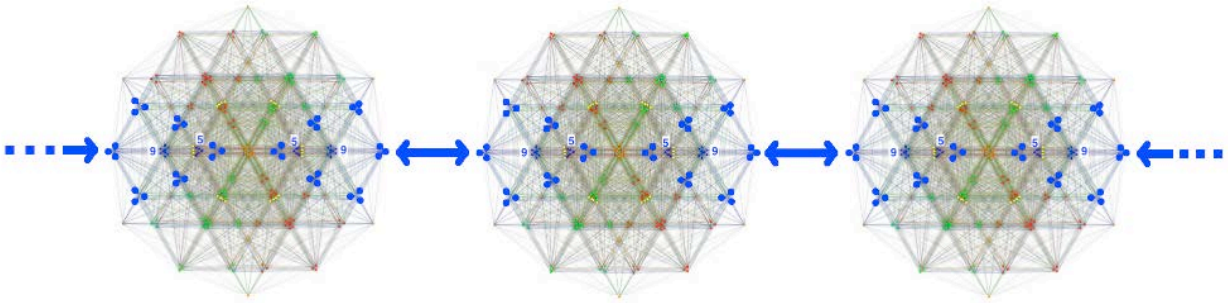
Cl(0,16) has 16-dim Barnes-Wall Lattice Structure

Cl(0,8) has 8-dim E8 Lattice Structure
so
Cl(0,24) has 24-dim Leech Lattice Structure
and
Cl(1,25) = M(2, Cl(0,24)) has Lorentz Leech Lattice Structure
with Monster Group Symmetry of each Lattice Cell

Since all matrix entries are Cl(0,24) = tensor product of 3 copies of Cl(0,8)
8-Periodicity allows formation of the tensor products of copies of Cl(1,25)

One Cl(1,25) containing one Cl(0,16) containing one E8 gives a Lagrangian description of one local spacetime neighborhood.

To get a realistic global spacetime structure, take the tensor product Cl(1,25) x ... x Cl(1,25) with all E8 local 8-dim Octonionic spacetimes consistently aligned as described by 64-dim D8 / D4xD4 (this visualization uses hexagonal 2D projection of the 240 E8 root vectors)



Completion of the Union of all Tensor Products of the form Cl(1,25) x ...(N times tensor product)... x Cl(1,25) gives an Algebraic Quantum Field Theory (AQFT)

For N = 2^8 = 256 the copies of Cl(1,25) are on the 256 vertices of the 8-dim HyperCube

For N = 2^16 = 65,536 = 4^8 the copies of Cl(1,25) fill in the 8-dim HyperCube as described by William Gilbert's web page: "... The n-bit reflected binary Gray code will describe a path on the edges of an n- dimensional cube that can be used as the initial stage of a Hilbert curve that will fill an n-dimensional cube. ...".

The vertices of the Hilbert curve are at the centers
of the 2^8 sub-8-HyperCubes whose edge lengths
are 1/2 of the edge lengths of the original 8-dim HyperCube

As N grows, the copies of Cl(1,25) continue to fill the 8-dim HyperCube of E8 SpaceTime using higher Hilbert curve stages from the 8-bit reflected binary Gray code subdividing the initial 8-dim HyperCube into more and more sub-HyperCubes.

If edges of sub-HyperCubes, equal to the distance between adjacent copies of Cl(1,25), remain constantly at the Planck Length, then the full 8-dim HyperCube of our Universe expands as N grows to 2^16 and beyond similarly to the way shown by this 3-HyperCube example for N = 2^3, 4^3, 8^3 from Wiliam Gilbert's web page:

The Union of all Cl(1,25) tensor products is the Union of all subdivided 8-HyperCubes and their Completion is a huge superposition of 8-HyperCube Continuous Volumes which Completion belongs to the Third Grothendieck Universe

and

is an AQFT that is a Real Clifford Algebra generalization of the Complex Clifford Algebra Fock Space Hyperfinite II1 von Neumann factor Algebra

The Third Grothendieck Universe AQFT contains
within each Cl(1,25)
a realistic E8 Lagrangian within Cl(16)

and

contains

10 copies of 56-dim Fr3(O)
are 560 TriVectors of Cl(16)
to describe a World-Lines = Strings String Theory
with Bohm Quantum Potential
arising from Nambu-Goto Action

Similarity of the Bohmion carrier of the Bohm Quantum Potential to the spin 2 Graviton accounts for the Bohmion's ability to support Penrose Consciousness with Superposition Separation Energy Difference G m^2 / a where, for a Human Brain,

m = mass of electron and a = 1 nanometer in Tubulin Dimer

"... Bohm's Quantum Potential can be viewed as
an internal energy of a quantum system ..."
according to Dennis, de Gosson, and Hiley (arXiv 1412.5133)
and
Bohm Quantum Potential inherits Sarfatti Back-Reaction
from its similarity to General Relativity

Peter R. Holland says in "The Quantum Theory of Motion":"... 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 ...".

Penrose-Hameroff-type 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 to 10^19 Tubulin Dimers described by a large Real Clifford Algebra.

Paola Zizzi in gr-qc/0007006 describes the Octonionic Inflation Era of Our Universe as a Quantum Consciousness Superpositon of States ending with Self-Decoherence after 64 doublings of Octonionic Inflation, at which time Our Universe is “... 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]. ..".

64 doublings to 2^64 qubits corresponds to the Clifford algebra
Cl(64) = Cl(8x8) = Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8)
By the periodicity-8 theorem of Real Clifford algebras, Cl(64) is the smallest Real Clifford algebra for which we can reflexively identify each component Cl(8) with a basis vector in the Cl(8) vector space. This reflexive identification causes our universe to decohere at N = 2^64 = 10^19.

The End of Inflation time was at about 10^(-34) sec = 2^64 Tplanck
and the size of our Universe was then about 10^(-24) cm
which is about the size of a Schwinger Source Kerr-Newman Cloud.

What about information in the Microtubules of Human Consciousness ?

The information in one Microtubule is based on Cl(16)
which is contained in the Cl(1,25) of 26D String Theory E8 Physics

How does this give rise to Penrose-Hameroff Quantum Consciousness ?

Consider the Superposition of States State 0 and State 1 involving one Tubulin Dimer with Conformation Electron mass m and State1 / State 0 position separation a .

The Superposition Separation Energy Difference is the internal energy

$$E\_ssediff = G\ m^2 / a$$

that can be seen as the energy of 26D String Theory Bohmions
which physically represent the Bohm Quantum Potential internal energy.

For a given Tubulin Dimer a = 1 nanometer = 10^(-7) cm so that
T = h / E_electron = (Compton / Schwarzschild) (a / c) = 10^26 sec = 10^19 years

Now consider the case of N Tubulin Dimers with total mass Nm in Coherent Superposition connected by the Bohm Quantum Potential Force that does not fall off with distance

$$E\_ssediff = G\ (Nm)^2 / a$$

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

$$E\_N = G\ (Nm)^2 / L = G\ (Nm)^2 / (a\ N^{(1/3)}) = N^{(5/3)}\ Gm^2 / a = N^{(5/3)}\ E\_ssediff$$

The decoherence time for the system of N Tubulin Electrons is

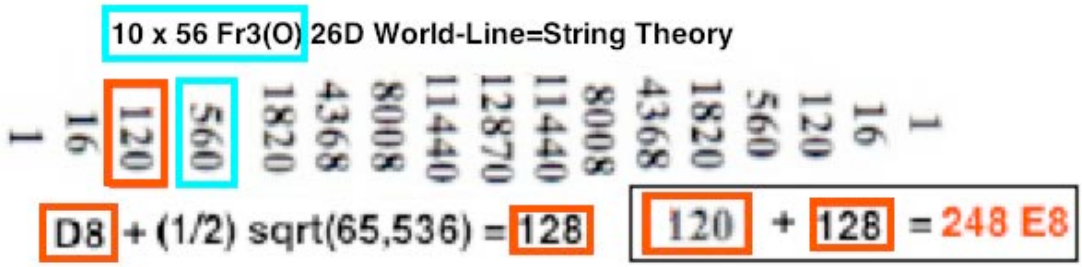
$$T\_N = h / E\_N = h / N^{(5/3)}\ E\_ssediff = N^{(-5/3)}\ 10^{26}\ sec$$

so we have the following rough approximate Decoherence Times T_N

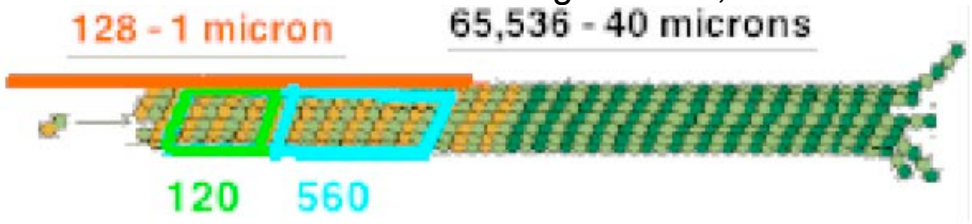
Number of Involved Tubulin Dimers	Time T_N	
10^(11+9) = 10^20	10^(-33 + 26) = 10^(-7) sec	10^11 neurons x 10^9 TD / neuron 10^20 Tubulin Dimers in Human Brain
10^16	10^(-27 + 26) = 10^(-1) sec - 10 Hz Human Alpha EEG is 8 to 13 Hz Fundamental Schumann Resonance is 7.8 Hz	

Time of Traverse by a String World-Line Quantum Bohmion of a Quantum Consciousness Hamiltonian Circuit of 10^16 TD separated from nearest neighbors by 10 nm is 10^16 x 10 nm / c = (10^16 x 10^(-6)) cm / c = 10^10 cm / c = 0.3 sec

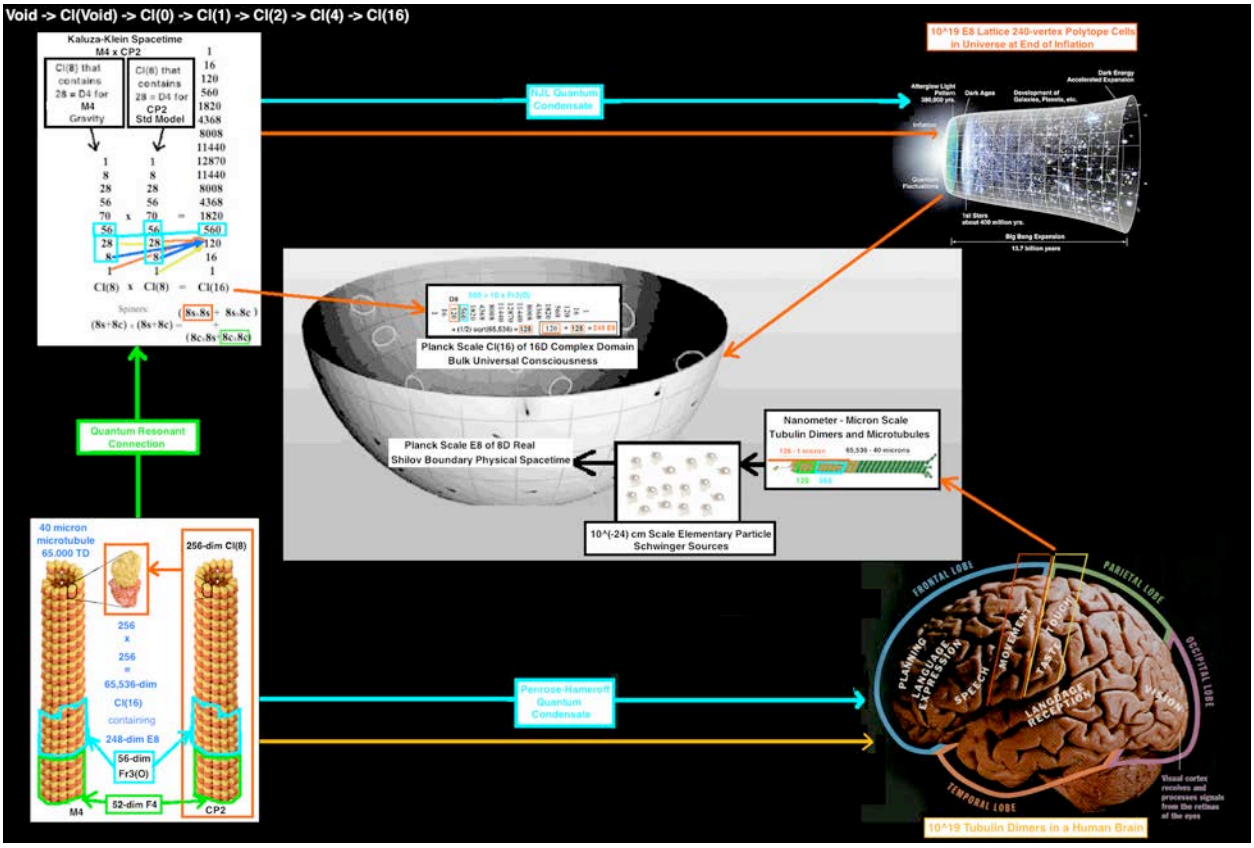
Cl(16) has 65,536 elements.



Human Brain Microtubules 40 microns long have 65,536 Tubulin Dimers



so can have Bohm Quantum Resonance with Cl(16) Spacetime cells



so that at any and all Times the State of Consciousness of a Human
is in exact resonant correspondence with
a subset of the cells of E8 Classical Lagrangian Spacetime
Therefore
E8 Classical Lagrangian Spacetime Nis effectively the Spirit World
in which the Human States of Consciousness = Souls exist.
After the death of the Human Physical Body
the Spirit World interactions with its Soul are no longer constrained
by Physical World interactions with its Body
so that the Spirit World can harmonize the individual Soul
with the collective Universal Soul.
William KIngdon Clifford, who invented Real Clifford Algebras, called them
“mind-stuff”, saying: “...

When matter takes the complex form of a living human brain,
the corresponding mind-stuff
takes the form of a human consciousness ...”.

Appendix: History of Real Clifford Algebras

Real Clifford Algebras have 8-Periodicity whereby

Cl(8N) = Cl(8) x ...(N times tensor product)... Cl(8)

so that Cl(8) = M(16,R) = 16x16 Real Matrices is their basic building block.

Ancient (over 50,000 years ago) African IFA Divination
has the structure of Cl(8) (dimension 2^8 = 256 = 16x16)

National Geographic Genographic Y-DNA project showed that
around 50,000 to 40,000 years ago humans began to leave Africa:

M96 went up the Nile River to Giza
Two Giza Pyramids and Sphinx represent Cl(8)xCl(8) and Cl(16)

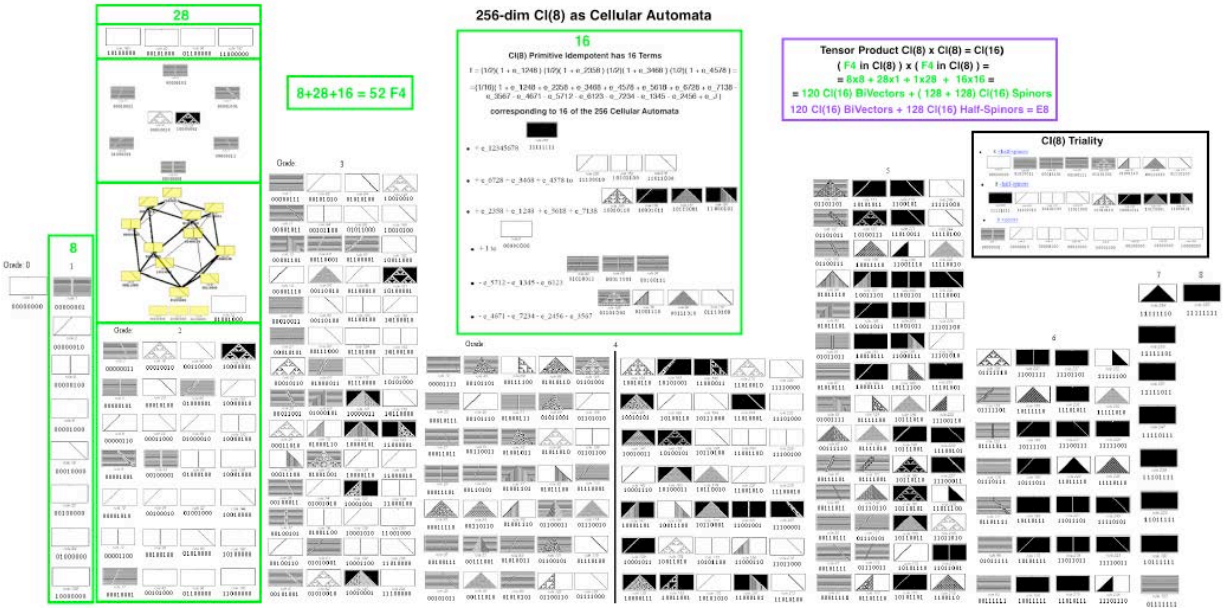
M89 went across the Red Sea to the Persian Gulf (then fertile land Eden)
Torah has 613 = 248 + 365 commandments
248 E8 is in Cl(16) - 365 center of 27x27 Magic Square of Fr3(O) in C(16)

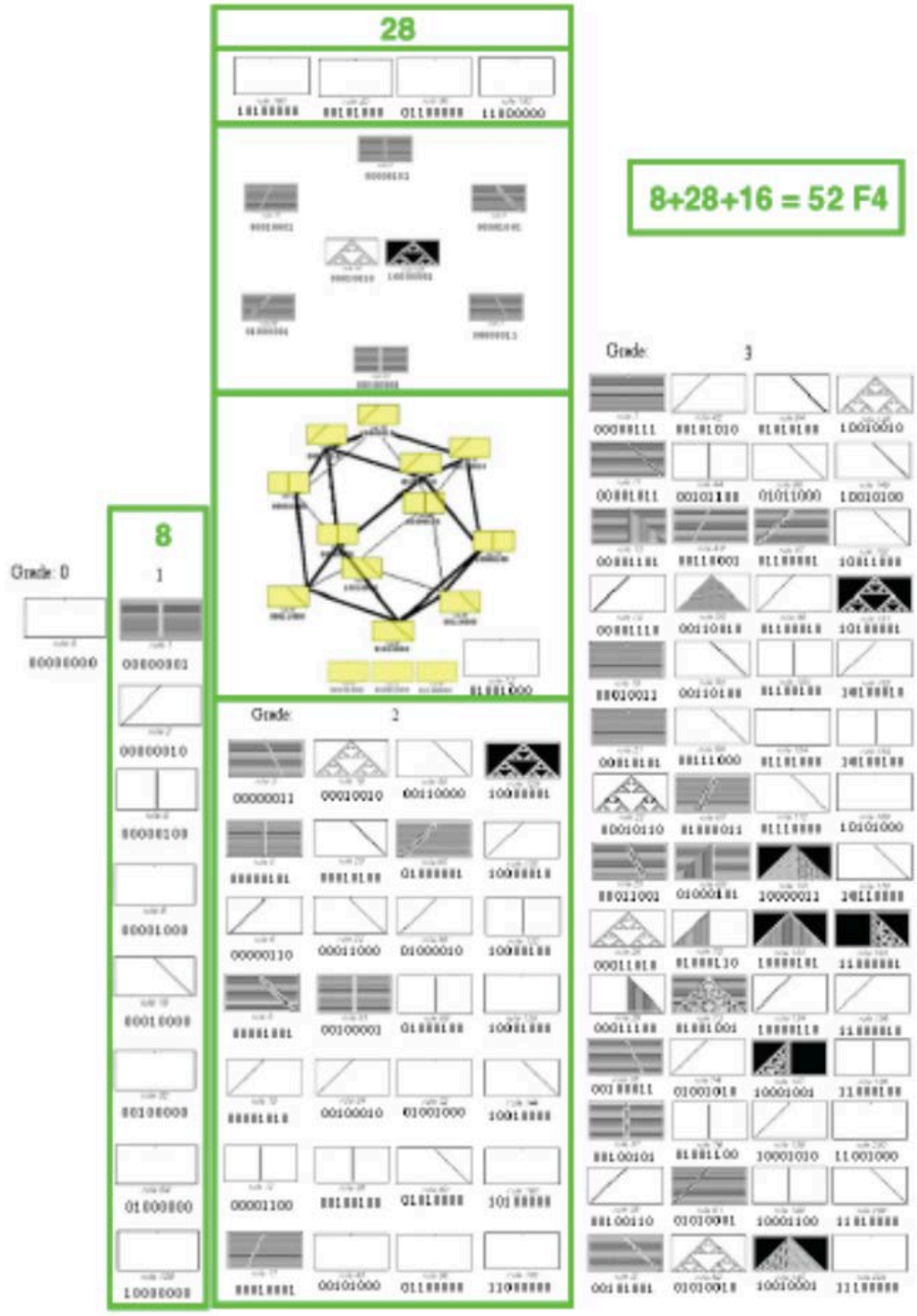
M174 went around the Asian Coast to the Sunda Shelf (then fertile land)
and on to Japan and Tibet
Angkor Temples Mt. Meru Binomial Triangle of Clifford Agebra Gradings
Rg Veda = 24 + 24 + 64 + 64 = 64 = 240 Root Vectors of E8 in Cl(16)

Ron Eglash (in his book "African Fractals" (Rutgers 1999) and on his web site) says: "... **a historical path for base-2 calculation ... begins with African divination**, runs through the geomancy of European alchemists, and is finally transformed into binary calculation, where it is now applied in every digital circuit ...".

Raymond Aschheim (email May 2015) said, about Cellular Automata (CA): "... An elementary CA is defined by the next value (either 0 or 1) for a cell, depending on its ... value, and the ... value of it[s] left and of it[s] right neighbor cell (it is one dimensional, and involve only the first neighbors, and the cell itself) ... So the next value depends [on] 3 bits ... eight possible combination of three bits, and for each ... combination... the next value is either zero or one. So **the[re] are 256 ... CAs** ...".

The 256 Elementary Cellular Automata correspond to the 256-dim Cl(8) Clifford Algebra with graded structure 1 8 28 56 (35+35=70) 56 28 8 1




28
8+28+16 = 52 F4
Grade: 0
8
1
Grade: 2
Grade: 3

256-dim Cl(8) as Cellular Automata

16

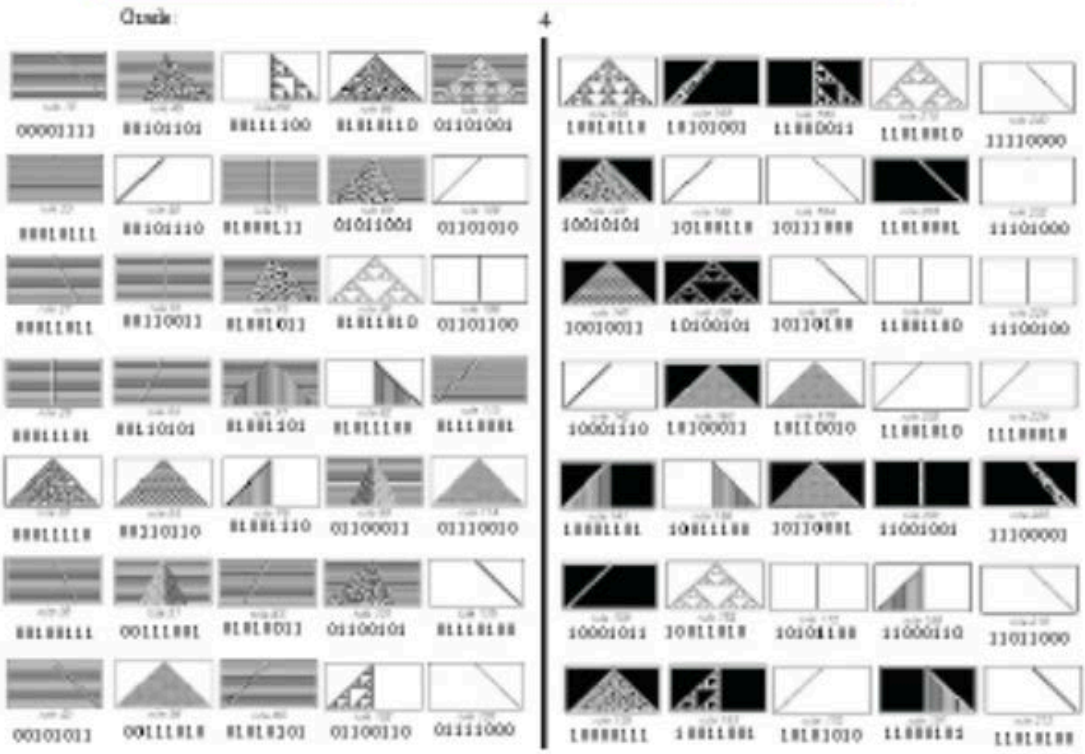
Cl(8) Primitive Idempotent has 16 Terms

f = (1/2)(1 + e_1248) (1/2)(1 + e_2358) (1/2)(1 + e_3468) (1/2)(1 + e_4578) =

=(1/16)(1 + e_1248 + e_2358 + e_3468 + e_4578 + e_5618 + e_6728 + e_7138 - e_3567 - e_4671 - e_5712 - e_6123 - e_7234 - e_1345 - e_2456 + e_J)

corresponding to 16 of the 256 Cellular Automata

- + e_12345678 11111111
- + e_6728 + e_3468 + e_4578 to 11100010 10101100 11011000
- + e_2358 + e_1248 + e_5618 + e_7138 10000110 10011011 10110001 11000101
- + 1 to 00000000
- - e_5712 - e_1345 - e_6123 01010011 00001100 01100111
- - e_4671 - e_7234 - e_2456 - e_3567 01101001 01001110 00111010 01110100



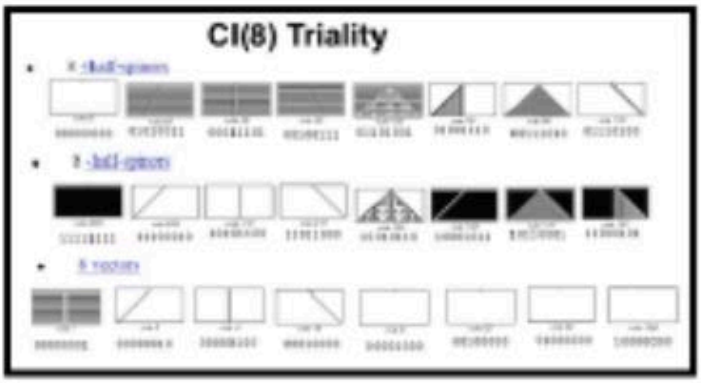
Tensor Product Cl(8) x Cl(8) = Cl(16)

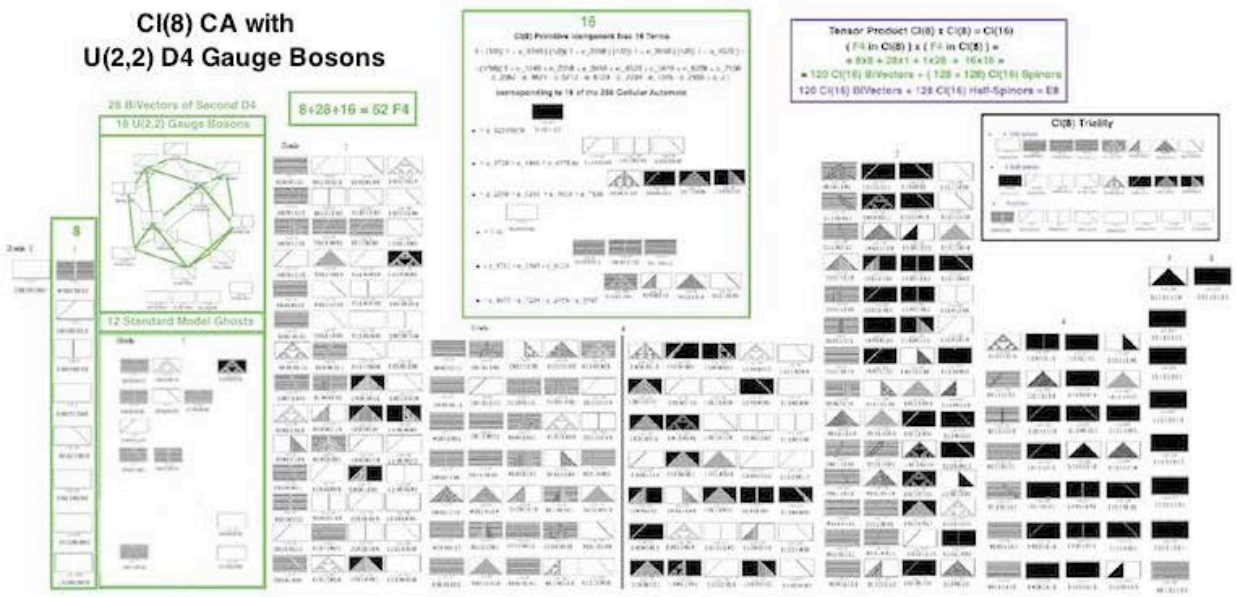
(F4 in Cl(8)) x (F4 in Cl(8)) =

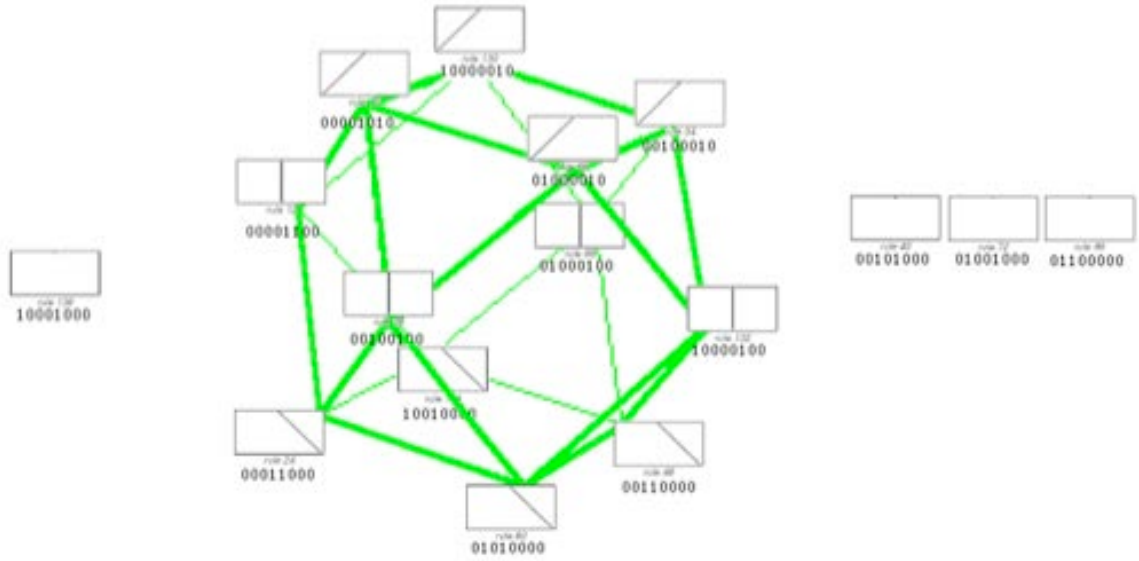
= 8x8 + 28x1 + 1x28 + 16x16 =

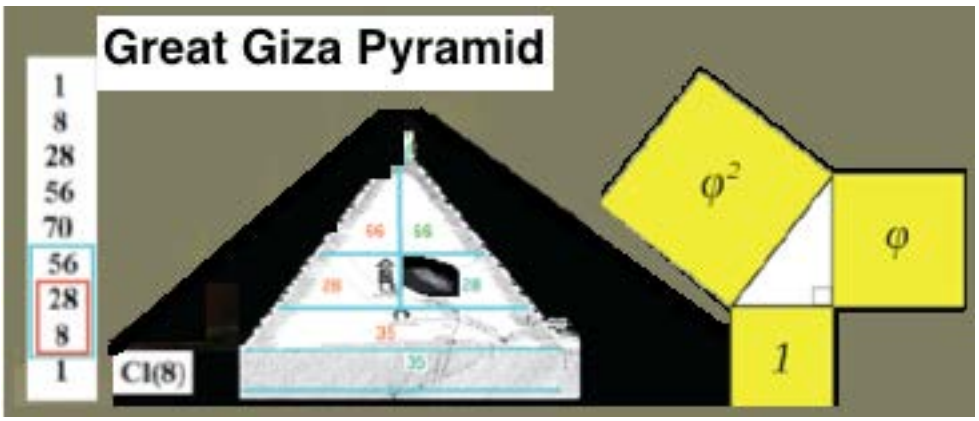
= 120 Cl(16) BiVectors + (128 + 128) Cl(16) Spinors

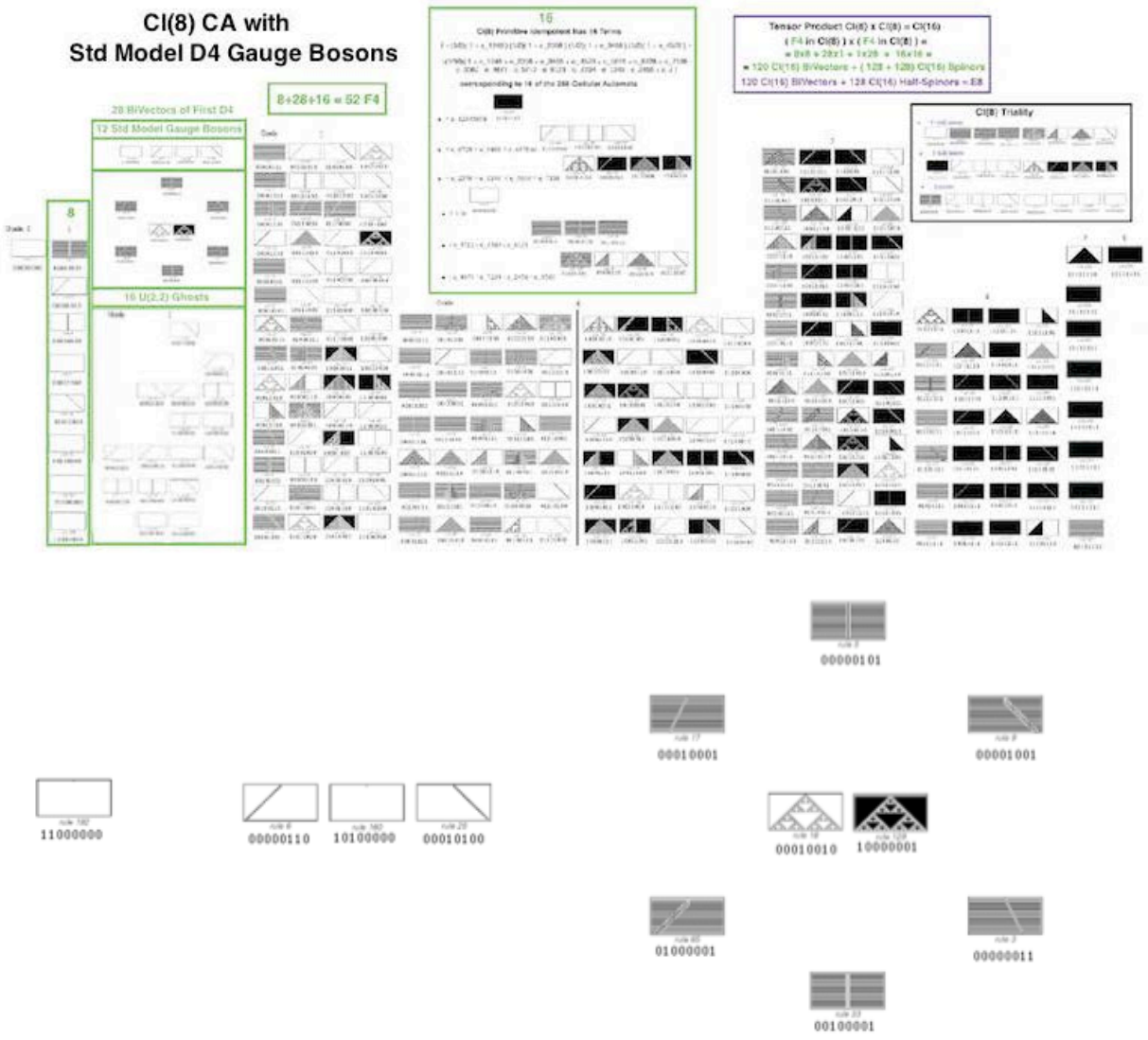
120 Cl(16) BiVectors + 128 Cl(16) Half-Spinors = E8

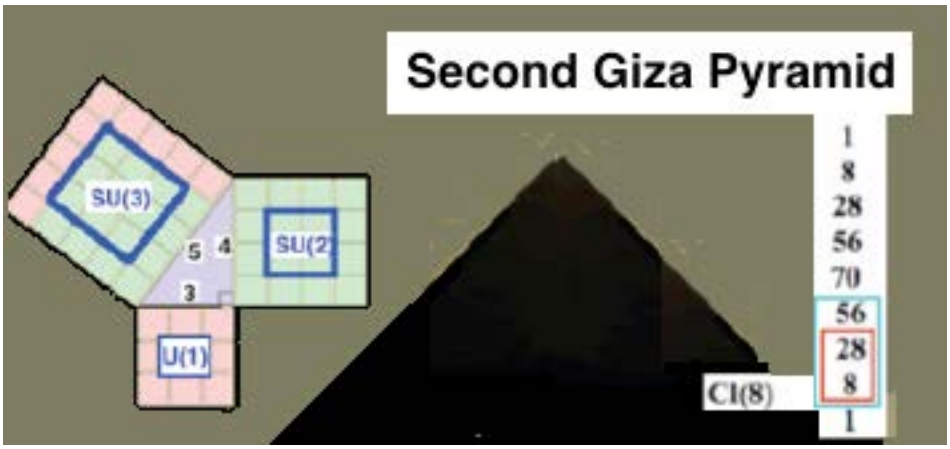



Cl(8) CA with
U(2,2) D4 Gauge Bosons
28 BiVectors of Second D4
8+28+16 = 62 F4
16 U(2,2) Gauge Bosons
12 Standard Model Ghosts
8
Cl(8) Triality

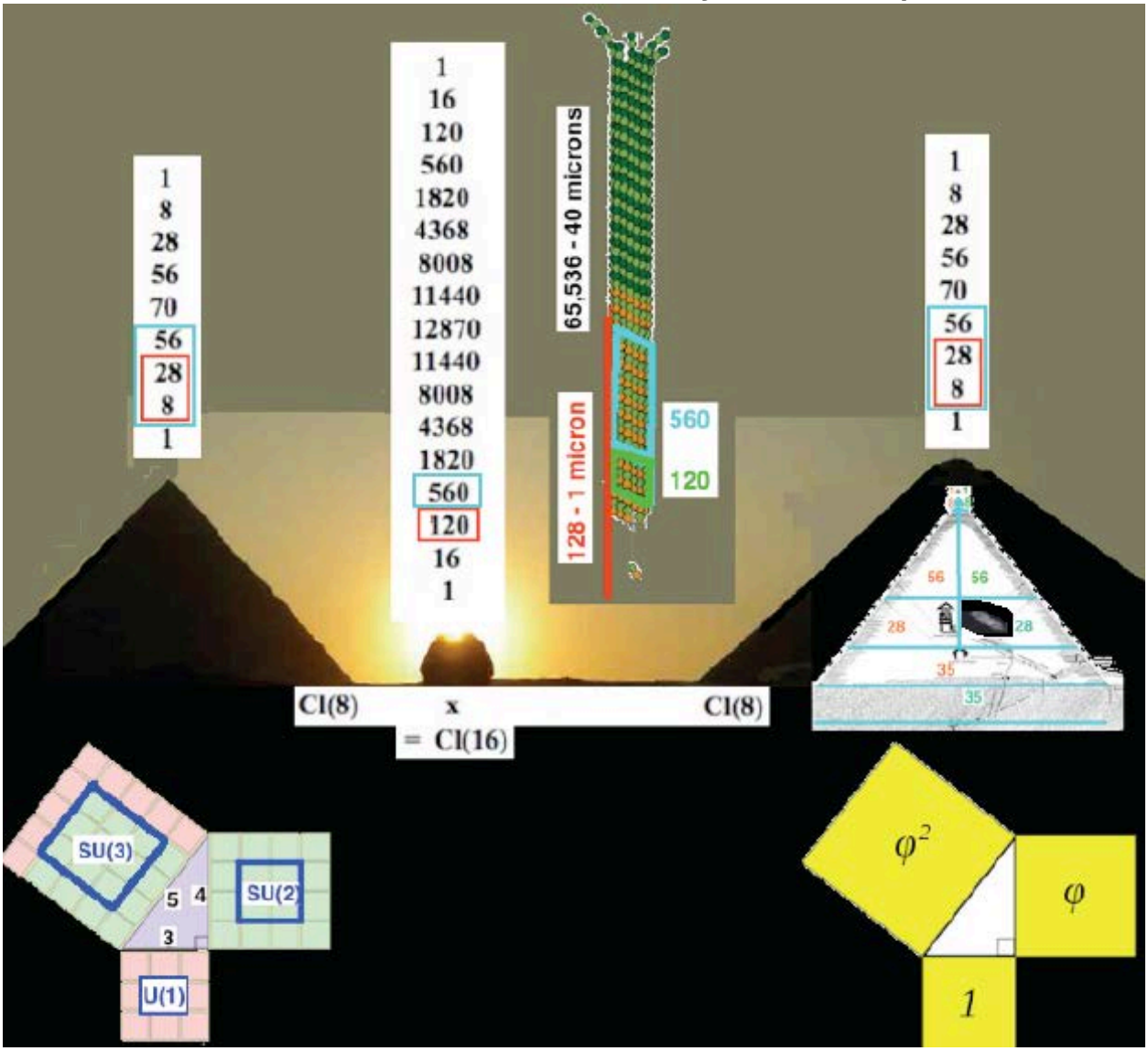

10000010
00001010
01000010
00001100
01000100
00100100
10000100
10001000
00011000
00110000
01010000
00101000
01001000
01100000


Great Giza Pyramid
1
8
28
56
70
56
28
8
1
Cl(8)
φ²
φ
1


Cl(8) CA with
Std Model D4 Gauge Bosons
8+28+16 = 52 F4
28 BiVectors of First D4
12 Std Model Gauge Bosons
16 U(2,2) Ghosts
Cl(8) Triality
00000101
00010001
00001001
11000000
00000110
10100000
00010100
00010010
10000001
01000001
00000011
00100001


Second Giza Pyramid
SU(3)
SU(2)
U(1)
5
4
3
1
8
28
56
70
56
28
8
1
Cl(8)

Here are some details about the Giza Pyramids and Sphinx:



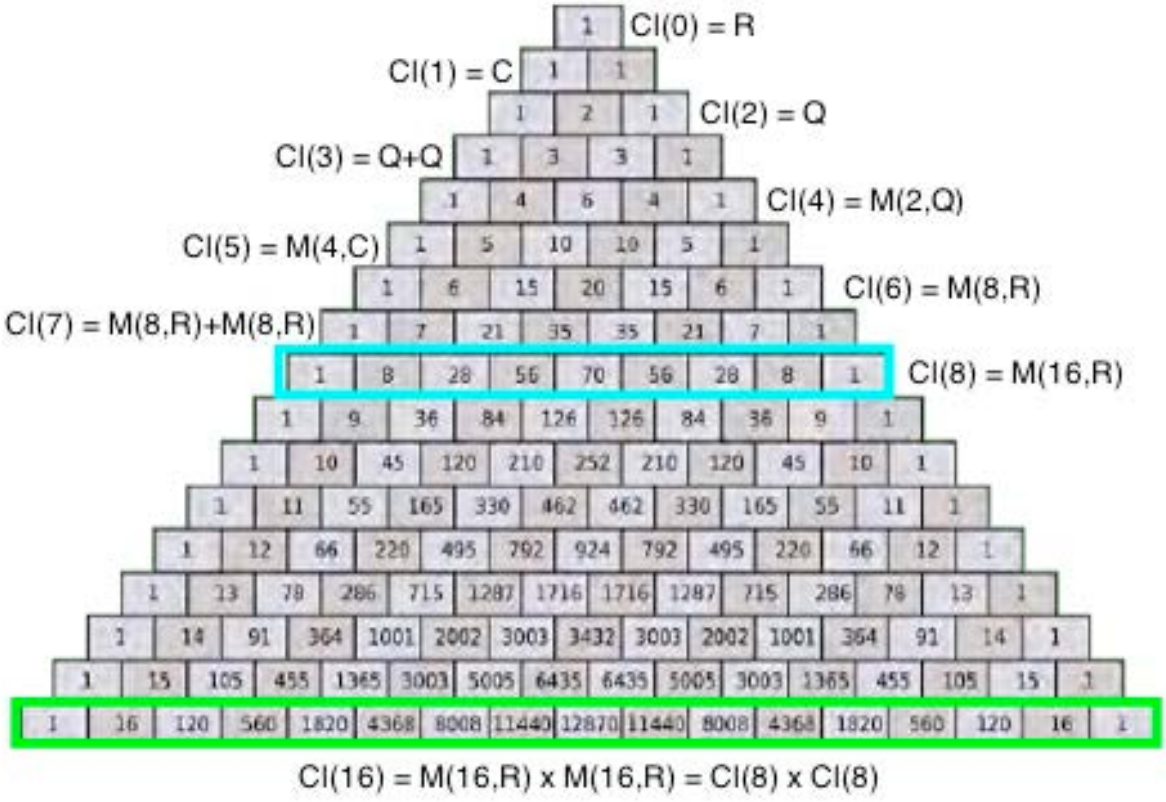
The **Great Pyramid** (right in image above) has

203 layers + 35 underground + 1+8+8+1 capstone = 256 = Cl(8)

It has a Grand Gallery for Physical World and a Grand Void for Spirit World
Its slope is Golden Ratio Triangle (H4 in E8 has Golden Ratio structure)
The Golden Ratio governs the Gravitational Spiral of Galaxies
The **Second Pyramid** (left in image above) has slope of 3-4-5 Triangle
corresponding to U(1) - SU(2) - SU(3) Standard Model Gauge Groups
The **Sphinx** represents Cl(16) = Cl(8) x Cl(8) = Great x Second Pyramids
and shows correspondence between 65,536-dim Cl(16) Physics cell
and 65,536 Tubulins of maximal Microtubule Quantum Consciousness cell

Here are some details about Mt. Meru Binomial Graded Structure and the Rg Veda:

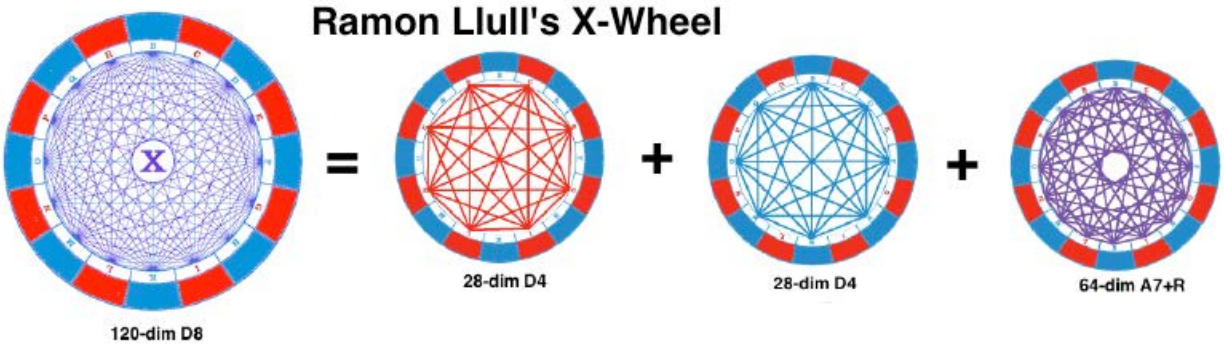
Angkor Temples contain representations of Mt. Meru which corresponds to the Binomial Triangle and the Grading Structure of Clifford Algebras



Rg Veda in Sanskrit is the oldest human document:

24 First Richa Syllables + 24 First Richa Gaps = D4sm + D4gde (purple)
8x8 = 64 Last-8 Syllables of Last 8 lines = D8 / D4sm x D4gde (blue)
8x8 = 64 (red) plus 8x8 = 64 (green) give 128 = E8 /D8 = Fermions
Middle-8 Syllables of Last 8 lines plus First-8 Syllables of Last 8 Lines
24+24+64+64+64 = 240 Root Vectors of E8 in Cl(16)

Here are some details about Ramon Llull's X-wheel and D8:
Around 1300 AD Ramon Llull constructed his X-wheel
with 16 vertices (Vectors of Cl(16) and D8)
and 120 diameter lines (BiVectors of C(16) and D8)



X-wheel D8 is made up of two copies of 28-dim D4 plus 64-dim A7+R
A7+R = D8 / D4 x D4 Symmetric Space
One D4 contains D3 = Spin(2,4) of Conformal Gravity+Dark Energy
Other D4 contains SU(3) of Standard Model with SU(2)xU(1) from CP2

Here are some details about Clifford's 1878 ideas
bringing Real Clifford Algebras to the Europeans:
William KIngdon Clifford (1845 - 1879), according to Wikipedia - (1878, "On the Nature of Things-in-Themselves", Mind, Vol. 3, No. 9, pp. 57–67), said:
“... That element of which ... even the simplest feeling is a complex, I shall call **Mind-stuff**. A moving molecule of inorganic matter does not possess mind or consciousness ; but it possesses a small piece of mind-stuff. ... When molecules are ... combined together ... **the elements of mind-stuff** which go along with them ... combine ... to form the ... beginnings of Sentience. When the molecules are so combined as to form the brain and nervous system ... the corresponding elements of mind-stuff are so combined as to form some kind of consciousness ... changes in the complex which take place at the same time get so linked together that the repetition of one implies the repetition of the other. When matter takes the complex form of a living human brain,

the corresponding mind-stuff takes the form of a human consciousness ...”.

Here is a table of Real Clifford Algebras Cl(p,q)
as Matrices of Reals, Complex Numbers, or Quaternions
for spaces with signature (p,q)

The p=0 line is Cl(0,q) = Cl(q)