# Overture to Beethoven's Grosse Fugue (Opus 133) is an Outline of the E8 Lie Algebra

Frank Dodd (Tony) Smith, Jr. - 2019

**Abstract**

The Overture to Beethoven's Grosse Fugue (Opus 133) is an Outline of E8 Lie Algebra.
Visualizations of Beethoven's Grosse Fugue (Opus 133) by Stephen Malinowski
show details of the correspondences between the Grosse Fugue and E8.

Since Beethoven wrote the Grosse Fugue in 1825, two years before his death in 1827,
and
since the E8 Lie Algebra and the Cl(16) Real Clifford Algebra in which it lives
were not known to the mathematics community until
Marius Sophus Lie and Wilhelm Killing invented Lie Algebras in the 1870s and 1880s
and William Kingdon Clifford invented Clifford Algebras in 1878
it was not possible for Beethoven to have used the mathematics knowledge of his day in writing the Grosse Fugue
but
the correspondences between the Grosse Fugue Oveture and the E8 Lie Algebra
are far too extensive to be mere coincidence.

A possible explanation could be that (Appendix on Quantum Consciousness - page 9)
our conscious brains have structure similar to the structure of E8
so that when Beethoven was composing, looking deep inside his conscious brain
to "hear" music mentally that he could not hear normally because of his deafness,
he was "seeing" basic structures similar to E8.

Human quantum consciousness is based on microtubules containing
maximally about 65,536 Tubulin Dimers.

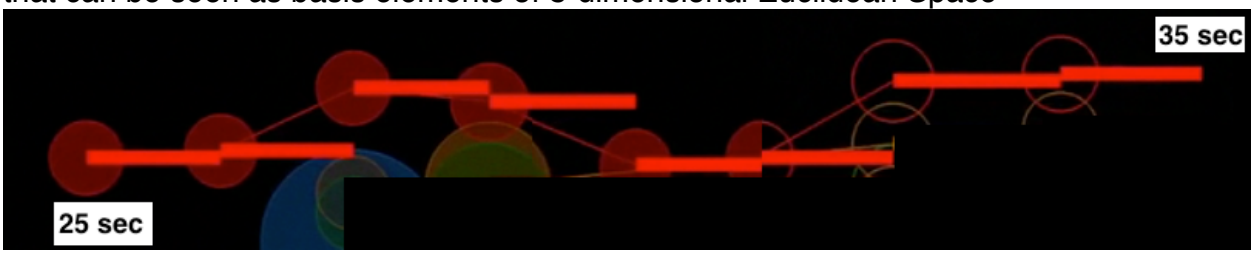
E8 lives in the 65,536-dimensional Real Clifford Algebra Cl(16).

Cl(16) is the basic structure of Our Universe (viXra 1810.0365).

so Beethoven could have been "seeing" in his mind that the E8 inside Cl(16)
looks like part of the structure of microtubules of his consciousness
and then writing that structure into the Grosse Fugue.

A similar line of reasoning might explain correspondences between Cl(16) Physics and the Archetype images of Jung's Red Book (Appendix on Red Book Physics - page 23).

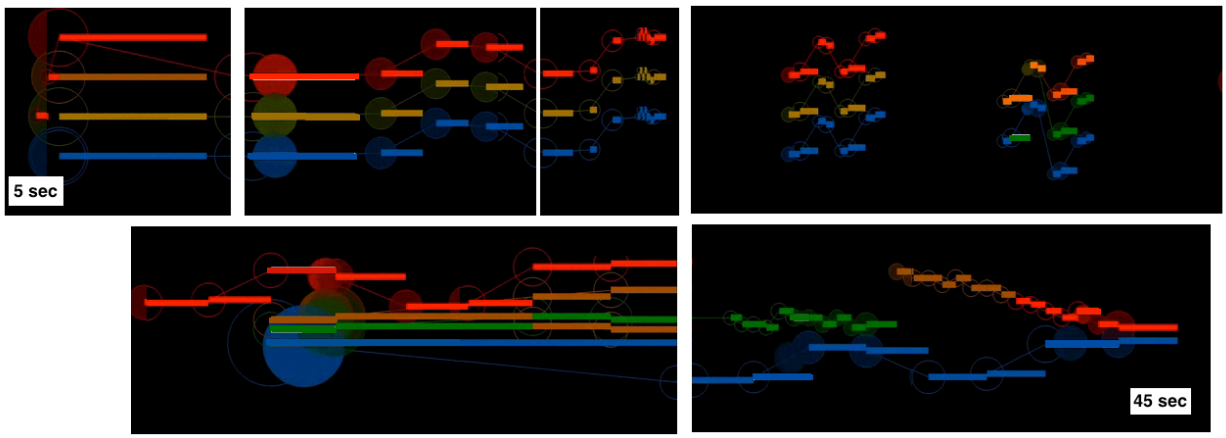
Visualizations of Beethoven's Grosse Fugue (Opus 133) (about 16 minutes long)
have been done by Stephen Malinowski
http://www.musanim.com/GrosseFuge/GrosseFugeViewersGuide.pdf
Its Primary Subject has 8 notes
that can be seen as basis elements of 8-dimensional Euclidean Space




According to Wikipedia, it is played in every possible variation: fortissimo and pianissimo, different rhythms, upside down and backwards.

The E8 Lie Algebra is constructed from the largest possible consistent
group of reflections in 8-dim Euclidean space,
analogous to the variations of the Grosse Fugue Primary Subject.

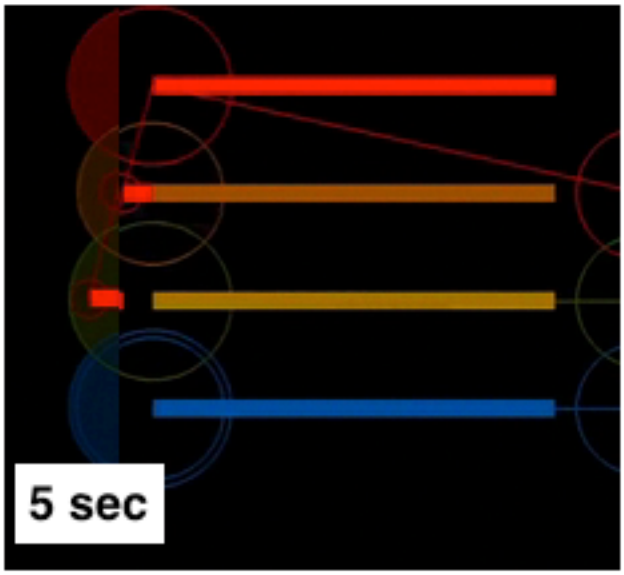
The Overture to the Grosse Fugue (24 bars, about 40 seconds)"... presents ... the material that will make up the entire piece ..." (quote from Wikipedia)



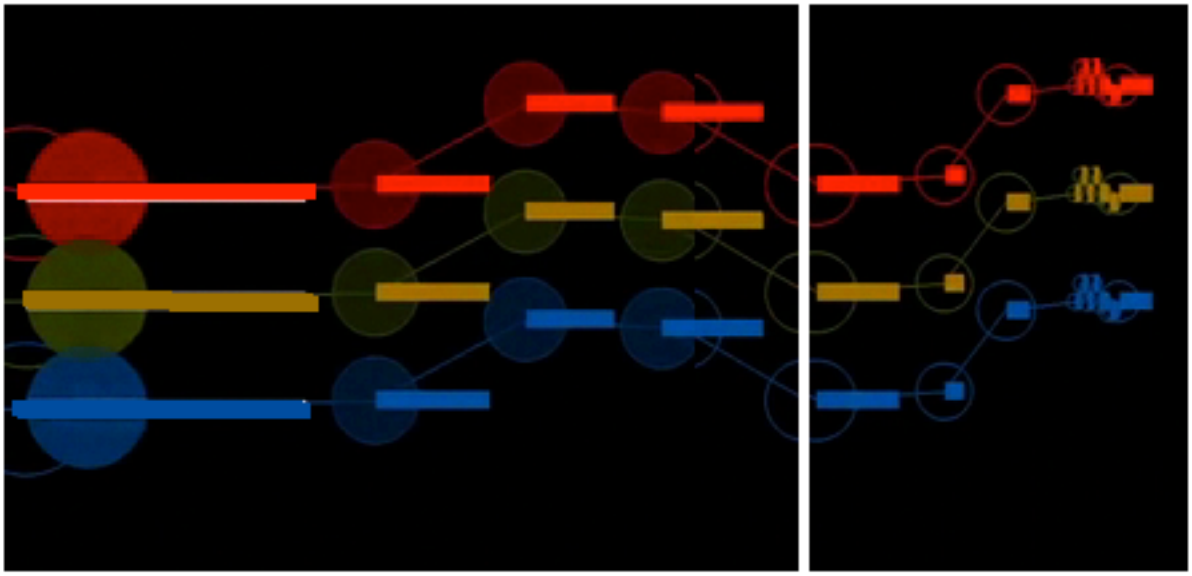

Here is how those segments of the Overture correspond to E8 Lie Algebra structures:

The initial segment introduces the instruments of the String Quartet:

first violin; second violin; viola; cello



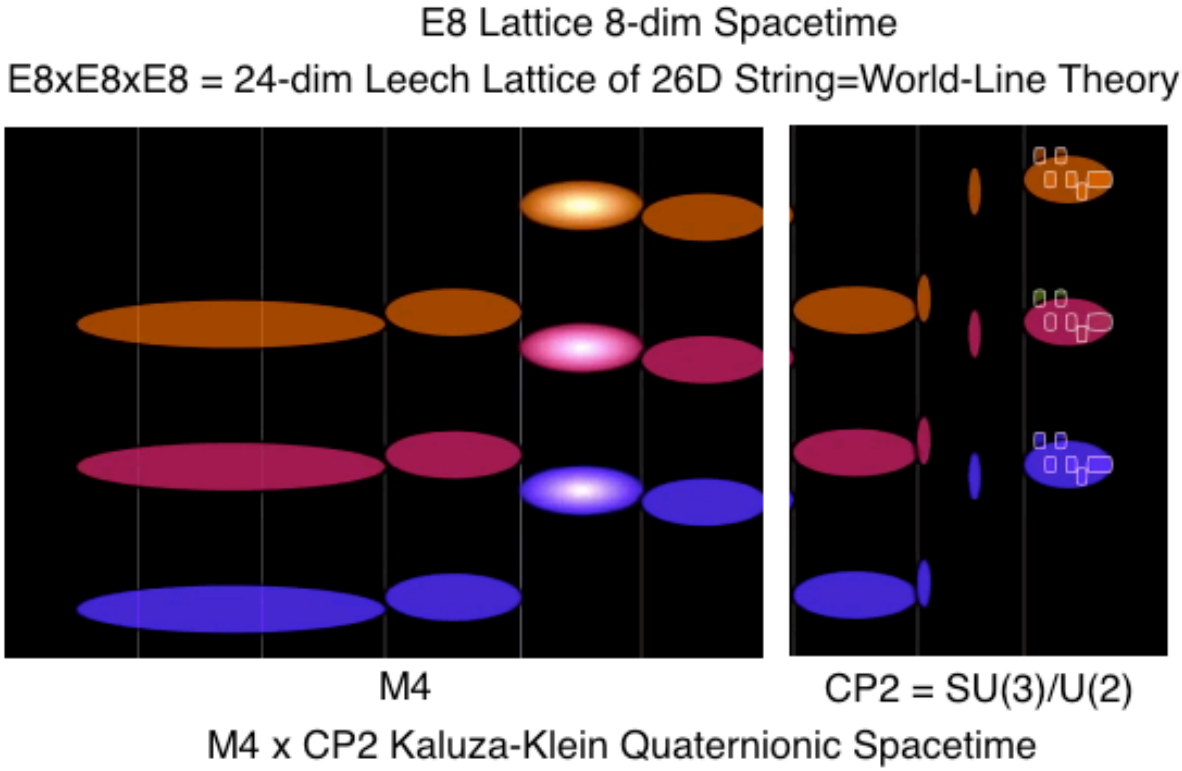

Statement of the 8 elements of the Main Fugal Subject



corresponds to the 8 dimensions of an Octonionic Vector Space.

E8 has a D8 subalgebra that acts as rotations / reflections in a 16-dimensional Space that is an 8-complex-dimensional Complex Domain known as a LIe Ball.
The Shilov Boundary of the LIe Ball is an 8-real-dimensional Lie Sphere RP1 x S7 with symmetry Spin(10) / Spin(8) x U(1) corresponding to 8-dim Octonionic Spacetime and to the 8 elements of the First Fugue.

At low energies (relative to the Planck Energy) the Octonionic Symmetry of Spacetime breaks to Quaternionic Symmetry of (4+4)-dim Kaluza-Klein M4 x CP2

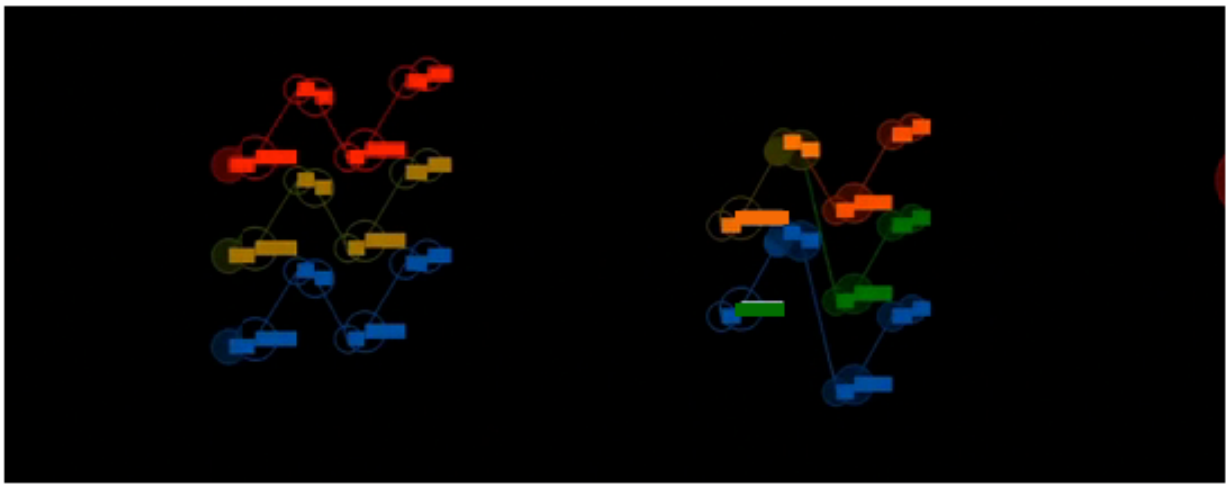



The M4 Physical Spacetime with Lie Sphere structure RP1 x S3
corresponds to 1 long note (time) and 3 medium notes (space).

The CP2 Internal Symmetry Space of CP2 = SU(3) / SU(2)xU)(1)
corresponds to 1 medium note, 2 short notes, and one complicated medium note.

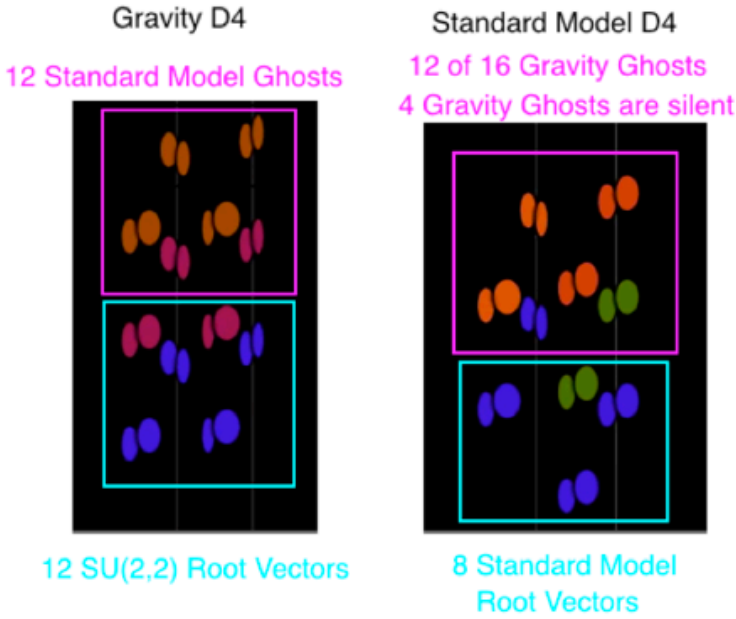
The whole thing is repeated in 3 instruments (second violin, first violin, cello)
to correspond to the 24-dim Leech Lattice underlying 26D String=World-Line Theory.

Repetition of Main Fugal Subject twice, in diminution



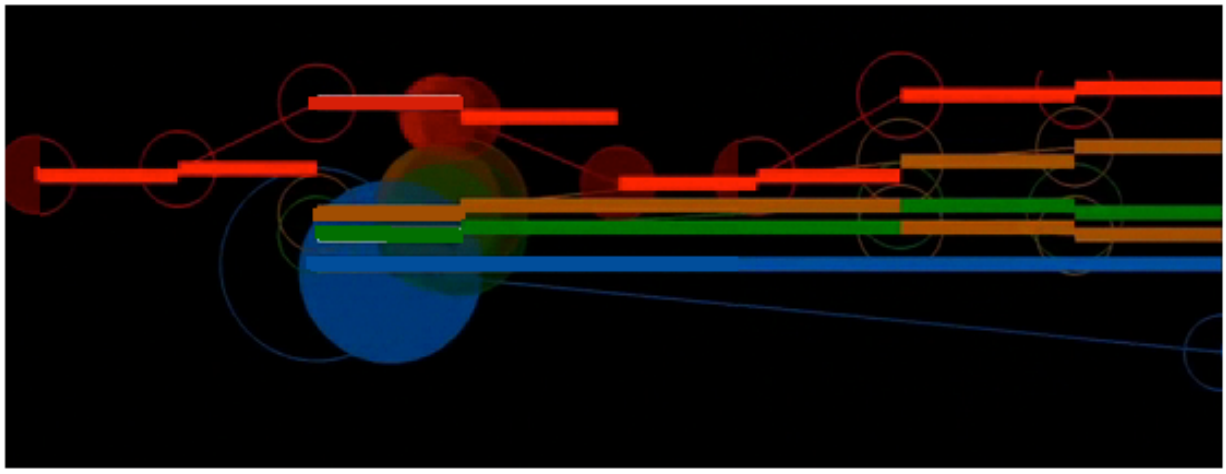
corresponds to the two D4 subalgebras in the D8 subalgebra of E8.

The D4 for Gravity+Dark Energy is 28-dimensional
with 24 Root Vectors and 4 Cartan Subalgebra elements.
12 of the Grosse Fugue notes correspond to the 12 Standard Model Ghosts.
The other 12 Grosse Fugue notes correspond to the cuboctahedral Root Vectors
of the SU(2,2) subalgebra of the Conformal Gravity+Dark Energy U(2,2).
The 4 Cartan subalgebra elements of 16-dimensional U(2,2) are silent.



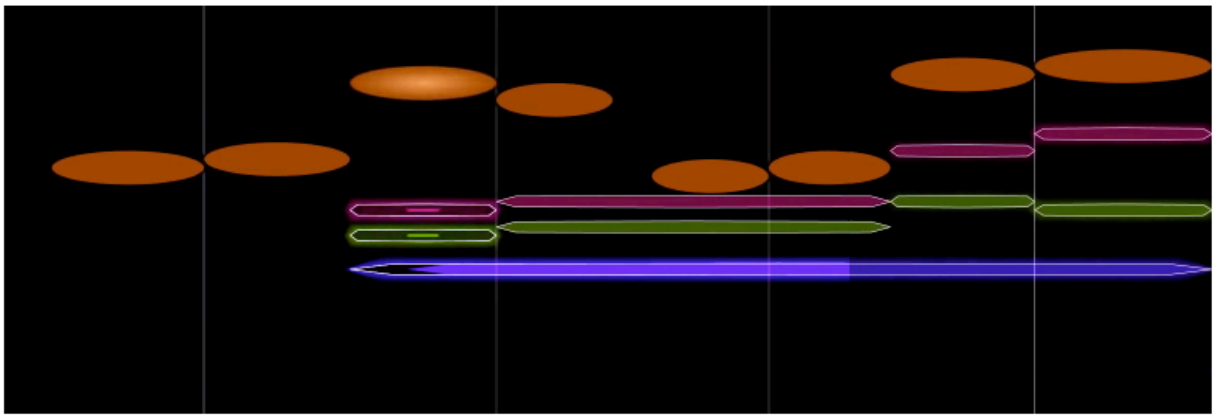

The D4 for the Standard Model is also 28-dimensional
with 24 Root Vectors and 4 Cartan Subalgebra elements.
12 Grosse Fugue notes correspond to 12 of the 16 Gravity+Dark Energy Ghosts.
The 4 Gravity+Dark Energy Ghost Cartan Subalgebra elements are silent.
The other 8 Grosse Fugue notes correspond to the Standard Model Root Vectors
of SU(3)xSU(2)xU(1). The 4 Standard Model Cartan Subalgebra elements are silent.

The Main Fugal Subject again



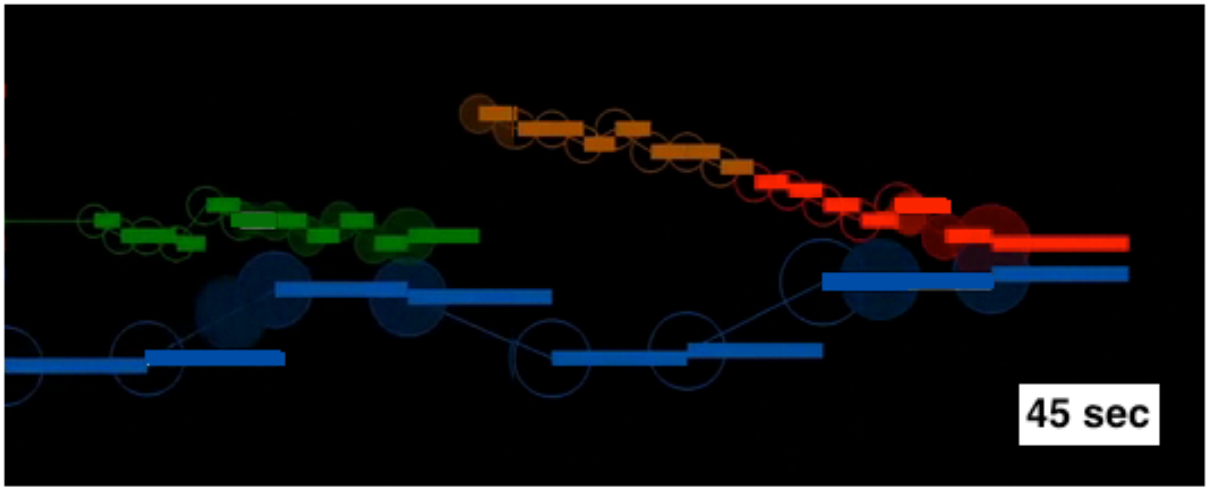
corresponds to 8 Fermion Particles of the First Generation.

8 Fermion Particles

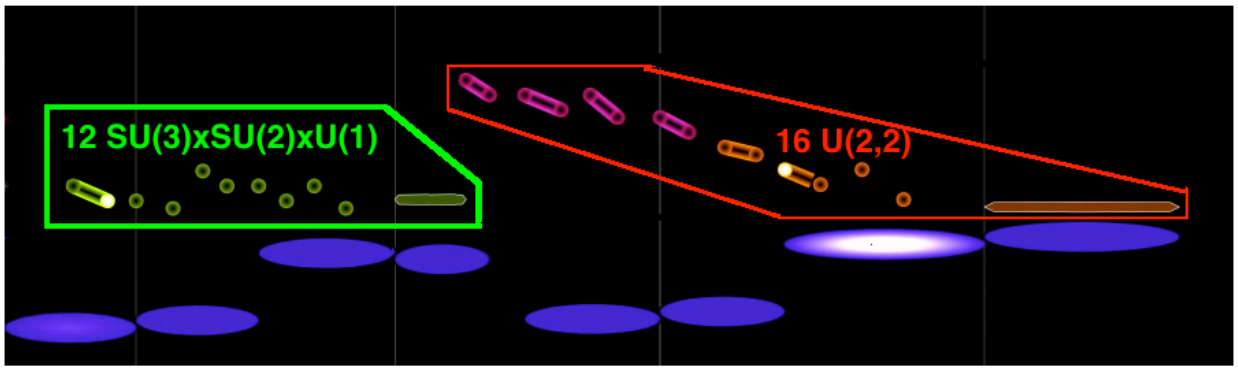


Each of the 8 Fermion Particles has 8 Spacetime components
so they represent 8x8 = 64 elements of E8

Statement of the Other Fugal Subject with 12 + 16 elements corresponding
to the 12-element Standard Model SU(3) x SU(2) x U(1) and
to the 16-element Conformal Gravity+Dark Energy U(2,2)
of the two 28-dimensional D4 subalgebras of the D8 subalgebra of E8




Statement of the First Subject in the cello
corresponds to 8 Fermion AntiParticles of the First Generation




8 Fermion AntiParticles

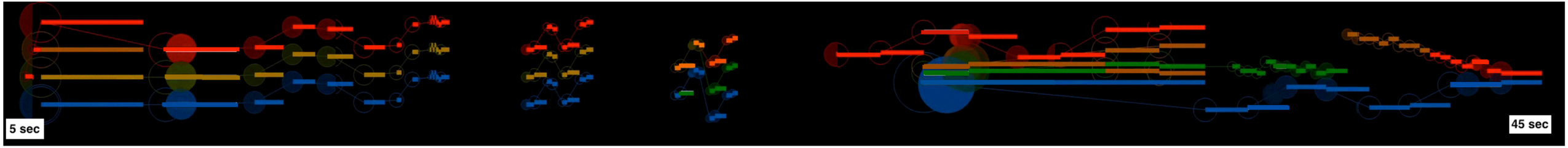
Each of the 8 Fermion AntiParticles has 8 Spacetime components
so they represent 8x8 = 64 elements of E8.

The 128-dim Symmetric Space E8 / D8 is represented by
Grosse Fugue notes for 8 Fermion Particles and 8 Fermion AntiParticles.
The two 28-dim D4 subalgebras of 120-dim D8 are represented by
Grosse Fugue notes for Standard Model and Gravity+Dark Energy.
The remainder of E8 is 64-dim D8 / D4xD4 which represents
A7 + R = central element of E8 Maximal Contraction Heisenberg Algebra
where A7 is Symmetry of Unimodular Gravity of 8-dim Spacetime
and represents Creation and Annihilation Operators for 8-dim Spacetime.

**Grosse Fugue Overture corresponds to the entire E8 Lie Algebra**

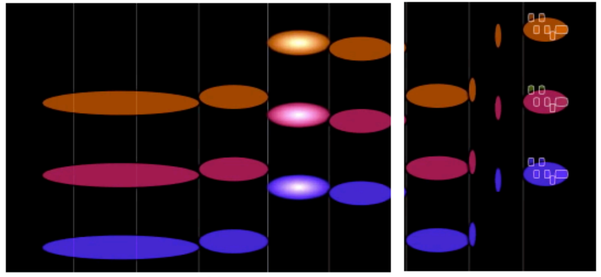
On the following page is a summary diagram of the Grosse Fugue Overture and E8:

Beethoven's Grosse Fugue Opus 133 Overture




E8 Lattice 8-dim Spacetime

E8xE8xE8 = 24-dim Leech Lattice of 26D String=World-Line Theory

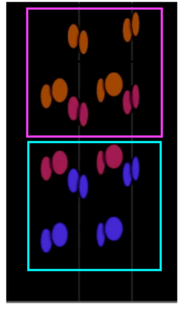


M4 CP2 = SU(3)/U(2)

M4 x CP2 Kaluza-Klein Quaternionic Spacetime

Gravity D4

12 Standard Model Ghosts

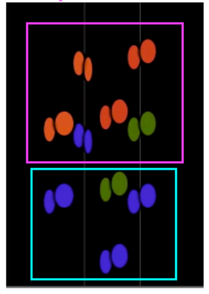


12 SU(2,2) Root Vectors

Standard Model D4

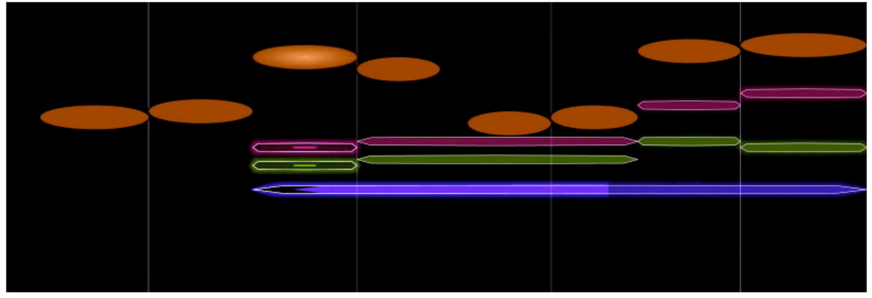
12 of 16 Gravity Ghosts

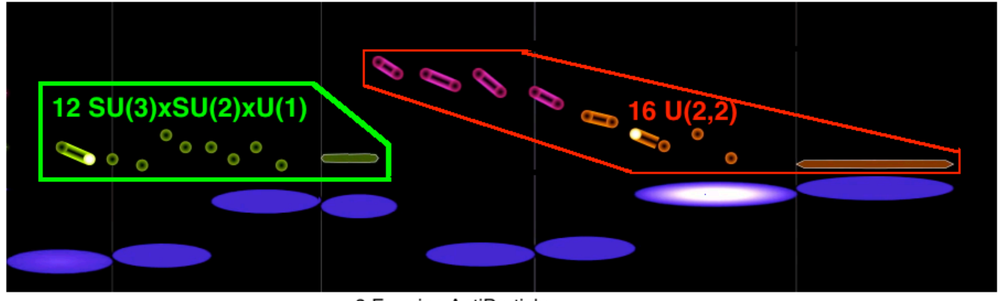
4 Gravity Ghosts are siler



8 Standard Model Root Vectors

8 Fermion Particles






8 Fermion AntiParticles

Beethoven's Grosse Fugue Opus 133 Overture

is an Outline of E8 Lie Algebra

# Quantum Consciousness

**The Algebraic Quantum Field Theory ( AQFT ) structure of the Bohm Quantum Potential of 26D String Theory** is given by the Cl(16) Physics Local Lagrangian

$\int$ Gauge Gravity + Standard Model + Fermion Particle-AntiParticle
8-dim SpaceTime .

and by 8-Periodicity of Real Clifford Algebras,
as the **Completion of the Union of all Tensor Products of the form**

**Cl(1,25) x ...(N times tensor product)... x Cl(1,25)**

which is analogous to Fock Space Hyperfinite II1 von Neumann factor algebra
that is based on 2-Periodicity of Complex Clifford Algebras.

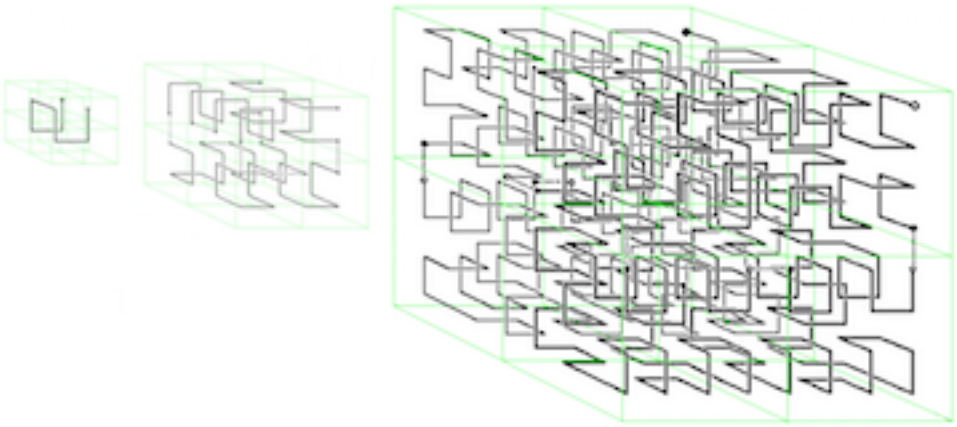
**For N = 2^8 = 256** the copies of Cl(1,25) are on the 256 vertices of the 8-dim HyperCube

**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

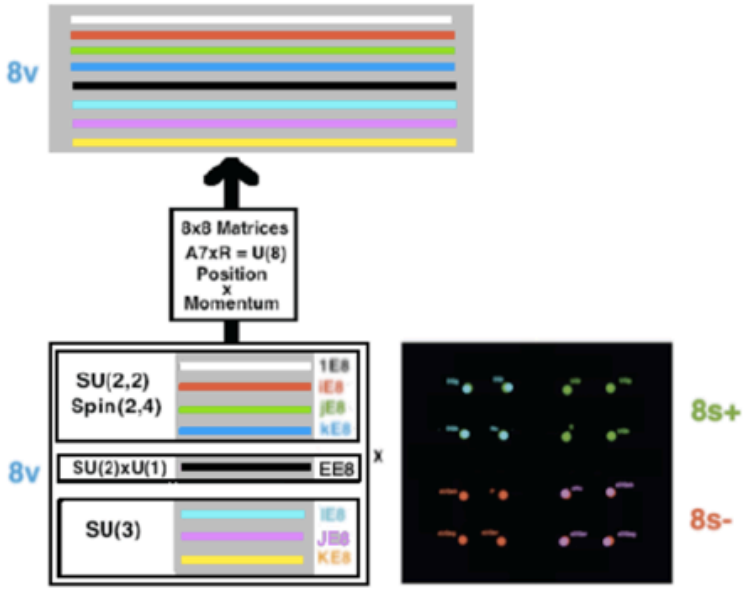
**As N grows**, the copies of Cl(1,25) continue to fill the 8-dim HyperCube of E8 SpaceTime
using higher Hilbert curve stages from the 8-bit reflected binary Gray code
subdividing the initial 8-dim HyperCube into more and more sub-HyperCubes.

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**.

26D String Theory Structure is




Green, Schwartz, and Witten, in "Superstring Theory" vol. 1, describe 26D String Theory saying ".... 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** ...".

Tachyons localized at orbifolds of fermions produce virtual clouds of particles / antiparticles that dress fermions by filling their Schwinger Source regions.

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

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

**The massless spin 2 state = Bohmion = Carrier of the Bohm Force of the Bohm Quantum Potential.**

**Similarity of the spin 2 Bohmion 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 spin-2 structure similar to General Relativity**

Peter R. Holland says in "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 ...".

**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

$$Cl(64) = Cl(8x8) = Cl(8) \times Cl(8) \times Cl(8) \times Cl(8) \times Cl(8) \times Cl(8) \times Cl(8) \times Cl(8)$$

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.

Octonionic Quantum Processes are Not Unitary and so can produce Fermions.
(see Stephen Adler's book "Quaternionic Quantum Mechanics ..." at pages 50-52 and 561).
At the end of 64 Unfoldings, Non-Unitary Octonionic Inflation ended having
produced about (1/2) 16^64 = (1/2) (2^4)^64 = 2^255 = 6 x 10^76 Fermions.
At the End of Inflation Our Universe had Temperature / Energy 10^27 K = 10^14 GeV
so each of the 10^77 Fermions had energy of 10^14 GeV and collisions among them
would for each of the 10^77 Fermions produce jets containing about 10^12 particles of
energy 100 GeV or so so that the total number created by Inflation was about 10^89.

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 Fermion Schwinger Source Kerr-Newman Cloud.
The 2^64 qubits created by Inflation is roughly 10^19 which is roughly
the number of Quantum Consciousness Tubulins in the Human Brain.
Therefore

**the Human Brain Quantum Consciousness has evolved in Our Universe**
**to be roughly equivalent**
**to the Maximum Consciousness of Our Inflationary Era Universe.**

Further,
each cell of E8 Lagrangian Spacetime corresponds to 65,536-dim Cl(16)
which contains 248-dim E8 = 120-dim D8 bivectors +128-dim D8 half-spinors
Human Brain Microtubules 40 microns long have 65,536 Tubulin Dimers

( image adapted from 12biophys.blogspot.com Lecture 11 )
and 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 Lagrangian Spacetime (as a Nambu-Jona-Lasinio Condensate)**
**is 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.

**A Single Cell of E8 26-dimensional Bosonic String Theory,**
**in which Strings are physically interpreted as World-Lines,**
**can be described by taking the quotient of its 24-dimensional O+, O-, Ov**
**subspace modulo the 24-dimensional Leech lattice.**
**Its automorphism group is the largest finite sporadic group, the Monster Group,**
**whose order is**
**8080, 17424, 79451, 28758, 86459, 90496, 17107, 57005, 75436, 80000, 00000 =**
**= 2^46 .3^20 .5^9 .7^6 .11^2 .13^3 .17.19.23.29.31.41.47.59.71**
**or about 8 x 10^53.**

"... 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
Peter R. Holland says in "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 ...".

**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
with math description in terms of a large Real Clifford Algebra:

Resonance is discussed by Carver Mead in "Collective Electrodynamics" ( MIT 2000 ):
"... we can build ... a resonator from ... electric dipole ... configuration[s] ...

[ such as  Tubulin Dimers ]

Because there are charges at the two ends of the dipole, we can have a contribution to the electric coupling from the scalar potential ... as well [as] from the magnetic coupling ... from the vector potential ... electric dipole coupling is stronger than magnetic dipole coupling ... the coupling of ... two ... configurations ... is the same, whether retarded or advanced potentials are used. Any ... configuration ... couples to any other on its light cone, whether past or future. ... The total phase accumulation in a ... configuration ... is the sum of that due to its own current, and that due to currents in other ... configurations ... far away ...
The energy in a single resonator alternates between the kinetic energy of the electrons (inductance), and the potential energy of the electrons (capacitance). With the two resonators coupled, the energy shifts back and forth between the two resonators in such a way that the total energy is constant ... The conservation of energy holds despite an arbitrary separation between the resonators ... Instead of scaling linearly with the number of charges that take part in the motion, the momentum of a collective system scales as the square of the number of charges! ... The inertia of a collective system, however, is a manifestation of the interaction, and cannot be assigned to the elements separately. ... Thus, it is clear that collective quantum systems do not have a classical correspondence limit. ...".

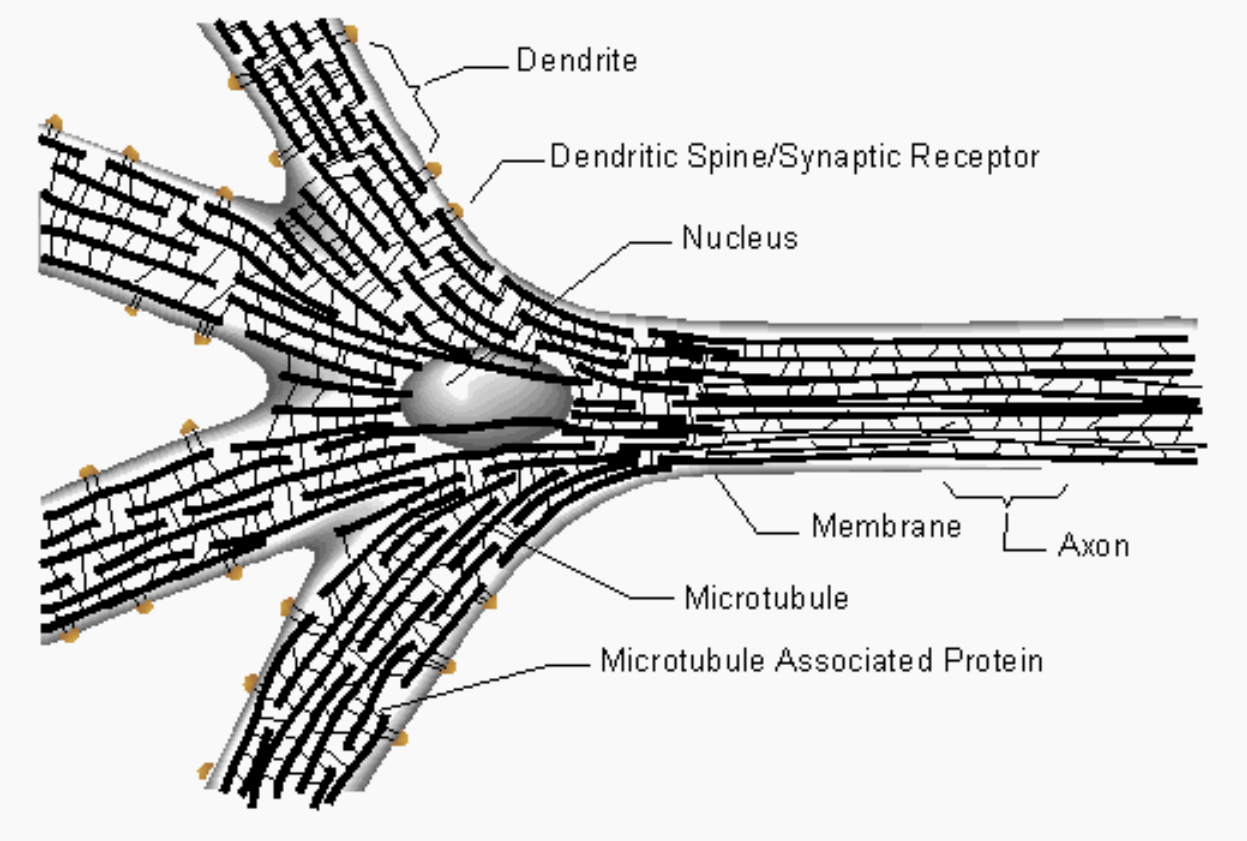
For **the 10^18 Tubulin Dimers of the human brain**,
the resonant frequencies are the same and exchanges of energy among them
act to keep them **locked in a Quantum Protectorate collective coherent state**.

Philip W. Anderson in cond-mat/0007287 and cond-mat/007185 said:
"... Laughlin and Pines have introduced the term "Quantum protectorate" as a general descriptor of the fact that certain states of quantum many-body systems exhibit properties which are unaffected by imperfections, impurities and thermal fluctuations. They instance ... flux quantization in superconductors, equivalent to the Josephson frequency relation which again has mensuration accuracy and is independent of imperfections and scattering. ...
... the source of quantum protection is a collective state of the quantum field involved such that the individual particles are sufficiently tightly coupled that elementary excitations no longer involve a few particles but are collective excitations of the whole system, and therefore, macroscopic behavior is mostly determined by overall conservation laws ... a "quantum protectorate" ...[ is ]... a state in which the manybody correlations are so strong that the dynamics can no longer be described in terms of individual particles, and therefore perturbations which scatter individual particles are not effective ...".

Mershin, Sanabria, Miller, Nawarathna, Skoulakis, Mavromatos, Kolomenskii, Scheussler, Ludena, and Nanopoulos in physics/0505080 “Towards Experimental Tests of Quantum Effects in Cytoskeletal Proteins” said:

Classically, the various dimers can only be in the ...[  ]... conformations. Each dimer is influenced by the neighboring dimers resulting in the possibility of a transition. This is the basis for classical information processing, which constitutes the picture of a (classical) cellular automaton.
If we assume ... that each dimer can find itself in a QM superposition of ...[ those ]... states, a quantum nature results. Tubulin can then be viewed as a typical two-state quantum mechanical system, where the dimers couple to conformational changes with 10^(-9) - 10^(-11) sec transitions, corresponding to an angular frequency ~ 10^10 - 10^12 Hz. In this approximation, the upper bound of this frequency range is assumed to represent (in order of magnitude) the characteristic frequency of the dimers, viewed as a two-state quantum-mechanical system ...[
The Energy Gap of our Universe as superconductor condensate spacetime is from 3 x 10^(-18) Hz (radius of universe) to 3 x 10^43 Hz (Planck length). Its RMS amplitude is 10^13 Hz = 10 THz = energy of neutrino masses = critical temperature Tc of BSCCO superconducting crystal Josephson Junctions ]... large-scale quantum coherence ...[ has been observed ]... at temperatures within a factor of three of biological temperatures. MRI magnets contain hundreds of miles of superconducting wire and routinely carry a persistent current. There is no distance limit - the macroscopic wave function of the superfluid condensate of electron pairs, or Cooper pairs, in a sufficiently long cable could maintain its quantum phase coherence for many thousands of miles ... there is no limit to the total mass of the electrons participating in the superfluid state. The condensate is “protected” from thermal fluctuations by the BCS energy gap at the Fermi surface ... The term “quantum protectorate” ... describe[s] this and related many-body systems ...”.

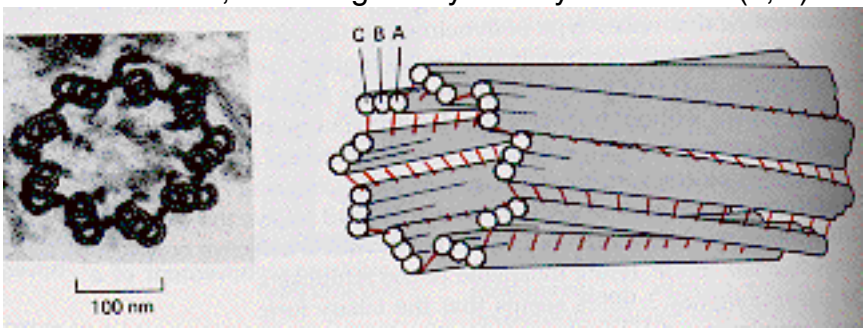
The Human Brain has about 10^11 Neuron cells, each about 1,000 nm in size.
The cytoskeleton of cells, including neurons of the brain, is made up of Microtubules



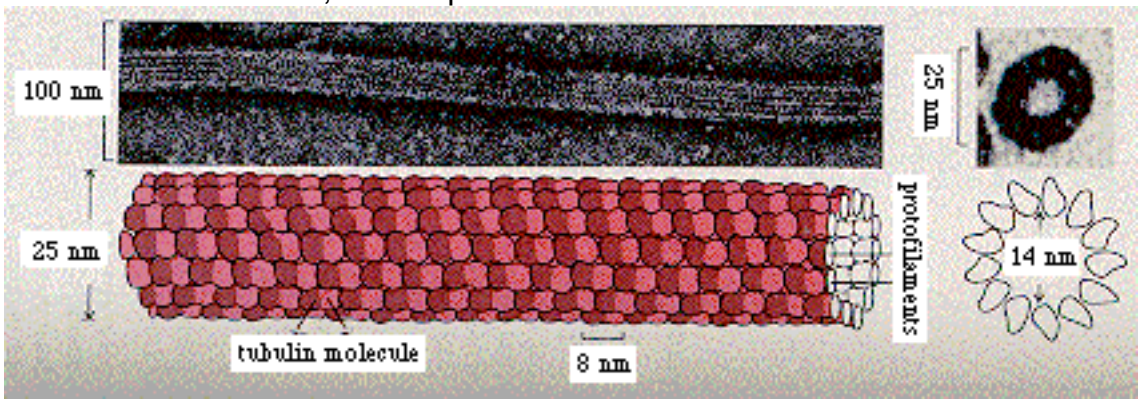

( image from “Orchestrated Objective Reduction of Quantum Coherence in Brain Microtubules: The “Orch OR” Model for Consciousness” by Penrose and Hameroff )

Each Neuron contains about 10^9 Tubulin Dimers, organized into Microtubules some of which are organized by a Centrosome. Centrosomes contain a pair of Centrioles.

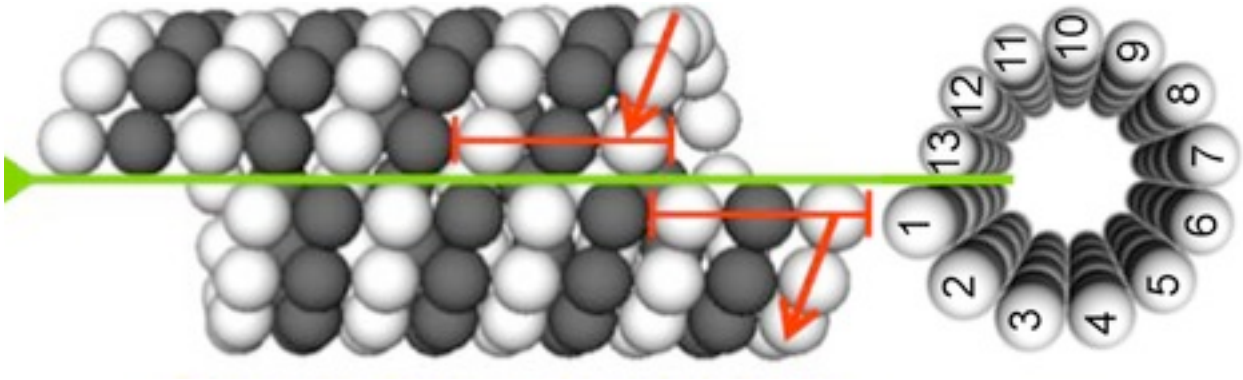
A Centriole is about 200 nm wide and 400 nm long. Its wall is made up of 9 groups of 3 Microtubules, reflecting the symmetry of 27-dim J(3,O)



Each Microtubule is a hollow cylindrical tube with about 25 nm outside diameter and 14 nm inside diameter, made up of 13 columns of Tubulin Dimers




( illustrations and information about cells, microtubules, and centrioles are from Molecular Biology of the Cell, 2nd ed, by Alberts, Bray, Lewis, Raff, Roberts, and Watson (Garland 1989) )



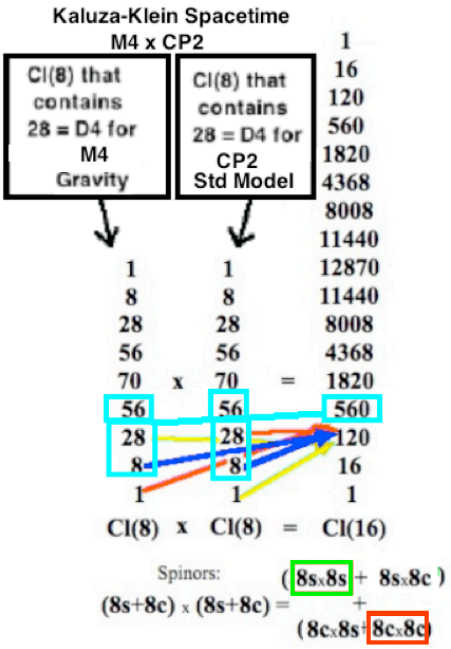

( image from Wikipedia on Microtubule )

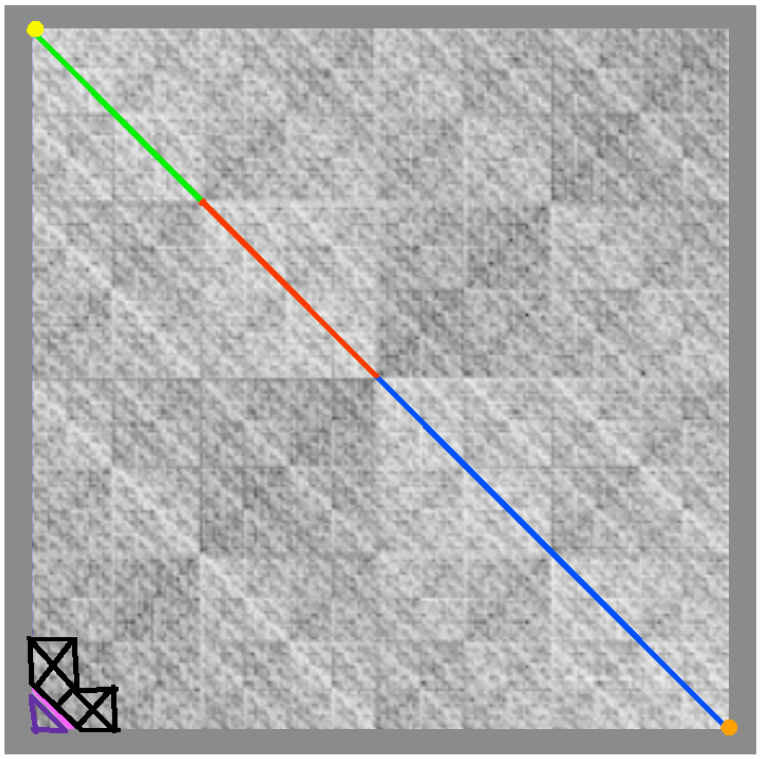
Each Tubulin Dimer is about 8 nm x 4 nm x 4 nm, consists of two parts, alpha-tubulin and beta-tubulin ( each made up of about 450 Amino Acids, each containing roughly 20 Atoms )
A Microtubule 40 microns = 40,000 nm long contains 13 x 40,000 / 8 = 65,000 Dimers

( images adapted from nonlocal.com/hbar/microtubules.html by Rhett Savage )
The black dots indicate the position of the Conformation Electrons.
There are two energetically distinct configurations for the Tubulin Dimers:
Conformation Electrons Similarly Aligned (left image) - State 0
Conformation Electrons Maximally Separated (right image) - State 1

The two structures - State 0 ground state and State 1 higher energy state - make Tubulin Dimers the basis for a Microtubule binary math / code system.

**Microtubule binary math / code system corresponds**
**to Clifford Algebras Cl(8) and Cl(8)xCl(8) = Cl(16)**
**containing 16-dim V16 (magenta) and**
**120 (inside purple outline) + 128-dim (yellow green red) = 248-dim E8 and**
**560 (inside black outline) 10 copies of 56-dim Fr3(O):**



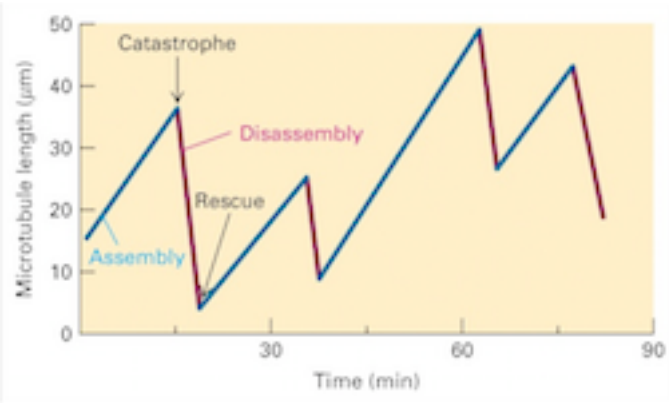



That leaves 1 (orange) + and 127 (blue) = 128-dim Mirror Fermion half-spinors and
65,536 - 256 - 560 - 120 - 16 = 64,584 elements of Cl(16) available
to carry information in the processes of Quantum Consciousness.

According to 12biophys.blogspot.com Lecture 11 Microtubule structure is dynamic:
"... One end of the microtubule is composed of stable (GTP) monomers
while the rest of the tubule is made up of unstable (GDP) monomers.
The GTP end comprises a cap of stable monomers.
Random fluctuations either increase or decrease the size of the cap.

This results in 2 different dynamic states for the microtubule.

Growing: cap is present Shrinking: cap is gone ...


...".

Microtubules spend most of their lives between 10 microns and 40 microns,
sizes that can represent E8 as half of the Even Part (half) of Cl(16) ( 10 microns )
or as the Even Part (half) of Cl(16) ( 20 microns ) or as full Cl(16) ( 40 microns ).

In a given Microtubule

the 128 Cl(8) Half-Spinor part ▬▬▬▬▬▬▬▬ is represented by a line of 128 Dimers in its stable GTP region and

the 120 Cl(16) BiVector part ▭ by a 12 x 10 block of Dimers in its stable GTP region
The 560 Cl(16) TriVector part is represented similarly.

( image adapted from 12biophys.blogspot.com Lecture 11 )

## How do the Microtubules communicate with each other ?

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 **either the energy of 26D String Theory spin two gravitons** or the **Bohm Quantum Potential internal energy**, equivalently.
Communication between two Microtubules is by the Bohm Quantum Potential between their respective corresponding Dimers
with the correspondence being based on connection
between respective E8 and Fr3(O) subsets

## How is information encoded in the Microtubules ?

Each Microtubule contains E8 and Fr3(O),
allowing Microtubules to be corrrelated with each other.
The parts of the Microtubule beyond E8 and Fr3(O)
are in Cl(16) for 40 micron Microtubules,
or the Even Subalgebra of Cl(16) for 20 micron Microtubules,
or half of the Even Subalgebra of Cl(16) for 10 micron Microtubules
so since by 8-Periodicity of Real Clifford Algebras Cl(16) = Cl(8) x Cl(8) and
since Cl(8) information is described by the Quantum Reed-Muller code [[ 256 , 0 , 24 ]]
**the information content** of Cl(16) and its Subalgebras **is described by the Tensor Product Quantum Reed-Muller code [[ 256 , 0 , 24 ]] x [[ 256 , 0 , 24 ]]**

## What about information in the Many 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 spin two gravitons
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 in Coherent Superposition
connected by the Bohm Quantum Potential Force that does not fall off with distance.
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

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

**The decoherence time for the system of N Tubulin Electrons** is

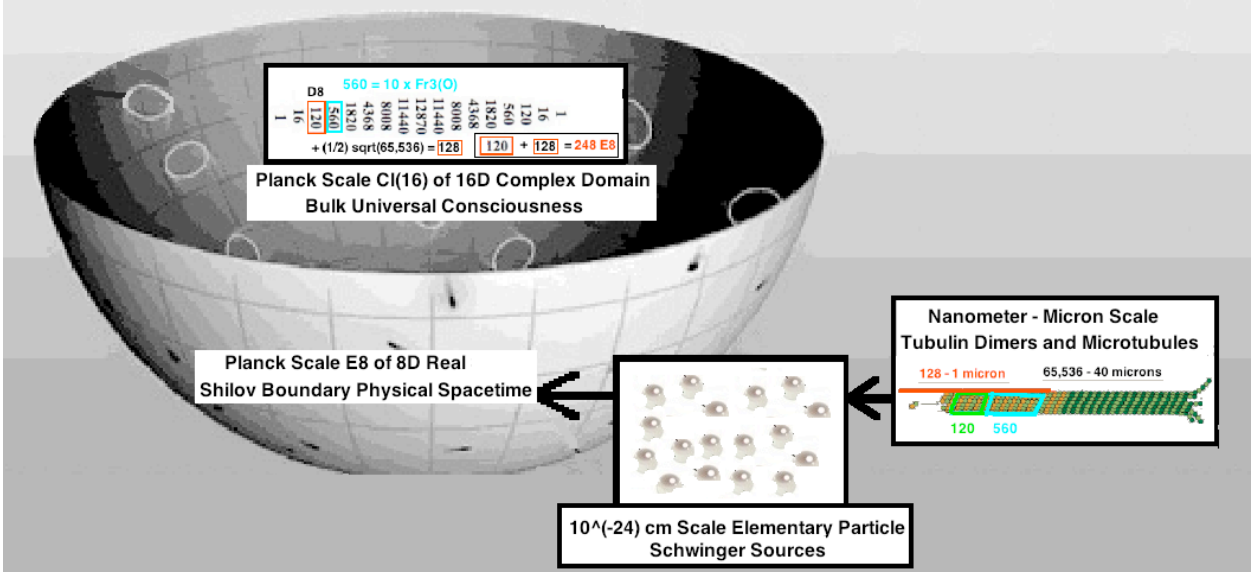
$$T_N = h / E_N = h / N^{(5/3)} E_{ssediff} = N^{(-5/3)} 10^{26} \text{ sec}$$

so we have the following rough approximate Decoherence Times T_N

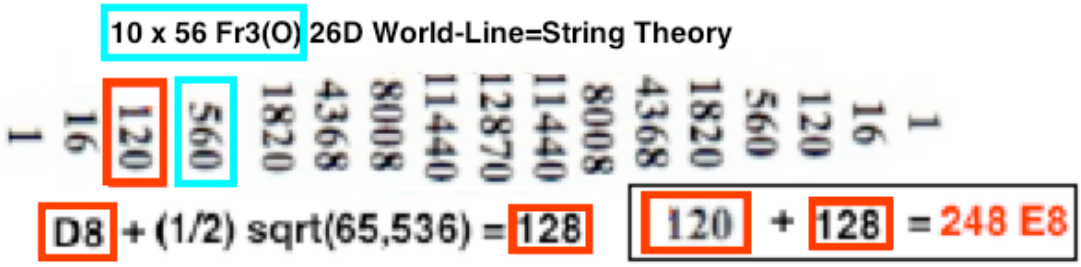
| Number of Involved Tubulin Dimers | Time T_N | |
|---|---|---|
| 10^(11+9) = 10^20 | 10^(-33 + 26) = 10^(-7) sec | 10^11 neurons x 10^9 TD / neuron<br>10^20 Tubuin Dimers in Human Brain |
| 10^16 | 10^(-27 + 26) = 10^(-1) sec - 10 Hz<br>Human Alpha EEG is 8 to 13 Hz<br>Fundamental Schumann Resonance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

Each cell of E8 Classical Lagrangian Spacetime corresponds to 65,536-dim Cl(16)
**which contains 248-dim E8 = 120-dim D8 bivectors +128-dim D8 half-spinors**




In E8 Physics ( viXra 1602.0319 )
**Spacetime is the 8-dimensional Shilov Boundary RP1 x S7**
of the **Type IV8 Bounded Complex Domain Bulk Space**
of the Symmetric Space Spin(10) / Spin(8)xU(1)
which **Bulk Space** has 16 Real dimensions
and is the Vector Space of the Real Clifford Algebra Cl(16).
By 8-Periodicity,
Cl(16) = tensor product Cl(8) x Cl(8) = Real 256x256 Matrix Algebra M(R,256)
and so has 256x256 = 65,536 elements.




Cl(8) has 8 Vectors, 28 BiVectors, and 16 Spinors with 8+28+16 = 52 = F4 Lie Algebra.
Cl(16) has 120 BiVectors and 128 Half-Spinors for 120+128 = 248 = E8 Lie Algebra
giving a Lagrangian for the Standard Model and for Gravity - Dark Energy.
Cl(16) has 560 TriVectors for 10 copies of Fr3(O) and Cl(1,25) AQFT
so 65,536 - 248 - 560 = 64,728 elements of Cl(16) are for Consciousness Information.

The Complex Bulk Space Cl(16)
contains the Maximal Contraction of E8 which is H92 + A7
a generalized Heisenberg Algebra of Quantum Creation-Annihilation Operators with
graded structure

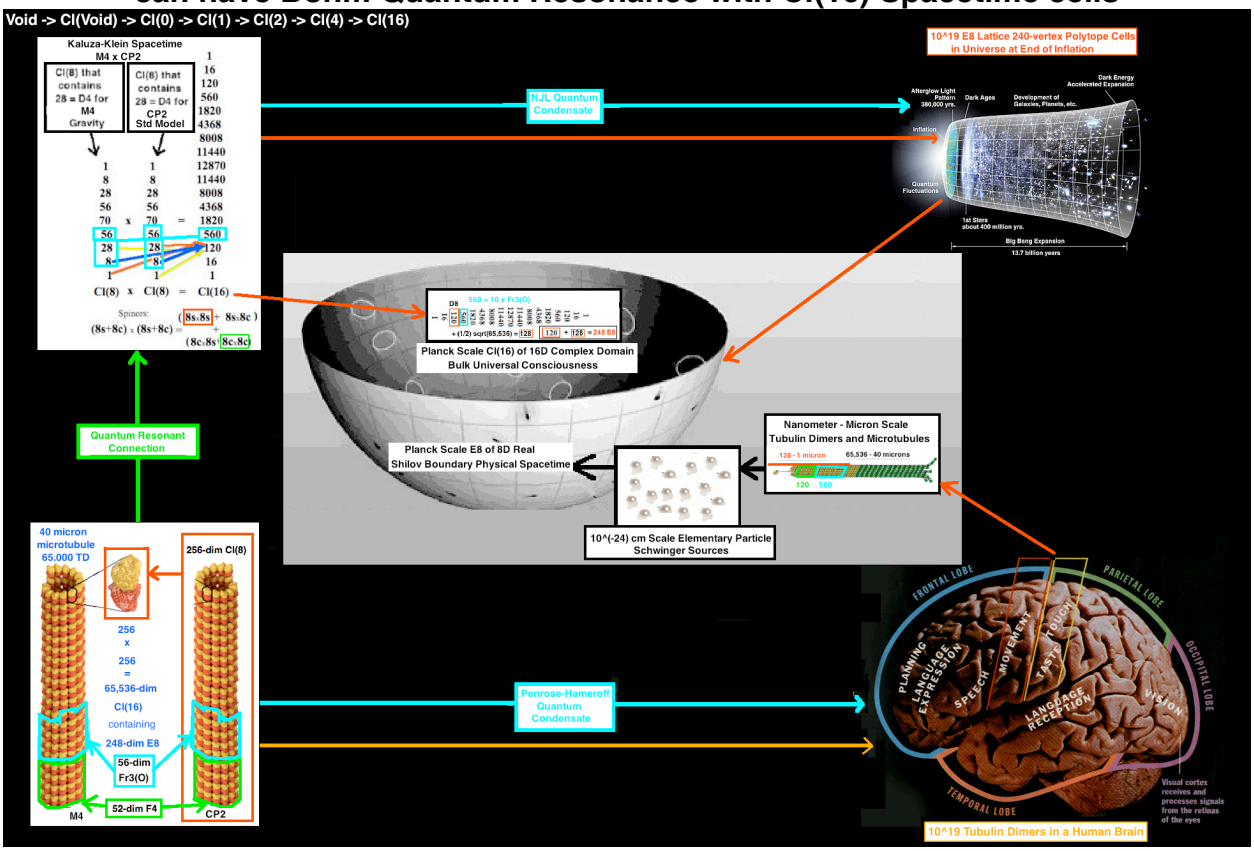
$$28 + 64 + ((SL(8,R)+1) + 64 + 28$$

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


( image adapted from 12biophys.blogspot.com Lecture 11 )

**and 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 NJL Condensate** is 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** ...".

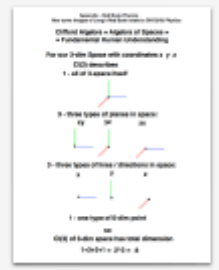
# RED BOOK PHYSICS

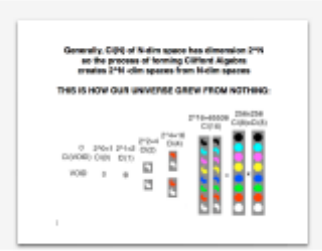
How Jung's Red Book Archetypes connect with E8 - Cl(16) Physics

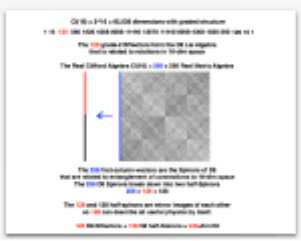
Frank Dodd (Tony) Smith, Jr. - 2018

The first five pages after the cover summarize the rest of this paper.

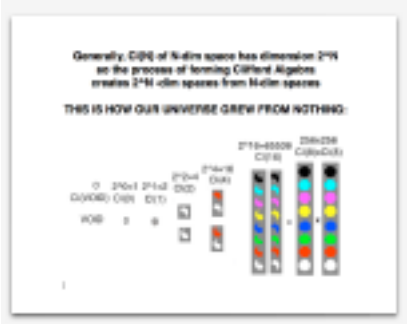
## CLIFFORD ALGEBRAS to E8





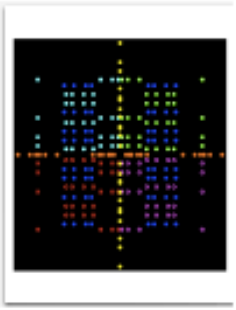



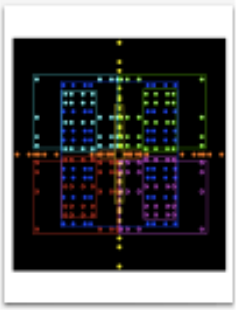

## CLIFFORD EVOLUTION of OUR UNIVERSE

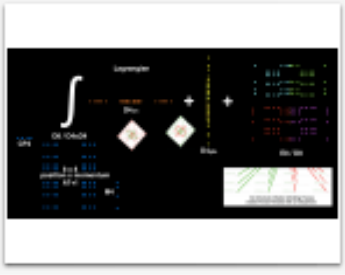


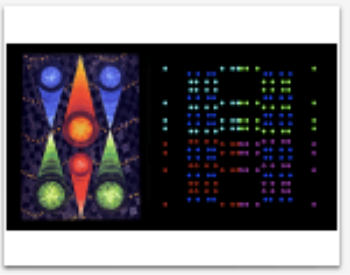

## CREATION - OCTONIONIC NON-UNITARY INFLATION
## 28+64+28 = 120 D8 = 4X32 =128 D8 HALF-SPINOR

## E8 - PARTICLES and FORCES - 8D LAGRANGIAN - TRIALITY



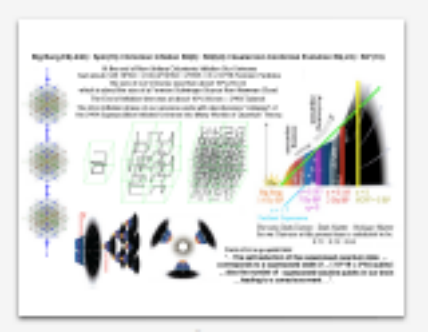




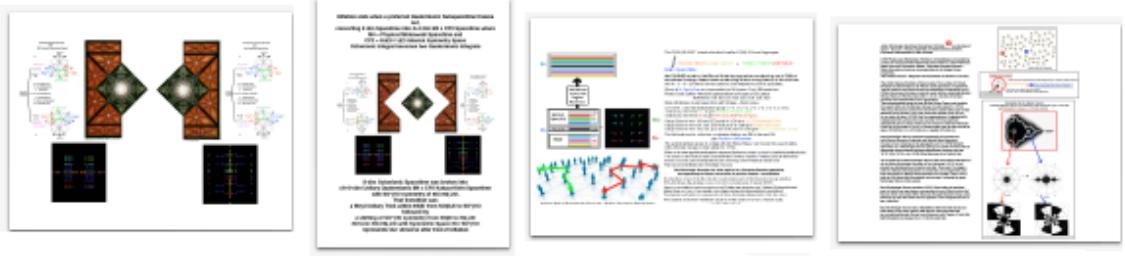


## E8 HEISENBERG CREATION-ANNIHILATION - 28+64+(63+1)+64=28

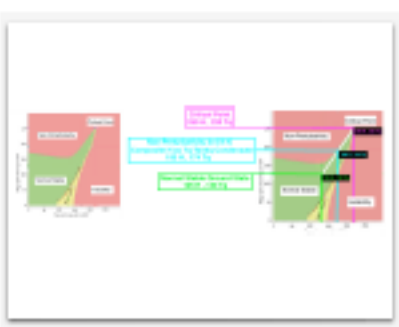
## AFTER INFLATION - QUATERNIONIC UNITARY EXPANSION
## now - DE : DM : OM = 0.75 : 0.21 : 0.04

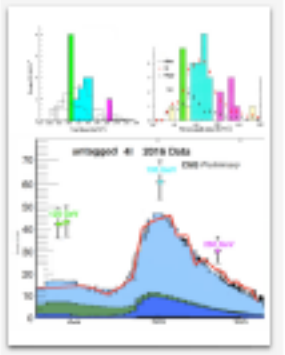


## E8 = H4 STANDARD MODEL  CP2 + H4 GRAVITY+DARK ENERGY M4
## STRINGS = WORLD LINES 26D STRING THEORY - SPIN-2 BOHMIONS
## QUANTUM BLOCKCHAINS OF SCHWINGER SOURCES

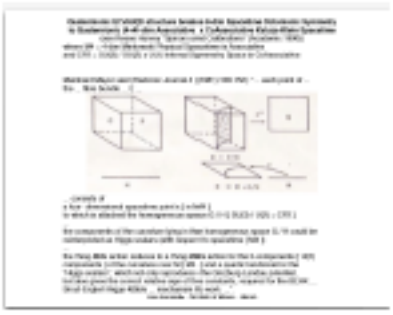


## HIGGS = NAMBU-JONA-LASINIO TRUTH QUARK COMPOSITE
## FERMILAB TRUTH QUARK MASSES 130 GeV - 174 GeV - 220 GeV
## CMS HIGGS MASSES 125 GeV - 195 GeV - 260 GeV

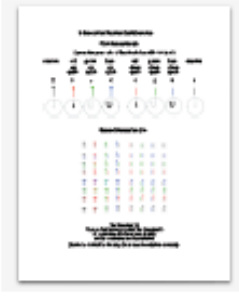




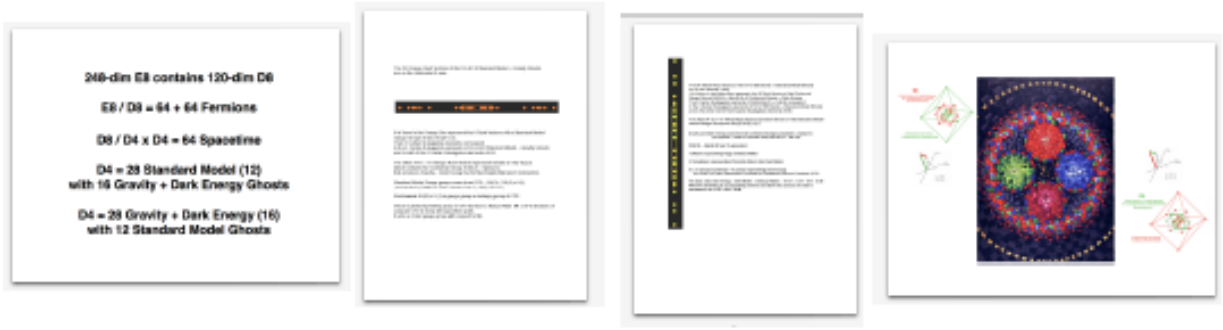
## M4xCP2 KALUZA-KLEIN - MAYER HIGGS - 3 FERMION GENERATIONS



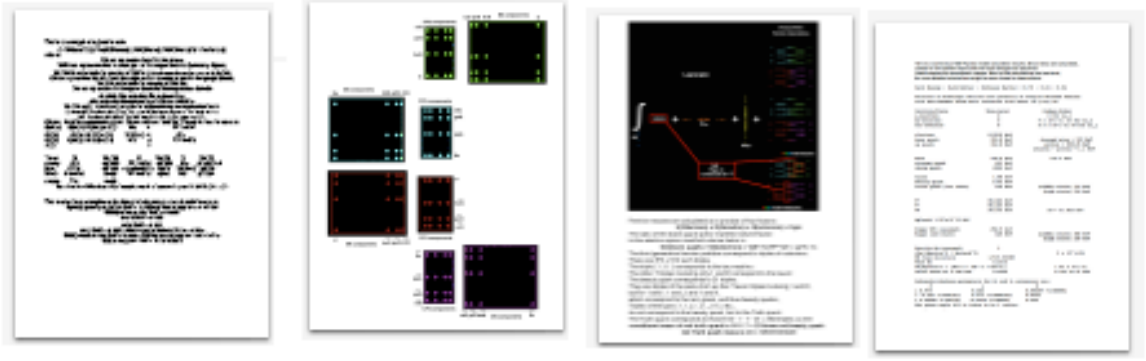
## FERMION OCTONIONIC BRAIDS - FERMION MASSES



## D4 STANDARD MODEL and GRAVITY+DE GHOSTS
## D4 GRAVITY+DE and STANDARD MODEL GHOSTS



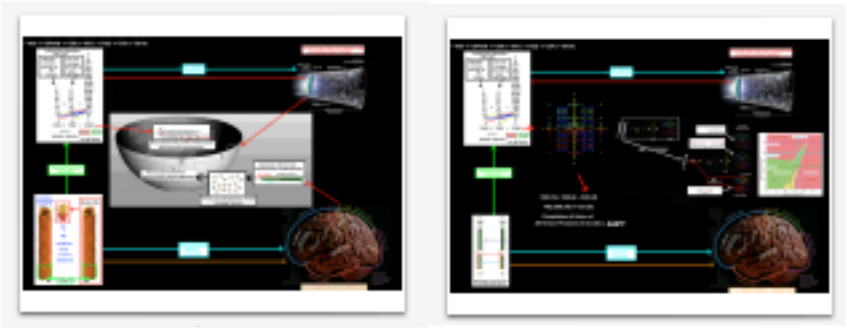

## FORCE STRENGTHS - 4D LAGRANGIAN - CALCULATION RESULTS



## E8 - H4 - F4 - D4 - D3=A3 - H3 - H2=PENROSE STAR

## CELLULAR AUTOMATA - CL(8) - CL(16) - MICROTUBULE - PYRAMIDS

## SHILOV BOUNDARY HUMAN MIND
## COMPLEX DOMAIN UNIVERSAL CONSCIOUSNESS



William KIngdon Clifford (1845 - 1879)
described Geometry in terms of his invention: Real Clifford Algebras,
which he called "**mind-stuff**", saying:

"... 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** ...".

(Wikipedia - (1878, "On the Nature of Things-in-Themselves", Mind, Vol. 3, No. 9, pp. 57–67))

Red Book Physics

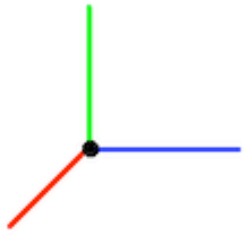
How some Images of Jung's Red Book relate to C8-Cl(16) Physics

# Clifford Algebra = Algebra of Spaces =
# = Fundamental Human Understanding

## For our 3-dim Space with coordinates x y z

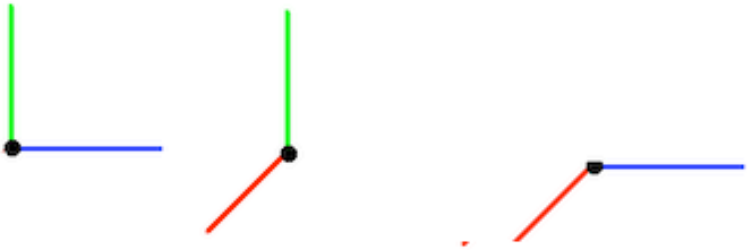
## Cl(3) describes

## 1 - all of 3-space itself



## 3 - three types of planes in space:

xy yz zx



## 3 - three types of lines / directions in space:

x y z

## 1 - one type of 0-dim point

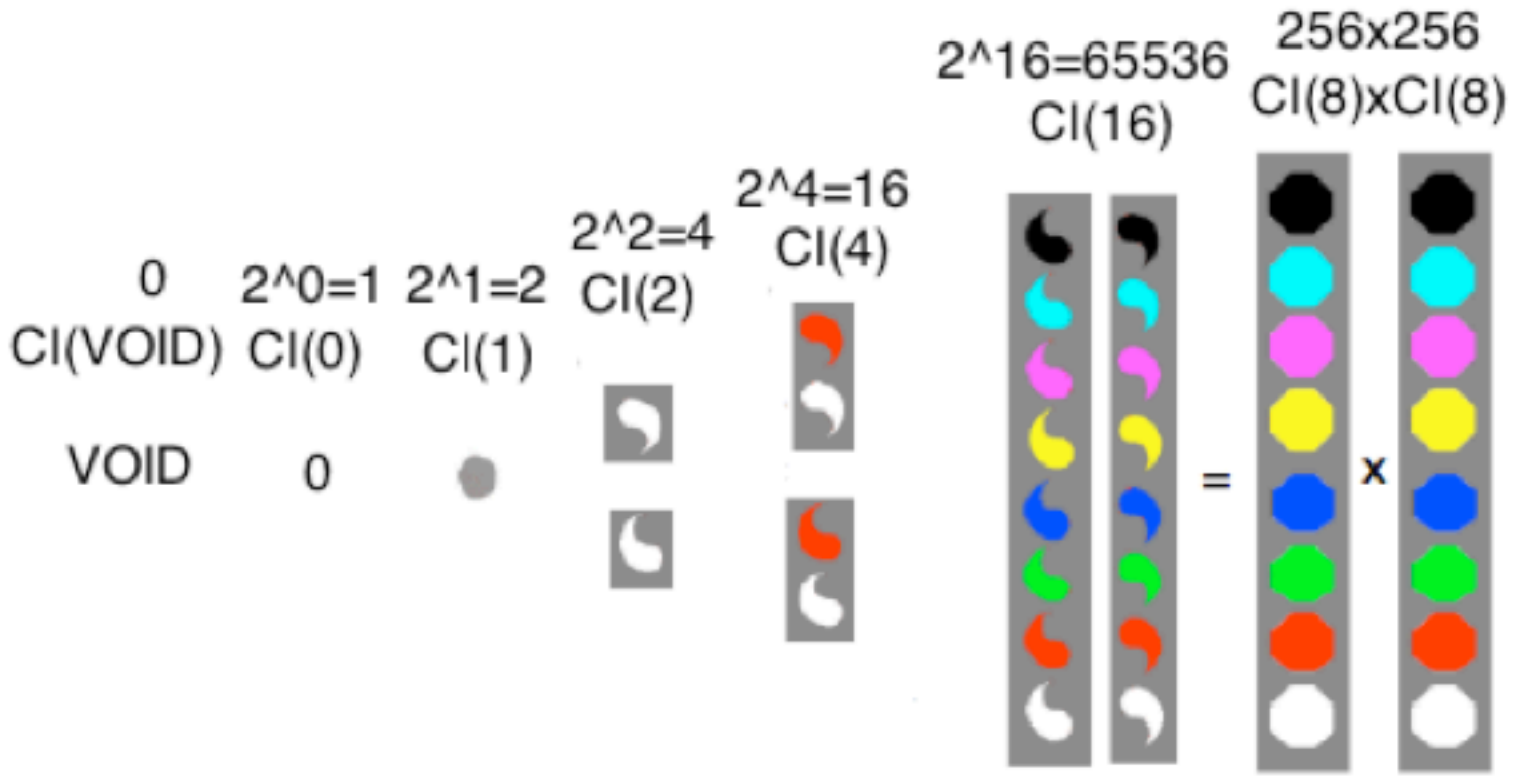
## so

## Cl(3) of 3-dim space has total dimension

## 1+3+3+1 = 2^3 = 8

**Generally, Cl(N) of N-dim space has dimension 2^N so the process of forming Clifford Algebra creates 2^N -dim spaces from N-dim spaces**

**THIS IS HOW OUR UNIVERSE GREW FROM NOTHING:**

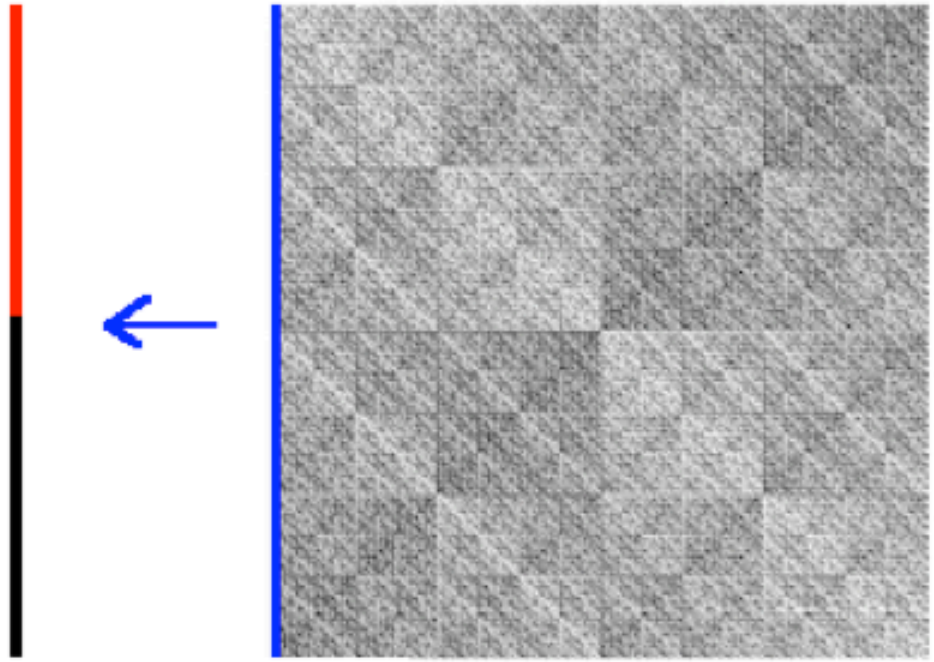


**Cl(16) = 2^16 = 65,536 dimensions with graded structure**

**1 16 120 560 1820 4368 8008 11440 12870 11440 8008 4368 1820 560 120 16 1**

**The 120 grade-2 BiVectors form the D8 Lie Algebra**
**that is related to rotations in 16-dim space**

**The Real Clifford Algebra Cl(16) = 256 x 256 Real Matrix Algebra**



**The 256 first-column-vectors are the Spinors of D8**
**that are related to entanglement of connections to 16-dim space**
**The 256 D8 Spinors break down into two half-Spinors**
**256 = 128 + 128**

**The 128 and 128 half-spinors are mirror images of each other**
**so 128 can describe all useful physics by itself.**

**120 D8 BiVectors + 128 D8 half-Spinors = 248-dim E8**

**248-dim E8 lives in Cl(16)**
**containing 120-dim D8 biVectors of Cl(16)**

**E8 / D8 = 64 + 64 Fermions = 128-dim D8 half-Spinors of Cl(16)**

**D8 / D4 x D4 = 64 Spacetime**

**D4 = 28 Standard Model (12)**
**with 16 Gravity + Dark Energy Ghosts**

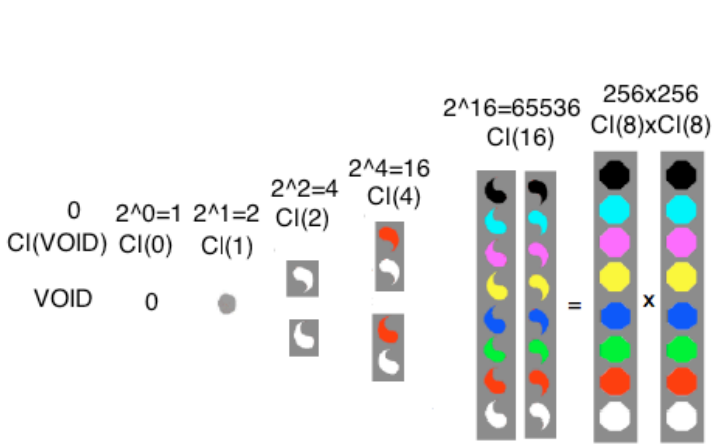
**D4 = 28 Gravity + Dark Energy (16)**
**with 12 Standard Model Ghosts**

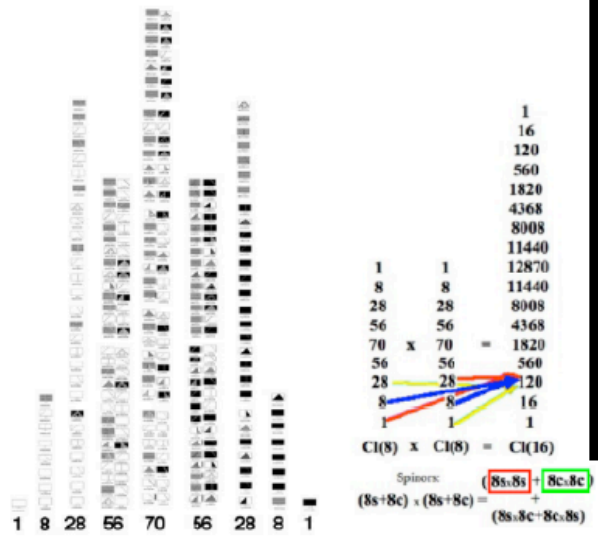
| Dimension of Clifford Algebra | | | | | | |
|---|---|---|---|---|---|---|
| 0 | 2^0=1 | 2^1=2 | 2^2=4 | 2^4=16 | 2^16=65536 | 256x256 |

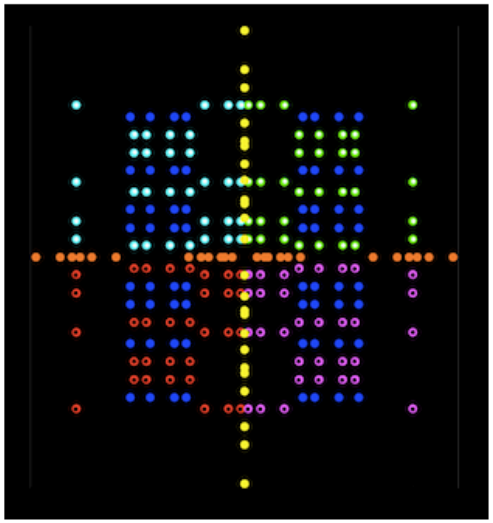
VOID -> Cl(VOID) -> Cl(0,0) -> Cl(0,1)-> Cl(0,2) -> Cl(0,4) -> Cl(0,16) = Cl(0,8)xCl(0,8) --> Cl(0,16)xCl(0,8) = Cl(0,24) -> M(2,Cl(0,24)) = Cl(1,25) ->

-> Completion of Union of All Tensor Products of Cl(1,25) = hyperfinite AQFT

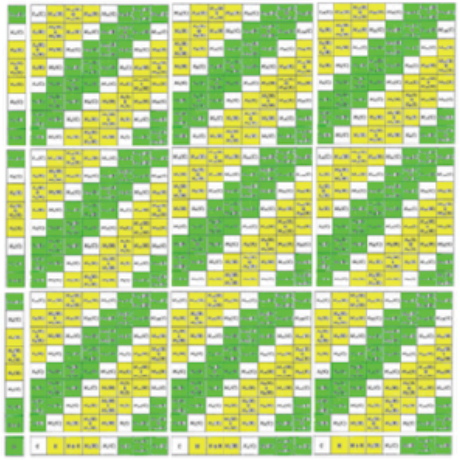
Cl(1,25) = Cl(1,9)xCl(0,8)xCl(0,8) and Cl(1,9) = Cl(1,5) x Cl(0,4) = Cl(2,4) x Cl(0,4)



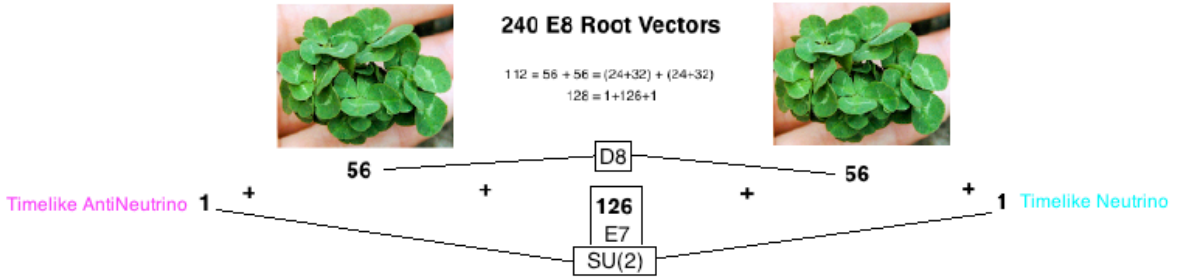
Cl(16) contains 120 + 64 + 64 = 248 = E8
with 112 + 128 = 240 root vectors



The completion of the union of all tensor products of Cl(16) = Cl(8)xCl(8) produces a generalized Hyperfinite II1 von Neumann factor that gives the Cl(16)-E8 model a natural Algebraic Quantum Field Theory

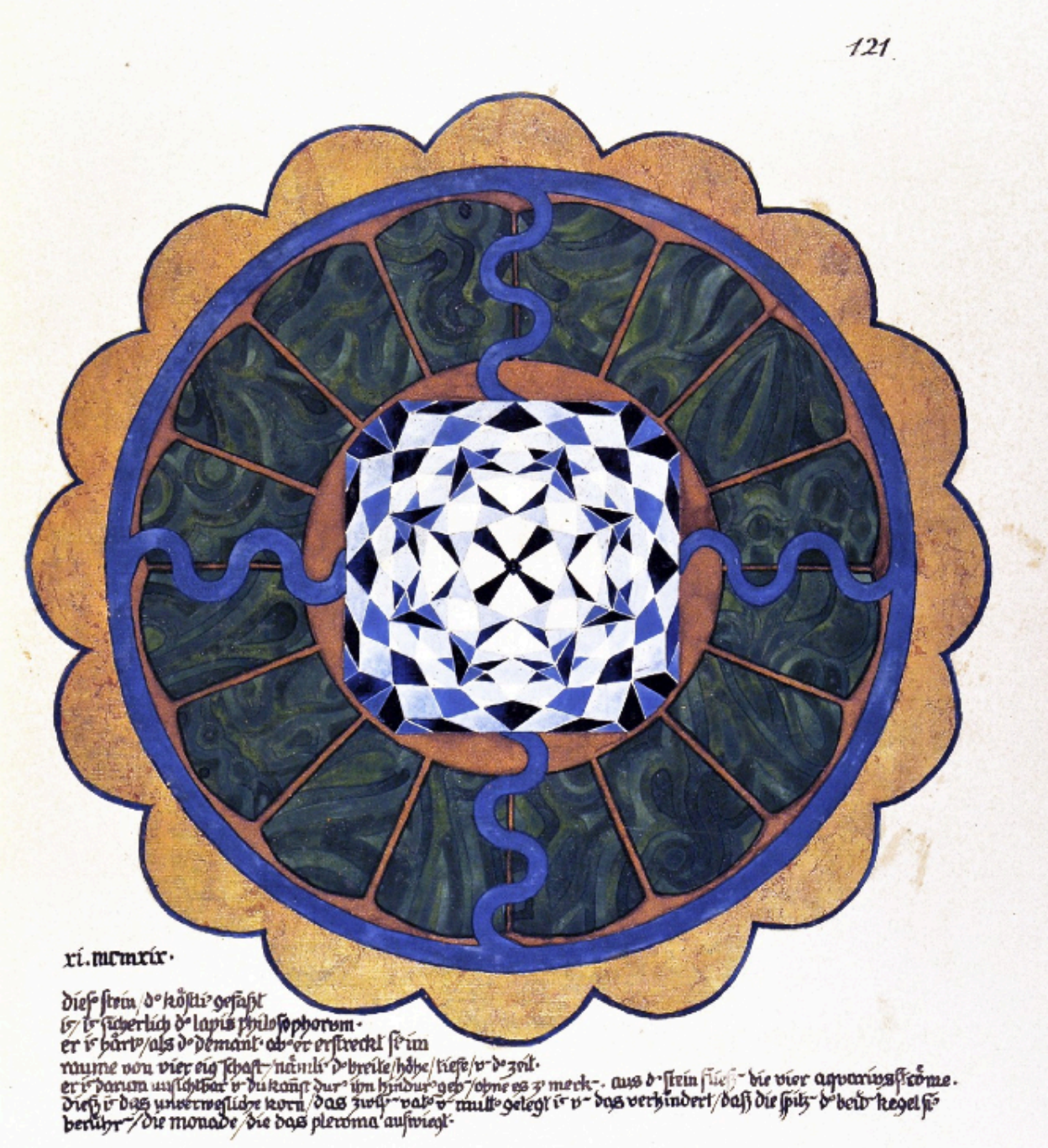
The Cl(16)-E8 AQFT inherits structure from the Cl(16)-E8 Local Lagrangian

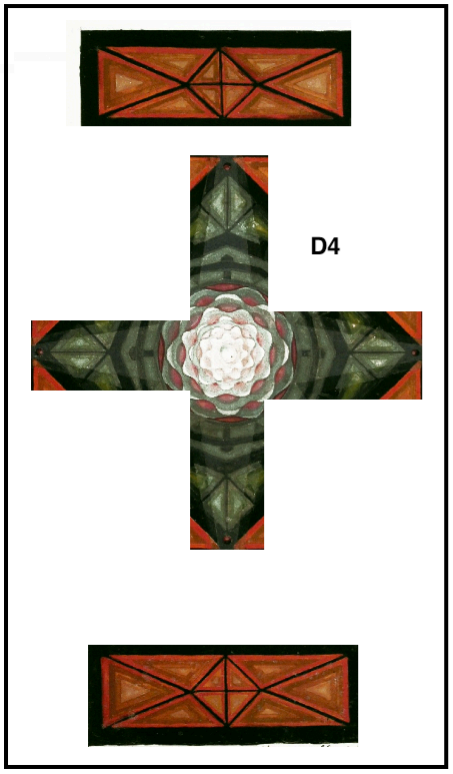
The Creation-Annihilation Operator structure of Cl(16)-E8 AQFT is given by the Maximal Contraction of E8 = semidirect product A7 x h92 where h92 = 92+1+92 = 185-dim Heisenberg algebra and A7 = 63-dim SL(8)

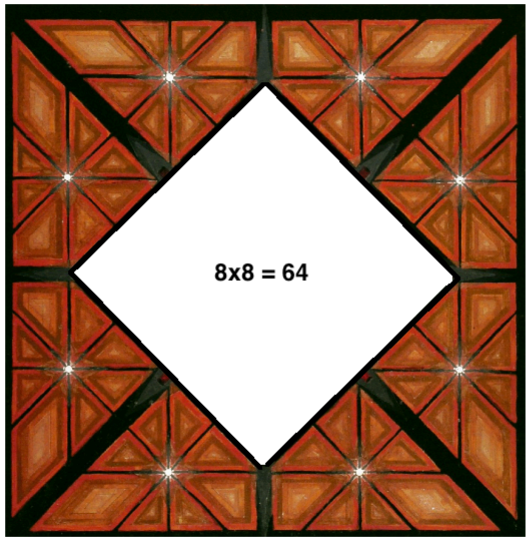


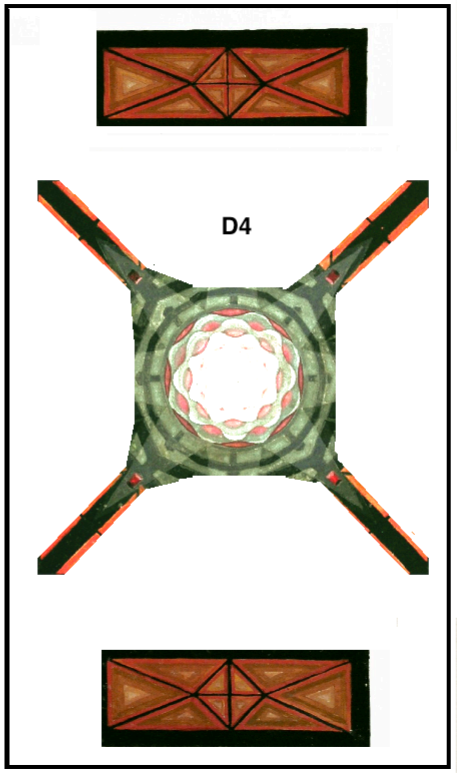
**When Our Planck Scale Universe emerged from its Parent Universe by Quantum Fluctuation it was described by SO(16) symmetry of Compact E8(-248).**
**E8 Compact Form E8(-248) with Symmetric Space E8 / Spin(16) represents Our Planck Scale Universe when it emerged from its Parent Universe by Quantum Fluctuation.**

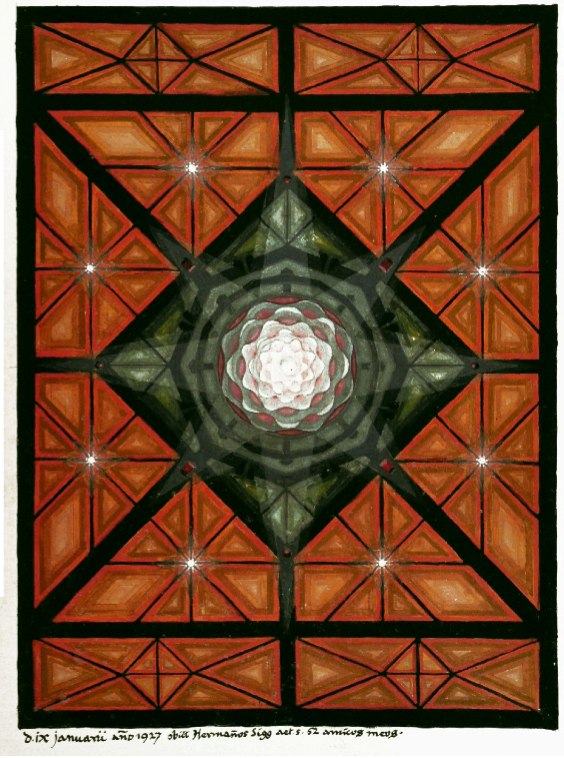
**E8 Split Form EVIII E8(8) with Symmetric Space E8 / SO(8,8)**
**represents**
**Our Universe during Octonionic Inflation**
**with Non-Unitary Quantum Processes.**

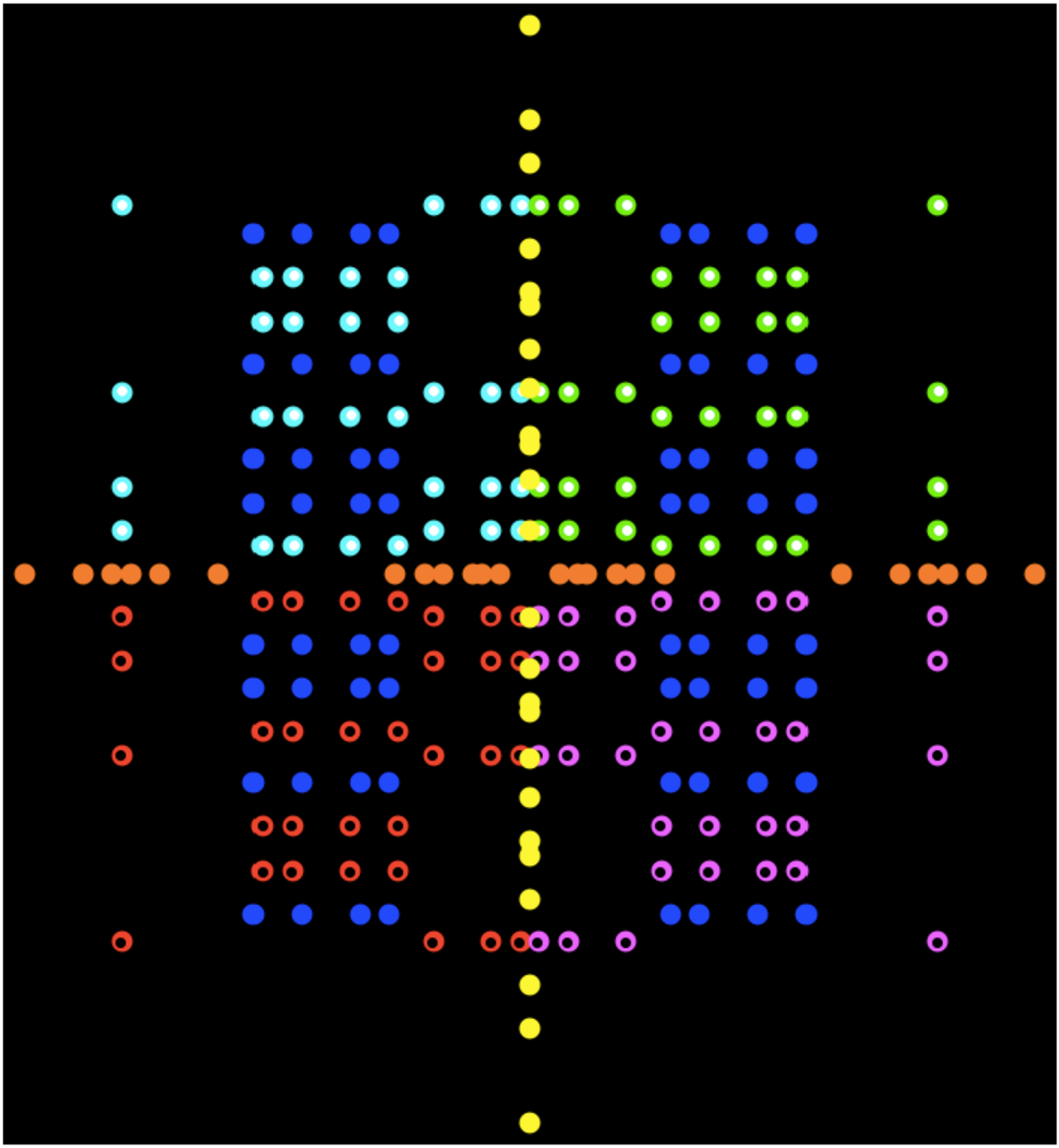


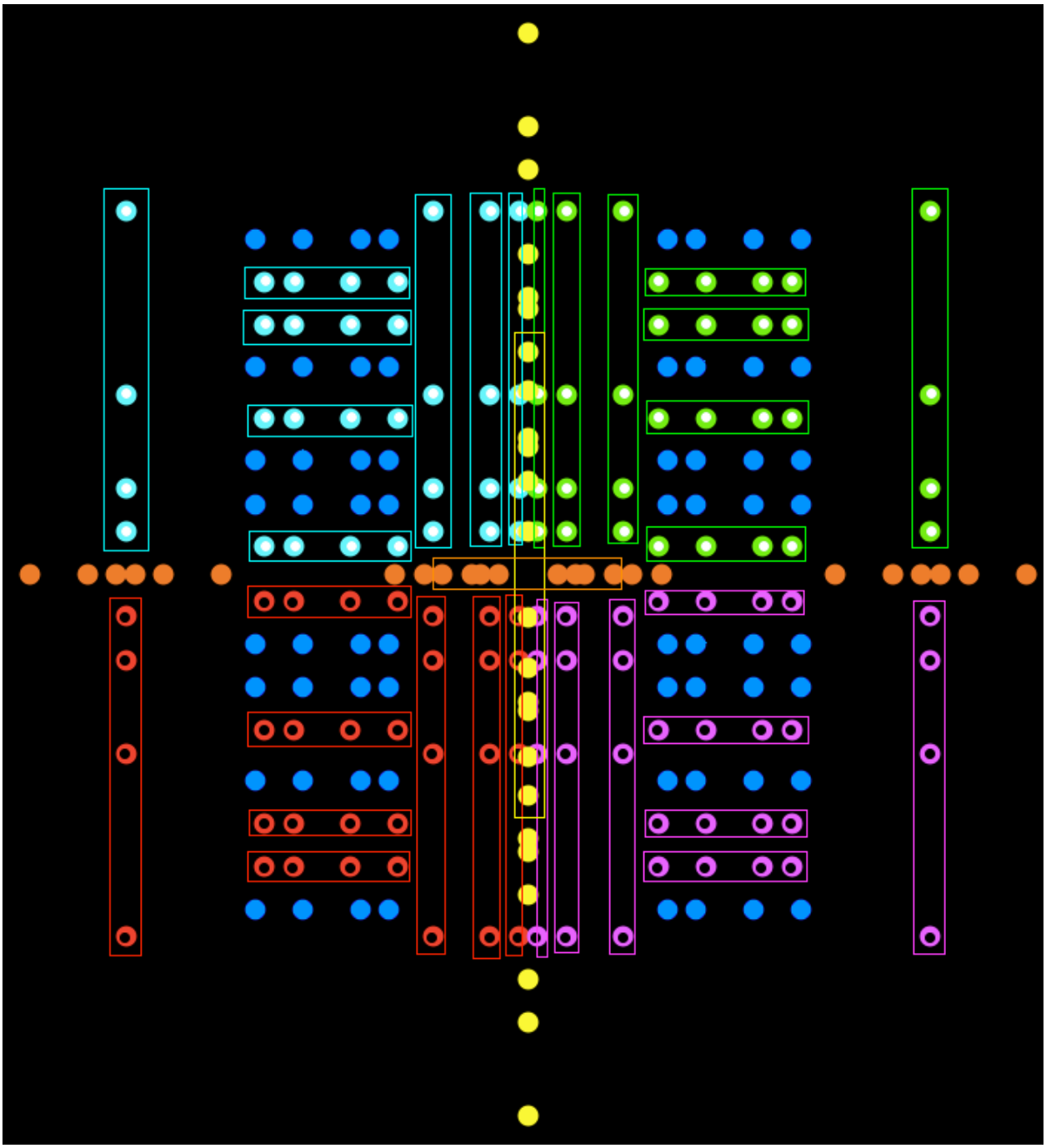

D4

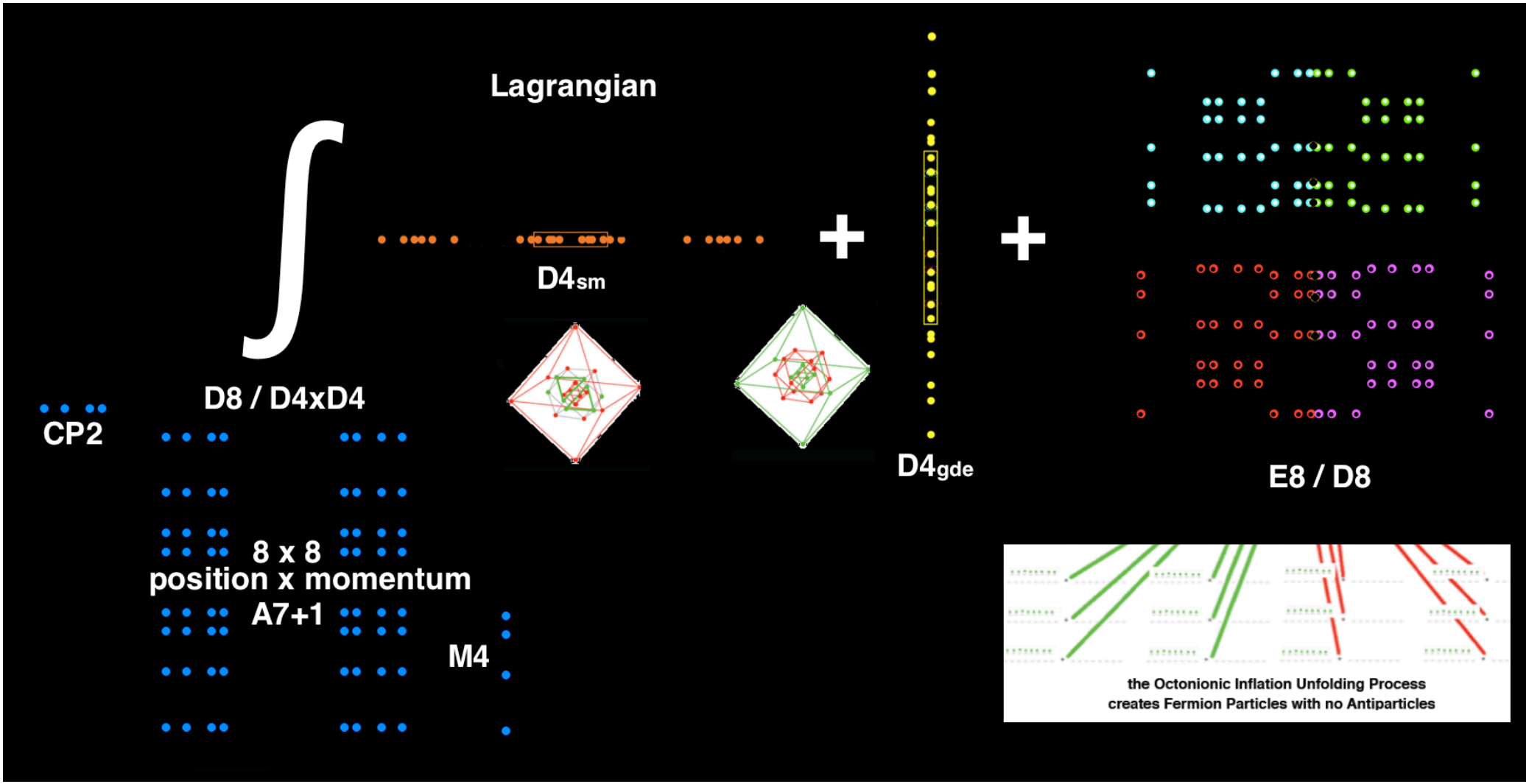

8x8 = 64

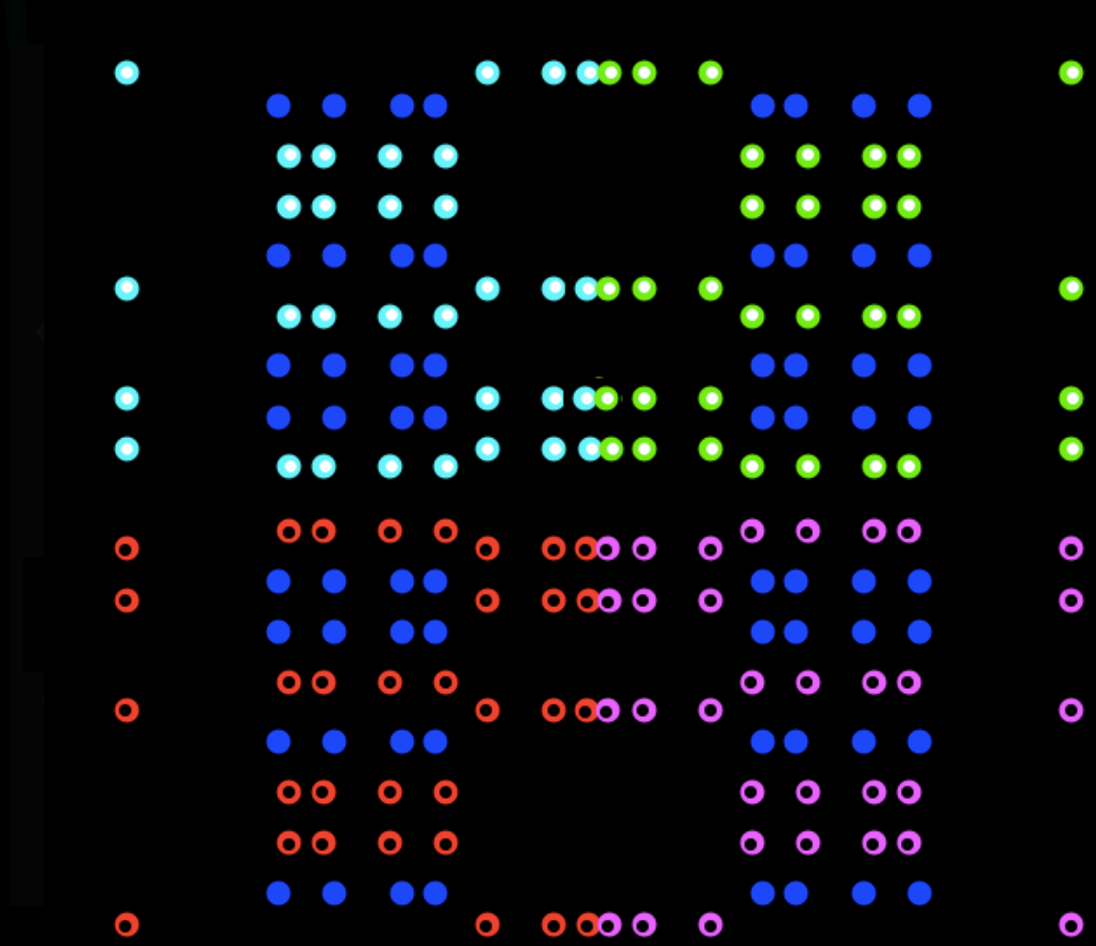

D4

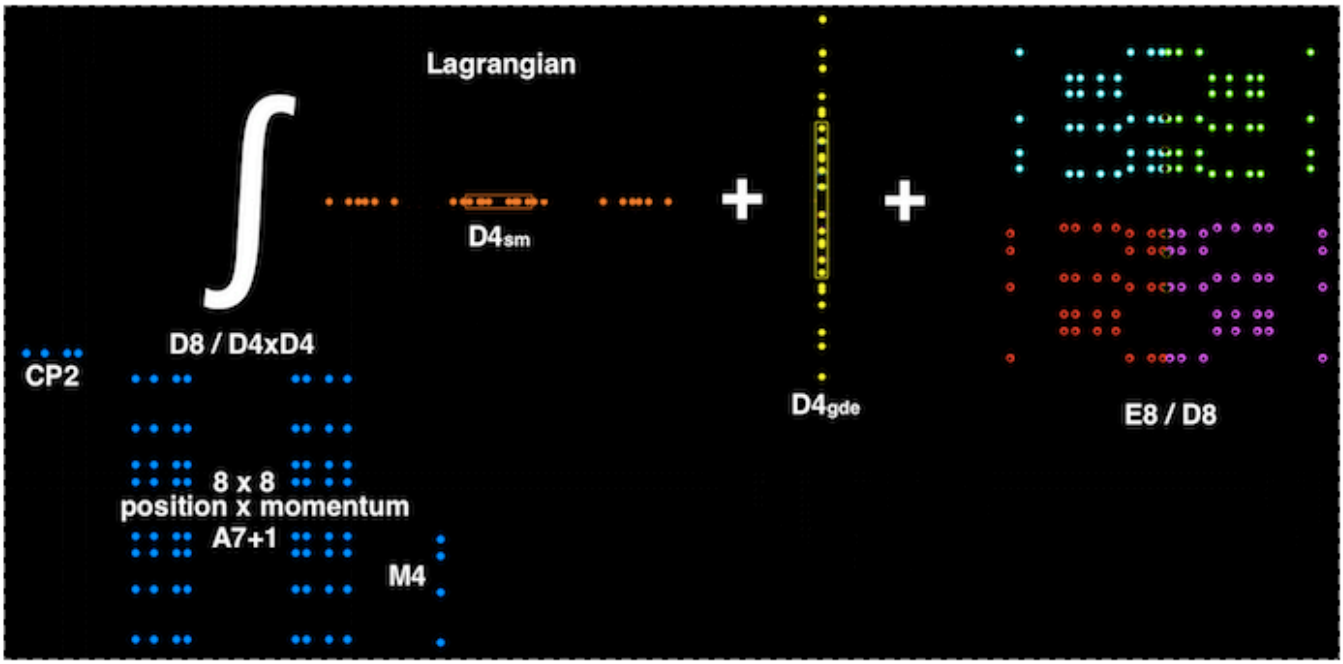

D. IX januarii año 1927 obiit Hermanos Sigg aet. s. 52 annus mens.






Lagrangian
D4sm
D4gde
E8 / D8
D8 / D4xD4
CP2
8 x 8
position x momentum
A7+1
M4
the Octonionic Inflation Unfolding Process
creates Fermion Particles with no Antiparticles

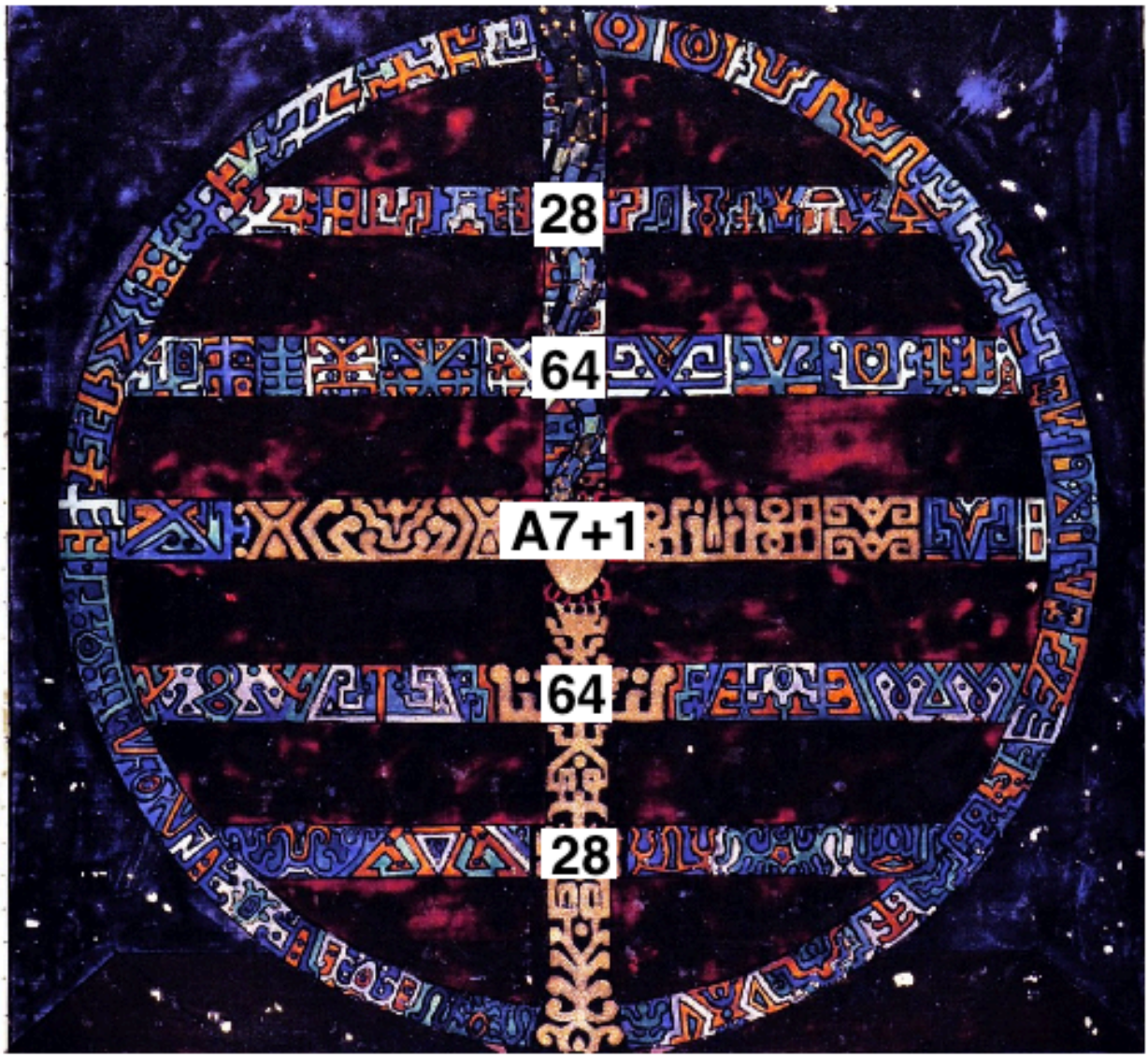




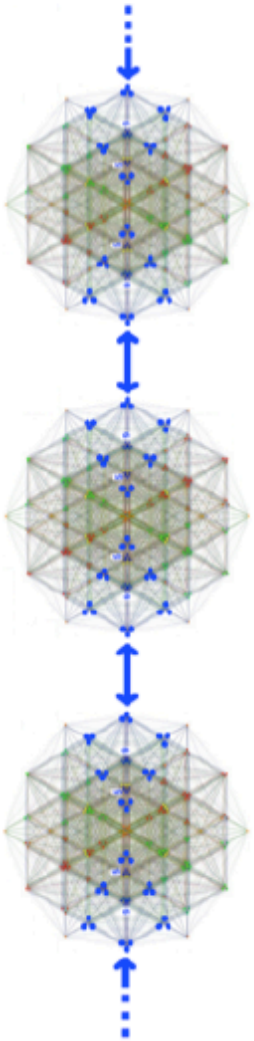

**Creation-Annihilation Operators for 8 components of 8+8 Fermions**
**are**
**odd-grade-+/-1 part**
**of**
**E8 Maximal Contraction generalized Heisenberg Algebra**

$$h92 \times A7 = 28 + 64 + ((SL(8,R)+1) + 64 + 28$$

(see Rutwig Campoamor-Stursberg in Acta Physica Polonica B 41 (2010) 53-77 "Contractions of Exceptional Lie Algebras and SemiDirect Products")


28
64
A7+1
64
28

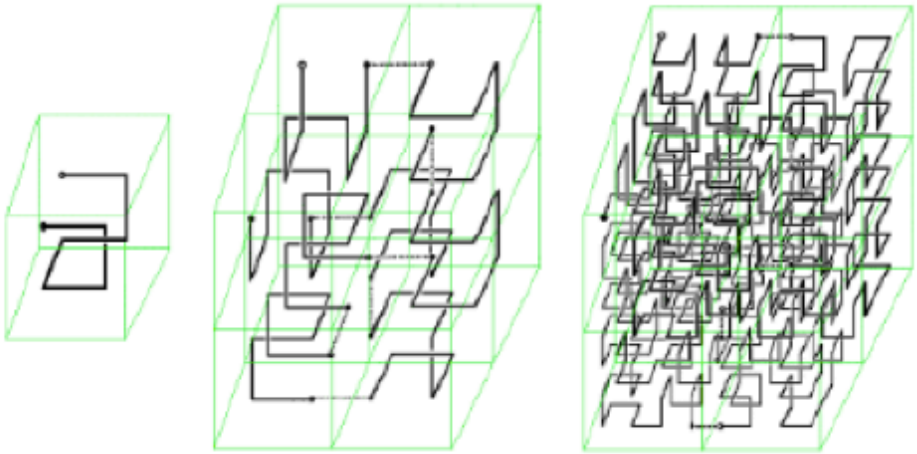
**Big Bang E8(-248) : Spin(16) I Octonion Inflation E8(8) : SO(8,8) I Quaternion Conformal Evolution E8(-24) : SO*(16)**

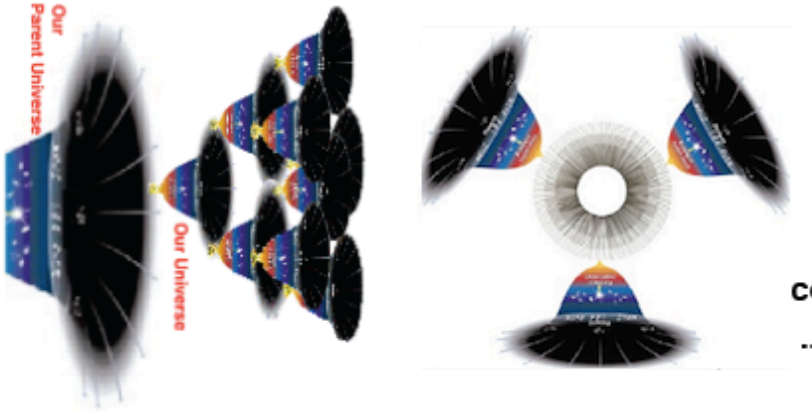


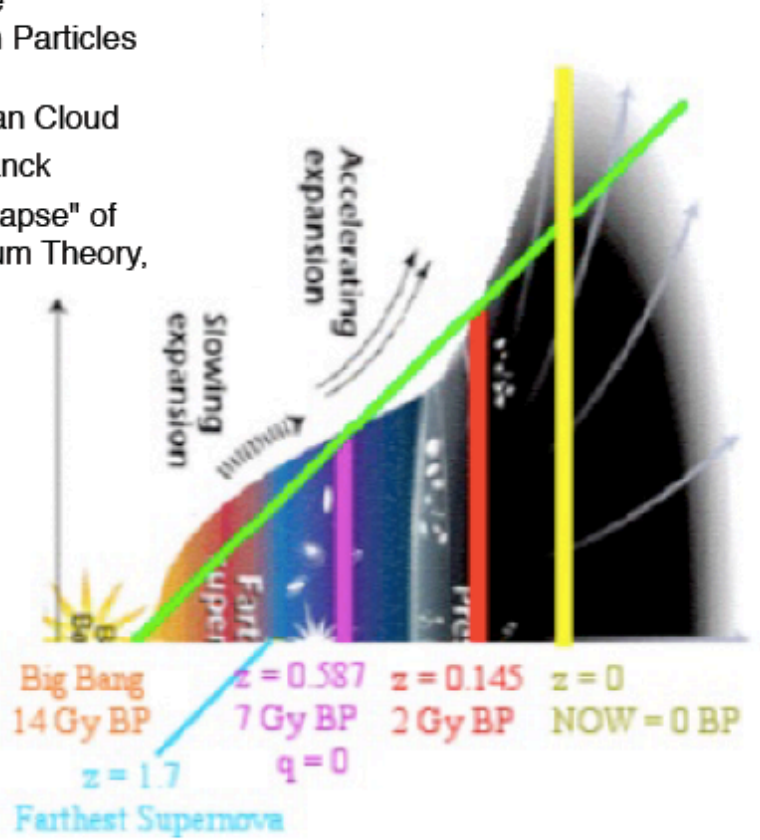
At the end of Non-Unitary Octonionic Inflation Our Universe
had about (1/2) 16^64 = (1/2) (2^4)^64 = 2^255 = 6 x 10^76 Fermion Particles
the size of our Universe was then about 10^(-24) cm
which is about the size of a Fermion Schwinger Source Kerr-Newman Cloud

The End of Inflation time was at about 10^(-34) sec = 2^64 Tplanck

The Zizzi Inflation phase of our universe ends with decoherence "collapse" of the 2^64 Superposition Inflated Universe into Many Worlds of Quantum Theory,





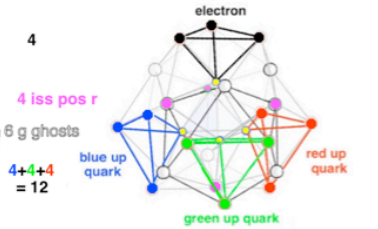




The ratio Dark Energy : Dark Matter : Ordinary Matter for our Universe at the present time is calculated to be:
0.75 : 0.21 : 0.04

Paola Zizzi in gr-qc/0007006:

"... **The self-reduction of the superposed quantum state ... corresponds to a superposed state of ... [ 10^19 = 2^64 qubits ] ... also the number of superposed tubulins-qubits in our brain ... leading to a conscious event**. ...".

**Standard Model 600-Cell**
**with**
**CP2 Internal Symmetry Space**

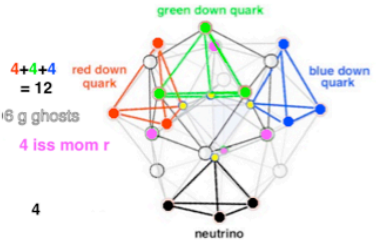


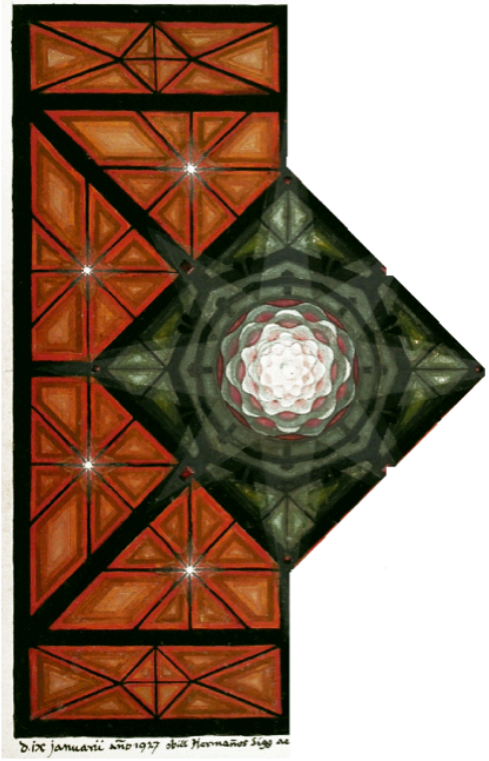

D4sm

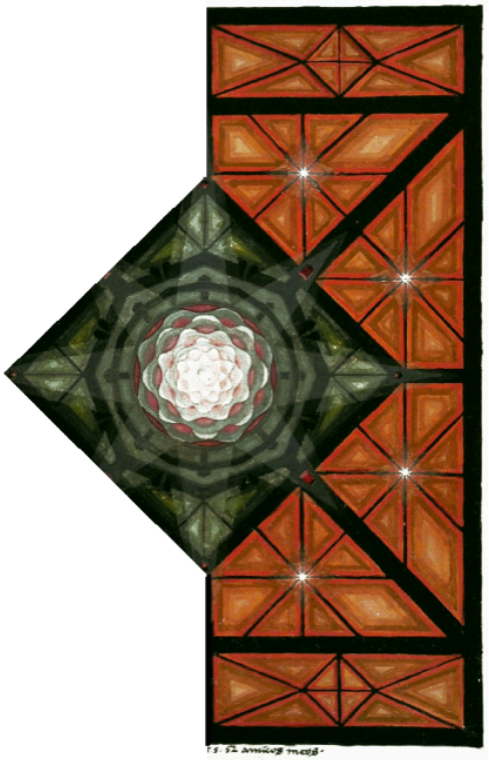
12 iss pos uvw
12 up antiquarks
4 positron

12 sm A0 A1 A2

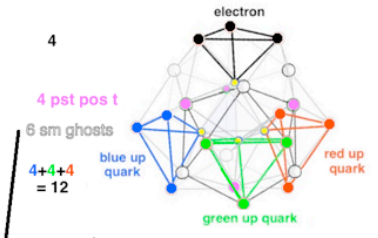
4 antineutrino
12 down antiquarks
12 iss pos uvw





**Conformal Gravity 600-Cell**
**with**
**M4 Physical SpaceTime**

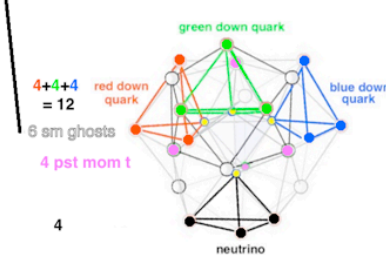


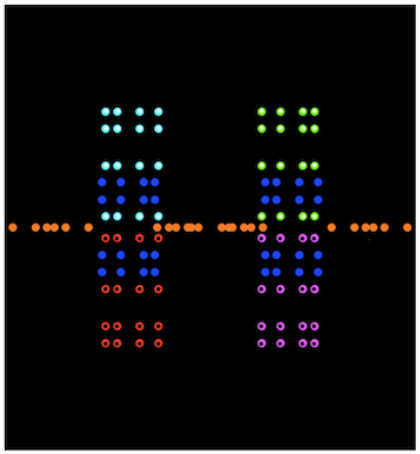

D4g

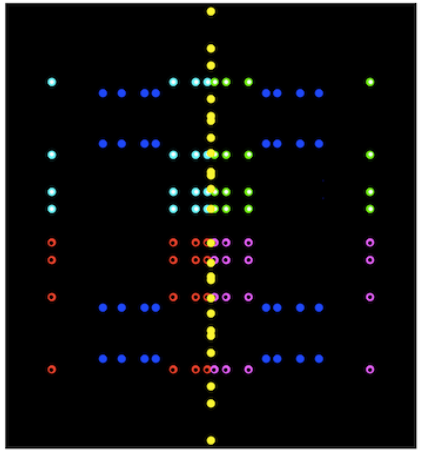
12 pst pos xyz
12 up antiquarks
4 positron

12 cnf grav A3=D3

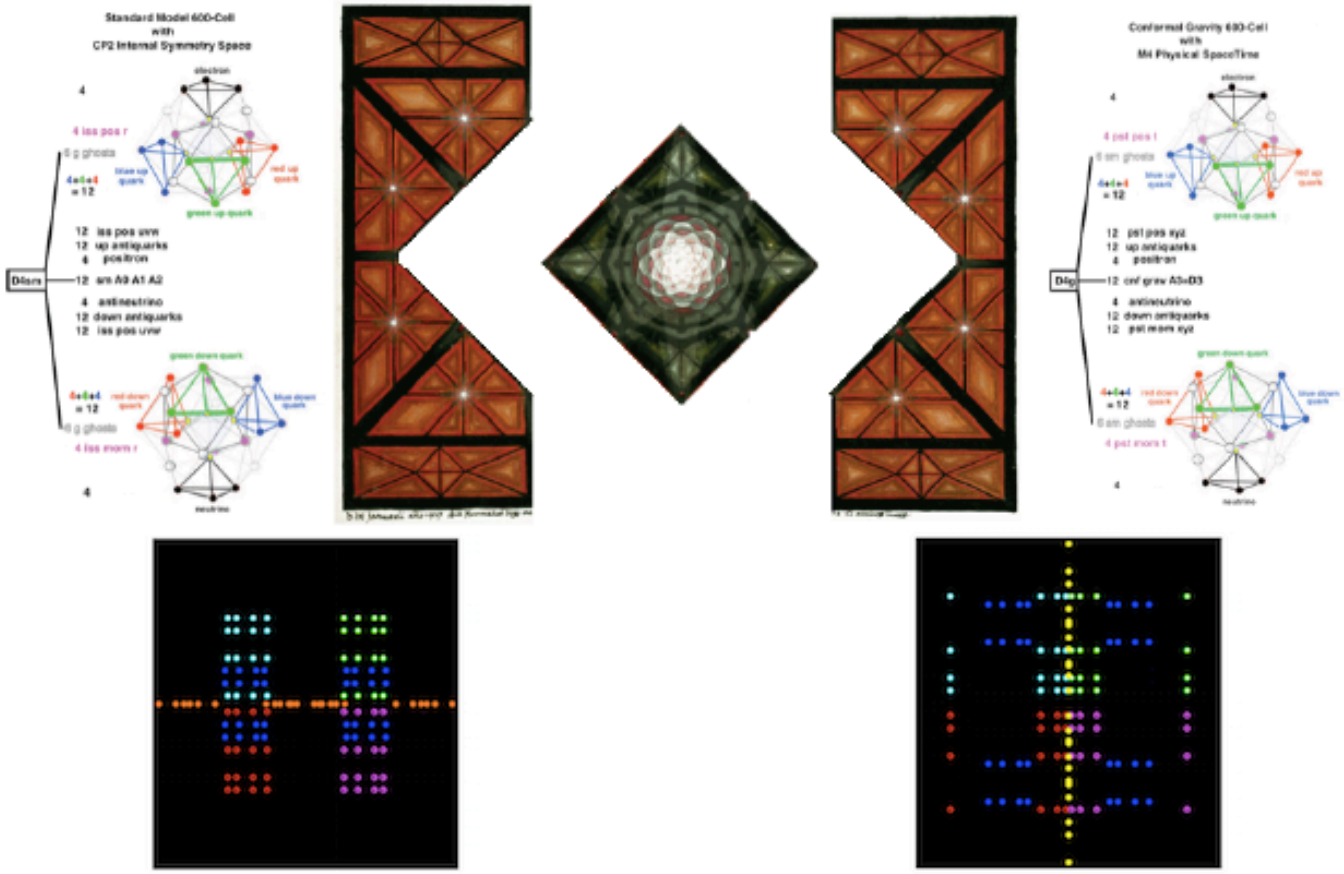
4 antineutrino
12 down antiquarks
12 pst mom xyz



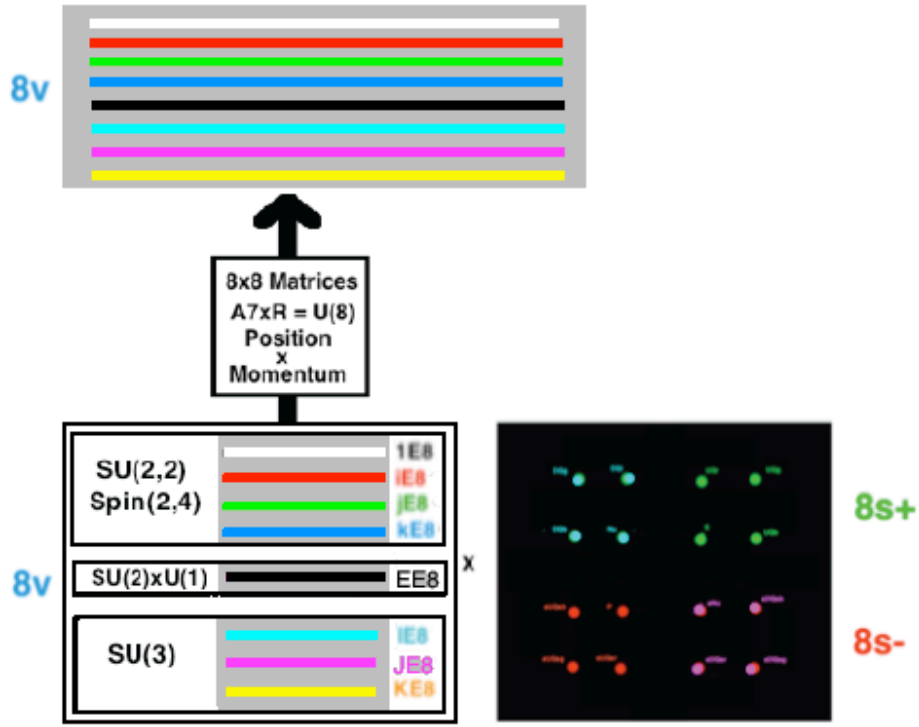





**Inflation ends when a preferred Quaternionic Subspacetime freezes out,**
**converting 8 dim Spacetime into 4+4 dim M4 x CP2 Spacetime where**
**M4 = Physical Minkowski Spacetime and**
**CP2 = SU(3) / U(2) Internal Symmetry Space**
**Octonionic Integral becomes two Quaternionic Integrals**




**8-dim Octonionic Spacetime was broken into**
**(4+4)-dim Unitary Quaternionic M4 x CP2 Kaluza-Klein Spacetime**
**with SO*(16) symmetry of EIX E8(-24).**
**That transition was**
**a Weyl Unitary Trick within E8(8) from SO(8,8) to SO*(16)**
**followed by**
**a shifting of SO*(16) symmetry from E8(8) to E8(-24)**
**E8 form EIX E8(-24) with Symmetric Space E8 / SO*(16)**
**represents Our Universe after End of Inflation**




Indra's Net of Schwinger Sources - Bohm Quantum Blockchain

The Cl(16)-E8 AQFT inherits structure from the Cl(16)-E8 Local Lagrangian

$\int$ Standard Model Gauge Gravity + Fermion Particle-AntiParticle

8-dim SpaceTime

**the Cl(16)-E8 model at the Planck Scale has spacetime condensing out of Clifford structures forming a Leech lattice underlying 26-dim String Theory of World-Lines** with 8 + 8 + 8 = 24-dim of fermion particles and antiparticles and of spacetime.

Slices of 8v SpaceTime are represented as D8 branes. Each D8 brane has Planck-Scale Lattice Structure superpositions of 8 types of E8 Lattice denoted by 1E8, iE8, jE8, kE8, EE8, IE8, JE8, KE8

Stack D8 branes to get SpaceTime with Strings = World-Lines

Let Oct16 = discrete mutiplicative group { +/-1, +/-i, +/-j, +/-k, +/-E, +/-I, +/-J, +/-K}.
Orbifold by Oct16 the 8s+ to get 8 Fermion Particle Types
Orbifold by Oct16 the 8s- to get 8 Fermion AntiParticle Types

Gauge Bosons from 1E8 and EE8 parts of a D8 give U(2) Electroweak Force
Gauge Bosons from IE8, JE8, and KE8 parts of a D8 give SU(3) Color Force
Gauge Bosons from 1E8, iE8, jE8, and kE8 parts of a D8 give U(2,2) Conformal Gravity

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

The automorphism group of a single 26-dim String Theory cell modulo the Leech lattice is the Monster Group of order about 8 x 10^53.

When a fermion particle/antiparticle appearsTachyons create a cloud of particles/antiparticles. The cloud is one Planck-scale Fundamental Fermion Valence Particle plus an effectively neutral cloud of particle/antiparticle pairs forming a Kerr-Newman black hole. That cloud constitutes the Schwinger Source.

**The Schwinger Sources are finite regions in a Complex Domain spacetime corresponding to Green's functions of particle creation / annihilation.**

Its structure comes from the 24-dim Leech lattice part of the Monster Group which is 2^(1+24) times the double cover of Co1, for a total order of about 10^26.

(Since a Leech lattice is based on copies of an E8 lattice and since there are 7 distinct E8 integral domain lattices there are 7 (or 8 if you include a non-integral domain E8 lattice)mdistinct Leech lattices. The physical Leech lattice is a superposition of them, effectively adding a factor of 8 to the order.)

The volume of the Kerr-Newman Cloud is on the order of 10^27 x Planck scale, = roughly 10^(-24) cm.

Julian Schwinger describes Elementary Particles  as volumes of space - Sources - whose properties are determined by Green's Functions characteristic of the volumes.

In E8 Physics any Elementary Particle is immediately surrounded by a cloud of virtual particle-antiparticle pairs similar to a Kerr-Newman Black Hole with Symmetric Space - Bounded Complex Domain - Shilov Boundary structure corresponding to its Gauge Group properties.
The Poisson Kernel - Bergman Kernel defines the Green's Function.

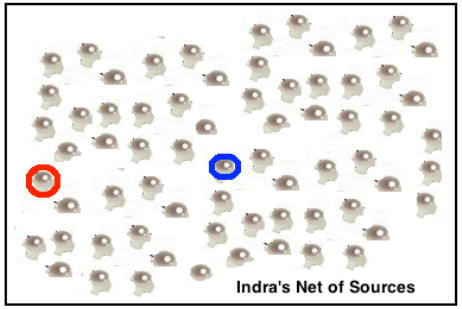
The initial Valence Particle is Planck scale. The number of Virtual Particles is determined by the Planck scale geometry of spacetime. The E8 model at the Planck Scale has spacetime condensing out of Clifford structures forming a Lorentz Leech lattice underlying 26-dim String Theory of World-Lines with 8 + 8 + 8 = 24-dim of fermion particles and antiparticles and of spacetime.
The automorphism group of one 26-dim String Theory cell modulo the Leech lattice is the Monster Group of order about 8 x 10^53.
The Cloud structure comes from the 24-dim Leech lattice part of the Monster Group which is 2^(1+24) times the double cover of Co1, for an order of about 10^26. Due to superpostions of algebraically independent E8 Lattices the total number of Virtual particle/ antiparticle pairs is about 10^27 so the volume of the Kerr-Newman Cloud is on the order of 10^27 x Planck scale, and its size should be about 10^(27/3) x 1.6 x 10^(-33) cm = roughly 10^(-24) cm.

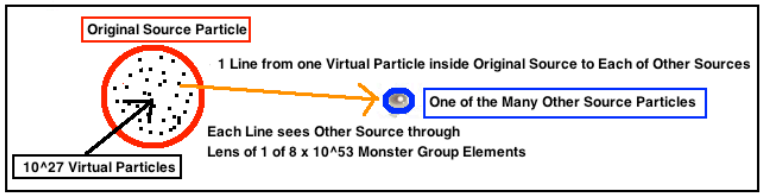
Each Schwinger Source particle-antiparticle pair should see (with Bohm Quantum Potential and Sarfatti Back-Reaction) the rest of our Universe in the perspective of 8 x 10^53 Monster Symmetry so a Schwinger Source acting as a Jewel of Indra's Net of Schwinger Source Bohm Quantum Blockchain Physics can see 10^27 x 8 x 10^53 = 8 x 10^80 Other Sources of an Indra's Net.

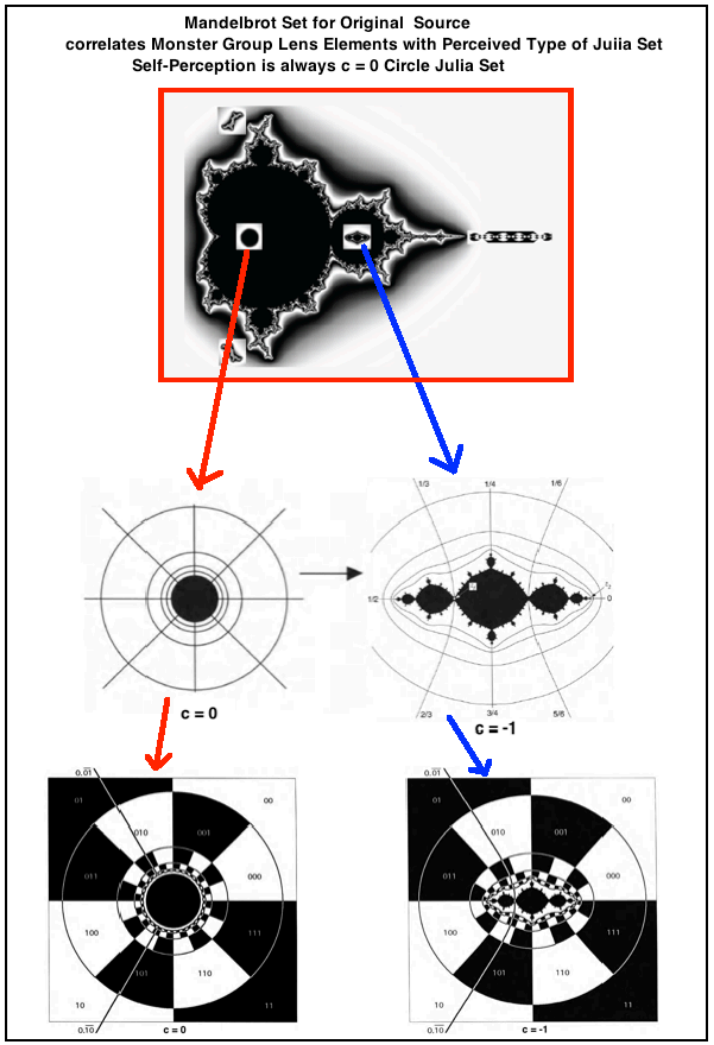
To fit inside the initial Schwinger Source the Information Elements of all the Other Schwinger Sources of Our Universe ( 10^77 or so ) should be distributed as a Fractal Julia Set. There are 2^n stage-n cells in a Binary Decomposition of Julia Sets, so a stage-256 Julia level set based on Binary Decomposition has 2^256 = about 10^77 cells so Full Indra Net information can be seen / reflected by each Schwinger Source Indra Jewel.

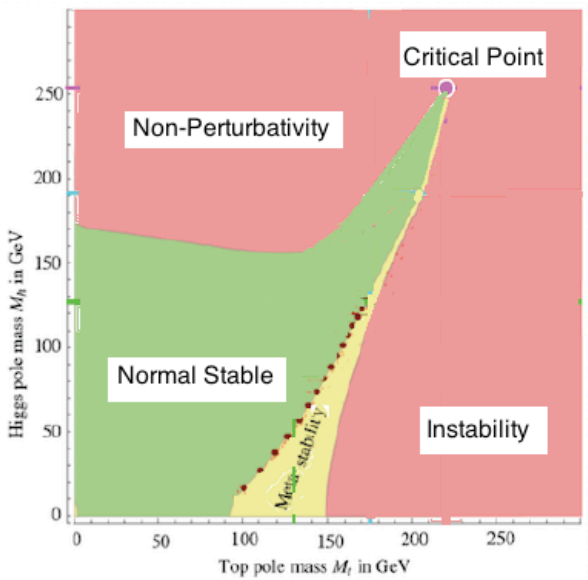
Each Schwinger Source contains 10^27 Virtual pairs of particles each of which can see along a connecting Line an Other Indra's Net Source which Line sees Other Sources through Monster Group Lens elements so that the Other Source appears to the Original Source to be a Julia Set.

Each Schwinger Source has a Mandelbrot Set that tells its Source what each of the many Indra's Net Source Julia set looks like by correlating Monster Group Lens Elements with Types of Julia Set. Self-Perception is always the c = 0 Circle Julia Set.



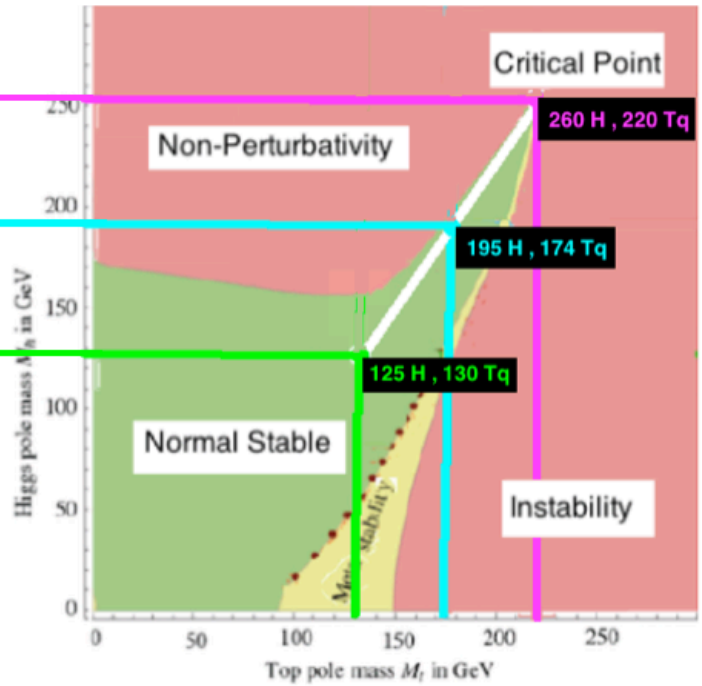



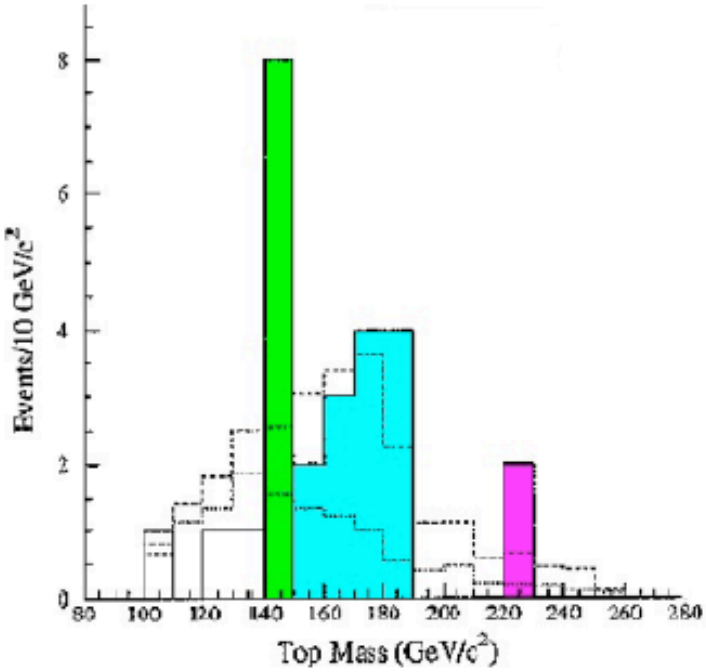


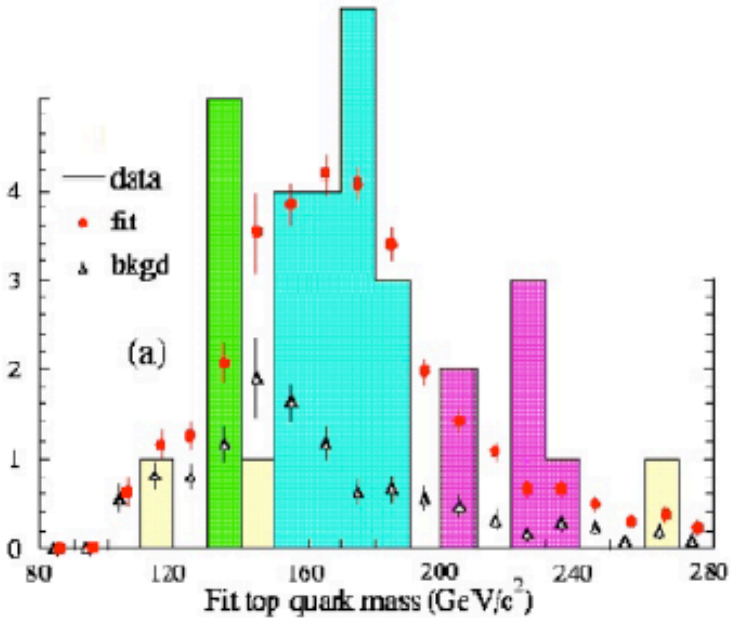

**Critical Point**
**250 H , 220 Tq**

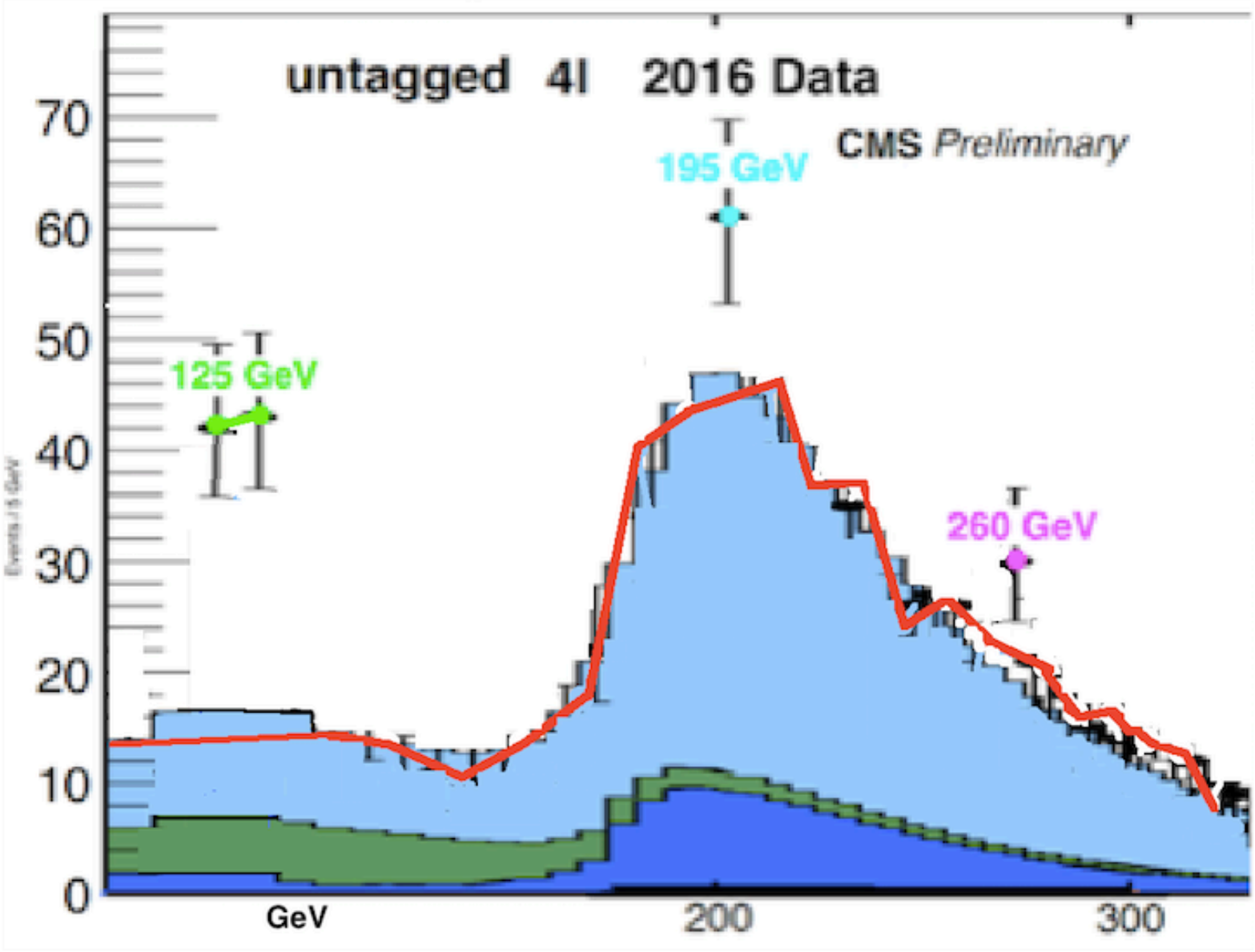
**Non-Perturbativity 4+4 K-K**
**Composite H as Tq-Tantiq Condensate**
**195 H , 174 Tq**

**Normal Stable Ground State**
**125 H , 130 Tq**

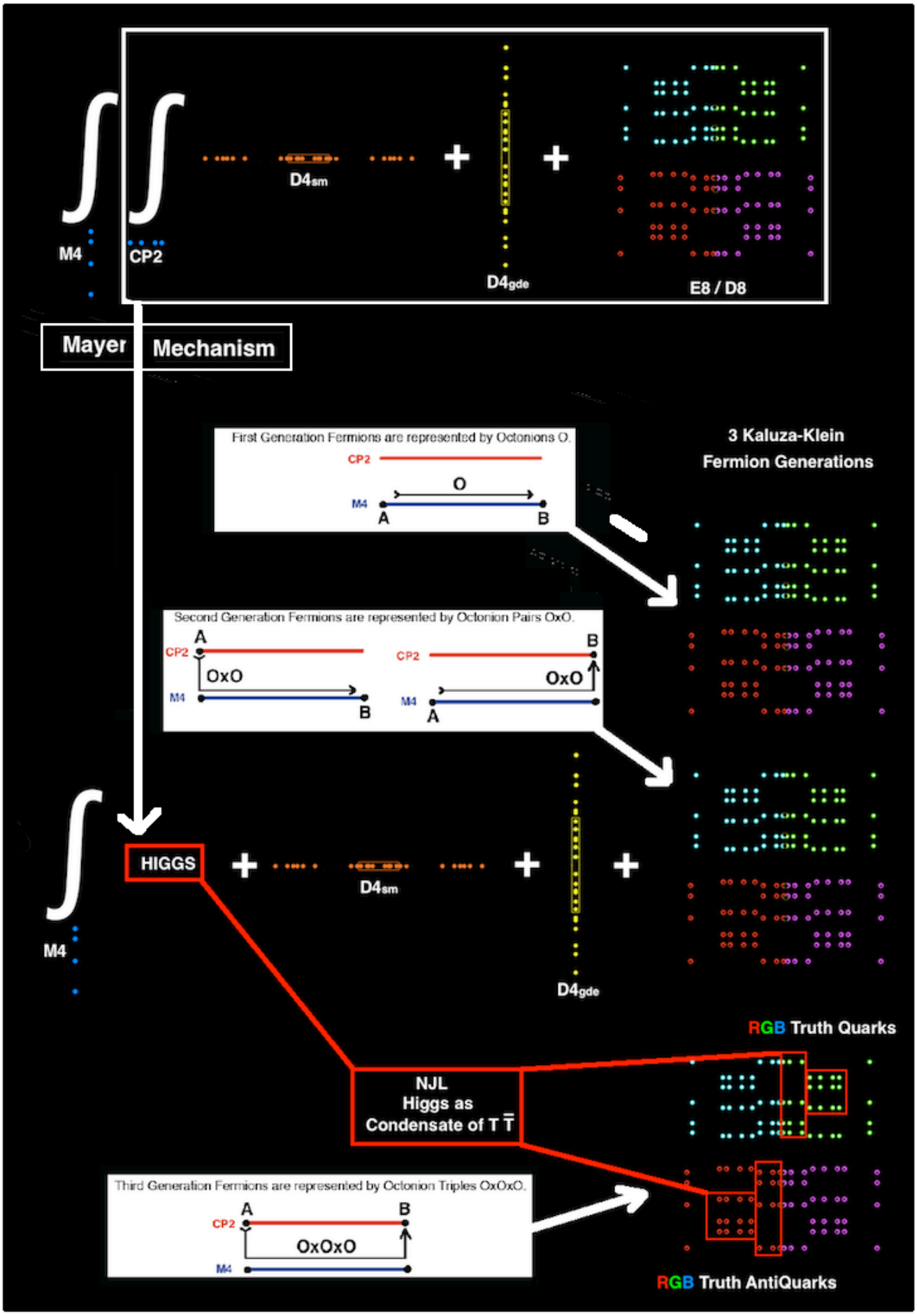



Events/10 GeV/c²
Top Mass (GeV/c²)


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


untagged 4l 2016 Data
CMS Preliminary
195 GeV
125 GeV
260 GeV
GeV

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

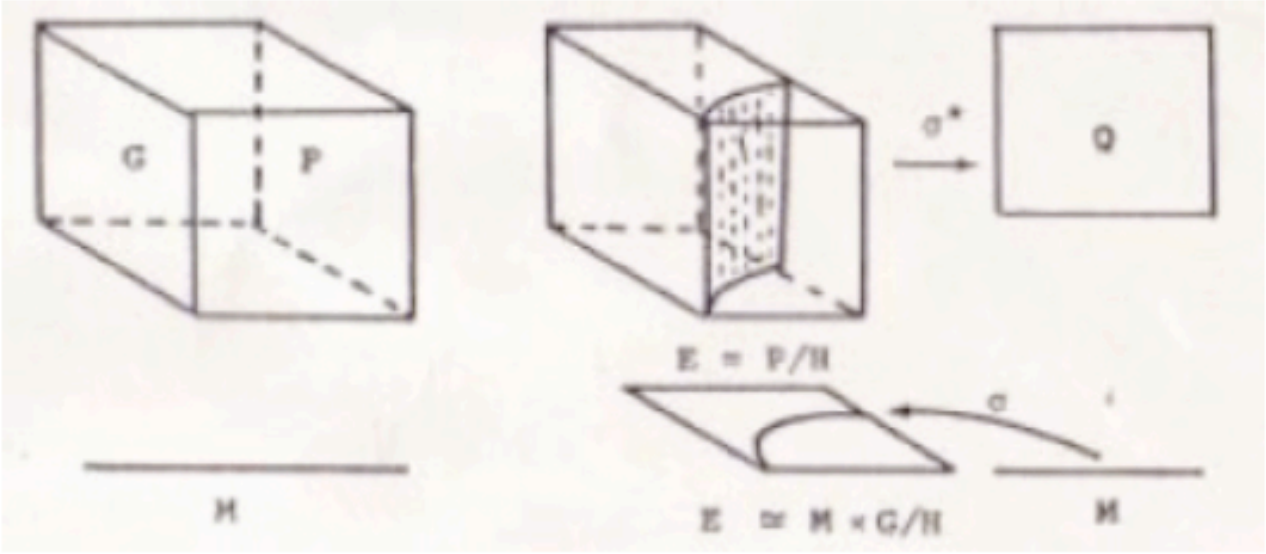


**Quaternionic E7xSU(2) structure breaks 8-dim Spacetime Octonionic Symmetry to Quaternionic (4+4)-dim Associative x CoAssociative Kaluza-Klein Spacetime**

(see Reese Harvey "Spinors and Calibrations" (Academic 1990))

where M4 = 4-dim Minkowski Physical Spacetime is Associative
and CP2 = SU(3) / SU(2) x U(1) Internal Symmetry Space is CoAssociative

Meinhard Mayer said (Hadronic Journal 4 (1981) 108-152): "... each point of ... the ... fibre bundle ... E ...



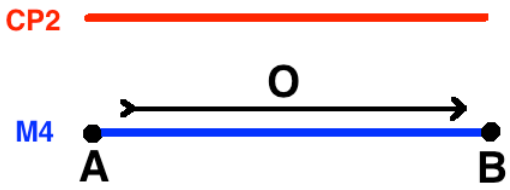

... consists of
a four- dimensional spacetime point x [ in M4 ]
to which is attached the homogeneous space G / H [ SU(3) / U(2) = CP2 ]
...
the components of the curvature lying in the homogeneous space G / H could be reinterpreted as Higgs scalars (with respect to spacetime [ M4 ])
...
the Yang-Mills action reduces to a Yang-Mills action for the h-components [ U(2) components ] of the curvature over M [ M4 ] and a quartic functional for the "Higgs scalars", which not only reproduces the Ginzburg-Landau potential, but also gives the correct relative sign of the constants, required for the BEHK ... Brout-Englert-Higgs-Kibble ... mechanism to work. ...".

(see Appendix - Details of Mayer - Higgs)

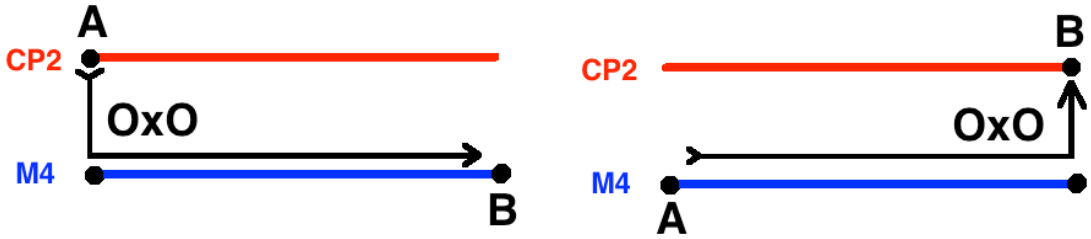
# 3 Generations of Fermions

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:

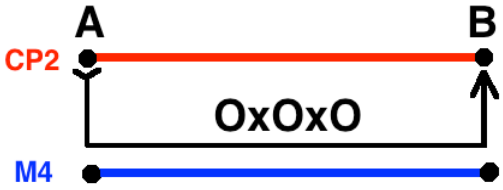
1 - A and B are both in M4: First Generation Fermion
whose path can be represented by the single O basis element
so that First Generation Fermions are represented by Octonions O.




2 - Either A or B, but not both, is in CP2: Second Generation Fermion
whose path must be augmented by one projection from CP2 to M4,
which projection can be represented by a second O basis element
so that Second Generation Fermions are represented by Octonion Pairs OxO.




3 - Both A and B are in CP2: Third Generation Fermion
whose path must be augmented by two projections from CP2 to M4,
which projections can be represented by a second O and a third O,
so that Third Generation Fermions are represented by Octonion Triples OxOxO.

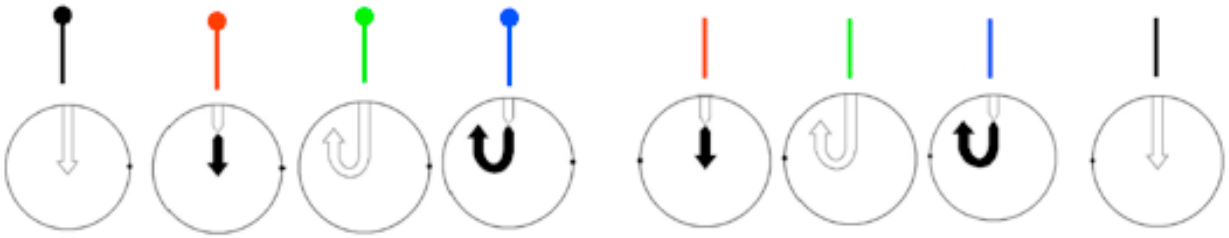


## 3 Generation Fermion Combinatorics

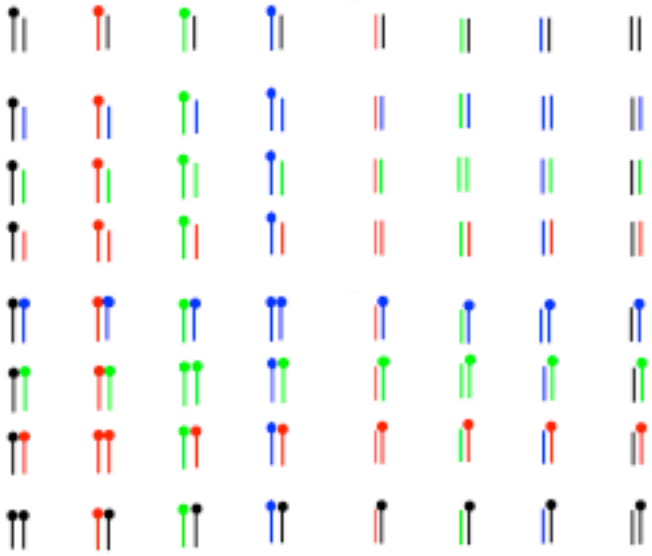
### First Generation (8)

( geometric representation of Octonions is from arXiv 1010.2979 )

| electron | red up quark | green up quark | blue up quark | red down quark | green down quark | blue down quark | neutrino |
|---|---|---|---|---|---|---|---|
| E | I | J | K | i | j | k | 1 |



### Second Generation (64)

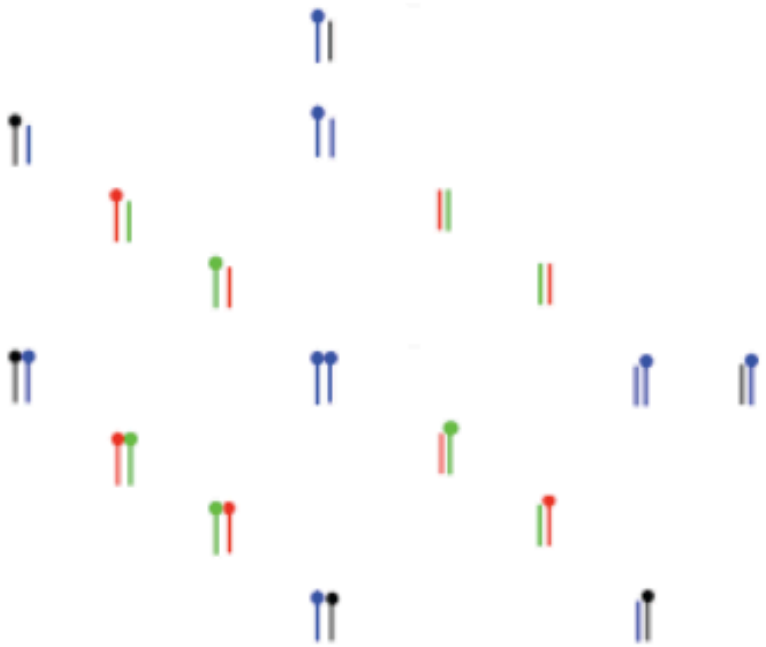


Mu Neutrino (1)
Rule: a Pair belongs to the Mu Neutrino if:
All elements are Colorless (black)
and all elements are Associative
(that is, is 1 which is the only Colorless Associative element) .

Muon (3)
Rule: a Pair belongs to the Muon if:
All elements are Colorless (black)
and at least one element is NonAssociative
(that is, is E which is the only Colorless NonAssociative element).

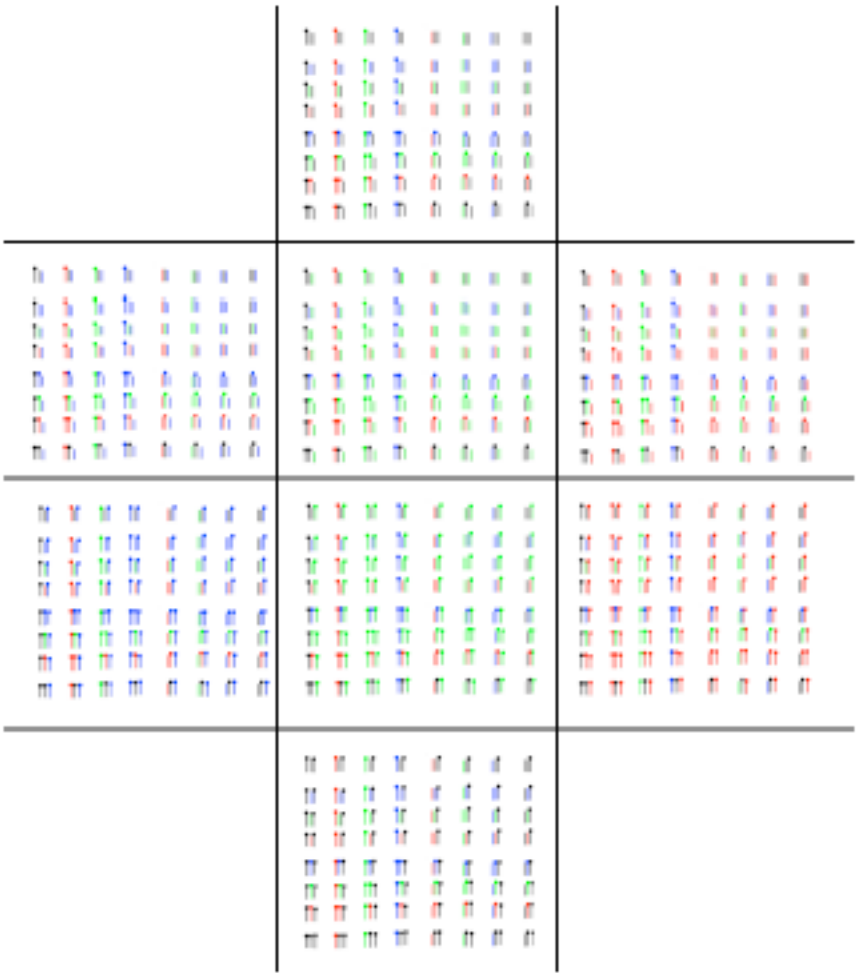
Blue Strange Quark **(3)**
Rule: a Pair belongs to the Blue Strange Quark if:
There is at least one Blue element and the other element is Blue or Colorless (black)
and all elements are Associative (that is, is either 1 or i or j or k).

Blue Charm Quark **(17)**
Rules: a Pair belongs to the Blue Charm Quark if:
1 - There is at least one Blue element and the other element is Blue or Colorless (black)
and at least one element is NonAssociative (that is, is either E or I or J or K)
2 - There is one Red element and one Green element (Red x Green = Blue).



( Red and Green Strange and Charm Quarks follow similar rules )

**Third Generation (512)**

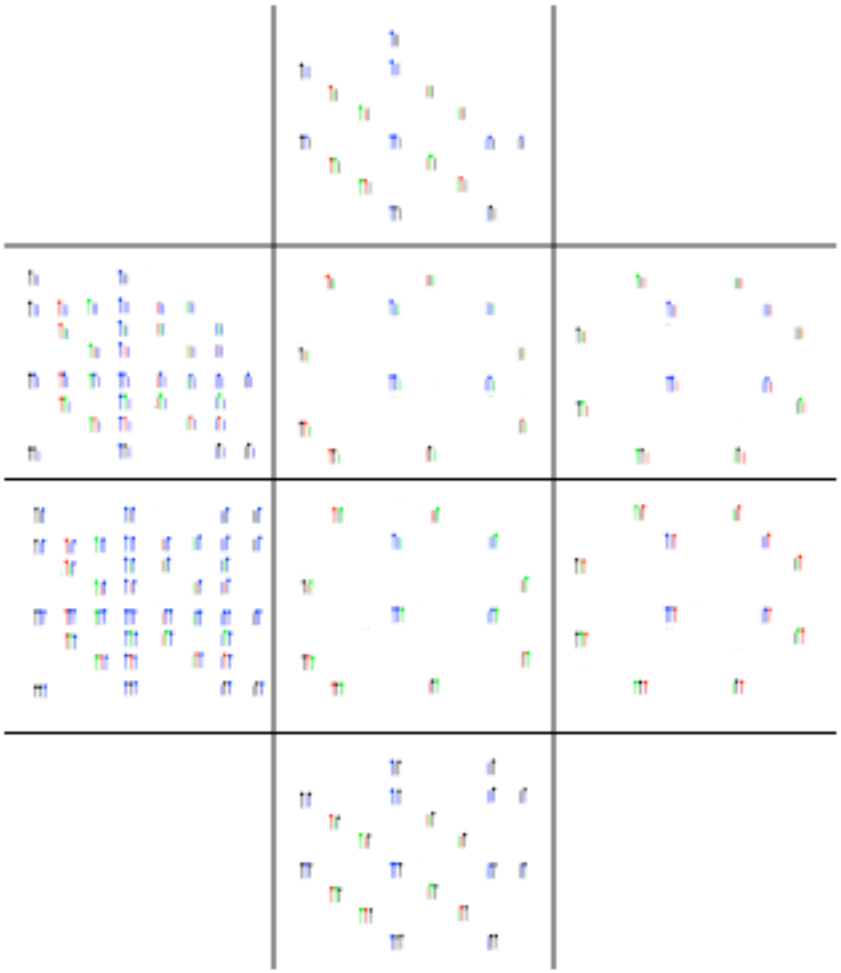


Tau Neutrino (1)
Rule: a Triple belongs to the Tau Neutrino if:
All elements are Colorless (black)
and all elements are Associative
(that is, is 1 which is the only Colorless Associative element)

Tauon (7)
Rule: a Triple belongs to the Tauon if:
All elements are Colorless (black)
and at least one element is NonAssociative (that is, is E which is the only Colorless NonAssociative element)

Blue Beauty Quark (7)
Rule: a Triple belongs to the Blue Beauty Quark if:
There is at least one Blue element and all other elements are Blue or Colorless (black) and all elements are Associative (that is, is either 1 or i or j or k).

Blue Truth Quark (161)
Rules: a Triple belongs to the Blue Truth Quark if:
1 - There is at least one Blue element and all other elements are Blue or Colorless (black)
and at least one element is NonAssociative (that is, is either E or I or J or K)
2 - There is one Red element and one Green element and the other element is Colorless (Red x Green = Blue)
3 - The Triple has one element each that is Red, Green, or Blue,
in which case the color of the Third element (for Third Generation) is determinative and must be Blue.



( Red and Green Beauty and Truth Quarks follow similar rules )

Fermion masses are calculated as a product of four factors:

**V(Qfermion) x N(Graviton) x N(octonion) x Sym**

The ratio of the down quark spinor manifold volume factor
to the electron spinor manifold volume factor is

**V(Qdown quark) / V(Qelectron) = V(S^7x RP^1)/1 = pi^5 / 3.**

The third generation fermion particles correspond to triples of octonions.
There are 8^3 = 512 such triples.
The triple { 1,1,1 } corresponds to the tau-neutrino.
The other 7 triples involving only 1 and E correspond to the tauon:
{ E, E, E } { E, E, 1 } { E, 1, E } { 1, E, E } { 1, 1, E } { 1, E, 1 } { E, 1, 1 }
The symmetry of the 7 tauon triples is the same
as the symmetry of the first generation tree-level-massive fermions,
3 down, quarks, the 3 up quarks, and the electron,
so by the Sym factor the tauon mass should be the same as
the sum of the masses of the first generation massive fermion particles.
Therefore the **tauon mass is calculated at tree level as 1.877 GeV**.

The beauty quark corresponds to 21 triples.
They are triples of the same form as the 7 tauon triples involving 1 and E,
but for 1 and I, 1 and J, and 1 and K = red, green, and blue beauty quarks.
The seven red beauty quark triples correspond to the seven tauon triples,
except that the beauty quark interacts with 6 Spin(0,5) gravitons
while the tauon interacts with only two.
The red beauty quark constituent mass should be the tauon mass times
the third generation graviton factor 6/2 = 3,
so the **red beauty quark mass is mb = 5.63111 GeV**.

Triples of the type { 1, I, J } , { I, J, K }, etc.,
do not correspond to the beauty quark, but to the truth quark.
The truth quark corresponds to those 512 - 1 - 7 - 21 = 483 triples,
so the constituent mass of the red truth quark
is 161 / 7 = 23 times the red beauty quark mass,
and the **red T-quark mass is mt = 129.5155 GeV**

**248-dim E8 contains 120-dim D8**

**E8 / D8 = 64 + 64 Fermions**

**D8 / D4 x D4 = 64 Spacetime**

**D4 = 28 Standard Model (12)**
**with 16 Gravity + Dark Energy Ghosts**

**D4 = 28 Gravity + Dark Energy (16)**
**with 12 Standard Model Ghosts**

The 24 Orange Root Vectors of the D4 of E8 Standard Model + Gravity Ghosts
are on the Horizontal X-axis.

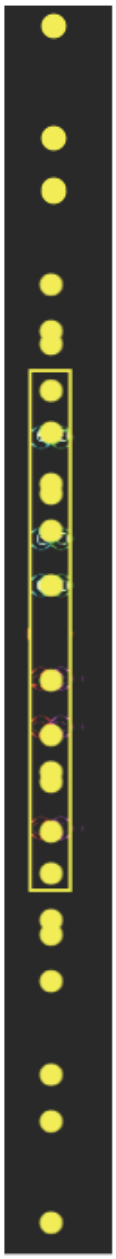
8 of them in the Orange Box represent the 8 Root Vectors of the Standard Model Gauge Groups SU(3) SU(2) U(1).
Their 4 Cartan Subalgebra elements correspond
to the 4 Cartan Subalgebra elements of D4 of E8 Standard Model + Gravity Ghosts
and to half of the 8 Cartan Subalgebra elements of E8.

The other 24-8 = 16 Orange Root Vectors represent Ghosts of 16D U(2,2)
which contains the Conformal Group SU(2,2) = Spin(2,4)
that produces Gravity + Dark Energy by the MacDowell-Mansouri mechanism.

Standard Model Gauge groups come from CP2 = SU(3) / SU(2) x U(1)
(as described by Batakis in Class. Quantum Grav. 3 (1986) L99-L105)

Electroweak SU(2) x U(1) is gauge group as isotropy group of CP2.

SU(3) is global symmetry group of CP2 but due to Kaluza-Klein M4 x CP2 structure of compact CP2 at every M4 spacetime point,
it acts as Color gauge group with respect to M4.



The 24 Yellow Root Vectors of the D4 of E8 Gravity + Standard Model Ghosts are on the Vertical Y-axis.
12 of them in theYellow Box represent the 12 Root Vectors of the Conformal Gauge Group SU(2,2) = Spin(2,4) of Conformal Gravity + Dark Energy.
The 4 Cartan Subalgebra elements of SU(2,2)xU(1) = U(2,2) correspond to the 4 Cartan Subalgebra elements of D4 of E8 Gravity + Standard Model Ghosts and to the other half of the 8 Cartan Subalgebra elements of E8.

The other 24-12 = 12 Yellow Root Vectors represent Ghosts of 12D Standard Model whose Gauge Groups are SU(3) SU(2) U(1).

Gravity and Dark Energy come from its Conformal Subgroup SU(2,2) = Spin(2,4)
(see Appendix - Details of Conformal Gravity and ratio DE : DM :OM)

SU(2,2) = Spin(2,4) has 15 generators:

1 Dilation representing Higgs Ordinary Matter

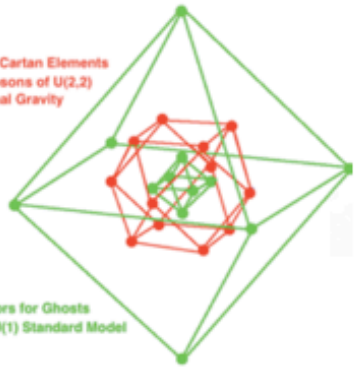
4 Translations representing Primordial Black Hole Dark Matter

10 = 4 Special Conformal + 6 Lorentz representing Dark Energy
(see Irving Ezra Segal, "Mathematical Cosmology and Extragalactic Astronomy" (Academic 1976))

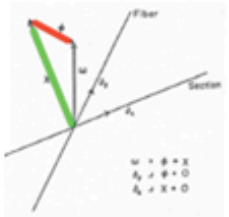
The basic ratio Dark Energy : Dark Matter : Ordinary Matter = 10:4:1 = 0.67 : 0.27 : 0.06
When the dynamics of our expanding universe are taken into account, the ratio is calculated to be **0.75 : 0.21 : 0.04**

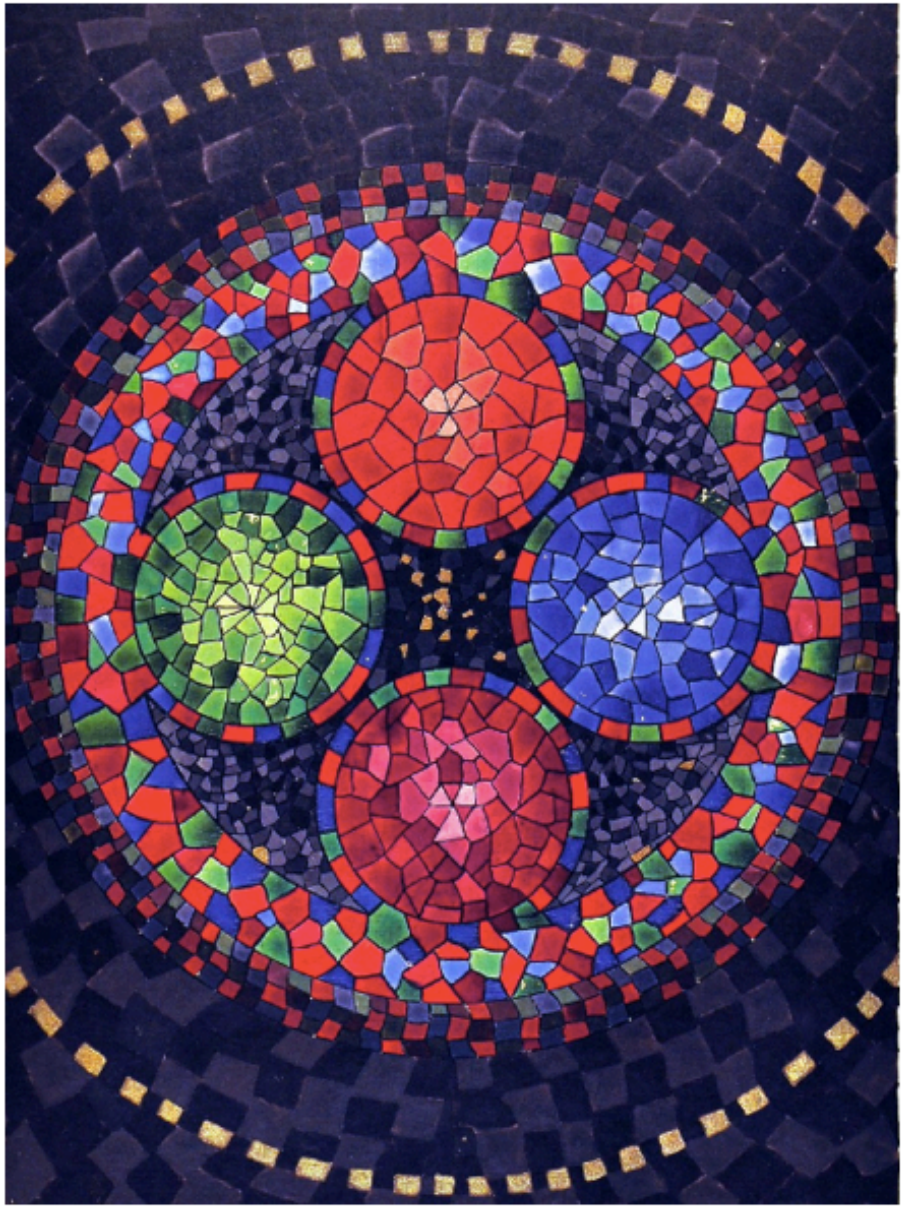
**D4**

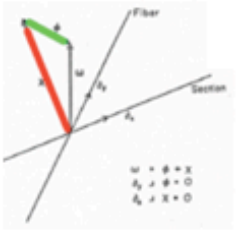
12 Root Vectors + 4 Cartan Elements
for 16 Gauge Bosons of U(2,2)
for Conformal Gravity



12 Root Vectors for Ghosts
of SU(3)xSU(2)xU(1) Standard Model

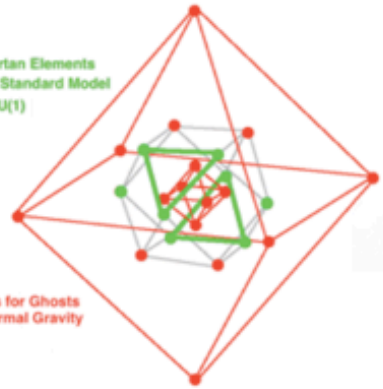





**D4**

8 Root Vectors + 4 Cartan Elements
for 12 Gauge Bosons of Standard Model
SU(3)xSU(2)xU(1)



16 Root Vectors for Ghosts
of U(2,2) Conformal Gravity

The force strength of a given force is

**(1 / Mforce^2 ) ( Vol(MISforce)) ( Vol(Qforce) / Vol(Dforce)^( 1 / mforce ))**

where:

Mforce represents the effective mass;

MISforce represents the relevant part of the target Internal Symmetry Space;

Vol(MISforce) stands for volume of MISforce and is sometimes also denoted by Vol(M);

Qforce represents the link from the origin to the relevant target for the gauge boson;

Vol(Qforce) stands for volume of Qforce;

Dforce represents the complex bounded homogeneous domain
of which Qforce is the Shilov boundary;

mforce is the dimensionality of Qforce, which is

Vol(Dforce)^( 1 / mforce ) stands for a dimensional normalization factor
(to reconcile the dimensionality of the Internal Symmetry Space of the target vertex
with the dimensionality of the link from the origin to the target vertex).

Qforce, Hermitian symmetric space, Dforce, mforce, and Vol(Dforce) for four forces are:

| | | | | |
|---|---|---|---|---|
| Spin(5) | Spin(7) / Spin(5)xU(1) | IV5 | 4 | RP^1xS^4 |
| SU(3) | SU(4) / SU(3)xU(1) | B^6(ball) | 4 | S^5 |
| SU(2) | Spin(5) / SU(2)xU(1) | IV3 | 2 | RP^1xS^2 |
| U(1) | - | - | 1 | - |

| Force | M | Vol(M) | Q | Vol(Q) | D | Vol(D) |
|---|---|---|---|---|---|---|
| gravity | S^4 | 8pi^2/3 | RP^1xS^4 | 8pi^3/3 | IV5 | pi^5/2^4 5! |
| color | CP^2 | 8pi^2/3 | squashed S^5 | 4pi^3 | B^6(ball) | pi^3/6 |
| Weak | S^2xS^2 | 2x4pi | RP^1xS^2 | 4pi^2 | IV3 | pi^3/24 |
| e-mag | T^4 | 4x2pi | - | - | - | - |

squashed S5 = Shilov boundary of complex domain of symmetric space SU(4) / SU(3) x U(1)

The relative force strengths at the characteristic energy level of each force are:

**Spin(5) gravity** at 10^19 GeV = 1 ; GGmproton^2 approx 5 x 10^-39

**SU(3) color** at 245 MeV = 0.6286

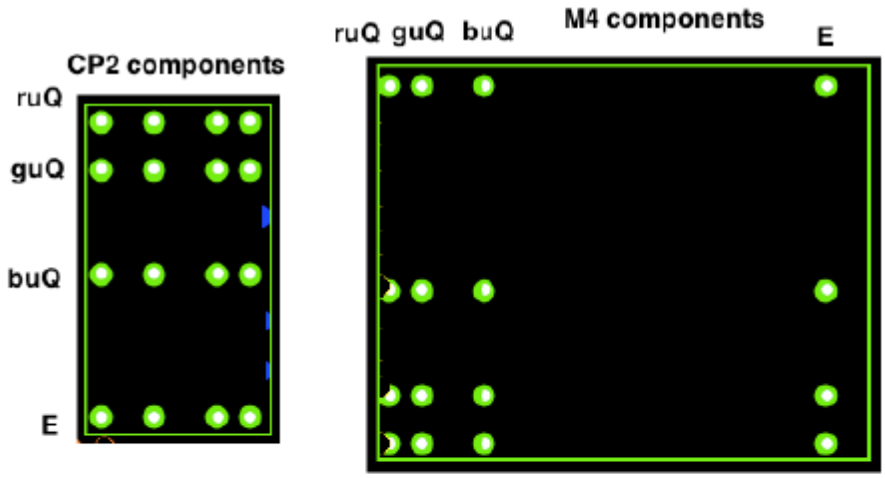
at 5.3 GeV = 0.166

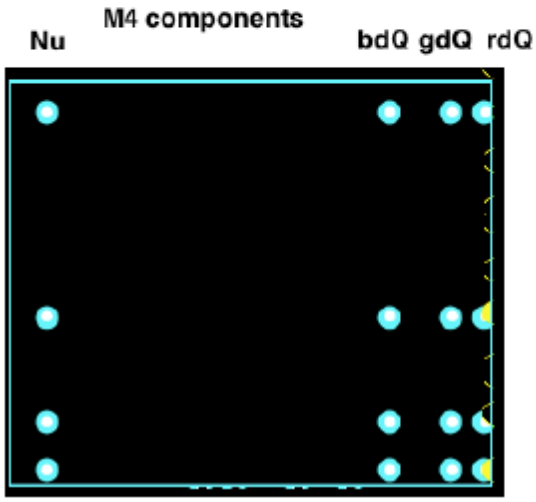
at 34 GeV = 0.121

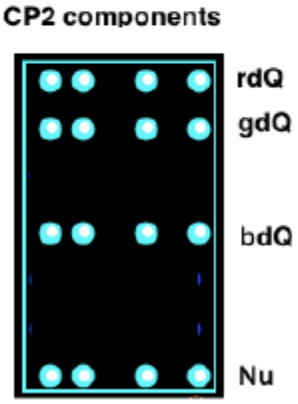
at 91 GeV = 0.106 ; with nonperturbative effects = 0.125

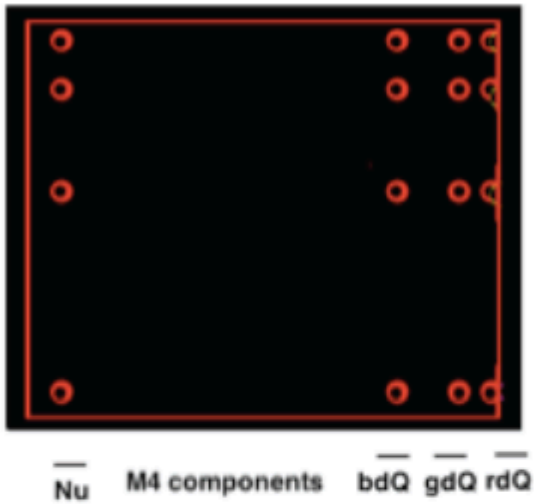
**SU(2) weak** at 100 GeV = 0.2535 ; GWmproton^2 approx 1.05 x 10^-5

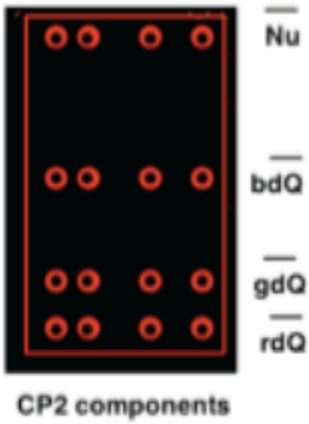
**U(1) e-mag** at 4 KeV = 1/137.03608

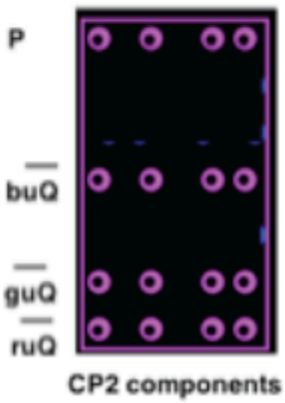

CP2 components
ruQ
guQ
buQ
E
ruQ guQ buQ
M4 components
E

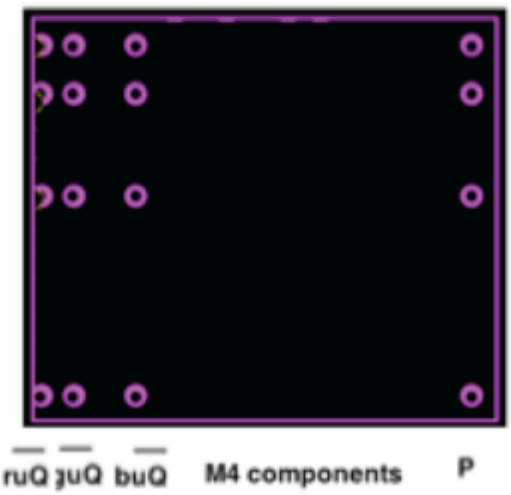

Nu
M4 components
bdQ gdQ rdQ

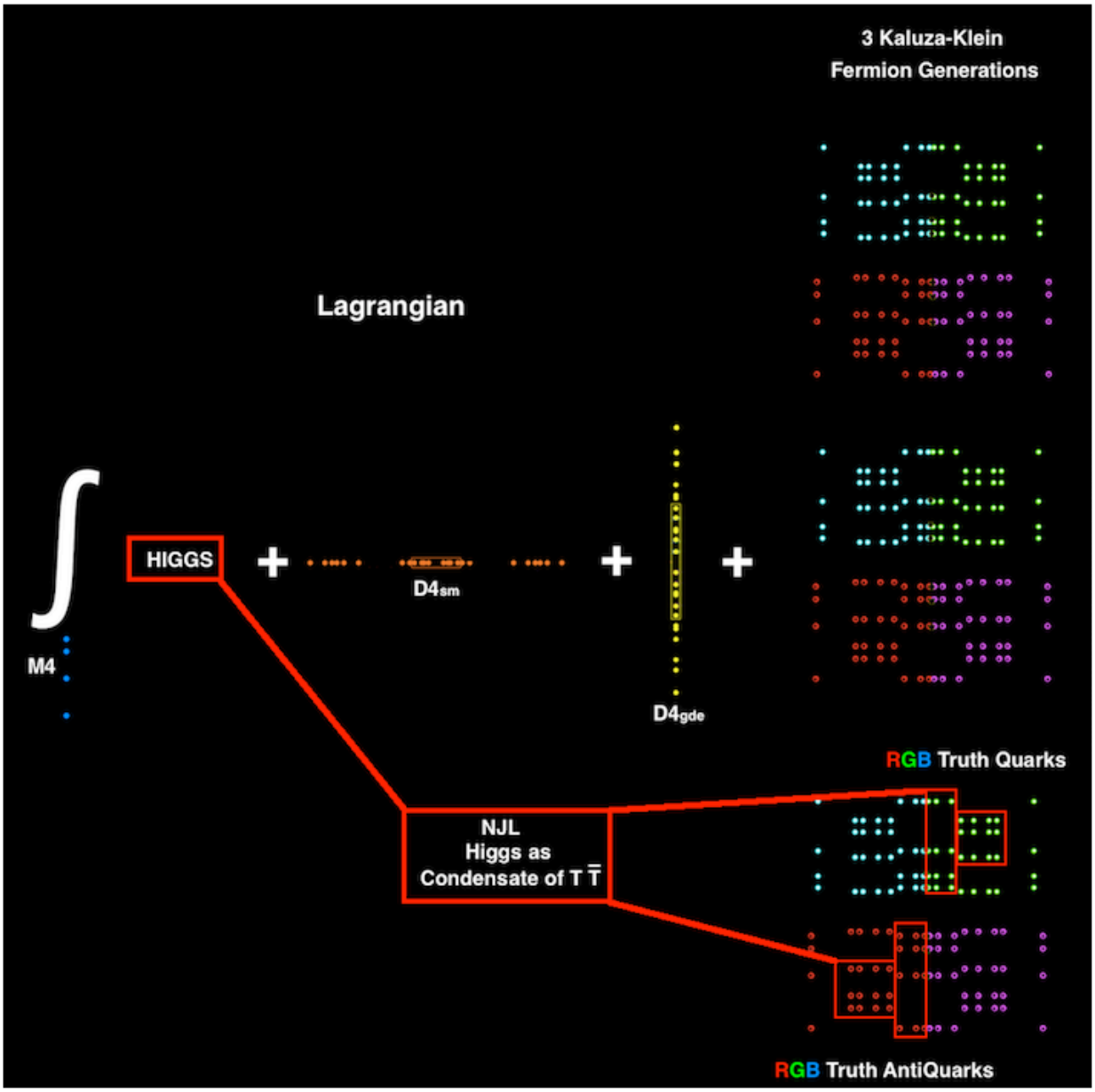

CP2 components
rdQ
gdQ
bdQ
Nu


Nu
M4 components
bdQ gdQ rdQ


Nu
bdQ
gdQ
rdQ
CP2 components


P
buQ
guQ
ruQ
CP2 components


ruQ guQ buQ
M4 components
P




Fermion masses are calculated as a product of four factors:

**V(Qfermion) x N(Graviton) x N(octonion) x Sym**

The ratio of the down quark spinor manifold volume factor
to the electron spinor manifold volume factor is

**V(Qdown quark) / V(Qelectron) = V(S^7x RP^1)/1 = pi^5 / 3.**

The third generation fermion particles correspond to triples of octonions.
There are 8^3 = 512 such triples.
The triple { 1,1,1 } corresponds to the tau-neutrino.
The other 7 triples involving only 1 and E correspond to the tauon:
The beauty quark corresponds to 21 triples.
They are triples of the same form as the 7 tauon triples involving 1 and E,
but for 1 and I, 1 and J, and 1 and K,
which correspond to the red, green, and blue beauty quarks,
Triples of the type { 1, I, J } , { I, J, K }, etc.,
do not correspond to the beauty quark, but to the Truth quark.
The Truth quark corresponds to those 512 - 1 - 7 - 21 = 483 triples, so the
**constituent mass of red truth quark is 161 / 7 = 23 times red beauty quark**

**red Truth quark mass is mt = 129.5155 GeV**

Here is a summary of E8 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.

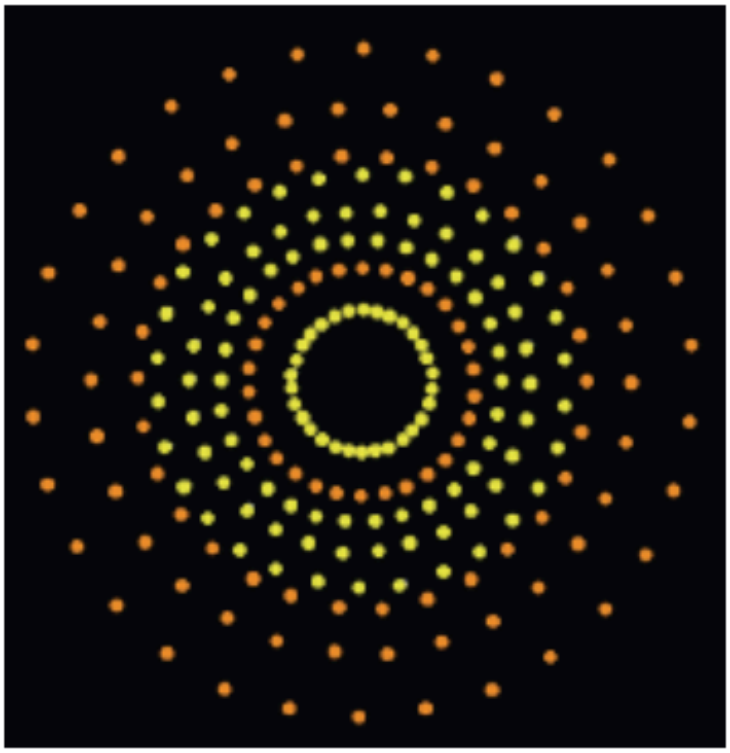
| Particle/Force | Tree-Level | Higher-Order |
|---|---|---|
| e-neutrino | 0 | 0 for nu_1 |
| mu-neutrino | 0 | 9 x 10^(-3) eV for nu_2 |
| tau-neutrino | 0 | 5.4 x 10^(-2) eV for nu_3 |
| electron | 0.5110 MeV | |
| down quark | 312.8 MeV | charged pion = 139 MeV |
| up quark | 312.8 MeV | proton = 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) 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 |

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 |

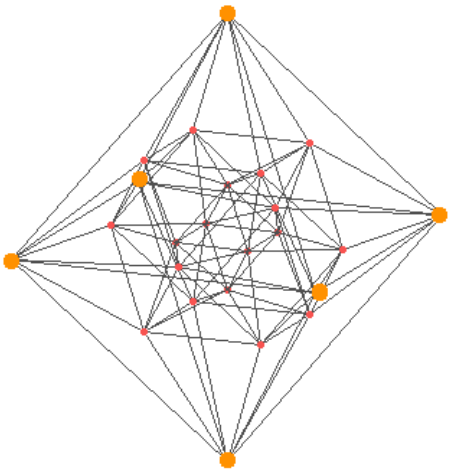
The phase angle d13 is taken to be 1 radian.

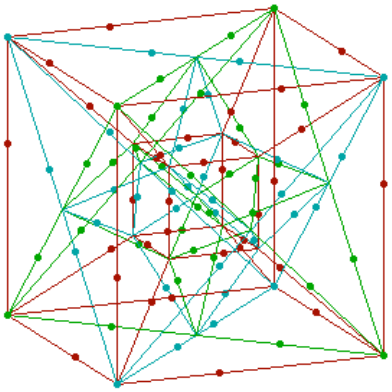
**E8 = H4 + H4 = 120 + 120 = 240-vertex Witting polytope tiling of 8-dim space**



E8 = 120 BiVectors + 128 half-Spinors of Cl(16) Clifford Algebra
with graded structure
1 16 120 560 1820 4368 8008 11440 12870 11440 8008 4368 1820 560 120 16 1
By 8-Periodicity of Real Clifford Algebras: Cl(16) = tensor product Cl(8) x Cl(8)
so with that product E8 = F4 x F4

**H4 = 24 (vertices) + 96 (edges) = 120-vertex 600-cell tiling of 4-dim space**
with Coxeter Group determined by E8



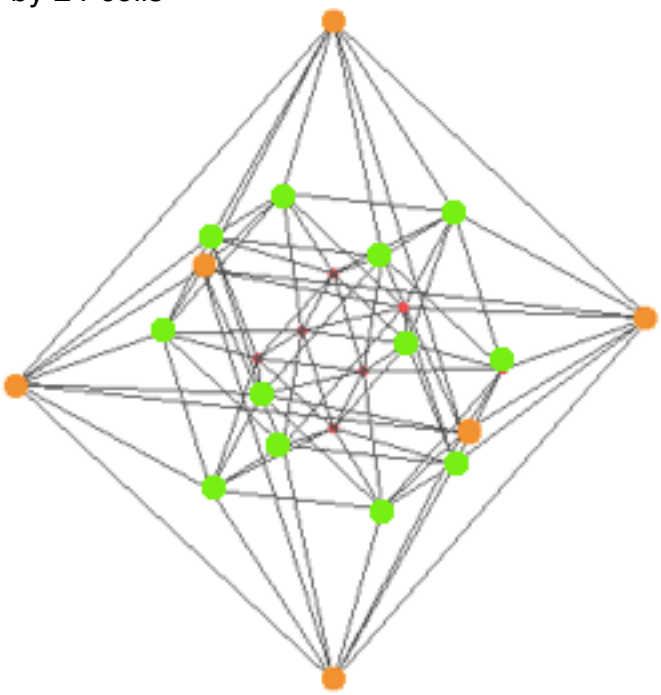


**F4 = 24 cell + dual 24-cell tiling of 4-dim space**

F4 = 8 Vectors + 28 BiVectors + 16 Spinors of Cl(8) Clifford Algebra
with graded structure 1 8 28 56 70 56 28 8 1
tile 4-dim space by 24-cells and their dual 24-cells

**D4 24-cell tiling of 4-dim space**

D4 = 28 BiVectors of Cl(8) Clifford Algebra with 24 root vectors
with graded structure 1 8 28 56 70 56 28 8 1
tile 4-dim space by 24-cells



**A3 = D3 = cuboctahedral tiling of 3-dim space**

A3=D3 = 15 BiVectors of Cl(6) Clifford Algebra with 12 root vectors and
with graded structure 1 6 15 20 15 6 1
tile 3-dim space by cuboctahedra
which can be seen as a central part of a 24-cell (green vertices above)

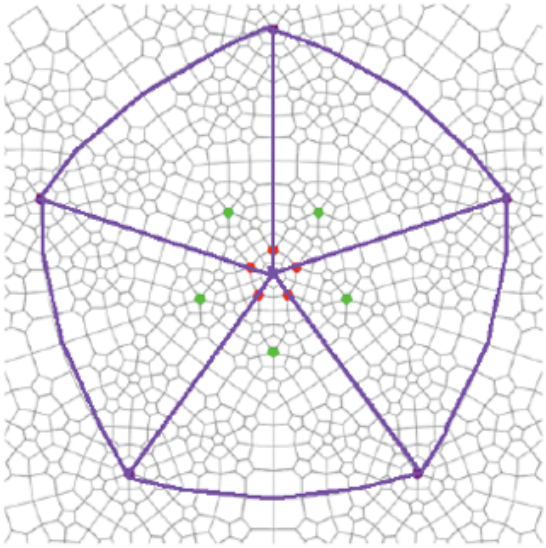
**H3 = 12-Vertex Icosahedron as Jitterbug Transform of 12-Vertex Cuboctahedron**

with Coxeter Group determined by D6

## H2 Penrose STAR tilings of 2-dim space

**H2 = I^5_2 = Penrose STAR tiling of 2-dim space**
with Coxeter group determined by A4 which contains A2
and field extension Q(sqrt(5))

The central part of the tiling has 5 pentagonal sectors

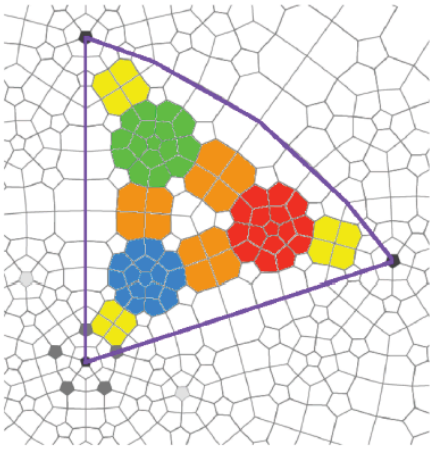


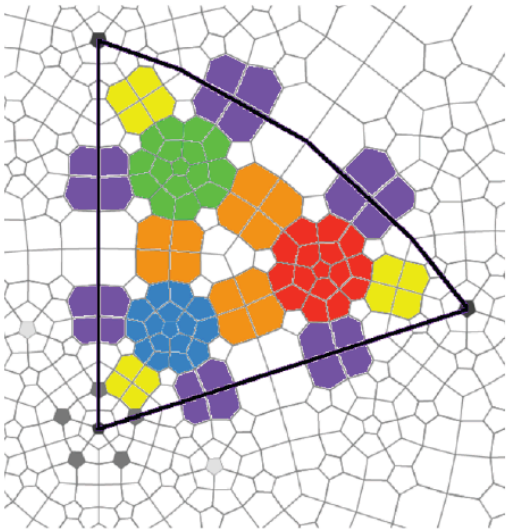
Each of the 5 pentagonal sectors of the tiling contains a 2-dim projected version of the 8-dim E8 Root Vector structure of E8 Physics corresponding to the Complex E6 subalgebra of Octonionic E8. The outer boundary of each sector is not a straight line but is curved with Conformal Symmetry and pentagonal sectors further out are conformally curved rather than straight-line pentagons.

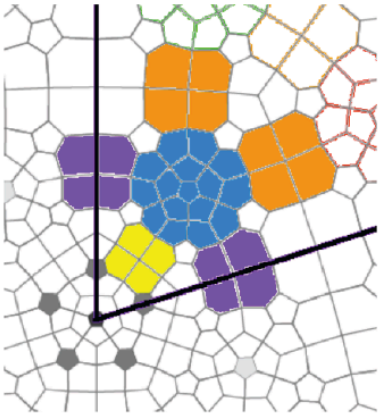
Each pentagonal sector represents the Complex part of Octonionic E8 Physics whose 240 E8 Root Vectors project to the 72 Root Vectors of E6 subalgebra of E8 which 72 E6 Root Vectors have the following physical interpretation

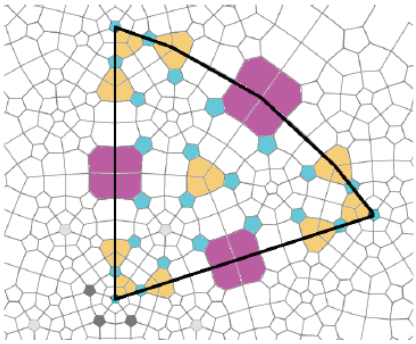
16 = 2x8 of which represent Complex Fermion Particles
16 = 2x8 of which represent Complex Fermion AntiParticles
16 = 2x(4+4) of which represent Complex (4+4)-dim Kaluza-Klein SpaceTime
12 of which represent the Standard Model
12 of which represent Gravity + Dark Energy

as shown in the following image of one of the pentagonal sectors:

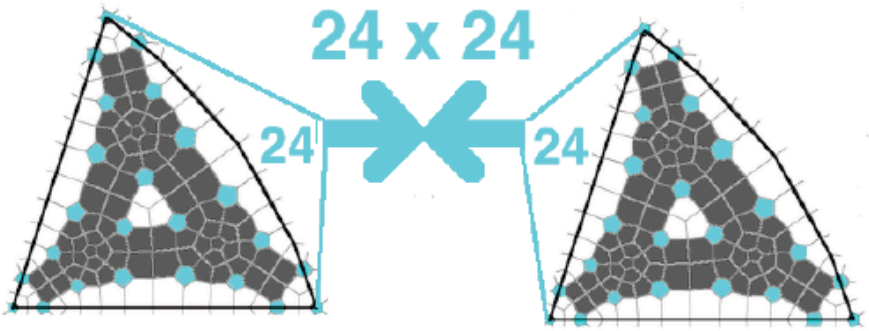








The Bohm Quantum Potential interacts between two Pentagonal Sectors by
24 Bohm Carrier Tiles of one Pentagonal Sector carrying E8 Configuration Information
and comparing it with
24 Bohm Carrier Tiles of the Other Sector carrying E8 Configuration Information.
If the resulting 24 x 24 Matrix shows that the two E8 Configurations are similar,
then a Bohm Quantum Potential Resonant Connection is established.




The Bohm Quantum Potential 24x24 Matrix is traceless because Configuration
Resonance is sensitive to similarity rather than dilation scale
and is symmetric because Configuration Resonance is symmetric between Sectors.

# 256-dim Cl(8) as Cellular Automata

**28**

**8**

**8+28+16 = 52 F4**

**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
- + e_6728 + e_3468 + e_4578 to
- + e_2358 + e_1248 + e_5618 + e_7138
- + 1 to
- - e_5712 - e_1345 - e_6123
- - e_4671 - e_7234 - e_2456 - e_3567

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

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

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

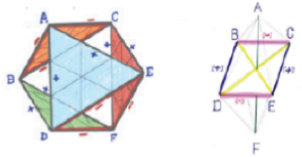
**= 120 Cl(16) BiVectors + ( 128 + 128) Cl(16) Spinors**

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

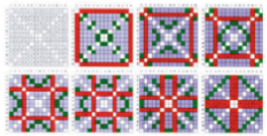
**Cl(8) Triality**

Guillermo Moreno (arXiv math/0512517) has shown that **V(7,2) = Spin(7) / Spin(5)** can be identified with the **Zero Divisors of Sedenions** which have 7+28 = 35 Associative Triples and for which Zero Divisors are given by the fibration V(7,2) -> G2 -> S3 [ 3-sphere ] and which have 4-2=2 ZD Irreducible Components and 10-dim Lie Sphere Spin(7) / Spin(5)xU(1) whose 10D correspond to **Cl(1,9) = Cl(2,8) Conformal over Cl(1,7)** that **V(15,2) = Spin(15) / Spin(13)** is related to, but not identified with, the **Zero Divisors of 32-ons** which have 35 + 120 = 155 Associative Triples and which have 8-2=6 ZD Irreducible Components and 26-dim Lie Sphere Spin(15) / Spin(13)xU(1) whose 26D correspond to **26D String Theory and to 26-dim traceless J(3,O)o** that **V(127,2) = Spin(127) / Spin(125)** is related to, but not identified with, the **Zero Divisors of Voudon 256-ons** corresponding to Cl(8) which have 1+6+28+120+496+2016+8128=10795 Associative Triples and which have 64-2=62 ZD Irreducible Components and 250-dim Lie Sphere Spin(127) / Spin(125)xU(1)

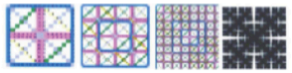
Robert de Marrais said "... 256 ... 2^8 ions Voudons ... Moreno ... determines that the automorphism group of the ZD's of all 2^n-ions ... obey a simple pattern: for n ≥ 4 this group has the form G2 x (n-3) x S3 (... order-6 permutation group on 3 elements) ... This says the automorphism group of the Sedenions' ZD's has order 14 x 1 x 6 = 84 ... based on 7 octahedral lattices ("Box-Kites") ...

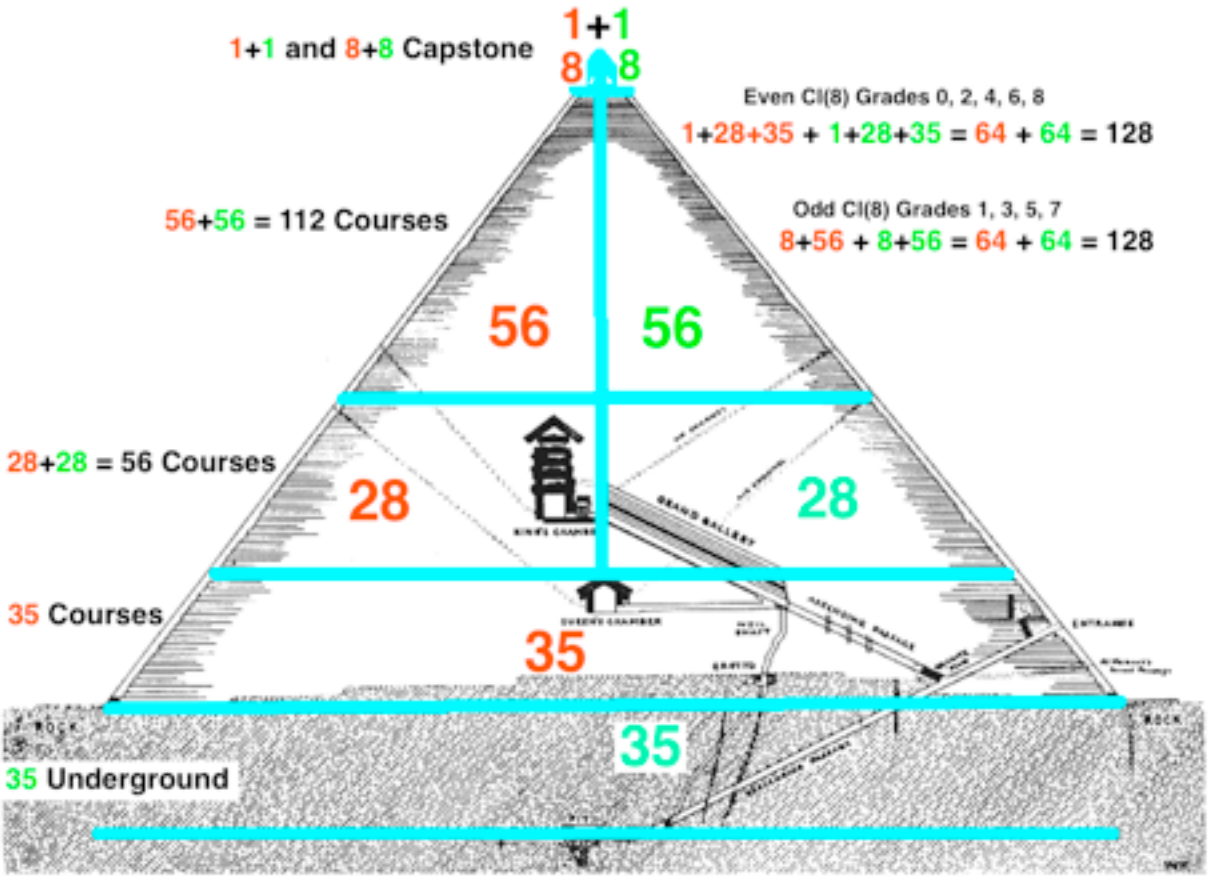


... Harmonics of Box-Kites, called here "Kite-Chain Middens," ... extend indefinitely into higher forms of 2^n -ions. All non-Midden-collected ZD diagonals in the ... 32-ons ... belong... to a set of 15 "emanation tables," ... they house 168 ... PSL(2,7) ... cells ... 8 ... 32-ons ,,, ET's ... from S = 8 to 15 ...

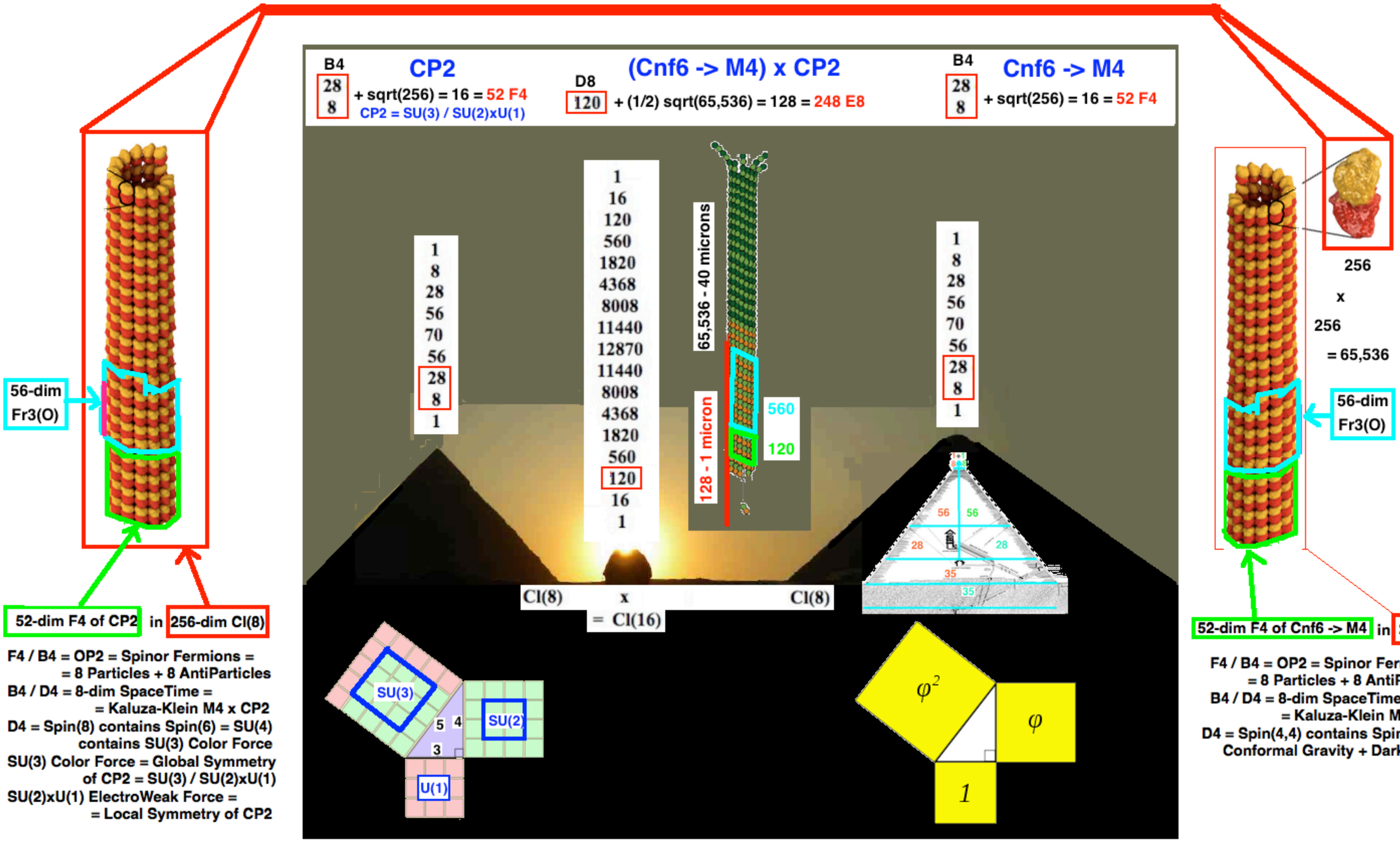


[here are] ... Emanation Tables ... ET's for S = 15, N = 5,6,7 ... and fractal limit ...






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




F4 / B4 = OP2 = Spinor Fermions =
= 8 Particles + 8 AntiParticles
B4 / D4 = 8-dim SpaceTime =
= Kaluza-Klein M4 x CP2
D4 = Spin(8) contains Spin(6) = SU(4)
contains SU(3) Color Force
SU(3) Color Force = Global Symmetry
of CP2 = SU(3) / SU(2)xU(1)
SU(2)xU(1) ElectroWeak Force =
= Local Symmetry of CP2

F4 / B4 = OP2 = Spinor Fermions =
= 8 Particles + 8 AntiParticles
B4 / D4 = 8-dim SpaceTime =
= Kaluza-Klein M4 x CP2
D4 = Spin(4,4) contains Spin(2,4) of
Conformal Gravity + Dark Energy

Cross section

Cross section

**E8 Kaluza-Klein (Cnf6 -> M4) x CP2**

In ( Cl(8) of CP2 ) x ( Cl(8) of Cnf6 -> M4 ) = Cl(16) containing E8
at each of the 256 points of Cl(8) of Cnf6 -> M4 there are all 256 points of Cl(8) of CP2

**D8 = Cl(16) BiVectors = 120**
**E8 / D8 = 128-dim Fermion Spinor Space = 8 components of 8+8 Fermions**
**D8 / D4 x D4 = A7+1 = 64 = 8-dim position x 8-dim momentum**
**D4 containing D3 = Spin(2,4) = A3 = SU(2,2) for Conformal Gravity + Dark Energy**
**D4 containing D3 = SU(4) containing Color Force SU(3)**
**10xFr3(O) = Cl(16) TriVectors = 560**

Void -> Cl(Void) -> Cl(0) -> Cl(1) -> Cl(2) -> Cl(4) -> Cl(16)

Kaluza-Klein Spacetime
M4 x CP2

Cl(8) that contains 28 = D4 for M4 Gravity

Cl(8) that contains 28 = D4 for CP2 Std Model

| | | | |
|---|---|---|---|
| 1 | 1 | 1 | 1 |
| 8 | 8 | 16 | 16 |
| 28 | 28 | 56 | 120 |
| 56 | 56 | 70 | 560 |
| 70 | 70 | 56 | 1820 |
| 56 | 56 | 28 | 4368 |
| 28 | 28 | 8 | 8008 |
| 8 | 8 | 1 | 11440 |
| 1 | 1 | | 12870 |
| | | | 11440 |
| | | | 8008 |
| | | | 4368 |
| | | | 1820 |
| | | | 560 |
| | | | 120 |
| | | | 16 |
| | | | 1 |

Cl(8) x Cl(8) = Cl(16)

Spinors:
(8s+8c) x (8s+8c) = (8sx8s + 8sx8c + 8cx8s + 8cx8c)

Quantum Resonant Connection

40 micron microtubule 65.000 TD

256-dim Cl(8)

256 x 256 = 65,536-dim Cl(16) containing 248-dim E8

56-dim Fr3(O)

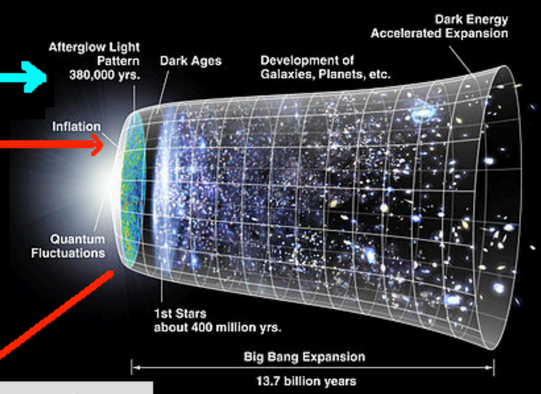
52-dim F4

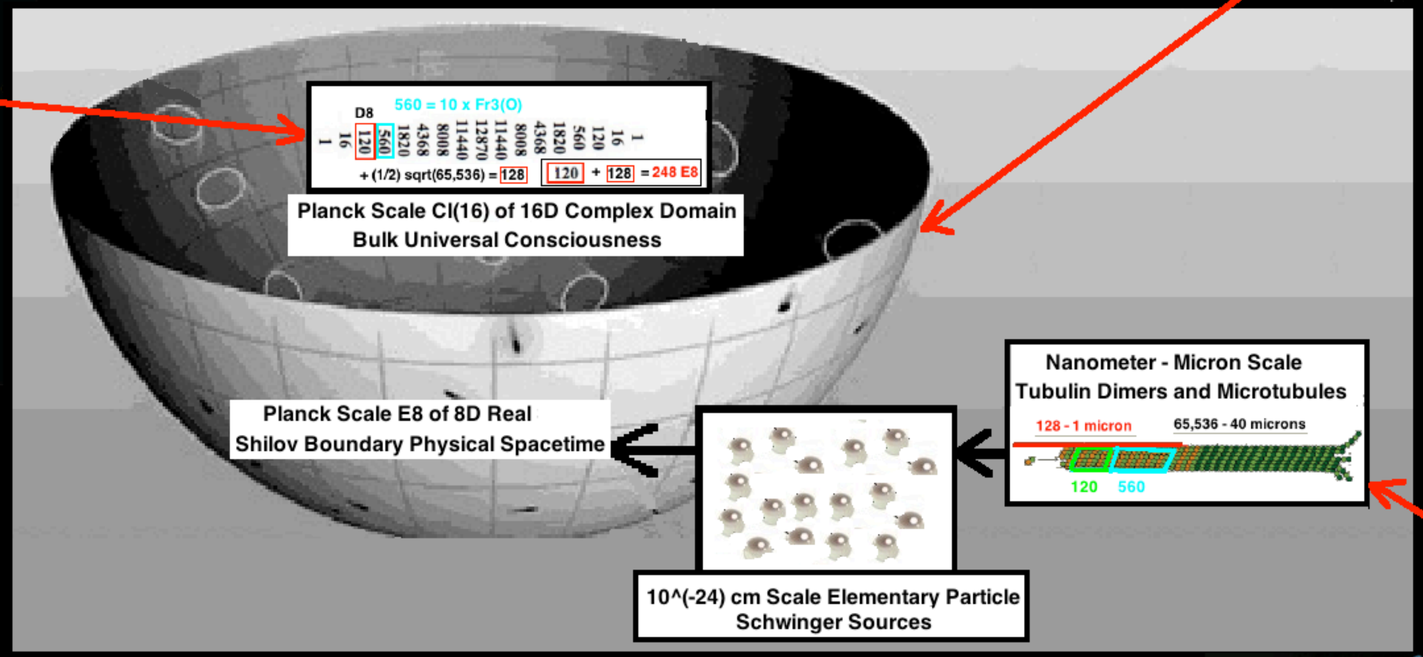
M4

CP2

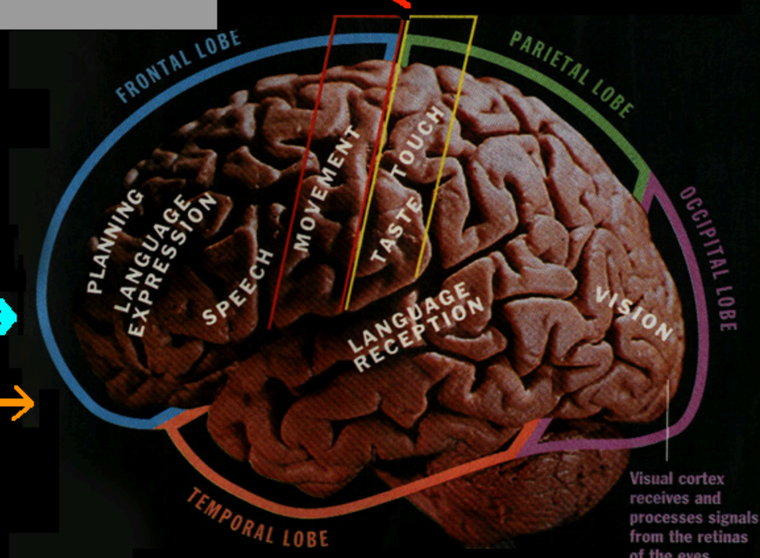
NJL Quantum Condensate

10^19 E8 Lattice 240-vertex Polytope Cells in Universe at End of Inflation




Penrose-Hameroff Quantum Condensate




10^19 Tubulin Dimers in a Human Brain

Void -> Cl(Void) -> Cl(0) -> Cl(1) -> Cl(2) -> Cl(4) -> Cl(16)

Kaluza-Klein Spacetime
M4 x CP2

| Cl(8) that contains 28 = D4 for M4 Gravity | | Cl(8) that contains 28 = D4 for CP2 Std Model | |
|---|---|---|---|
| | | | 1 |
| | | | 16 |
| | | | 120 |
| | | | 560 |
| | | | 1820 |
| | | | 4368 |
| | | | 8008 |
| | | | 11440 |
| 1 | | 1 | 12870 |
| 8 | | 8 | 11440 |
| 28 | | 28 | 8008 |
| 56 | | 56 | 4368 |
| 70 | x | 70 | = 1820 |
| 56 | | 56 | 560 |
| 28 | | 28 | 120 |
| 8 | | 8 | 16 |
| 1 | | 1 | 1 |

Cl(8) x Cl(8) = Cl(16)

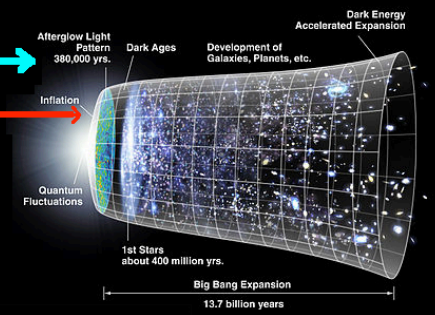
Spinors: $(8s \times 8s + 8s \times 8c) + (8c \times 8s + 8c \times 8c)$

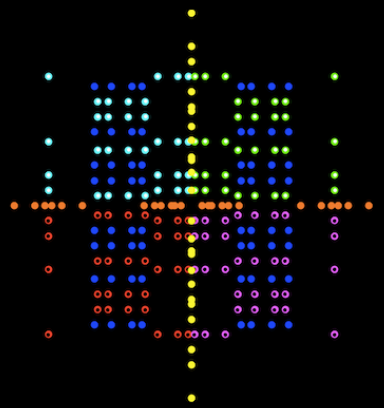
$(8s+8c) \times (8s+8c) =$

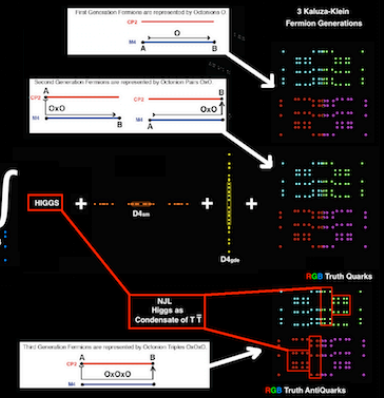
Quantum Resonant Connection

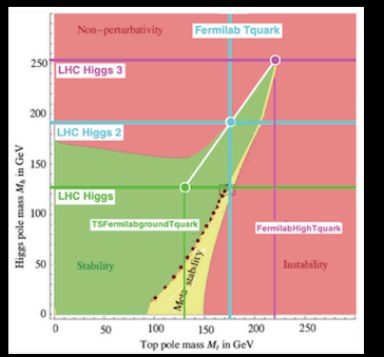
NJL Quantum Condensate

10^19 E8 Lattice 240-vertex Polytope Cells in Universe at End of Inflation



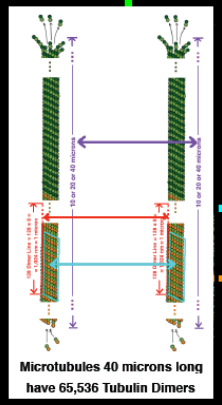



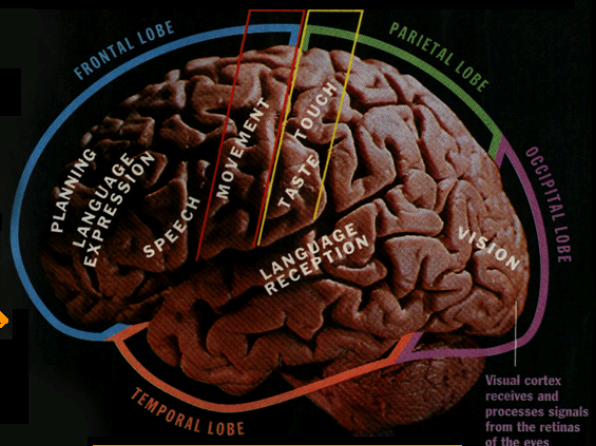

Cl(0,16) x Cl(0,8) = Cl(0,24)

M(2,Cl(0,24)) = Cl(1,25)

Completion of Union of
All Tensor Products of Cl(1,25) = **AQFT**




Penrose-Hameroff Quantum Condensate




10^19 Tubulin Dimers in a Human Brain