Cellular Automata, E8 Root Vectors, Fr3(O) String Theory, and Cl(1,25) Algebraic Quantum Field Theory

Frank Dodd (Tony) Smith, Jr. - 2018

Abstract

This paper discusses the relationship between the 256 Elementary Cellular Automata and the 240 Root Vectors of E8 and the E8 Physics Lagrangian, and their relationship to the Fr3(O) String Theory of Cl(16) Physics World-Lines = Strings and the AQFT resulting from the Completion of the Union of all tensor products of Cl(1,25).
For futher aspects of E8 and Cl(16) Physics see these papers: viXra 1804.0121 (441 pages); viXra 1806.0361 (115 pages); and my web site at http://valdostamuseum.com/hamsmith/ and files thereon including http://valdostamuseum.com/hamsmith/E8ResultsOriginVSHORT.pdf (62 pages).

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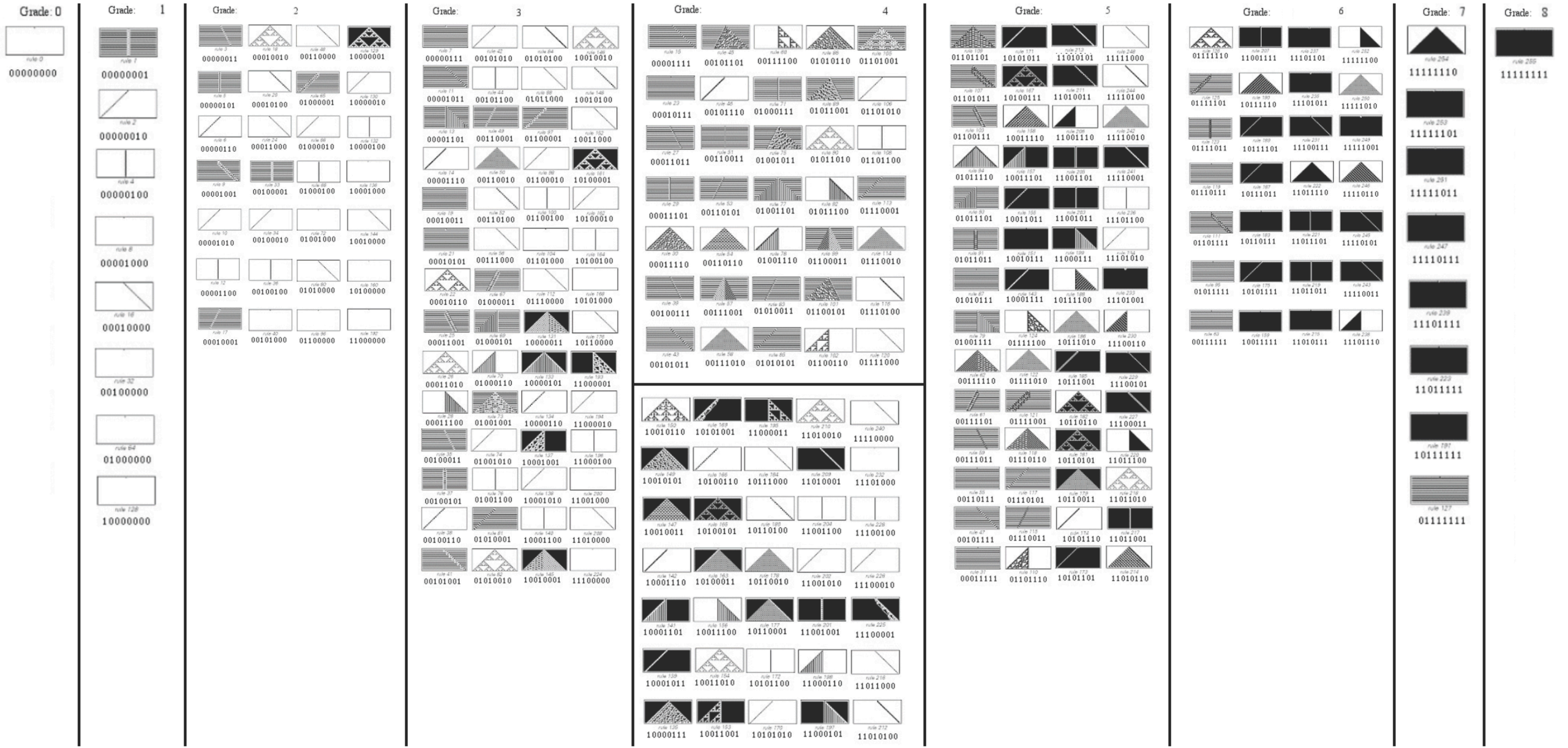
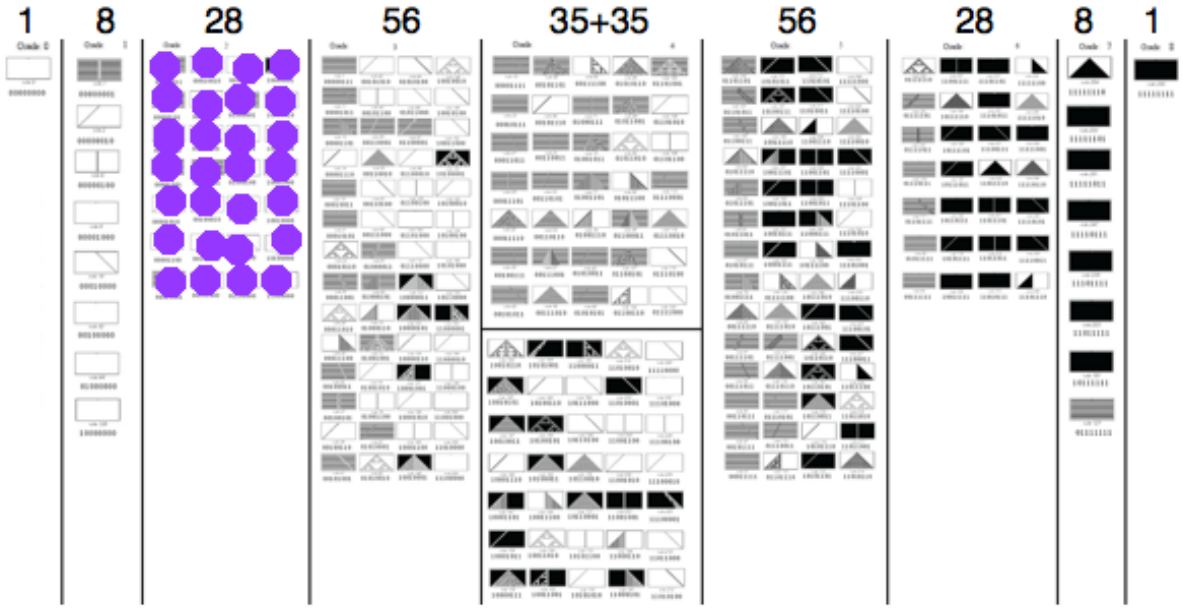
The 256 Elementary Cellular Automata represent the Real Clifford Algebra Cl(8)

Cl(8) Graded Structure:

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



The 28 BiVectors of Cl(8) (purple dots)



form the 28-dim D4 Lie Algebra

that represents Gauge Bosons and Ghosts

The 28 can represent either of two types:

16 Gauge Bosons and 12 Ghosts
or
12 Gauge Bosons and 16 Ghosts

First consider the case

16 Gauge Bosons and 12 Ghosts

16 Gauge Bosons represent U(2,2)
which gives Conformal Gravity + Dark Energy
and a Propagator phase

12 Ghosts represent SU(3)xSU(2)xU(1) Standard Model
but they are NOT effective as Gauge Bosons
in the First Copy of Cl(8) Clifford Algebra
so they are only “Ghosts”
of the true Standard Model Gauge Bosons
that we will see to be effective in a Second Copy of Cl(8)

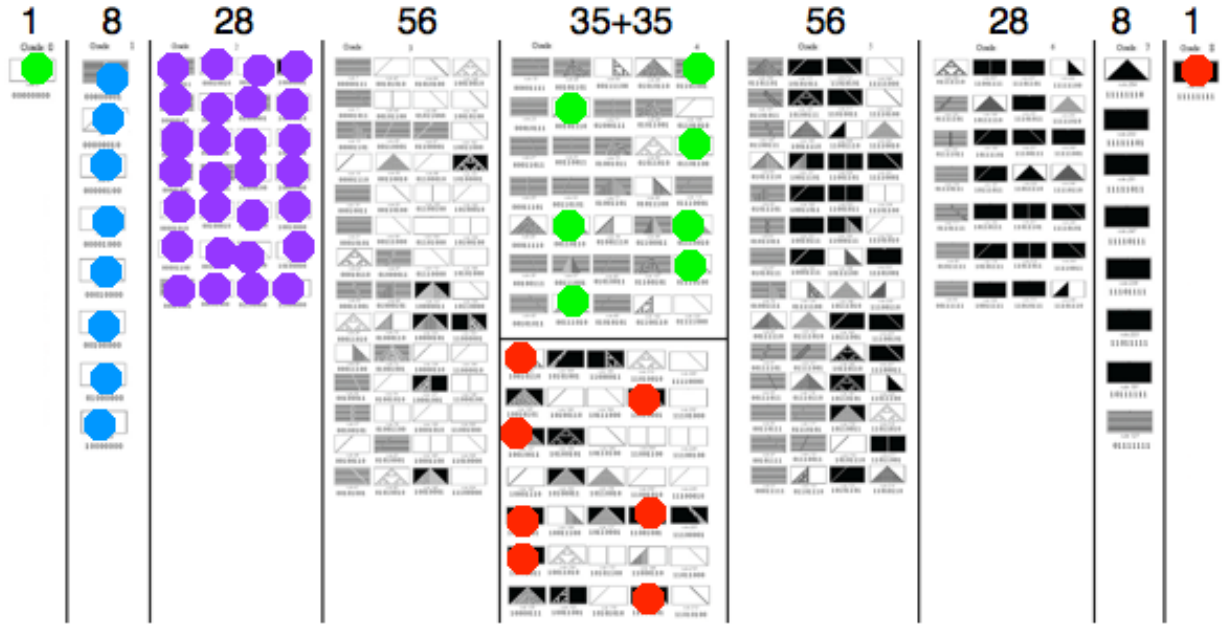
We will need both copies of Cl(8)
to make the tensor product
Cl(8) x Cl(8) = Cl(16) which contains the E8

whose 240 Root Vectors
are a recipe for a realistic Lagrangian

We will construct the Lagrangian
by
constructing the 248-dim E8 Lie Algebra
from
two copies of the 52-dim F4 Lie Algebra

one F4 from the First Cl(8)
and
the Second F4 from the Second Cl(8)

The First 52-dim F4 comes from the First Cl(8)
by
adding to the First 28 D4 elements: (purple dots) -
16 U(2,2) Conformal Gravity Gauge Bosons and
12 Standard Model Ghosts to connect with the Second D4

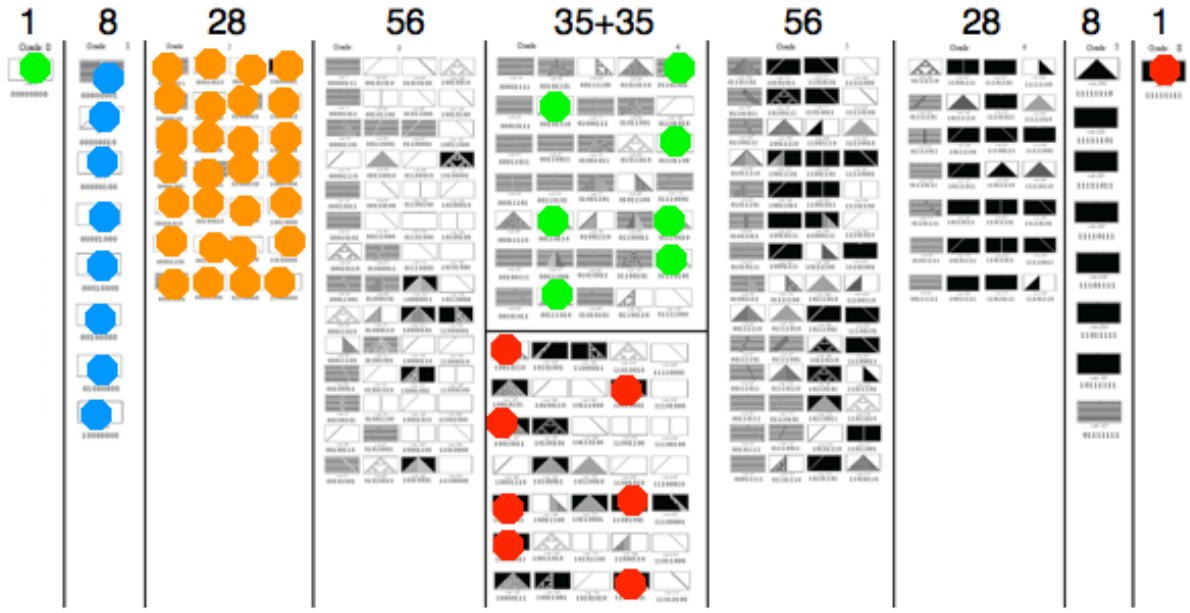


8 Vectors (blue dots) for 8-dim Spacetime

8 +half-Spinors (green dots) for 8 Fermion Particles
of the First Generation

8 -half-Spinors (red dots) for 8 Fermion AntiParticles
of the First Generation

The Second 52-dim F4 comes from the Second Cl(8)
by
adding to the Second 28 D4 elements: (orange dots) -
12 Standard Model Gauge Bosons and
16 Ghosts of U(2,2) to connect with the First D4



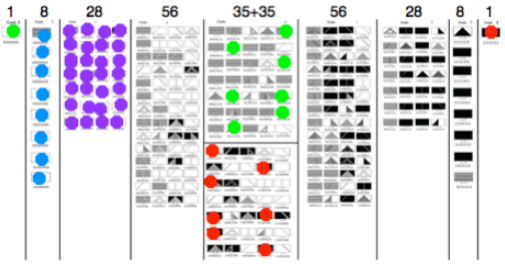
8 Vectors (blue dots) for 8-dim Spacetime

8 +half-Spinors (green dots) for 8 Fermion Particles
of the First Generation

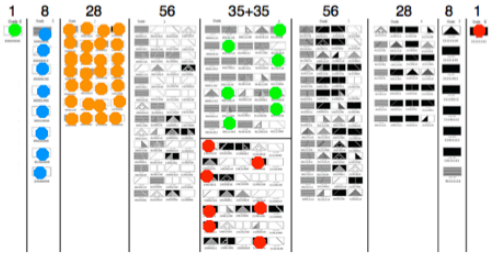
8 -half-Spinors (red dots) for 8 Fermion AntiParticles
of the First Generation

Cl(8) has a 16x16 Real Matrix Representation:

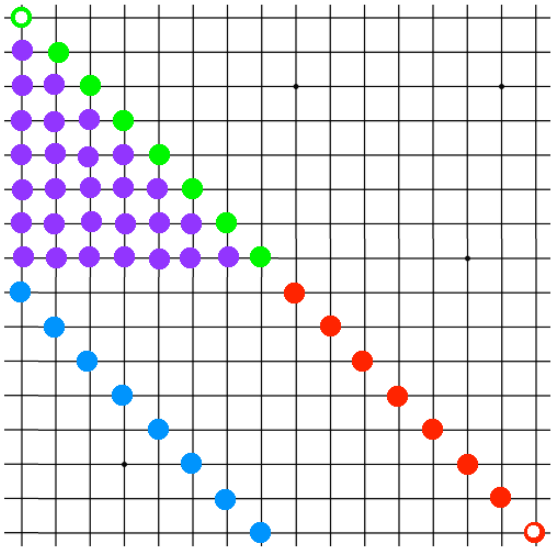
First Cl(8) D4 F4 acting on M4
Graded Representation



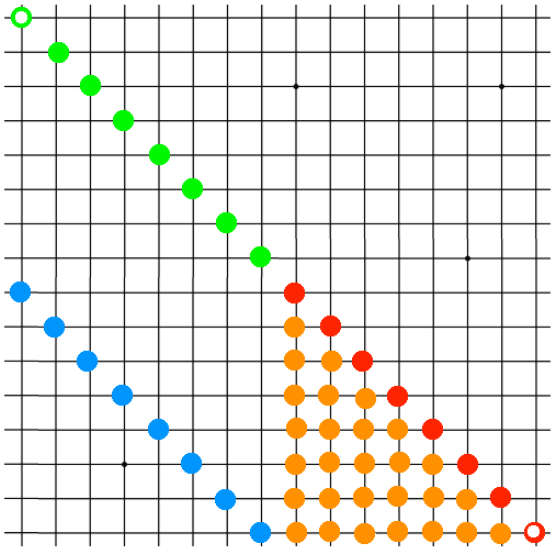
Second Cl(8) D4 F4 acting on CP2
Graded Representation



16x16 Matrix Representation



16x16 Matrix Representation



78-dim E6 = 52-dim F4 + 26-dim J3(O)o
so
E6 = Complexification of F4
and
E6 represents both
First F4 (Real) acting on M4
and
Second F4 (Imaginary) acting on CP2

Based on the tensor product
Cl(8) x Cl(8) = Cl(16)
and
the Cl(8) graded structure

1 8 28 56 35+35 56 28 8 1

we have

Cl(16) BiVectors =

Cl(8) BiVectors + Cl(8) BiVectors + (Cl(8) Vectors x Cl(8) Vectors)

28 + 28 + 64 =120 = D8 Lie Algebra

Cl(16) Spinors =

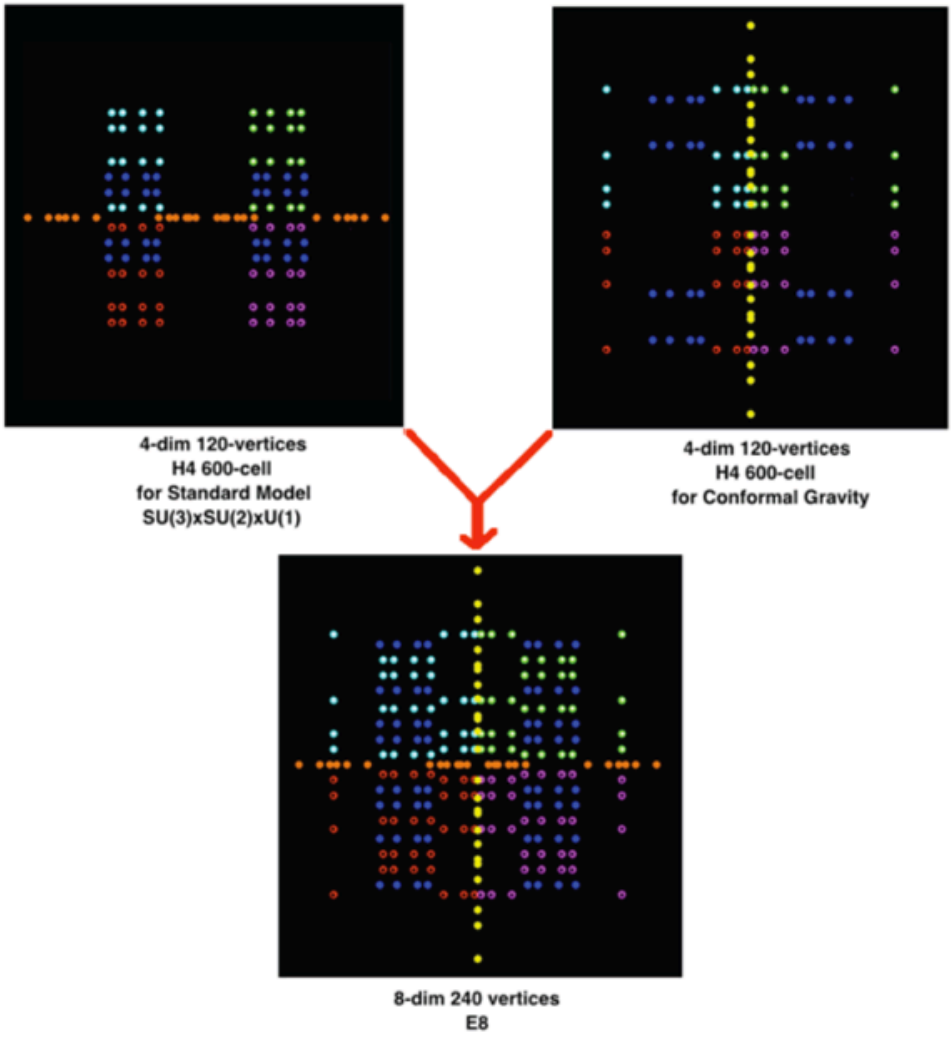
(Cl(8) +half-Spinors + -half-Spinors) x (Cl(8) +half-Spinors + -half-Spinors)

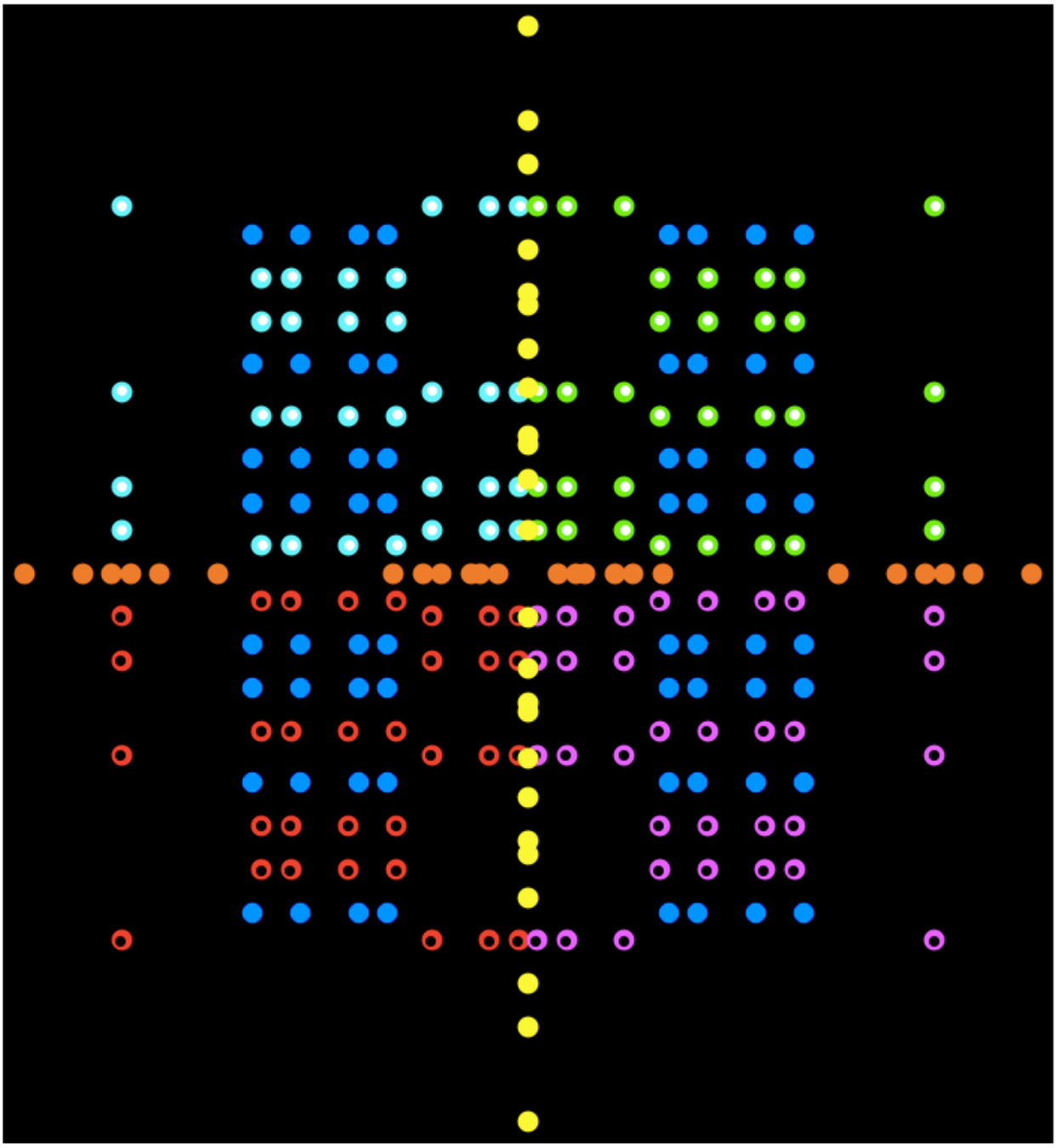
8 x 8 + 8 x 8 + 8 x 8 + 8 x 8 = 256

64 + 64 = 128 = Cl(16) ++quarter-Spinors + Cl(16) --quarter-Spinors

120 = Cl(16) BiVectors
+
128 = Cl(16) ++quarter-Spinors + Cl(16) --quarter-Spinors
=
248-dim E8 with 240 Root Vectors

248-dim E8 in Cl(16) has 240 Root Vectors -
- first shell of 8-dim E8 Lattice.
Since it is hard to visualize points on S7 in 8-dim space,
I prefer to represent the 240 E8 Root Vectors
in this 2D representation by Ray Aschheim



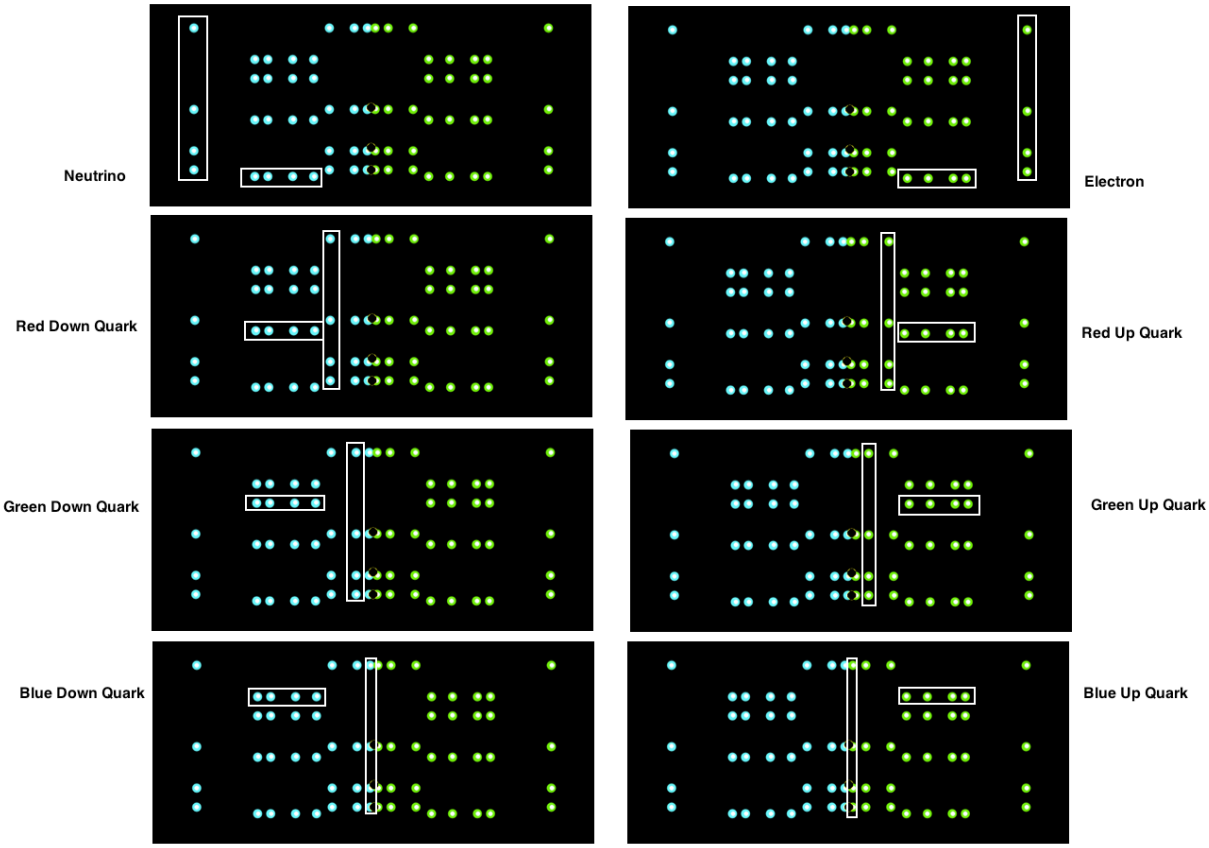


To understand the Geometry related to the 240 E8 Root Vectors, consider that
248-dim E8 = 120-dim Spin(16) D8 + 128-dim half-spinor of Spin(16) D8
240 E8 Root Vectors = 112 D8 Root Vectors + 128 D8 half-spinors
112 D8 Root Vectors = 24 D4 (orange) + 24 D4 (yellow) + 64 (blue)
128 D8 half-spinors = 128 elements of E8 / D8

Green and Cyan dots with white centers (32+32 = 64 dots) and
Red and Magenta dots with black centers (32+32 = 64 dots)
correspond to the 128 elements of E8 / D8.

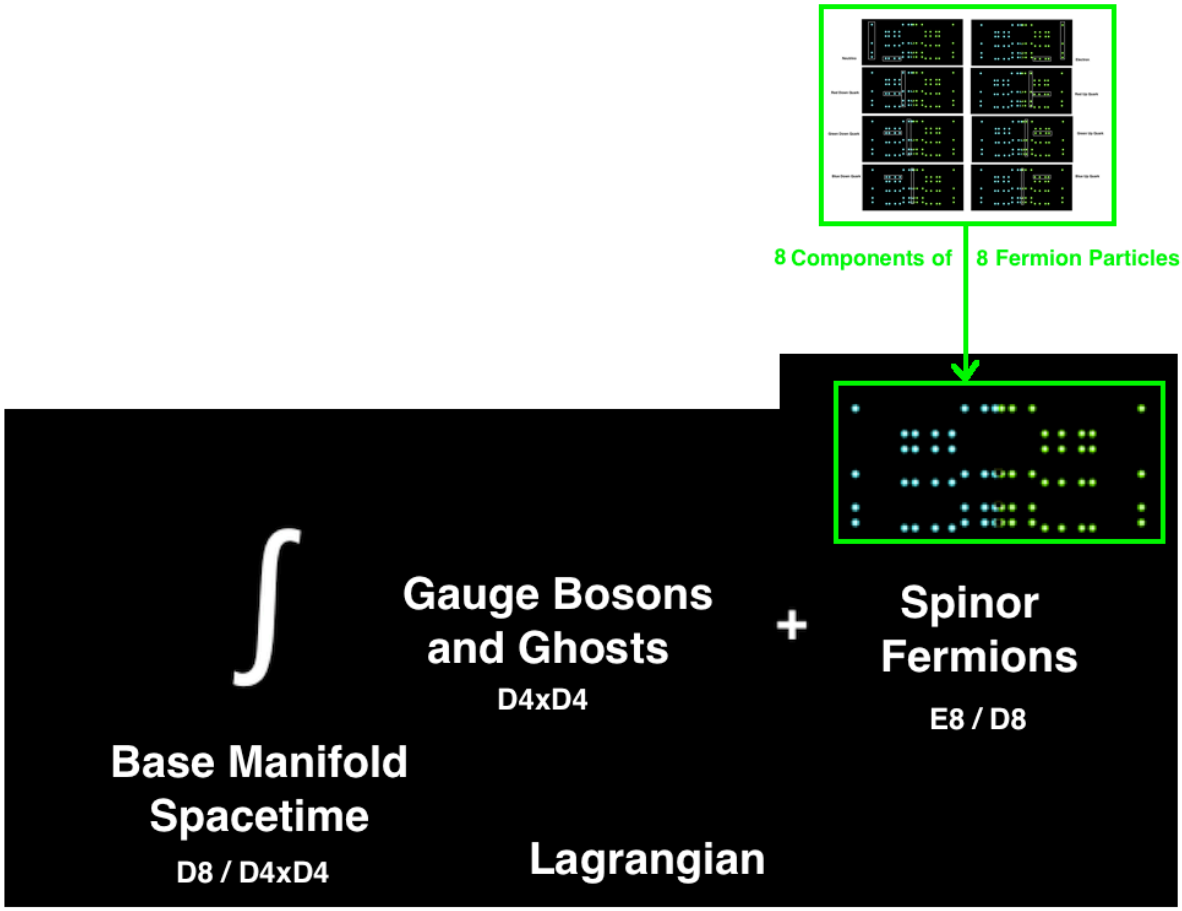
How do the 240 E8 Root Vectors
fit into a Realistic Lagrangian ?

The 64 Green and Cyan Root Vectors represent the
First Generation Fermion Particles of E8 / D8
Each of 8 Particles have
8 = 4+4 M4 x CP2 Kaluza-Klein components
so they are represented by 8x8 = 64 Root Vectors

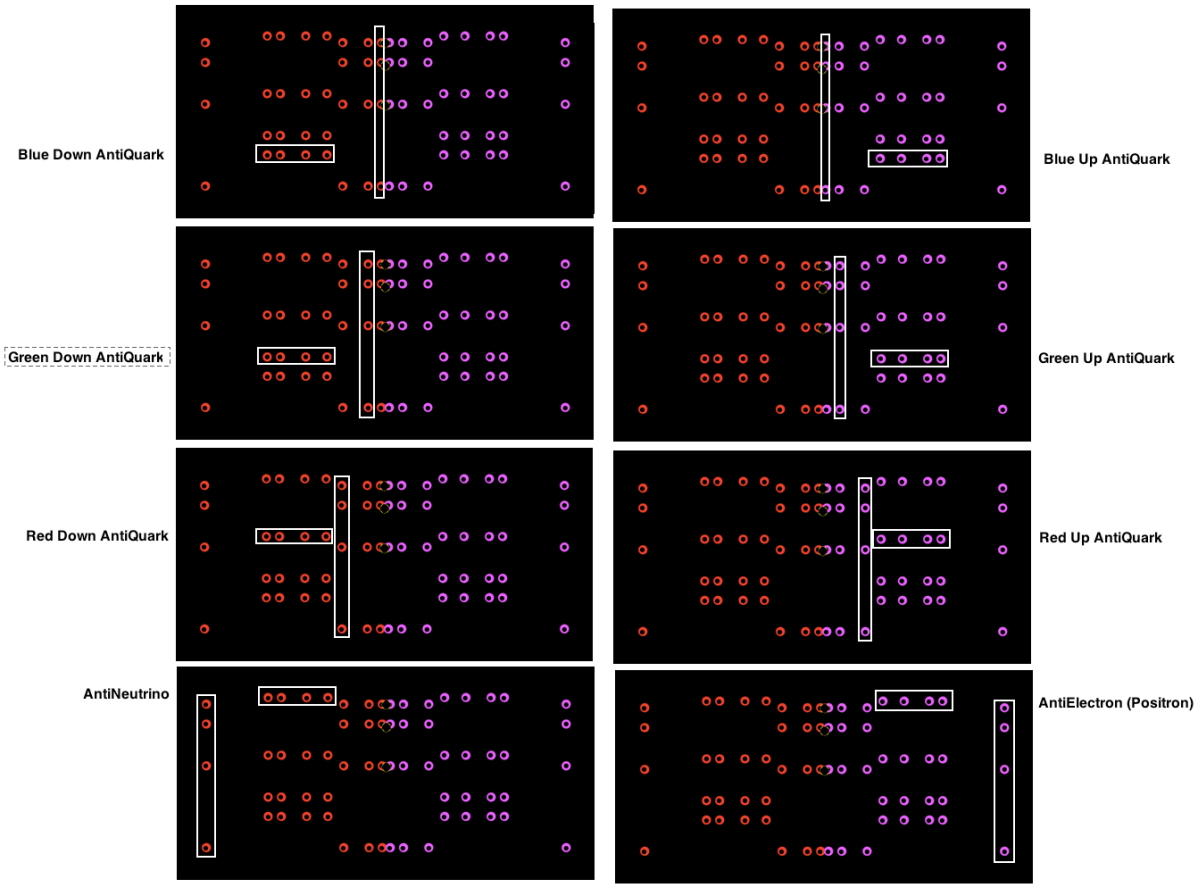


The 8 Fermion Particle Types {Nu,rDQ,gDQ,bDQ;bUQ,gUQ,rUQ,E} are represented by the real part RP1 x S7 of the Complex Shilov Boundary S of the 32-real-dim V non-tube type.bounded Domain (CxO)P2 of the EIII Symmetric Space E6 / Spin(10) x U(1).
The bounded Domain is in a subspace of J3(CxO) and S is a fiber space with fiber RP1 x S7 (Real part for Particles) and base space S9 with fibration S1 -> S9 -> CP4 that contains a RP1 x S7 (for AntiParticles, in the Complex part) that is isomorphic to the fibre RP1 x S7 (Real part for Particles).

Here is how they fit into the Lagrangian:



The 64 Red and Magenta Root Vectors represent the
First Generation Fermion AntiParticles of E8 / D8
Each of 8 AntiParticles have
8 = 4+4 M4 x CP2 Kaluza-Klein components
so they are represented by 8x8 = 64 Root Vectors



The 8 Fermion AntiParticle Types {Nu,rDQ,gDQ,bDQ;bUQ,gUQ,rUQ,E}
are represented by RP1 x S7 in the Complex part of the Shilov Boundary S
of the 32-real-dim V non-tube type bounded Domain (CxO)P2 of the EIII
Symmetric Space E6 / Spin(10) x U(1).
The bounded Domain is in a subspace of J3(CxO) and S is a fiber space
with fiber RP1 x S7 (Real part for Particles) and base space S9 with
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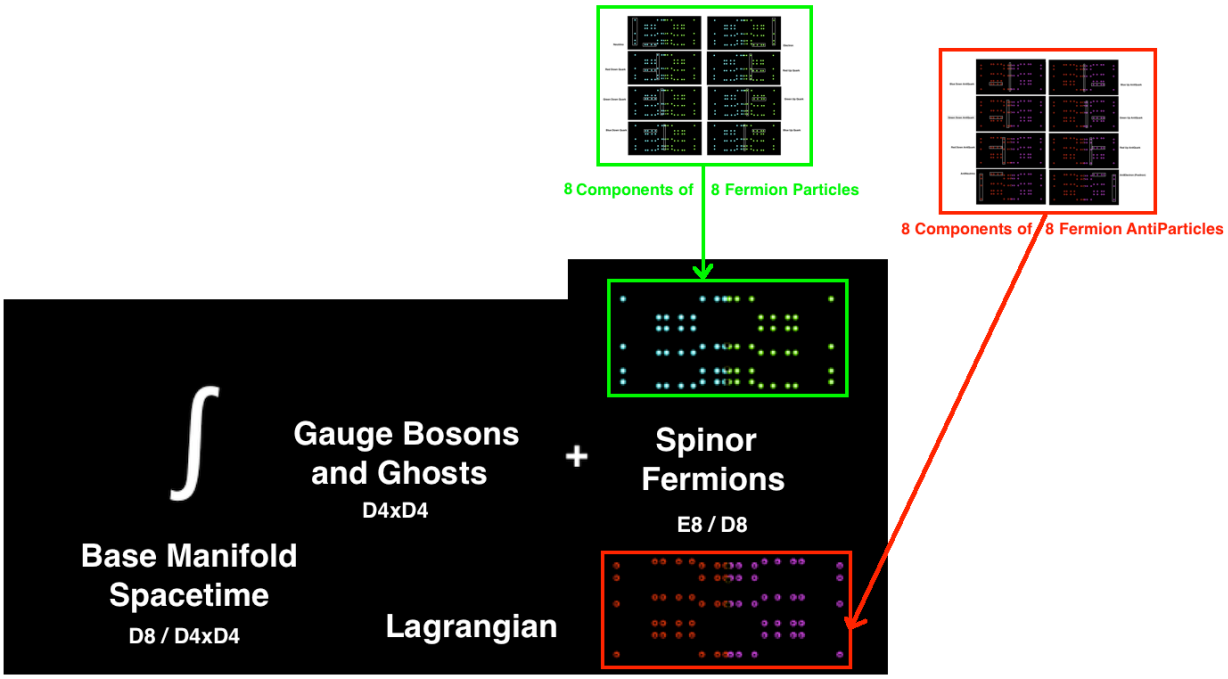
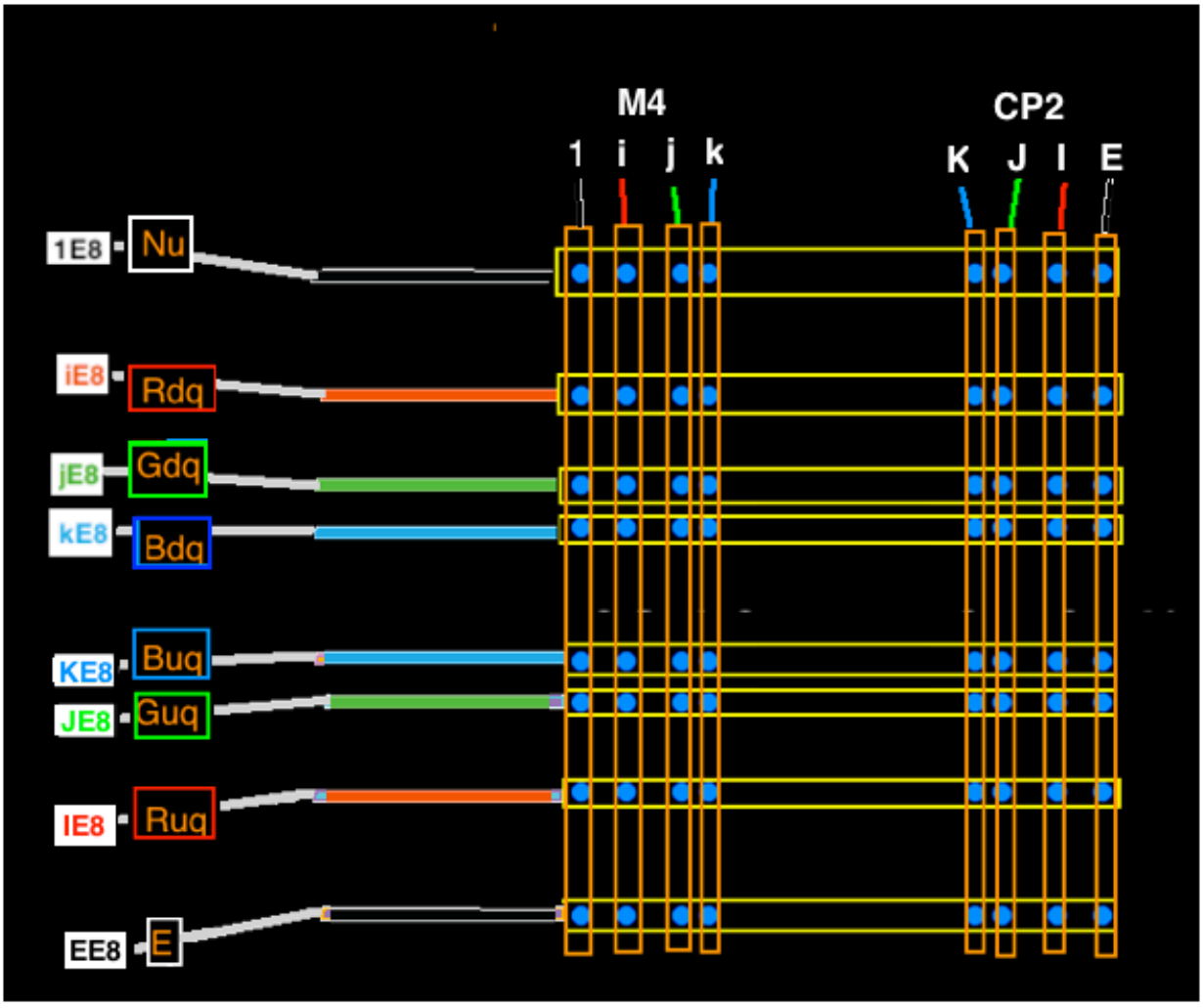
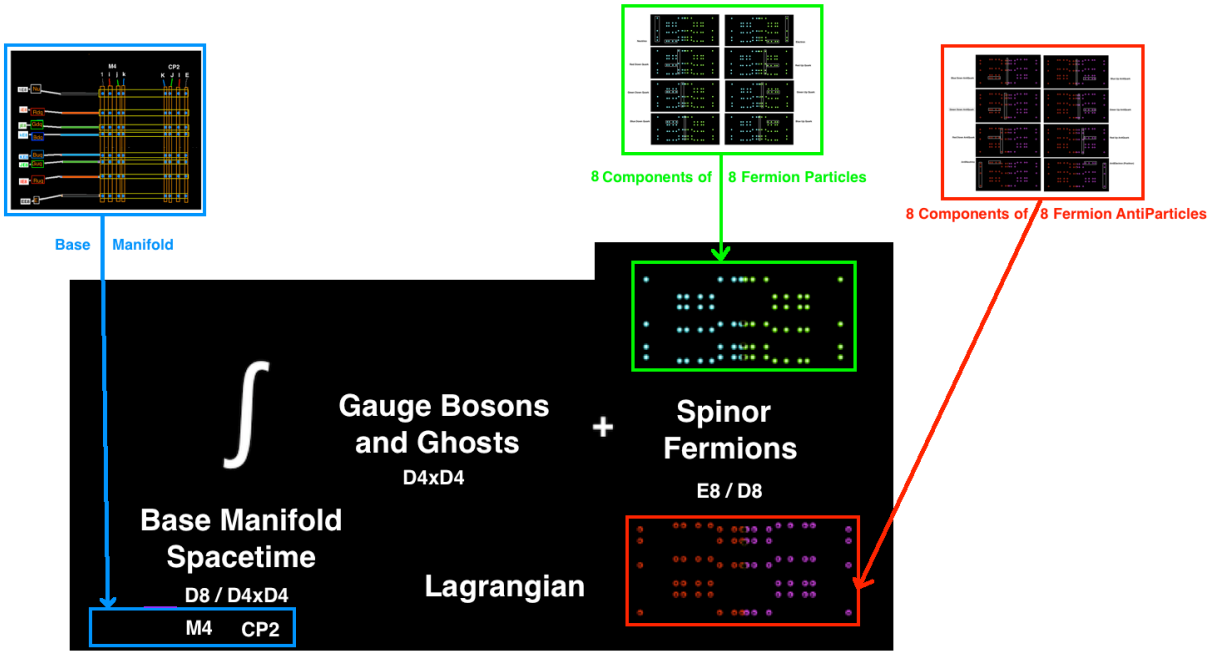


The 64 Blue Root Vectors of D8 / D4xD4 are a
Superposition of 8 E8 Spacetime Lattices
(7 being Integral Domains) corresponding to the 8
fundamental Fermion Types,
each of which has 8-dim M4 x CP2 Kaluza-Klein structure.
Effectively, each Fermion Type propagates within its own
E8 Lattice within the Superposition
forming an 8-dim Generalized Feynman Checkerboard

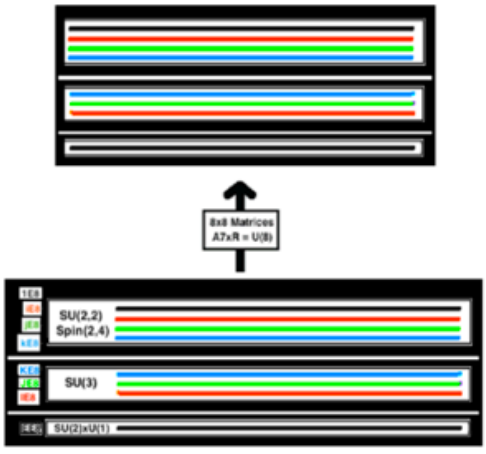


The 8 dimensions of M4xCP2 Spacetime {1,i,j,k,K,J,I,E}
are represented by the basis of the 8-real-dim space RP1 x S7
that is the Shilov Boundary of the 16-real-dim IV(8,2) Bounded Domain
(tube type) of the BDI Symmetric Space Spin(10) / Spin(8) x U(1)

Here is how they fit into the Lagrangian:

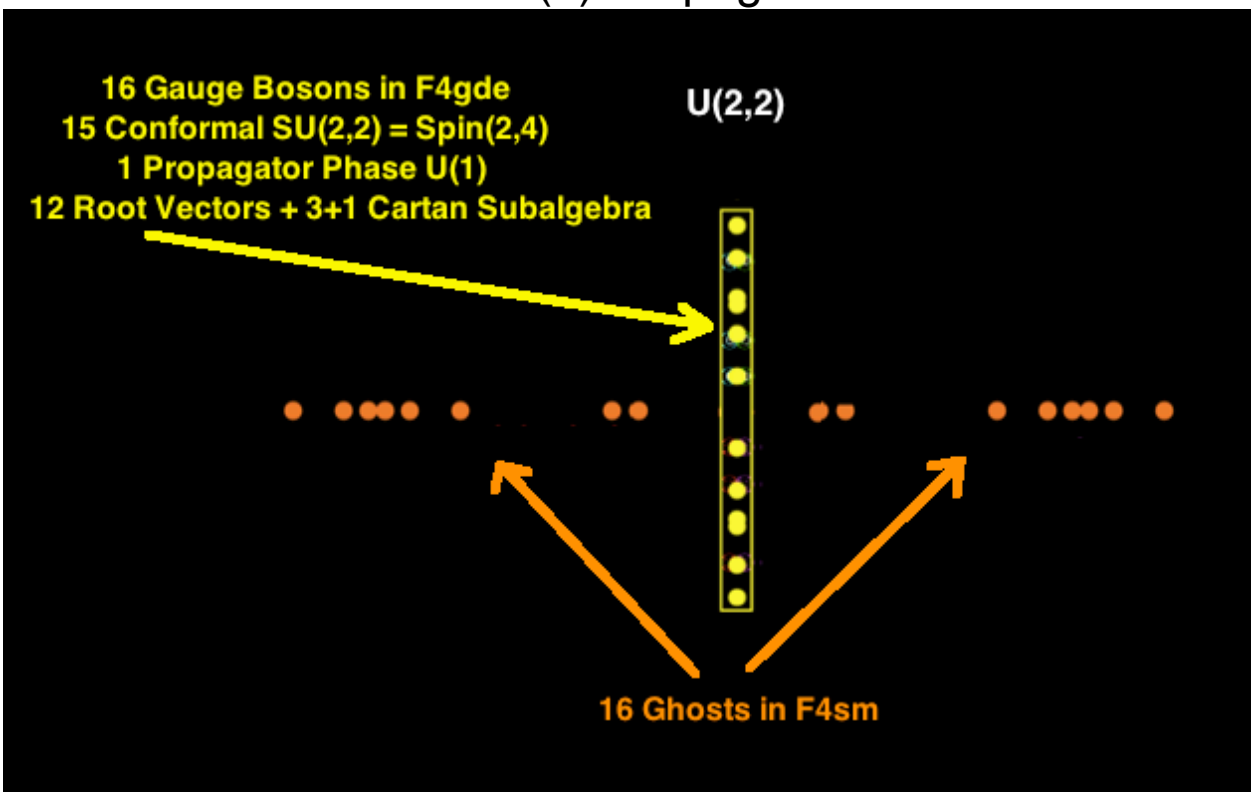


In “Space-Time Code. III” Phys. Rev. D (1972) 2922-2931 David Finkelstein said
“... The primitive quantum processes ... of which world lines are made
can be thought of as acts of emission or creation,
Their duals ... represent acts of absorption or annihilation. ...”.
Creation-Annihilation Operators are given by the
Maximal Contraction of E8 = semidirect product A7 x h92
where h92 = 92+1+92 Heisenberg algebra and A7 = 63-dim SL(8)

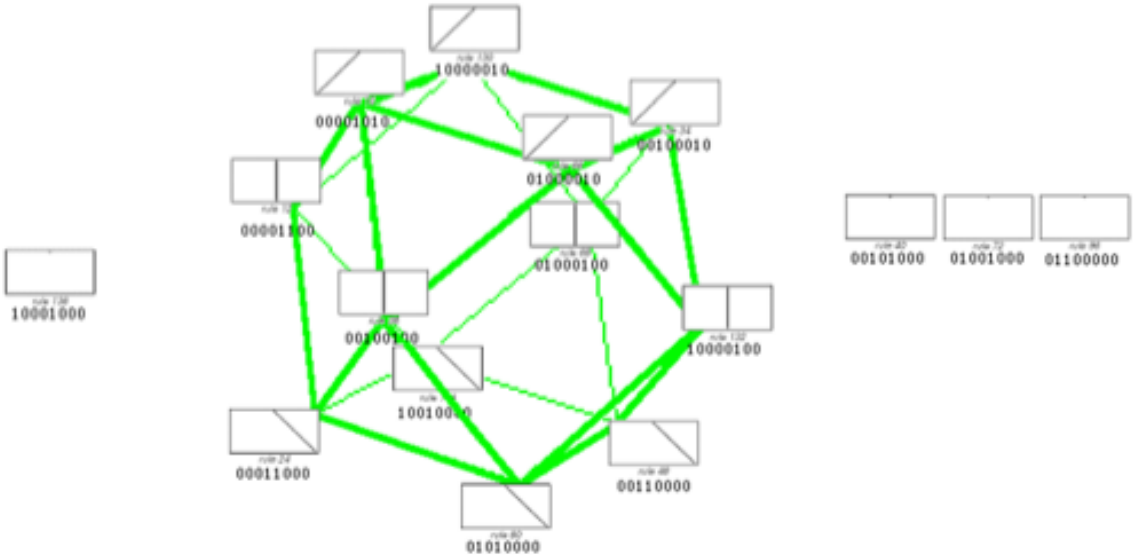


The 8x8 matrices linking one V Spacetime Superposition to the next
in a World-Line String form 64-dim A7 x R

Gravity+Dark Energy Gauge Bosons and Ghosts, and U(1) Propagator



These 1 + 12 + 3 = 16 grade-2 Cellular Automata
correspond to propagator phase,
Conformal Lie Algebra Root Vectors,
and Conformal Lie Algebra Cartan Subalgebra



The Conformal Group Spin(2,4) = SU(2,2)
gives Gravity+Dark Energy
by the MacDowell-Mansouri mechanism.
U(2,2) = U(1) x SU(2,2)
also contains the U(1) propagator phase

The ratio

Dark Energy : Dark Matter : Ordinary Matter

comes from the structure of
the Conformal Group SU(2,2) = Spin(2,4)
whose 15 generators are:

10 = 6 Lorentz + 4 Special Conformal for Dark Energy

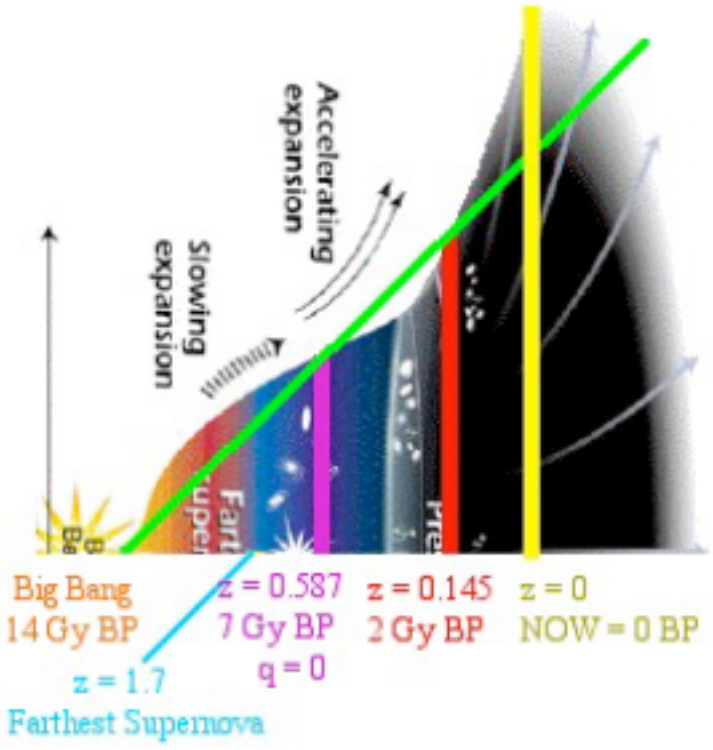
4 = Translations for Primordial Black Hole Dark Matter

1 = Dilation for Higgs Ordinary Matter

giving a tree-level ratio of

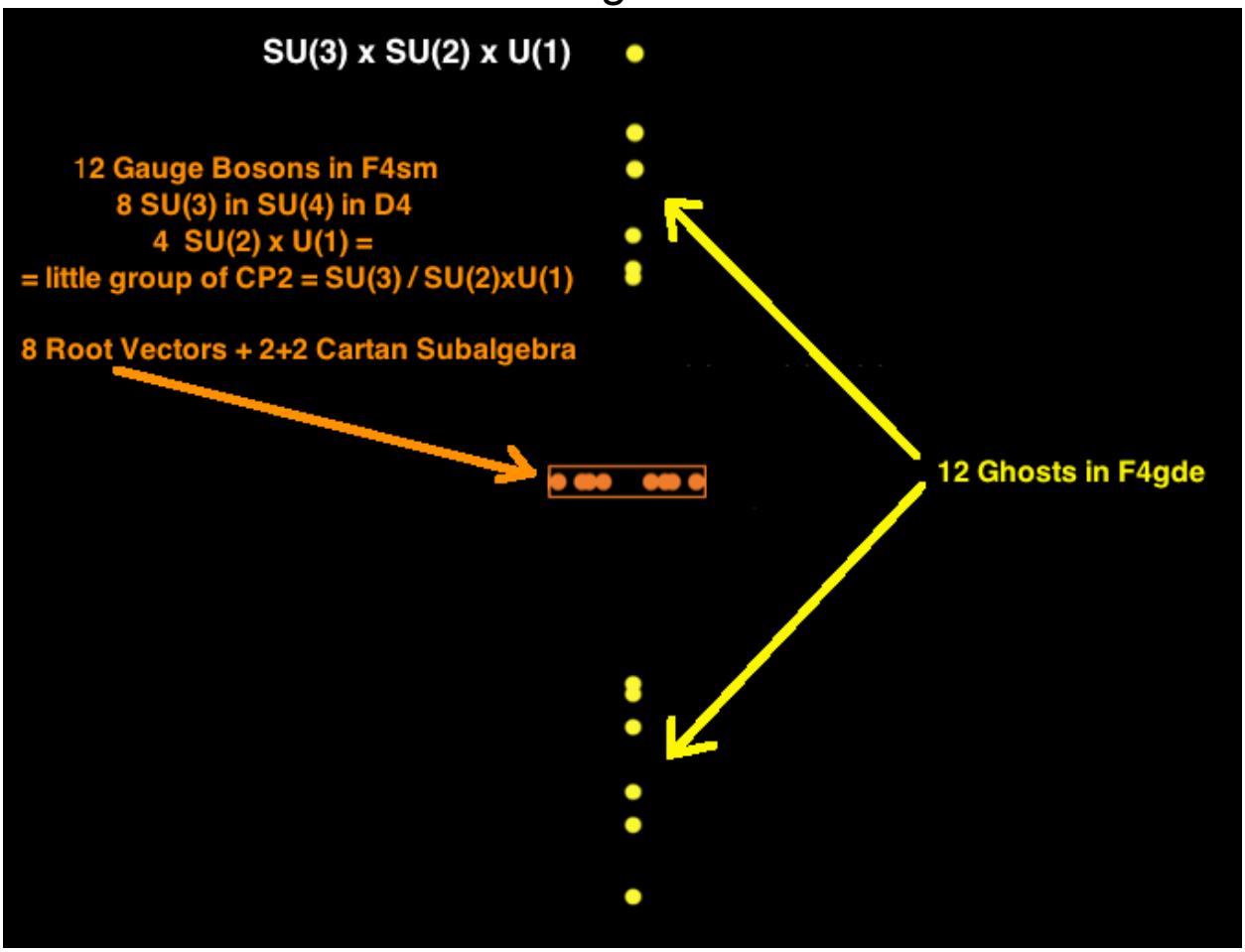
10 : 4 : 1 = 0.667 : 0.267 : 0.067

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



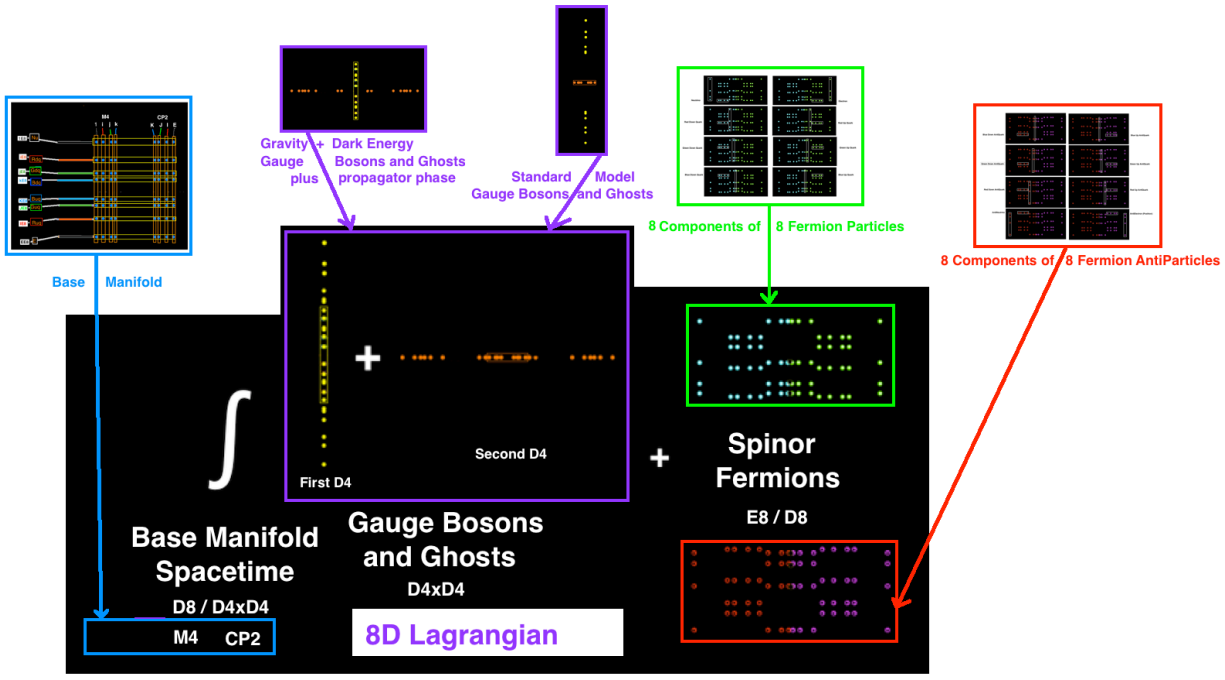
gives Dark Energy : Dark Matter : Ordinary Matter =
= 0.75 : 0.21 : 0.04

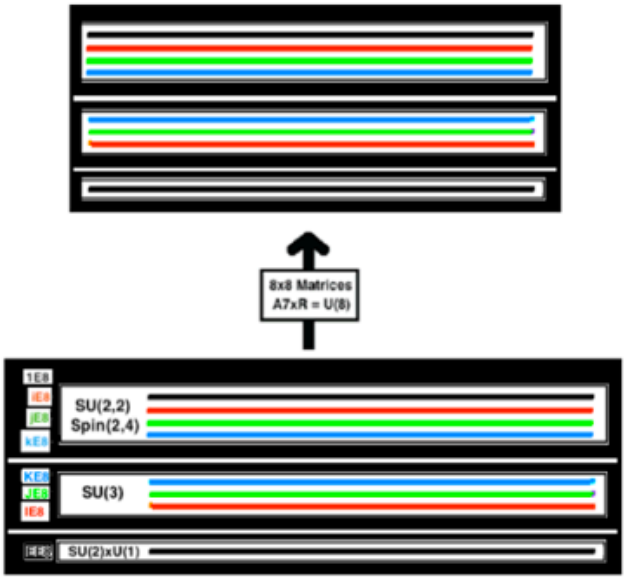
Standard Model Gauge Bosons and Ghosts



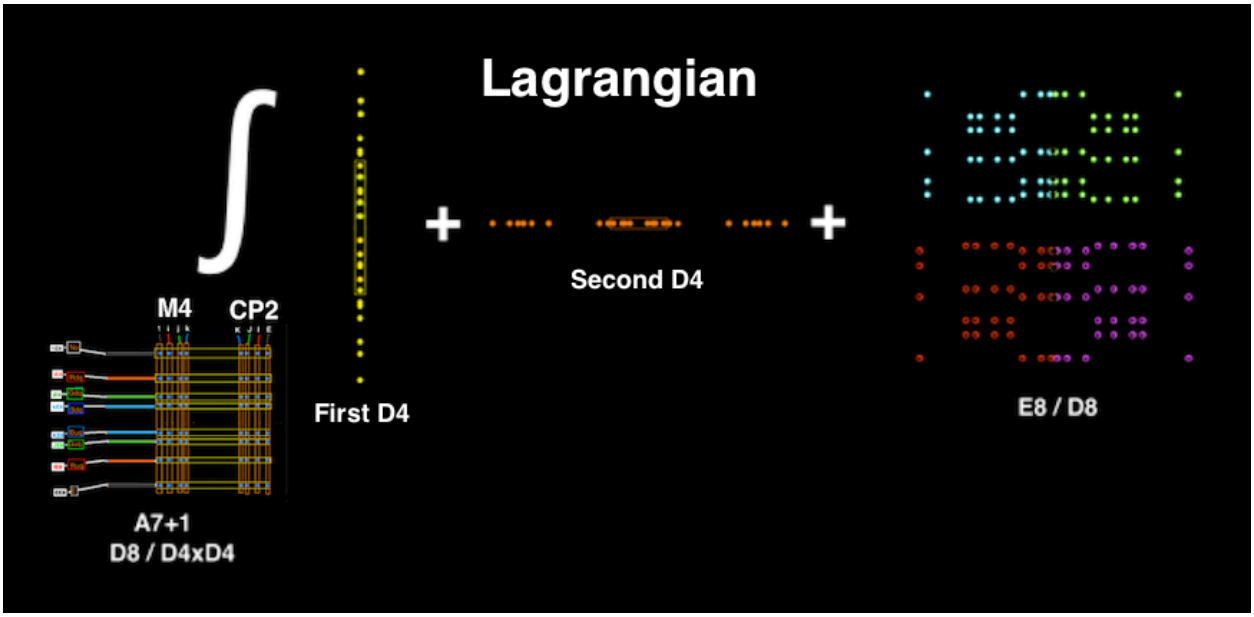
These 1 + 3 + 8 = 12 grade-2 Cellular Automata
correspond to
U(1) , SU(2) , SU(3) of the Standard Model

Here is how they fit into the Lagrangian:





Gauge Bosons from 1E8, iE8, jE8, and kE8 parts of a V give U(2,2) Conformal Gravity
Gauge Bosons from IE8, JE8, and KE8 parts of a V give SU(3) Color Force
Gauge Bosons from EE8 part of a V give U(2) Electroweak Force
Ghosts from one V Spacetime Superposition to the next are defined similarly.



The 8D Lagrangian Density has 3 fundamental terms

Fermion Particles and AntiParticles in E8 / D8
(8+8) x 8 Components = 64+64 = 128 Root Vectors

Standard Model Gauge Bosons
and Gravity+Dark Energy Ghosts
24 Root Vectors and
4 Cartan Subalgebra elements of CP2 part of E8 Physics

Gravity+Dark Energy Gauge Bosons
and Standard Model Ghosts plus U(1) Propagator Phase
24 Root Vectors and
4 Cartan Subalgebra elements of M4 part of E8 Physics

The 8D Lagrangian Base Manifold is
M4 x CP2 Kaluza-Klein of Superposition of 8 E8 Lattices
(4+4) x 8 = 64 Root Vectors

Lagrangian 8-dim Lorentz structure
satisfies Coleman-Mandula
because its Fermionic fundamental spinor representations
are built with respect to spinor representations for 8-dim
Spin(1,7) spacetime.

Each Fermionic Term Fermion has in 8-dim Spacetime
units of mass^(7/2).
Each BosonicTerm Gauge Boson + Ghost has
units of mass^(1)
Since (8+8)x(7/2) = 56 = 28 + 28
the Fermionic Terms cancel the Bosonic Terms
so the E8 Physics Lagrangian is UltraViolet finite.

Here is how the 8D Lagrangian gives
Higgs and 3 Fermion Generations

when its 8D Octonionic Spacetime symmetry
is broken to M4 x CP2 Kaluza-Klein

where

M4 is 4D Minkowski Spacetime

and

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

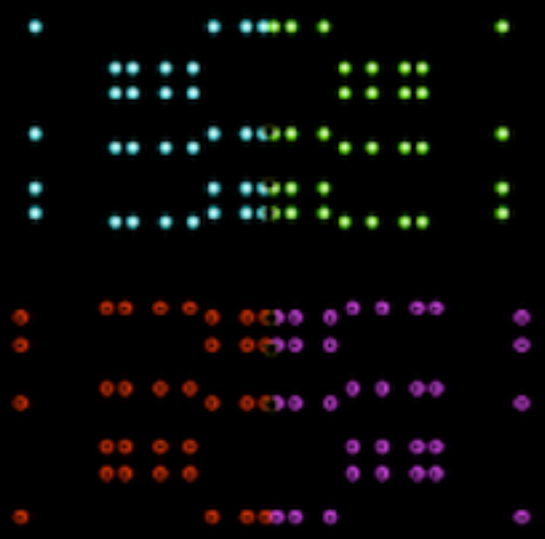
Lagrangian

$\int$

+

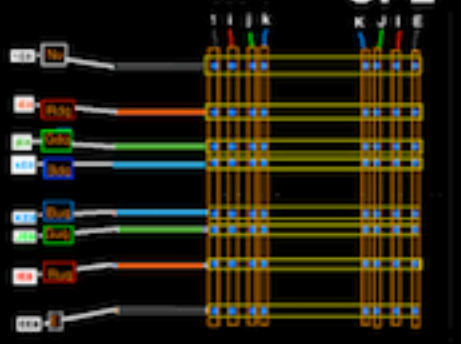
+

Second D4



E8 / D8

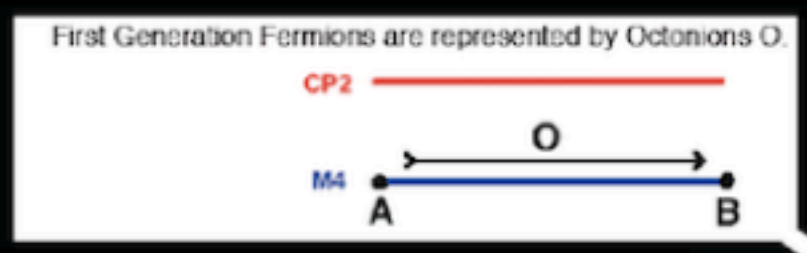
M4 CP2



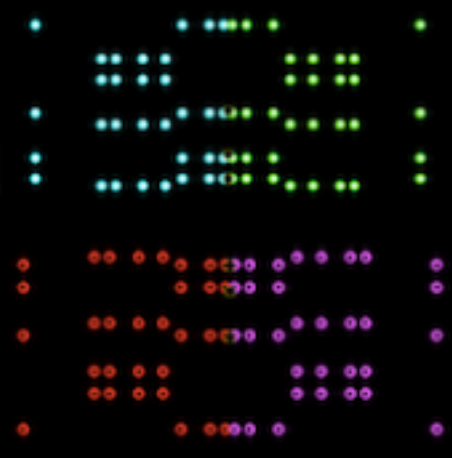
First D4

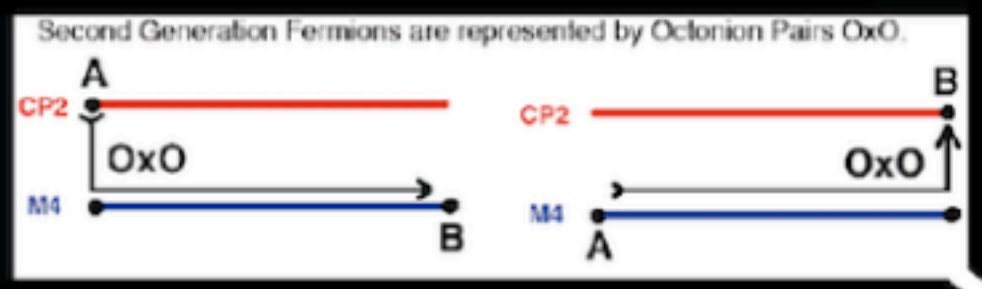
A7+1
D8 / D4xD4

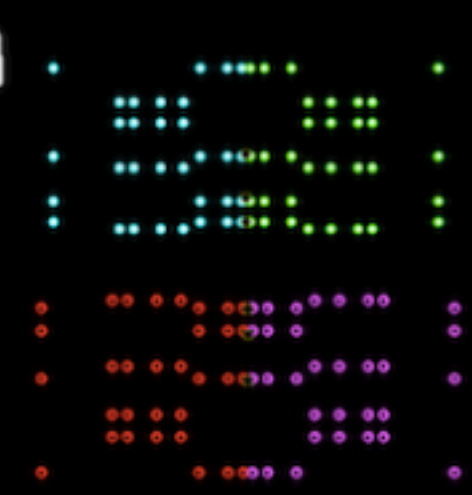
Mayer Mechanism



3 Kaluza-Klein
Fermion Generations







$\int$

HIGGS

+

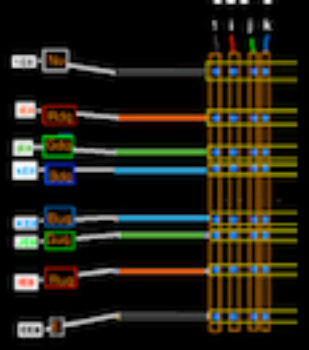
$D4_{sm}$

+

+

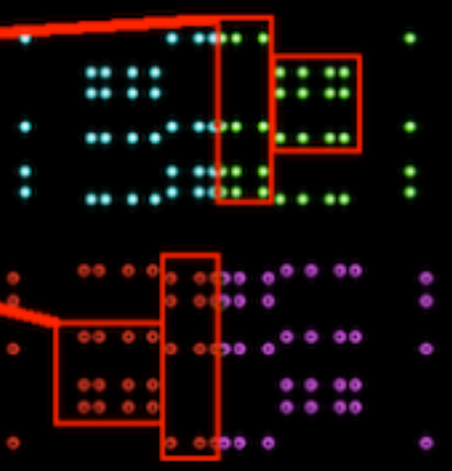
$D4_{gde}$

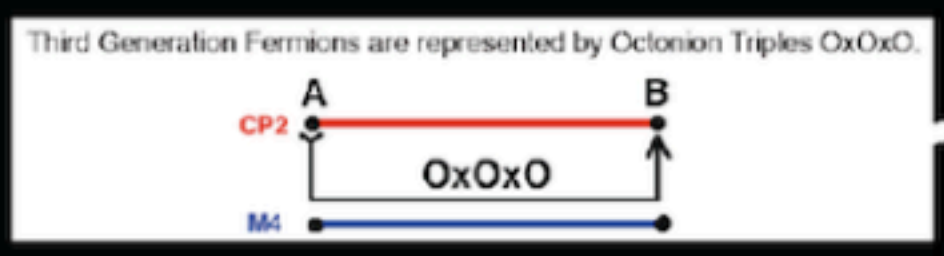
M4



RGB Truth Quarks

NJL
Higgs as
Condensate of $T\bar{T}$



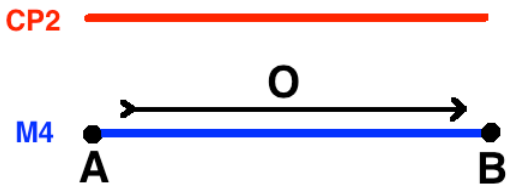


RGB Truth AntiQuarks

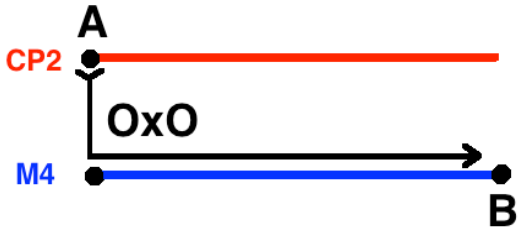
3 Generations of Fermions

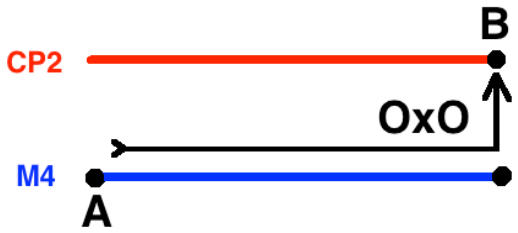
In Kaluza-Klein M4 x CP2 there are 3 possibilities
for a fermion to go from point A to point B:

1 - A and B are both in M4: First Generation Fermion
represented by single O basis element

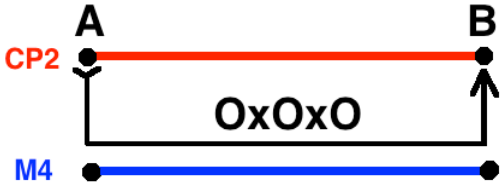


2 - Either A or B, but not both, is in CP2: Second Generation Fermion
whose path must be augmented by one projection from CP2 to M4,
which projection can be represented by a second O basis element
so that Second Generation Fermions are Octonion Pairs OxO.

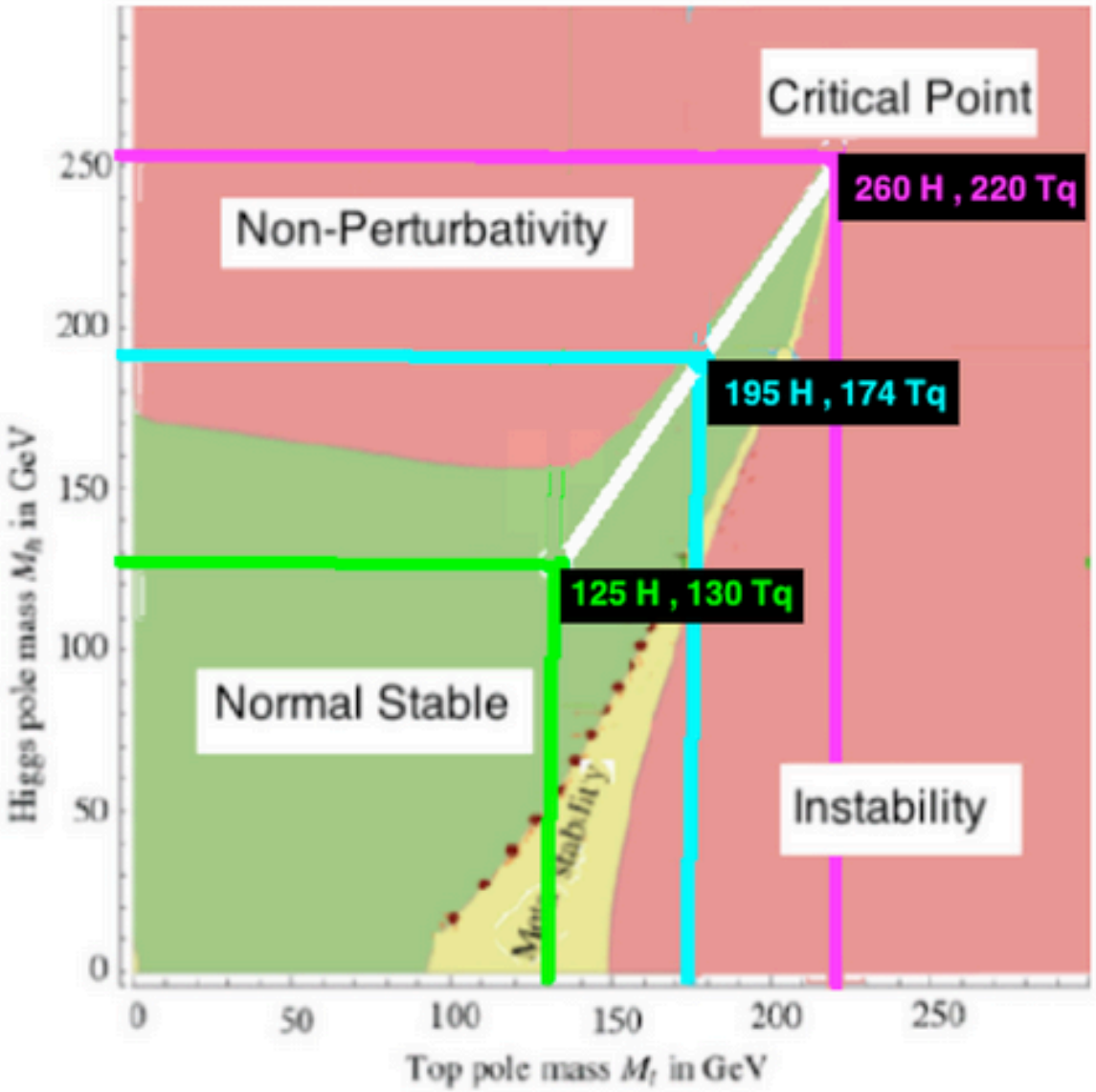




3 - Both A and B are in CP2: Third Generation Fermion
whose path must be augmented by two projections from CP2 to M4,
which projections can be represented by a second O and a third O,
so that Third Generation Fermions are Octonion Triples OxOxO.



When Octonionic Spacetime of 8D Lagrangian symmetry breaks to Quaternionic (4+4) Kaluza-Klein 4D Lagrangian Higgs emerges by Mayer Mechanism
and
Higgs as Truth Quark-AntiQuark Condensate form Nambu - Jona-Lasinio system with 3 Mass States for Higgs and Truth Quark



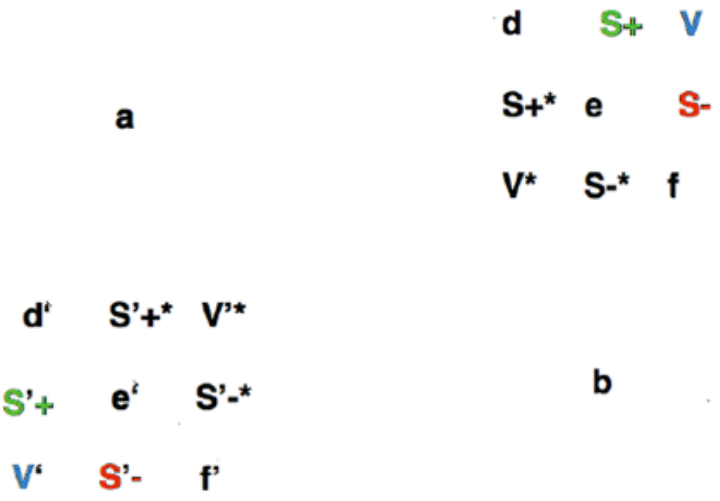
E8 Physics World-Lines = Strings as String Theory

Fundamental Interactions are not among Point Particles
but are among Strings = World-Line Histories of Particles.

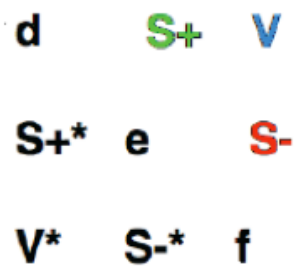
David Finkelstein said
(“Space-Time Code. III” Phys. Rev. D (1972) 2922-2931)
“... According to relativity,
the world is a collection of processes (events}
with an unexpectedly unified causal or chronological structure.
Then an object is secondary ...[to]...
a long causal sequence of processes, world line. ..
[if] we assemble these ... into chromosomelike code sequences ...
and braid and cross-link these strands
to make more complex objects and their interactions
...[then]... The idea of the quantum jump comes into its own ...”.

Do the 56-dim grade-3 TriVectors of Cl(8) represent 26D String Theory of E8 Physics ?

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



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



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

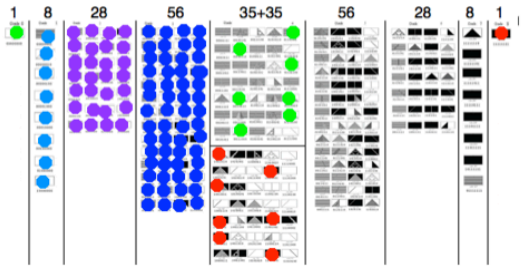
V = 8-dim Spacetime
the 8-real-dim space RP1 x S7 that is the Shilov Boundary
of the 16-real-dim IV(8,2) Bounded Domain (tube type)
of the BDI Symmetric Space Spin(10) / Spin(8) x U(1)

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

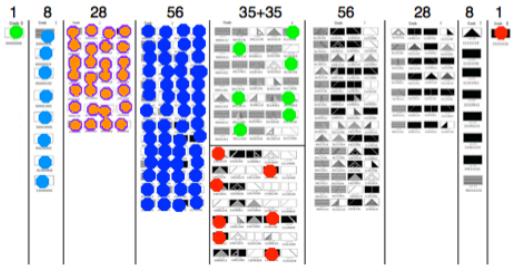
S- = 8 - half-Spinor Fermion AntiParticles
RP1 x S7 in the Complex part of the Shilov Boundary S of the 32-real-dim V non-tube type bounded Domain (CxO)P2 of the EIII Symmetric Space E6 / Spin(10) x U(1)

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

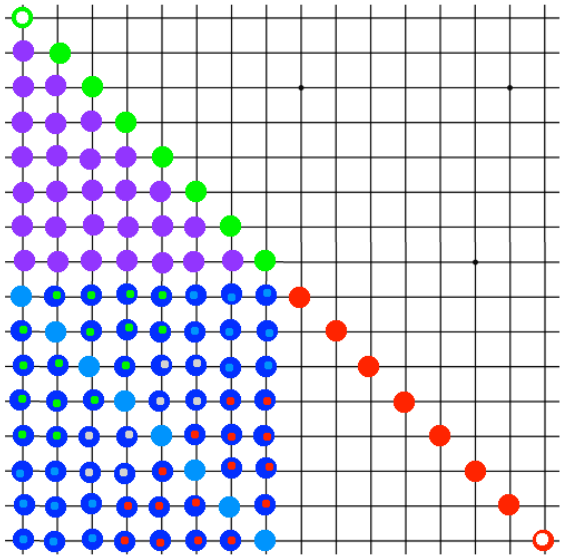
First Cl(8) D4 F4 acting on M4
Graded Representation



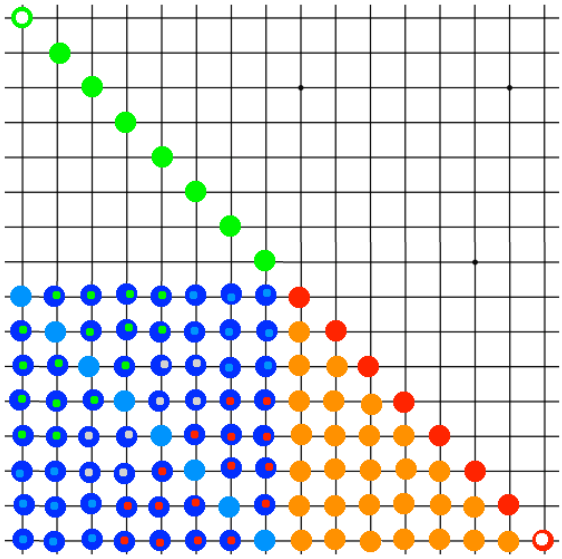
Second Cl(8) D4 F4 acting on CP2
Graded Representation



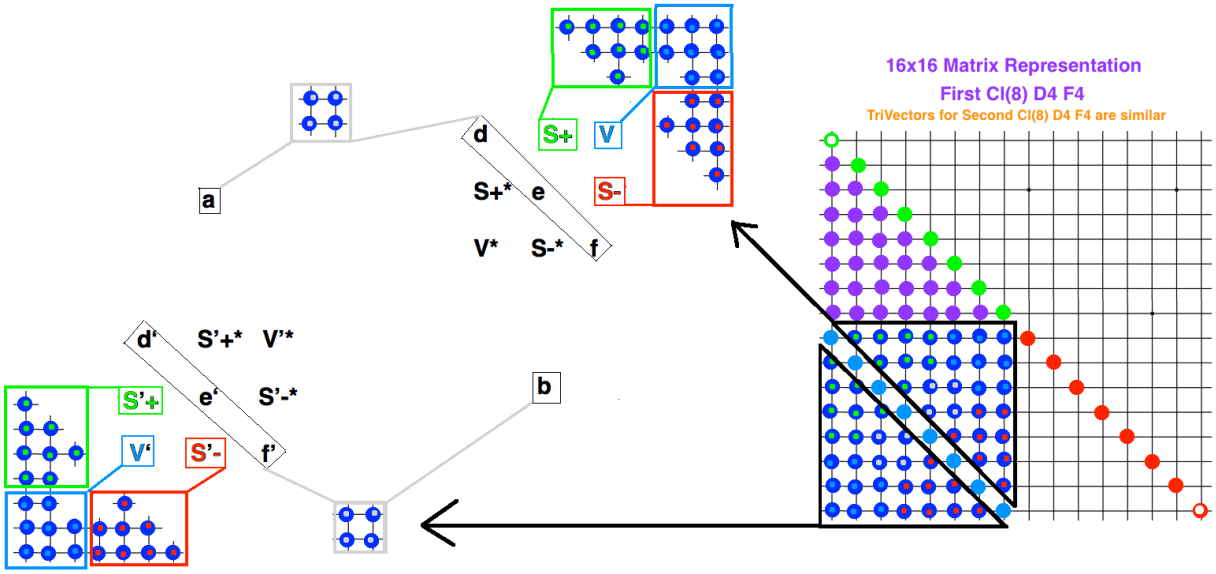
16x16 Matrix Representation



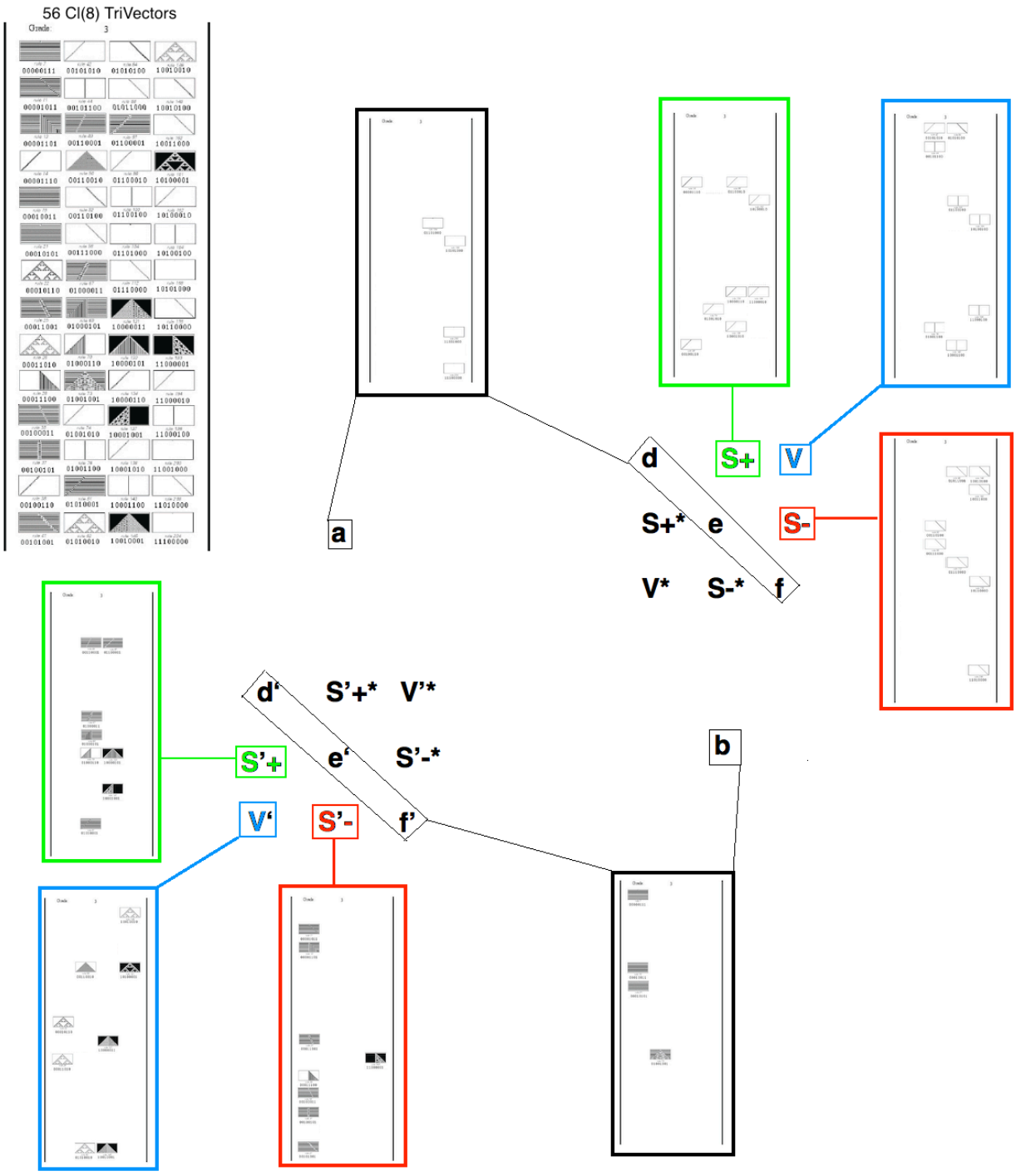
16x16 Matrix Representation



Cl(8) TriVectors correspond to Fr3(O)

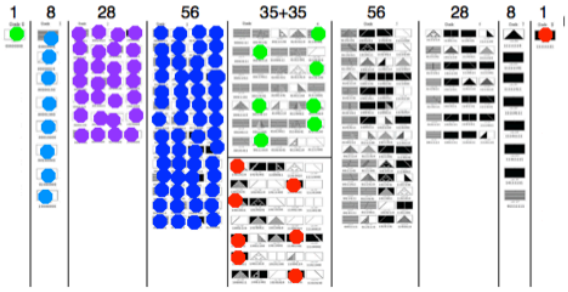


Here is the correspondence in terms of graded Cl(8):



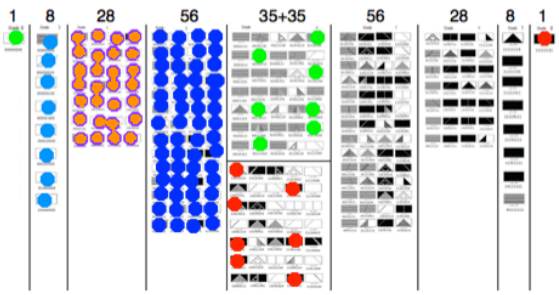
Due to 8-Periodicity of Real Clifford Algebras
tensor product Cl(8) x Cl(8) = Cl(16)

First Cl(8) D4 F4 acting on M4
Graded Representation

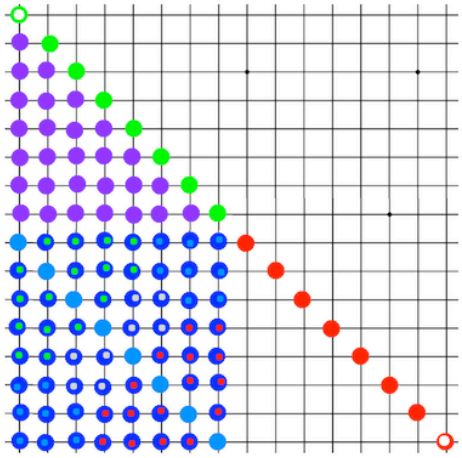


x

Second Cl(8) D4 F4 acting on CP2
Graded Representation

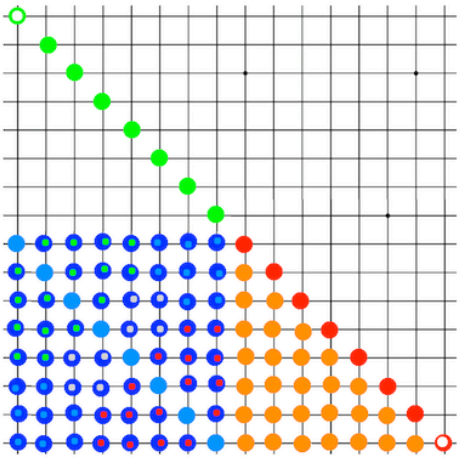


16x16 Matrix Representation



x

16x16 Matrix Representation



=

256x256 = 65,536-dim Cl(16) containing 248-dim E8
1 16 120 560 ...

BiVector D8 of E8 = 120 = 28 + 8x8 + 28 = 28 + 64 + 28

TriVector Cl(16) String Theory = 560 = 56 + 8x28 + 28x8 + 56 = 10 x 56

Cl(16) Spinors = 8 x 8 + 8 x 8 + 8 x 8 + 8 x 8

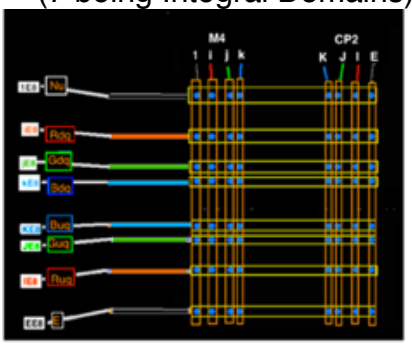
E8 half-Spinors = 8 x 8 + 8 x 8 = 64 + 64

The 560 TriVectors of Cl(16) are 10 copies of 56 = Fr3(O)

Fr3(O) is Complexification of J3(O)

d	S+	V
S+*	e	S-
V*	S-*	f

V is a Superposition of 8 E8 8-dim Spacetime Lattices
(7 being Integral Domains)



corresponding to the 8 fundamental Fermion Types.

Each Fermion Type propagates within its own E8 Lattice
within the Superposition
which accounts for 8 of the 10 copies of Fr3(O)

The other 2 copies of Fr3(O)
correspond to the 2 diagonal elements d and f
which describe the 10-dim R(1,9) space
that is Conformal over 8-dim R(0,8) space
which has Clifford Algebra Cl(0,8) = Cl(1,7) of RP1 x S7

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

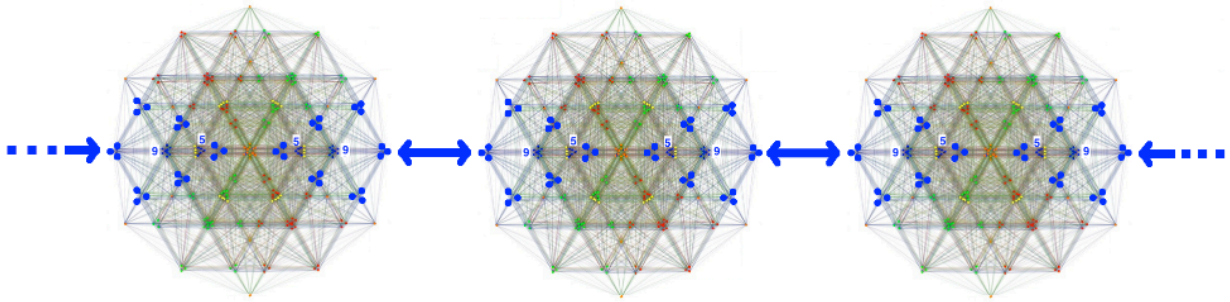
The Clifford Algebra of 26D String Theory is Cl(1,25)
Cl(1,25) = M(2,Cl(0,24)) =
= 2x2 matrices with entries in Cl(0,24) =
= Conformal Structure over Cl(0,24)

Cl(0,24) = Cl(0,8) x Cl(0,16)
Cl(0,16) has 16-dim Barnes-Wall Lattice Structure
Cl(0,8) has 8-dim E8 Lattice Structure
so
Cl(0,24) has 24-dim Leech Lattice Structure
and
Cl(1,25) = M(2, Cl(0,24)) has Lorentz Leech Lattice Structure
with Monster Group Symmetry of each Lattice Cell

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

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

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



Completion of the Union of all Tensor Products of the form

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

gives an Algebraic Quantum Field Theory (AQFT)

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

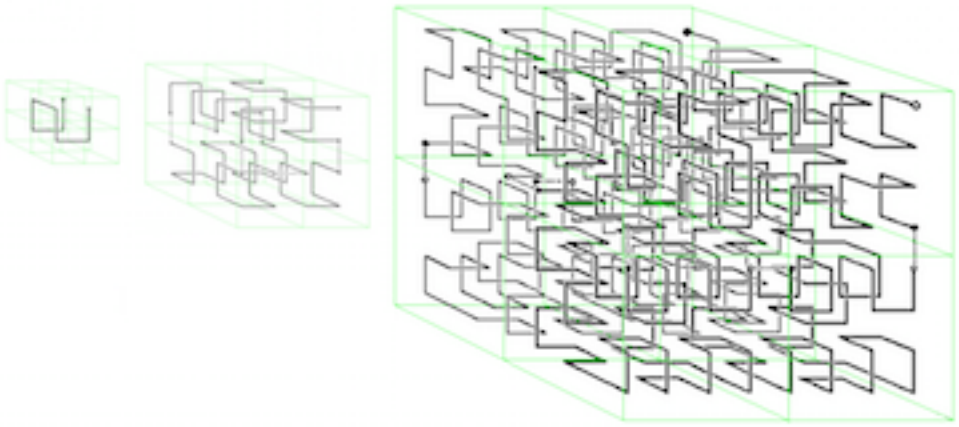
For N = 2^16 = 65,536 = 4^8 the copies of Cl(1,25) fill in the 8-dim HyperCube as described by William Gilbert's web page: "... The n-bit reflected binary Gray code will describe a path on the edges of an n-dimensional cube that can be used as the initial stage of a Hilbert curve that will fill an n-dimensional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

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

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

If edges of sub-HyperCubes, equal to the distance between adjacent copies of Cl(1,25), remain constantly at the Planck Length, then the full 8-dim HyperCube of our Universe expands as N grows to 2^16 and beyond

similarly to the way shown by this 3-HyperCube example for N = 2^3, 4^3, 8^3 from Wiliam Gilbert's web page:



The Union of all Cl(1,25) tensor products is
the Union of all subdivided 8-HyperCubes
and
their Completion is a huge superposition
of 8-HyperCube Continuous Volumes
which Completion belongs to the Third Grothendieck Universe
and
is an AQFT Real Clifford Algebra generalization of
the Complex Clifford Algebra Fock Space
Hyperfinite II1 von Neumann factor Algebra

The Third Grothendieck Universe AQFT contains within each Cl(1,25)
a realistic E8 Lagrangian within Cl(16)
(see viXra 1602.0319, 1701.0495, 1701.0496)
and
contains
10 copies of Fr3(O) within 560 TriVectors of Cl(16)
to describe a World-Lines = Strings String Theory
with structure of J3(O)o 26D String Theory

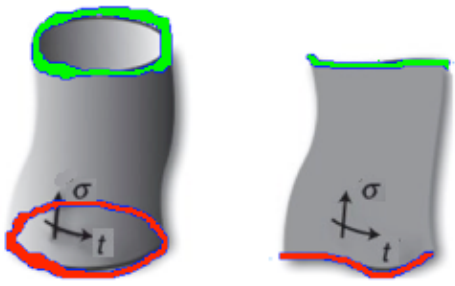
J3(O)o World-Line String Bohm Quantum Theory

A physically realistic Lattice Bosonic String Theory with Strings = World-Lines and Monster Group Symmetry
containing gravity and the Standard Model
can be constructed consistently with Cl(16) - E8 physics

In “Space-Time Code. III” Phys. Rev. D (1972) 2922-2931 David Finkelstein said
“... According to relativity, the world is a collection of processes (events} with an unexpectedly unified causal or chronological structure. Then an object is secondary ... [to]... a long causal sequence of processes, **world line**. .. [if] we assemble these ... into chromosomelike code sequences ... and braid and cross-link these strands to make more complex objects and their interactions. ...[then]... The idea of the quantum jump comes into its own, and reigns supreme, even over space and time. ...”.

Andrew Gray in arXiv quant-ph/9712037 said:
“... probabilites are ... assigned to entire fine-grained histories ...
base[d] ... on the Feynman path integral formulation ...
The formulation is fully relativistic and applicable to multi-particle systems.
It ... makes the same experimental predictions as quantum field theory …”.

Luis E. Ibanez and Angel M. Uranga in “String Theory and Particle Physics” said:
“... String theory proposes ... small one-dimensional extended objects, strings,
of typical size Ls = 1/ Ms, with Ms known as the string scale ...
As a string evolves in time, it sweeps out a two-dimensional surface in spacetime,
known as the worldsheet, which is the analog of the ... worldline of a point particle ...
for the bosonic string theory ... the classical string action is the total area spanned by the worldsheet ... This is the ... Nambu– Goto action ...”.
In my unconventional view



the red line and the green line are different strings/worldlines/histories and
the world-sheet is the minimal surface connecting them,
carrying the Bohm Potential,
as Standard Model gauge bosons carry Force Potential between Point Particles.
The t world-sheet coordinate is for Time of the string-world-line history.
The sigma world-sheet coordinate is for Bohm Potential Gauge Boson at a given Time.
(images adapted from “String Theory and Particle Physics” by Ibanez and Uranga)

Further, Ibanez and Uranga also said:
"... The string groundstate corresponds to a 26d spacetime tachyonic scalar field T(x).
This **tachyon** ... is ... unstable
...
The massless two-index tensor splits into irreducible representations of SO(24) ...
Its **trace** corresponds to a scalar field, the **dilaton** ϕ, whose vev fixes the string interaction coupling constant gs
...
the **antisymmetric** part is the 26d 2-form field BMN
...
The **symmetric traceless** part is the 26d graviton GMN ...".

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

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

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

Joe Polchinski in "String Theory, Volume 1, An Introduction to the Bosonic String" said:
"... we find at m^2 = - 4 / alpha' the tachyon,
and at m^2 = 0 the 24 x 24 states of the graviton, dilaton, and antisymmetric tensor ...".

Must the 24x24 symmetric matrices be interpreted as the graviton ? - !!! NO !!!

The 24x24 Real Symmetric Matrices form the Jordan Algebra J(24,R).

Jordan algebras correspond to the matrix algebra of quantum mechanical states,
that is, from a particle physics point of view,
the configuration of particles in spacetime upon which the gauge groups act.

24-Real-dim space has a natural Octonionic structure of 3-Octonionic-dim space.

The corresponding Jordan Algebra is J(3,O) = 3x3 Hermitian Octonion matrices.

Their 26-dim traceless part J(3,O)o describes the 26-dim of Bosonic String Theory
and
the algebra of its Quantum States,
so that
the 24x24 traceless symmetric spin-2 particle is the Quantum Bohmion.

Joseph Polchinski, in his books String Theory vols. I and II(Cambridge 1998), says: "... the **closed ... unoriented ... bosonic string ... theory** has the maximal 26-dimensional Poincare invariance ... It is possible to have a consistent theory ...[with]... the **dilaton** ... the [**string-**]**graviton** ...[and]... the **tachyon** ...[whose]... negative mass-squared means that the no-string 'vacuum' is actually unstable ... ".
The **dilaton** of E8 Physics sets the Planck scale as the scale for
the 16 dimensions that are orbifolded fermion particles and anti-particles
and the 4 dimensions of the CP2 Internal Symmetry Space of M4xCP2 spacetime.
The remaining 26-16-4 = 6 dimensions are the Conformal Physical Spacetime with Spin(2,4) = SU(2,2) symmetry that produces M4 Physical Spacetime

E8 Physics 26D String Theory Spacetime
10D = 6D Conformal Spacetime + 4D Compact CP2 Internal Symmetry Space
with CP2 = SU(3) / SU(2)xU(1) as unique Compactification
which specifies Gauge Groups of the Standard Model.

If Strings = World Lines and World Lines are past and future histories of particles, then **spin-2 string entities carry Bohm Quantum Potential** with Sarfatti Back-Reaction related to Cramer Transaction Quantum Theory.

Roger Penrose in "Road to Reality" (Knopf 2004) says: "... **quantum** mechanics ... alternates between ... **unitary** evolution **U** ... and state reduction R ...
quantum state **reduction** ... is ... **objective** ... **OR** ...
it is always a gravitational phenomenon ... [A] conscious event ... would be ...
orchestrated OR ... of ... large-scale quantum coherence ... of ... microtubules ...".

String-Gravity produces Sarfatti-Bohm Quantum Potential with Back-Reaction.
It is distinct from the MacDowell-Mansouri Gravity of stars and planets.
The **tachyon** produces the instability of a truly empty vacuum state with no strings.
It is natural, because if our Universe were ever to be in a state with no strings, then tachyons would create strings = World Lines thus filling our Universe with the particles and World-Lines = strings that we see. Something like this is necessary for particle creation in the Inflationary Era of non-unitary Octonionic processes.
Our construction of a 26D String Theory consistent with E8 Physics uses a structure that is not well-known, so I will mention it here before we start:

There are 7 independent E8 lattices, each corresponding to one of the 7 imaginary octionions denoted by iE8, jE8, kE8, EE8, IE8, JE8, and KE8 and related to both D8 adjoint and half-spinor parts of E8 and with 240 first-shell vertices. An 8th E8 lattice 1E8 with 240 first-shell vertices related to the D8 adjoint part of E8 is related to the 7 octonion imaginary lattices (viXra 1301.0150v2) .
It can act as an effectively independent lattice as part of the basis subsets {1E8,EE8} or {1E8,iE8,jE8,kE8}.

With that in mind, here is the construction:

Step 1:
Consider the 26 Dimensions of Bosonic String Theory as
a 26-dimensional traceless part J3(O)o living inside a Fr3(O)

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

(where Ov, O+, and O- are in Octonion space with basis {1,i,j,k,E,I,J,K}
and a and b are real numbers with basis {1})
of the 27-dimensional Jordan algebra J3(O) of 3x3 Hermitian Octonion matrices.

Step 2:
Take a 3-brane to correspond to the Imaginary Quaternionic associative subspace spanned by {i,j,k} in the 8-dimenisonal Octonionic Ov space.

Step 3:
Compactify the 4-dimensional co-associative subspace spanned by {E,I,J,K} in the Octonionic Ov space as a CP2 = SU(3)/U(2), with its 4 world-brane scalars corresponding to the 4 covariant components of a Higgs scalar.
Add this subspace to the 3-brane, to get a 7-brane.

Step 4:
Orbifold the 1-dimensional Real subspace spanned by {1} in the Octonionic Ov space by the discrete multiplicative group Z2 = {-1,+1}, with its fixed points {-1,+1} corresponding to past and future time. This discretizes time steps and gets rid of the world-brane scalar corresponding to the subspace spanned by {1} in Ov. It also gives our brane a 2-level timelike structure, so that its past can connect to the future of a preceding brane and its future can connect to the past of a succeeding brane.
Add this subspace to the 7-brane, to get an 8-brane Spacetime Superposition.
Our basic 8-brane looks like two layers (past and future) of 7-branes.
Beyond the 8-brane our String Theory has 26 - 8 = 18 dimensions,
of which 25 - 8 = 17 have corresponding world-brane scalars:

8 world-brane scalars for Octonionic O+ space;
8 world-brane scalars for Octonionic O- space;
1 world-brane scalars for real a space;
and

1 dimension, for real b space, in which 8-branes containing spacelike 3-branes are stacked in timelike order.

Step 5:
To get rid of the world-brane scalars corresponding to the Octonionic O+ space, orbifold it by the 16-element discrete multiplicative group

Oct16 = {+/-1,+/-i,+/-j,+/-k,+/-E,+/-I,+/-J,+/-K}

to reduce O+ to 16 singular points {-1,-i,-j,-k,-E,-I,-J,-K,+1,+i,+j,+k,+E,+I,+J,+K}.

Let the 8 O+ singular points {-1,-i,-j,-k,-E,-I,-J,-K} correspond to
the fundamental fermion particles
{neutrino, red up quark, green up quark, blue up quark,
electron, red down quark, green down quark, blue down quark}
located on the past 7-brane layer of the 8-brane.

Let the 8 O+ singular points {+1,+i,+j,+k,+E,+I,+J,+K} correspond to
the fundamental fermion particles
{neutrino, red up quark, green up quark, blue up quark,
electron, red down quark, green down quark, blue down quark}
located on the future 7-brane layer of the 8-brane.

The 8 components of the 8 fundamental first-generation fermion particles = 8x8 = 64
correspond to the 64 of the 128-dim half-spinor 8-brane part of E8.
This gets rid of the 8 world-brane scalars corresponding to O+, and leaves:

8 world-brane scalars for Octonionic O- space;
1 world-brane scalars for real a space;
and

1 dimension, for real b space, in which 8-branes containing spacelike 3-branes are stacked in timelike order.

Step 6:
To get rid of the world-brane scalars corresponding to the Octonionic O- space, orbifold it by the 16-element discrete multiplicative group

Oct16 = {+/-1,+/-i,+/-j,+/-k,+/-E,+/-I,+/-J,+/-K}

to reduce O- to 16 singular points {-1,-i,-j,-k,-E,-I,-J,-K,+1,+i,+j,+k,+E,+I,+J,+K}.

Let the 8 O- singular points {-1,-i,-j,-k,-E,-I,-J,-K} correspond to the fundamental fermion anti-particles {anti-neutrino, red up anti-quark, green up anti-quark, blue up anti-quark, positron, red down anti-quark, green down anti-quark, blue down anti-quark}
located on the past 7-brane layer of D8.

Let the 8 O- singular points {+1,+i,+j,+k,+E,+I,+J,+K} correspond to the fundamental fermion anti-particles {anti-neutrino, red up anti-quark, green up anti-quark, blue up anti-quark, positron, red down anti-quark, green down anti-quark, blue down anti-quark}
located on the future 7-brane layer of the 8-brane.

The 8 components of 8 fundamental first-generation fermion anti-particles = 8x8 = 64
correspond to the 64 of the 128-dim half-spinor 8-brane part of E8.
This gets rid of the 8 world-brane scalars corresponding to O-, and leaves:

1 world-brane scalars for real a space;
and
1 dimension, for real b space, in which 8-branes containing spacelike 3-branes are stacked in timelike order.

Step 7:
Let the 1 world-brane scalar for real a space correspond to a Bohm-type Quantum Potential acting on strings in the stack of 8-branes.
Interpret strings as world-lines in the Many-Worlds, short strings representing virtual particles and loops.

Step 8:
Fundamentally, physics is described on HyperDiamond Lattice structures.
There are 7 independent E8 lattice Integral Domains, each corresponding to one of the 7 imaginary octionions. denoted by iE8, jE8, kE8, EE8, IE8, JE8, and KE8 and related to 8-brane adjoint and half-spinor parts of E8 and with 240 first-shell vertices.
An 8th 8-dim lattice 1E8 (not an Integral Domain) with 240 first-shell vertices related to the E8 adjoint part of E8 is related to the 7 octonion imaginary lattices.
Give each 8-brane structure based on Planck-scale E8 lattices so that
each 8-brane is a superposition/intersection/coincidence of the eight E8 lattices.
(see viXra 1301.0150)

Step 9:
Since Polchinski says "... If r D-branes coincide ... there are r^2 vectors, forming the adjoint of a U(r) gauge group ...", make the following assignments:

a gauge boson emanating from the 8-brane from its 1E8 and EE8 lattices is an SU(2)xU(1) ElectroWeak boson accounting for the photon and W+, W- and Z0 bosons.

a gauge boson emanating from the 8-brane from its IE8, JE8, and KE8 lattices is a SU(3) Color Gluon boson thus accounting for the 8 Color Force Gluon bosons.

The 4+8 = 12 bosons of the Standard Model Electroweak and Color forces correspond to 12 of the 28 dimensions of 28-dim Spin(8)
that corresponds to one of the 28 of the 120-dim adjoint 8-brane parts of E8.

a gauge boson emanating from the 8-brane from its 1E8, iE8, jE8, and kE8 lattices is a U(2,2) boson for conformal U(2,2) = Spin(2,4)xU(1) MacDowell-Mansouri gravity plus conformal structures consistent with the Higgs mechanism and with observed Dark Energy, Dark Matter, and Ordinary matter.

The 16-dim U(2,2) is a subgroup of 28-dim Spin(2,6)
that corresponds to the other 28 of the 120-dim adjoint 8-brane part of E8.

Step 10:
Since Polchinski says

"... there will also be r^2 massless scalars from
the components normal to the D-brane. ...
the collective coordinates ... X^u ... for the embedding
of n D-branes in spacetime are now enlarged to nxn matrices.

This 'noncommutative geometry' ...[may be]... an important hint
about the nature of spacetime. ...",

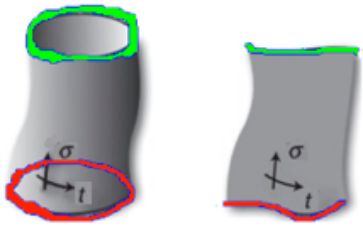
make the following assignment:

The 8x8 matrices for the collective coordinates
linking aa 8-brane to the next 8-brane in the stack
are needed to connect the eight E8 lattices of the 8-brane
to the eight E8 lattices of the next 8-brane in the stack.

The 8x8 = 64 correspond to the 64 of the 120 adjoint 8-brane part of E8.

We have now accounted for all the scalars
and
have shown that the model has the physics content of the realistic E8 Physics model
with Lagrangian structure based on E8 = (28 + 28 + 64) + (64 + 64)
and
AQFT structure based on Cl(1,25) with real Clifford Algebra periodicity
and generalized Hyperfinite II1 von Neumann factor algebra.

In my unconventional view



the red line and the green line
are different strings/worldlines/histories and
the world-sheet is the minimal surface connecting them,
carrying the Bohm Potential,
The t world-sheet coordinate is for Time
The sigma world-sheet coordinate is
for Bohm Potential Gauge Boson at a given Time.

Joe Polchinski in “String Theory, Volume 1, An Introduction to the Bosonic String” said:
“... we find at m^2 = - 4 / alpha’ the tachyon, and
at m^2 = 0 the 24 x 24 states of the graviton, dilaton, and antisymmetric tensor ...”.
Ibanez and Uranga said:
“... This tachyon ... is ... unstable ...
the antisymmetric part is the 26d 2-form field BMN ...
The symmetric traceless part is the 26d graviton GMN ...
Its trace corresponds to a scalar field, the dilaton ϕ ...”.

Tachyons localized at orbifolds of fermions
produce virtual clouds
of particles / antiparticles that dress fermions.

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

In E8 Physics,
the String Theory graviton is NOT a graviton
but is the Quantum Bohmion.

The 24x24 Real Symmetric Matrices form the Jordan Algebra J(24,R).
24-Real-dim space has a natural Octonionic structure.
The corresponding Jordan Algebra is
J(3,O) = 3x3 Hermitian Octonion matrices.
Their 26-dim traceless part J(3,O)o
describes the 26-dim of Bosonic String Theory
and the algebra of its Quantum States, so that
the 24x24 traceless symmetric spin-2 particle
is the Quantum Bohmion.

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

Tachyons create Schwinger Sources

When a fermion particle/antiparticle appears in E8 spacetime
it does not remain a single Planck-scale entity because
Tachyons create a cloud of particles/antiparticles.
The cloud is one Planck-scale Fundamental Fermion Valence Particle plus
a neutral cloud of particle/antiparticle pairs
forming a Kerr-Newman black hole.
That cloud constitutes the Schwinger Source.

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.

Schwinger Source 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.

As continuous manifold approximating E8 Lattice structure
Schwinger Sources are
Bounded Complex Domains and their Shilov Boundaries.
The Bounded Complex Domains have Bergman Kernels whose physical interpretation is that of Green's Function Propagators.

Fock "Fundamental of Quantum Mechanics" (1931): Quantum requires Linear Operators "... represented by a definite integral [of a]... kernel ... function ...".

Hua "Harmonic Analysis of Functions of Several Complex Variables in the Classical Domains" (1958): usedKernel Functions for Complex Classical Domains and caculated volumes of Bounded Domains and Shilov Boundaries.

Schwinger (1951 - see Schweber, PNAS 102, 7783-7788) "... introduced a description in terms of Green's functions, what Feynman had called propagators ...".

Wolf (J. Math. Mech 14 (1965) 1033-1047): Domains (complete simply connected Riemannian symmetric spaces) representing 4-dim Spacetime with Quaternionic Structure are:

S1 x S1 x S1 x S1 = 4 copies of U(1)
S2 x S2 = 2 copies of SU(2)
CP2 = SU(3) / SU(2)xU(1)
S4 = Spin(5) / Spin(4) = Euclidean version of Spin(2,3) / Spin(1,3)

Armand Wyler (1971 - C. R. Acad. Sc. Paris, t. 271, 186-188): showed how to use **Green's Functions = Kernel Functions** of Bounded Domain structures of **Sources = Leptons, Quarks, and Gauge Bosons, to calculate Particle Masses and Force Strengths**

Schwinger (1969 - see physics/0610054): "... replace[s] the particle with ... properties ... distributed througout ... small volumes of three-dimensional space ... a source function describing the intermediate propagation of the particle ...".

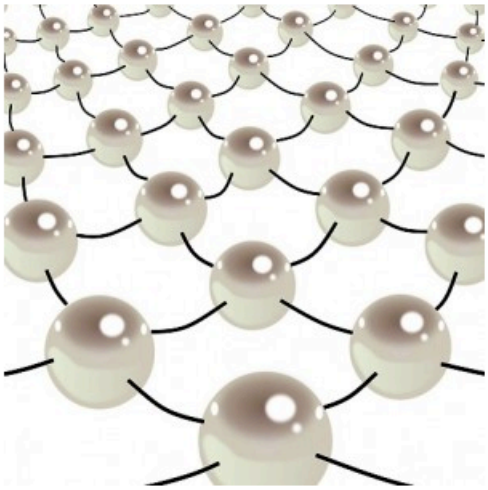
The idea of Schwinger Sources as more than mere points is in **David Finkelstein's Space-Time Code 1968** in which David said "... "... What is too simple about general relativity is the space-time point ... **each point of space-time is some kind of assembly of some kind of thing ... Each point, as Feynman once put it, has to remember with precision the values of indefinitely many fields describing many elementary particles; has to have data inputs and outputs connected to neighboring points; has to have a little arithmetic element to satisfy the field equations; and all in all might just as well be a complete computer** ...".

Each Source should contain about 10^27 particle/antiparticle pairs
and its **size should be about** 10^(27/3) x 1.6 x 10^(-33) cm = about **10^(-24) cm**.

Indra's Net Blockchain of Schwinger Sources

**"... "Indra's net" is the net of the Vedic deva Indra,
whose net hangs over his palace on Mount Meru,
the axis mundi of Buddhist and Hindu cosmology.
Indra's net has a multifaceted jewel at each vertex,
and each jewel is reflected in all of the other jewels ..."**

Image from https://brightwayzen.org/meetings-placeholder/indras-net-honoring-interdependence-scales/ :



In E8 Physics **each Indra Jewel is a Schwinger Source**.

Bohm Quantum Potential interactions are not just between two Jewels,
but are **between the two entire World-Line History Strings**

(image adapted from http://www.blockchaintechnologies.com/)

**The Blockchain computational logic for E8 Physics is
the Mind-Stuff Information structure of Real Clifford Algebra**

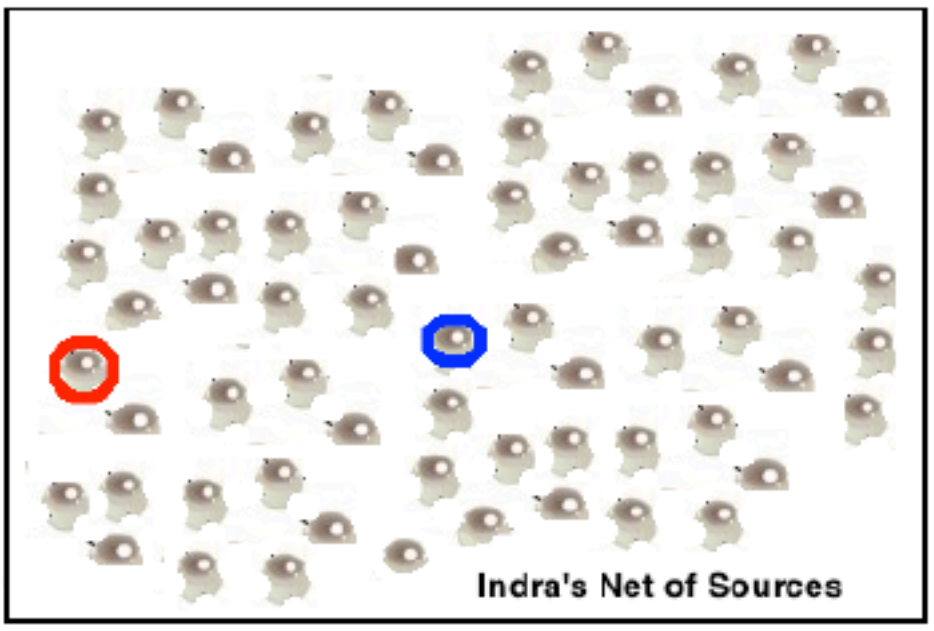
Each Node is a Schwinger Source that is connected by Bohm Quantum Potential
to all other Schwinger Source Nodes in our Universe
They are all governed by the E8 Physics Lagrangian
and the Algebraic Quantum Field Theory arising from
Completion of Union of All Tensor Products of Cl(1,25) =
= hyperfinite AQFT
each copy of Cl(1,25) contains Cl(16) which contains E8 and the E8 Lagrangian.

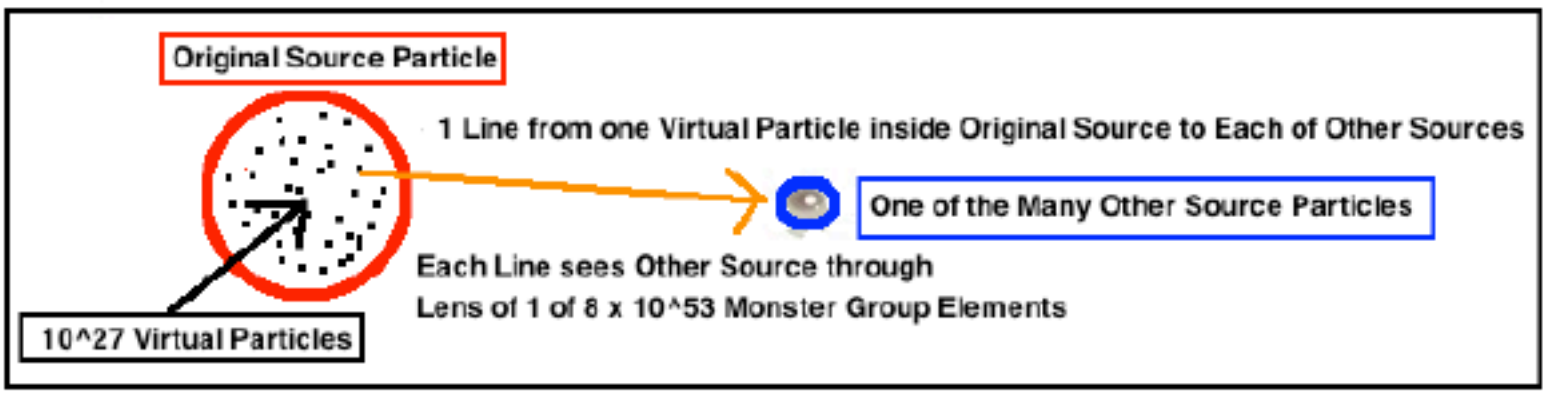
Each of 10^27 Schwinger Source particle-antiparticle pairs sees the rest of our Universe by way of 8 x 10^53 Monster Symmetry
so
a Schwinger Source acting as a Jewel of Indra's Net
can see / reflect
10^27 x 8 x 10^53 = 8 x 10^80 Other Schwinger Source Jewels.

To fit inside the initial Schwinger Source
the Information Elements of the Other Schwinger Sources of Our Universe (10^77 or so) should be distributed as a Fractal Julia Set.

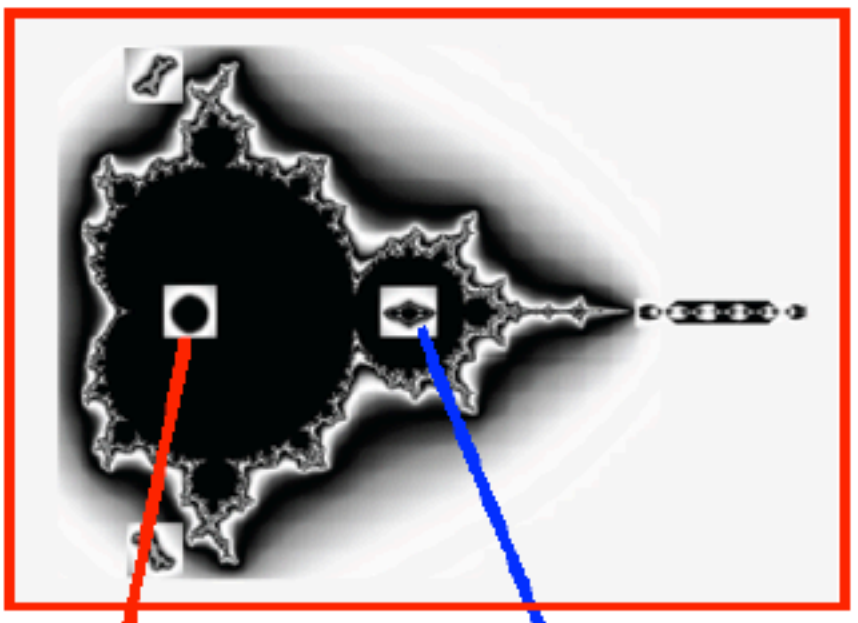
There are 2^n stage-n cells in a Binary Decomposition of Julia Sets, so a stage-256 Julia level set has 2^256 = about 10^77 cells
so Full Indra Net information can be seen / reflected
by each Schwinger Source Indra Jewel.

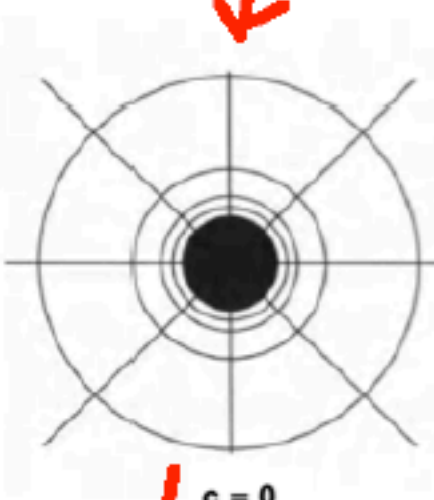
Each Schwinger Source has a Mandelbrot Set that tells its Source what each of the many Indra's Net Source Julia set looks like
by correlating Monster Group Lens Elements with Types of Julia Set. Self-Perception is always the c = 0 Circle Julia Set.

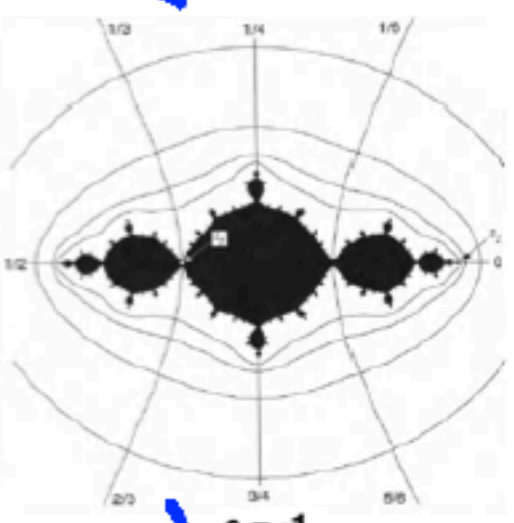




Mandelbrot Set for Original Source
correlates Monster Group Lens Elements with Perceived Type of Julia Set
Self-Perception is always c = 0 Circle Julia Set

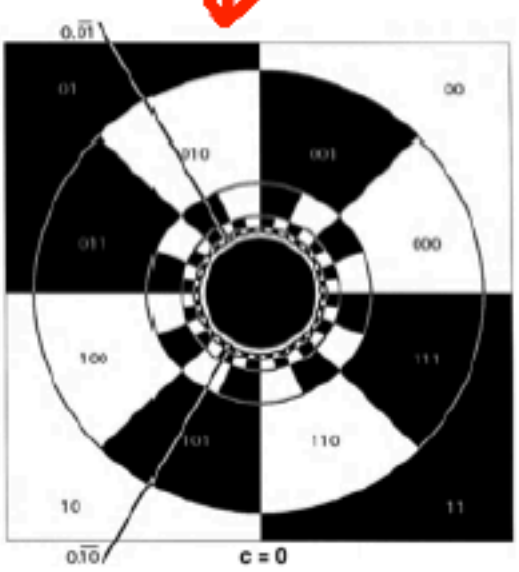


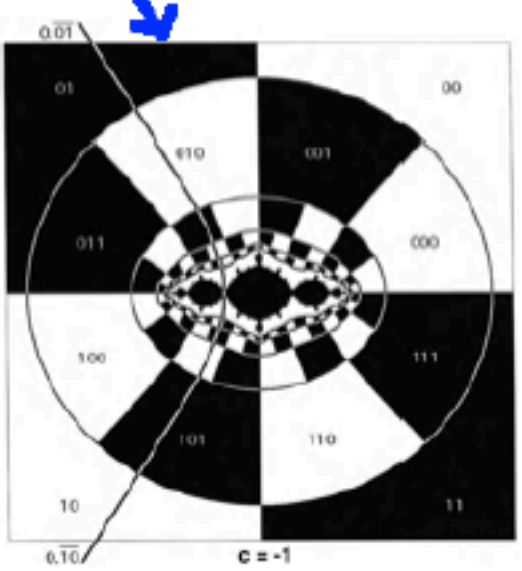




c = 0

c = -1





Lagrangian for Bohm Quantum Potential

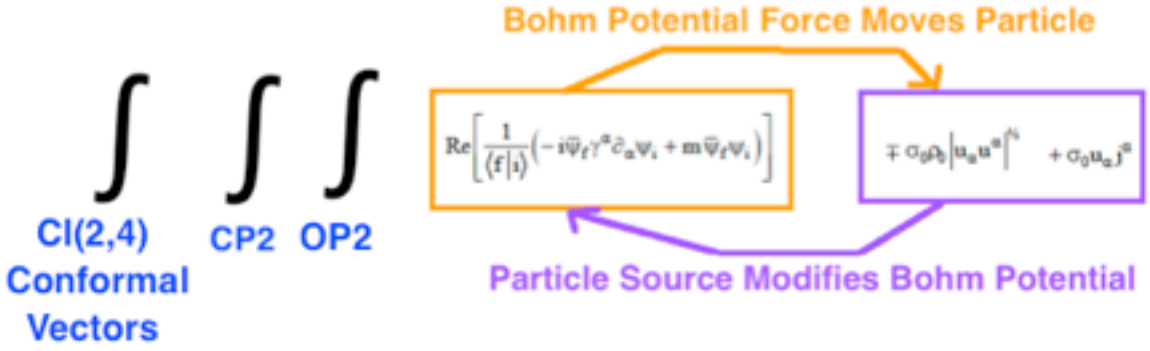
Sarfatti-Bohm Quantum Potential emerges from 26D World-Line String Theory so is treated separately from the Local Classical E8 Lagrangian in 8D (or in 4D) describing the Standard Model and Gravity+Dark Energy plus Propagator Phase.

Roderick Sutherland (arXiv 1509.02442) gave a Lagrangian for the Bohm Potential
saying: "... This paper focuses on interpretations of QM in which the underlying reality is taken to consist of particles have definite trajectories at all times ... An example ... is the Bohm model ...
This paper ... provid[es]... a Lagrangian ...[for]... the unfolding events ... describing more than one particle while maintaining a relativistic description ... requires the introduction of final boundary conditions as well as initial, thereby entailing retrocausality ...
In addition ... the Lagrangian approach pursued here to describe particle trajectories also entails the natural inclusion of an accompanying field to influence the particle's motion away from classical mechanics and reproduce the correct quantum predictions.
In so doing, it is ... providing a physical explanation for why quantum phenomena exist at all ... **the particle is seen to be the source of a field which alters the particle's trajectory via self-interaction** ...
The Dirac case ... each particle in an entangled many-particle state will be described by an individual Lagrangian density ... of the form:

$$\mathfrak{L} = \mathrm{Re}\left[\frac{1}{\langle f|i\rangle}\left(-i\bar{\psi}_f\gamma^\alpha\partial_\alpha\psi_i + m\bar{\psi}_f\psi_i\right)\right] \mp \sigma_0\rho_0\left|u_\alpha u^\alpha\right|^{1/2} + \sigma_0 u_\alpha j^\alpha$$

... the ...[first]... term ...[is]... Lagrangian densities for the PSI field alone ...
... sigma_o is the rest density distribution of the particle through space ...
j is the current density ...
... rho_o and u are the rest density and 4-velocity of the probability flow ...".

Jack Sarfatti extended the Sutherland Lagrangian to include Back-Reaction



where a, b and VM4 form Cl(2,4) vectors and VCP2 forms CP2
and S+ and S- form OP2 so that
26D = 16D orbifolded fermions + 10D
and 10D = 6D Conformal Space + 4D CP2 ISS
(ISS = Internal Symmetry Space and
6D Conformal contains 4D M4 of Kaluza-Klein M4xCP2)
saying (linkedin.com Pulse 13 January 2016):
"... the reason entanglement cannot be used as a direct messaging channel between subsystems of an entangled complex quantum system,
is the lack of direct back-reaction
of the classical particles and classical local gauge fields
on their shared entangled Bohmian quantum information pilot wave ...
Roderick. I. Sutherland ... using Lagrangian field theory, shows how to make the original 1952 Bohm pilot-wave theory completely relativistic,
and how to avoid the need for configuration space for many-particle entanglement.

The trick is that final boundary conditions on the action as well as initial boundary conditions influence what happens in the present.

The general theory is "post-quantum" ... and it is non-statistical ...
There is complete two-way action-reaction between quantum pilot waves and the classical particles and classical local gauge fields ...".

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) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8)

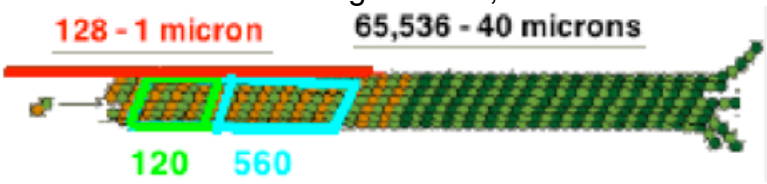
By the periodicity-8 theorem of Real Clifford algebras, Cl(64) is the smallest Real Clifford algebra for which we can reflexively identify each component Cl(8) with a basis vector in the Cl(8) vector space.
This reflexive identification causes our universe to decohere at N = 2^64 = 10^19.
Octonionic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

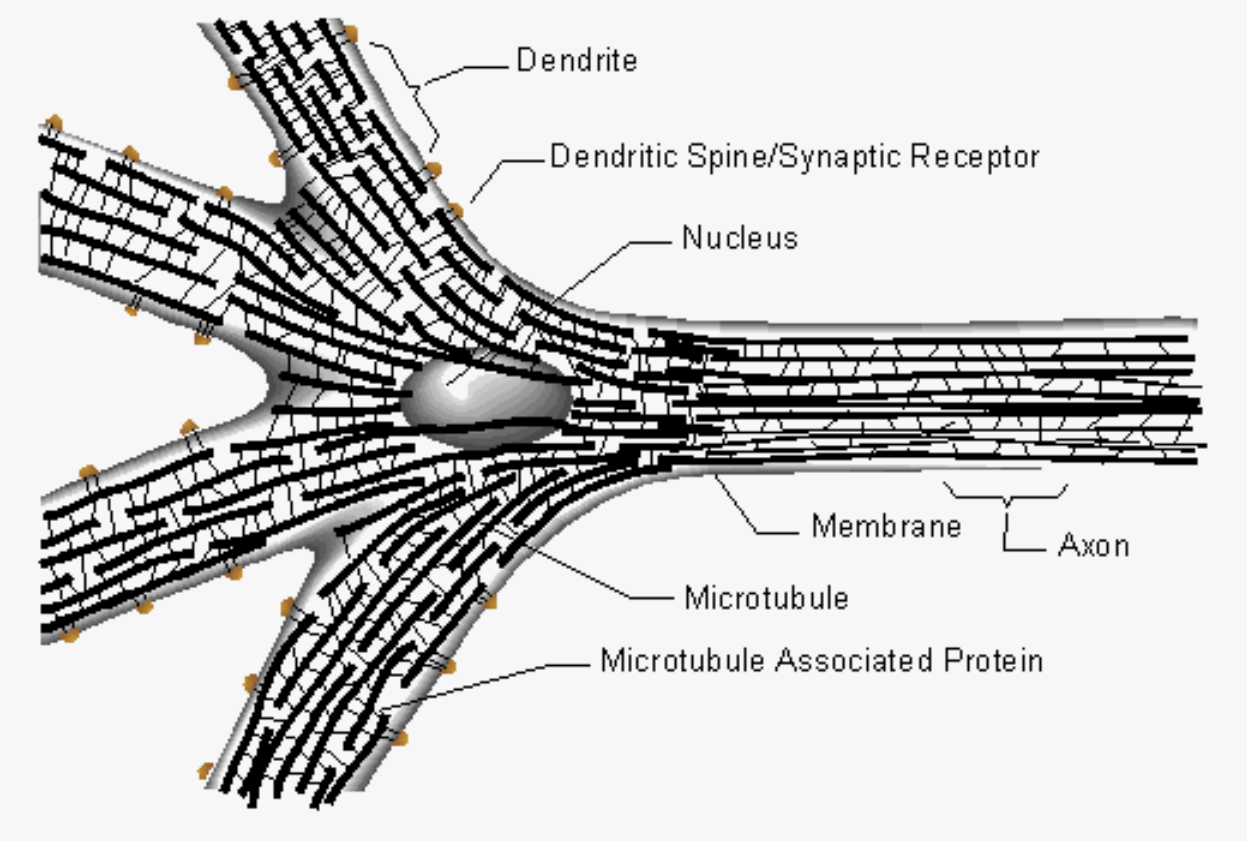
The energy in a single resonator alternates between the kinetic energy of the electrons (inductance), and the potential energy of the electrons (capacitance). With the two resonators coupled, the energy shifts back and forth between the two resonators in such a way that the total energy is constant ... 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:

"... **a "quantum protectorate" ...[is]... a state in which the many-body 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** ...”.

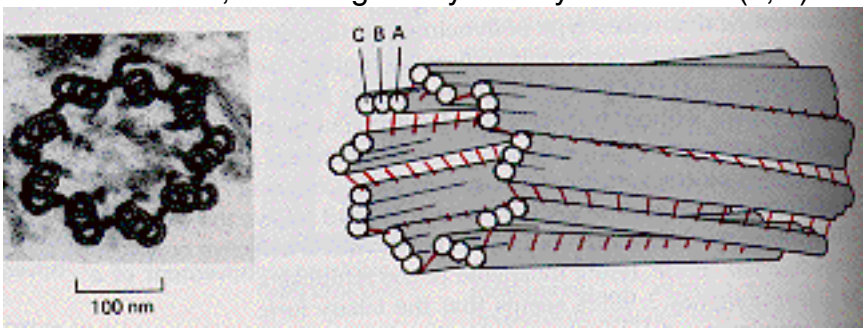
The Human Brain has about 10^11 Neuron cells, each about 1,000 nm in size.
The cytoskeleton of cells, including neurons of the brain, is made up of Microtubules



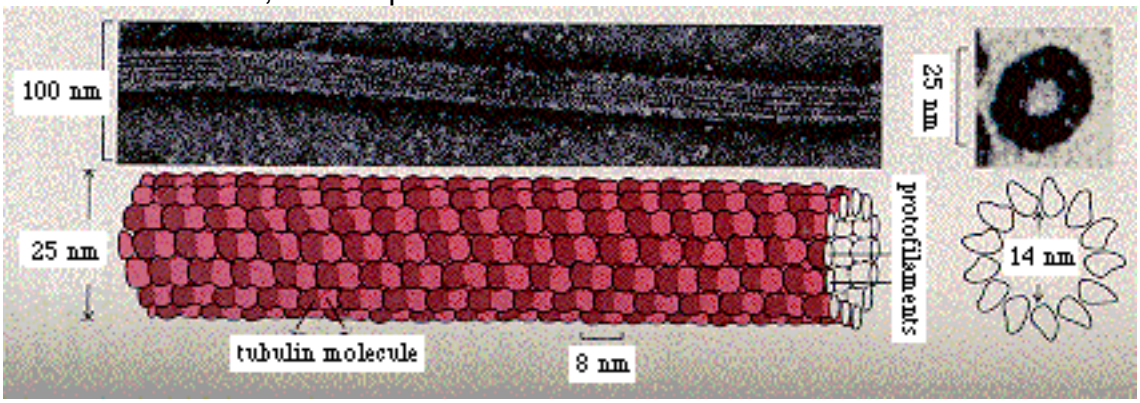
(image from “Orchestrated Objective Reduction of Quantum Coherence in Brain Microtubules: The “Orch OR” Model for Consciousness” by Penrose and Hameroff)

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.

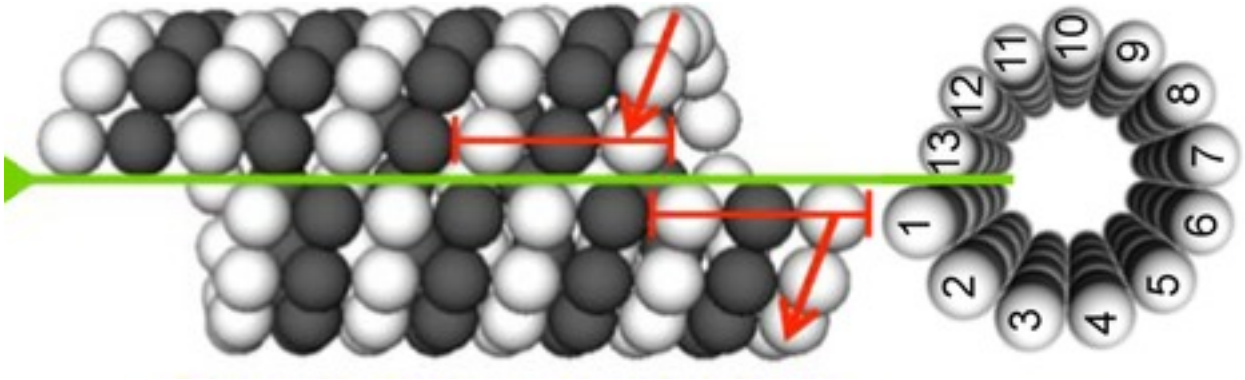
A Centriole is about 200 nm wide and 400 nm long. Its wall is made up of 9 groups of 3 Microtubules, reflecting the symmetry of 27-dim J(3,O)



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)

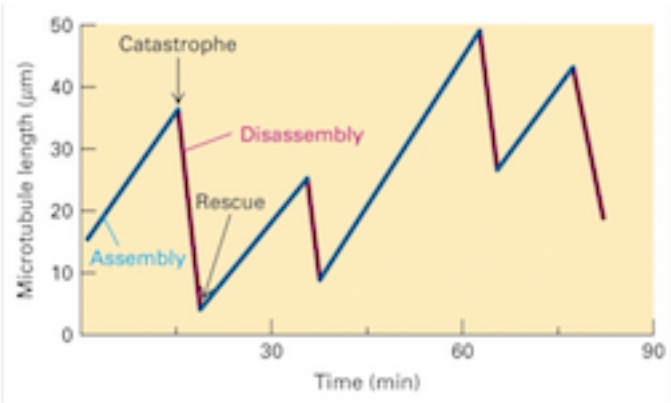
Each Tubulin Dimer is about 8 nm x 4 nm x 4 nm, consists of two parts, alpha-tubulin and beta-tubulin (each made up of about 450 Amino Acids, each containing roughly 20 Atoms)
A Microtubule 40 microns = 40,000 nm long contains 13 x 40,000 / 8 = 65,000 Dimers

(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

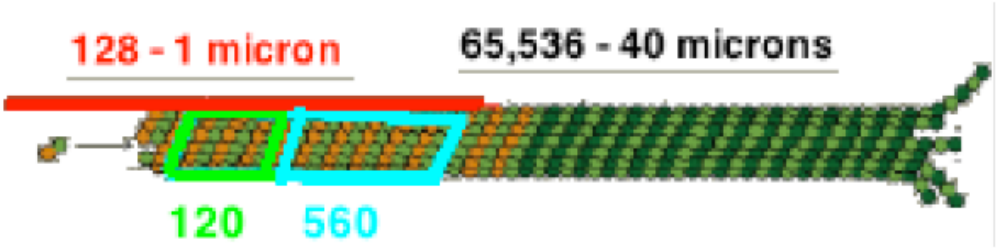
The two structures - State 0 ground state and State 1 higher energy state - make Tubulin Dimers the basis for a Microtubule binary math / code system.

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,

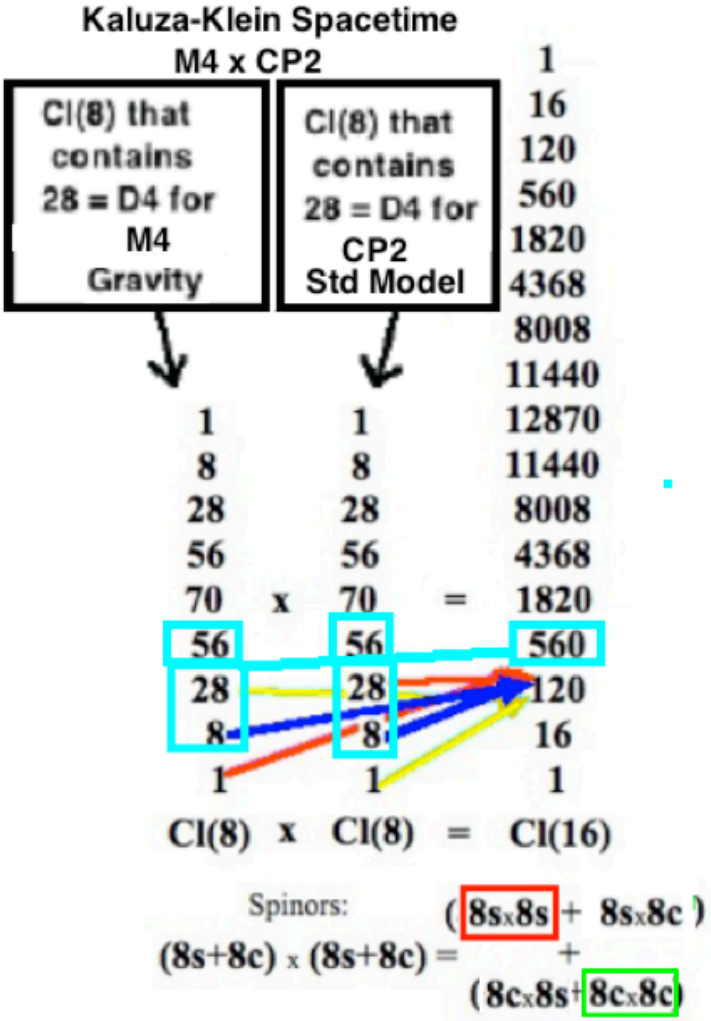


In a given Microtubule

the 128 D8 Half-Spinor part ——— is represented by a line of 128 Dimers in its stable GTP region and
the 120 D8 Cl(16) BiVector part by 120 Dimers in its stable GTP region and
the 560 Fr3(O) Cl(16) TriVector part by 560 Dimers in the stable GTP region
so **there remain 65,536 - 128 - 120 - 560 = 64,728 elements**
to carry Quantum Consciousness Information

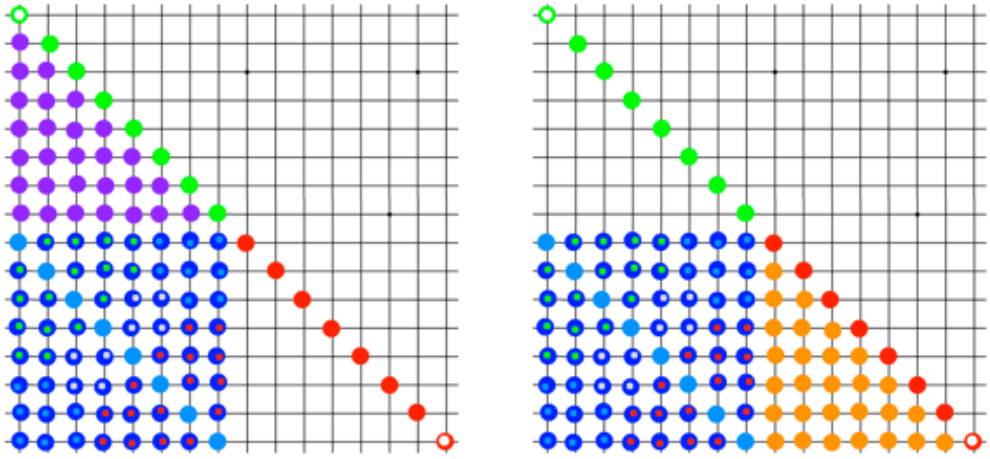
The Cl(16) of a given Cl(1,25) E8 Physics Lattice Cell
also has 65,536 - 128 - 120 - 560 = 764,728 elements for Quantum Information

Cl(16) = tensor product Cl(8) x Cl(8)



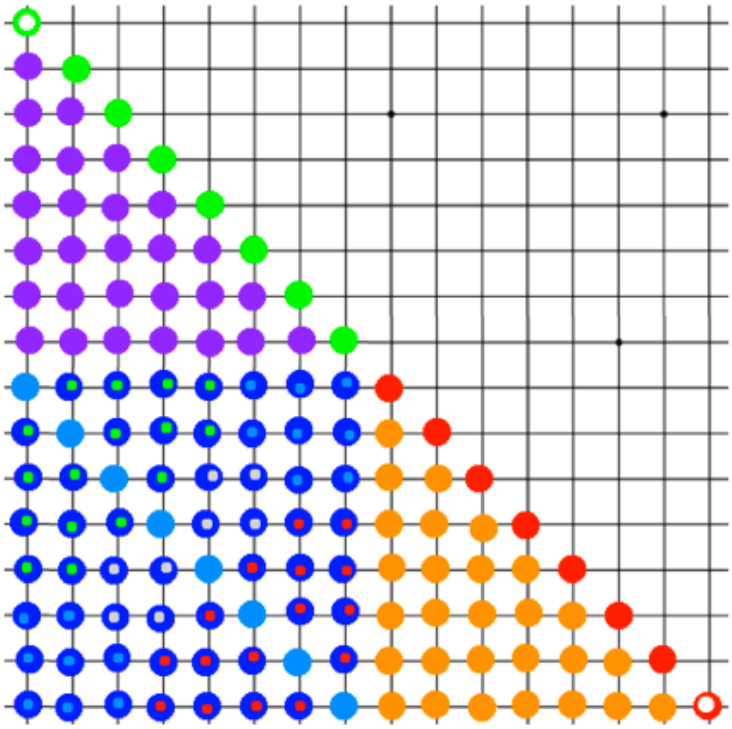
Cl(8) contains 28 D4 BiVectors and F4 by adding 8 Vectors and 16 Spinors to BiVectors
Cl(8) also contains Fr3(O) as 56 TriVectors

The 16x16 matrix representations of the two (M4 and CP2) copies of Cl(8)
that produce Cl(8) x Cl(8) = Cl(16) are



Individually each Cl(16) has 8+28+16 + 56 elements for F4 and Fr3(O)
and 256 - 108 = 148 elements for Quantum Information

If you combine all the F4 and Fr3(O) elements of both Cl(8) into one 16x16 matrix



then you see that at the Cl(8) level 136 elements are used for F4 and F43(O)
with 120 elements (the upper super-diagonal) remaining for Quantum Information.

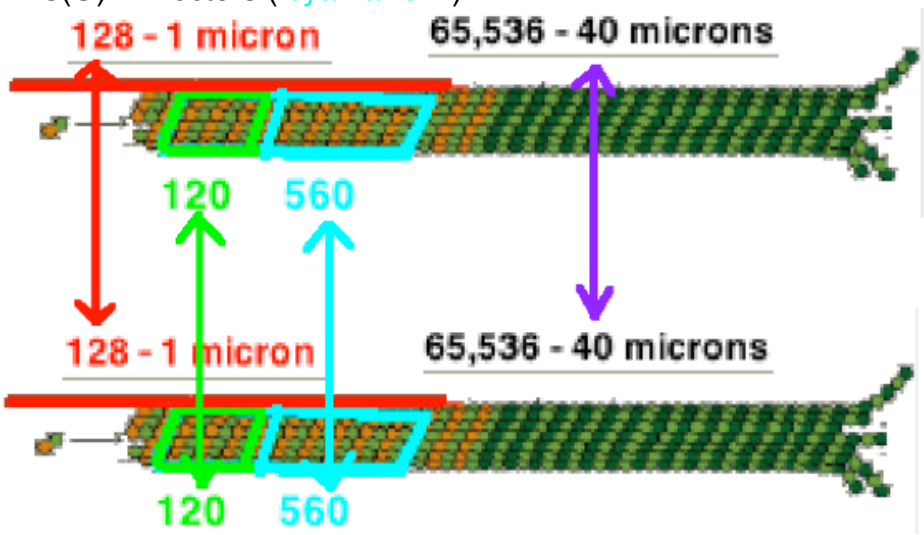
How do the Microtubules communicate with each other ?

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 (purple arrow)
with the correspondence being based on connection between respective E8 subsets, the 128 D8 Half-Spinors (red arrow) and the 120 D8 BiVectors (green arrow) and the 560 Fr3(O) TriVectors (cyan arrow)



How is information encoded in the Microtubules ?

Each Microtubule contains E8, allowing Microtubules to be corrrelated with each other.
The parts of the Microtubule beyond E8 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]]**

For a 40-micron Microtubule there are, outside the 248-E8 part, about 65,000 TD Qubits available to describe one Quantum Thought State among about 2^65,000 possibilities, analagous to the Book of Genesis of (22+5)^78,064 Hebrew Letter/Final possibilities.

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

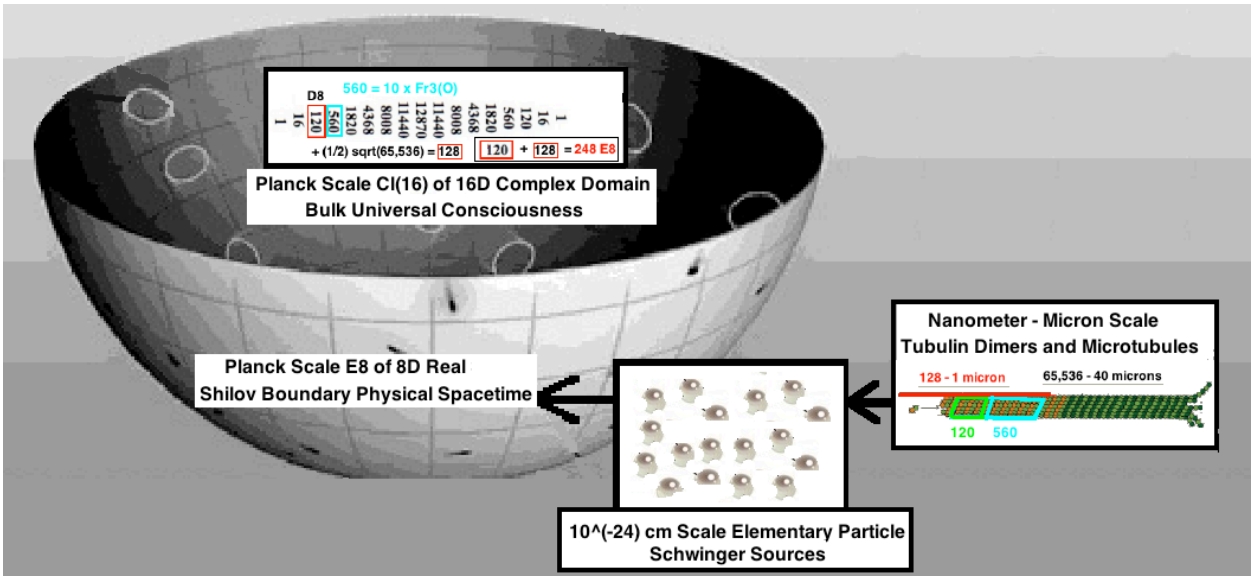
$$T_N = h / E_N = h / N^{(5/3)} E_{ssediff} = N^{(-5/3)} 10^{26} \text{ sec}$$

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 10^20 Tubuin Dimers in Human Brain
10^16	10^(-27 + 26) = 10^(-1) sec - 10 Hz Human Alpha EEG is 8 to 13 Hz Fundamental Schumann Resonance is 7.8 Hz	

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

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.

D8
1 16 120 560 1820 4368 8008 11440 12870 11440 8008 4368 1820 560 120 16 1
+ (1/2) sqrt(65,536) = 128
120 + 128 = 248 E8

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 with 120+128 = 248 = E8 Lie Algebra.
The 248 E8 elements of Cl(16) define
a Lagrangian for the Standard Model and for Gravity - Dark Energy
so that 65,536 - 248 = 65,288 elements of Cl(16) can carry Bits of 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

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

We live in the Physical Minkowski M4 part
of Kaluza-Klein M4 x CP2 structure of RP1 x S7 **Boundary**.
(where CP2 = SU(3) / SU(2)xU(1) is Internal Symmetry Space
of Standard Model gauge groups)

Our Consciousness is based on Binary States of Tubulin Dimers (each 4x4x8 nm size)
in Microtubules.

MIcrotubules are cylinders of sets of 13 Dimers with maximal length about 40,000 nm
so that
each Microtubule can contain about 13 x 40,000 / 8 = 65,000 Bits of Information.

The Physical Boundary in which we live
is a Real Shilov Boundary in which E8 is manifested
as Lagrangian Structure of Real Forms of E8
with Lagrangian Symmetric Space structure:
E8 / D8 = (OxO)P2 for 8 componets of 8+8 First-Generation Fermions
D8 / D4 x D4 for 8-dim spacetime position x 8-dim spacetime momentum
D4 for Standard Model Gauge Bosons and Gravity - Dark Energy Ghosts
D4 for Gravity - Dark Energy Gauge Bosons and Standard Model Ghosts

Microtubule Information in the Boundary
has Resonant Connection to Cl(16) Information in Bulk Space
by the spin-2 Bohm Quantum Potential with Sarfatti Back-Reaction
of 26D String Theory of World-Lines
consistent with Poisson Kernel as derivative of Green's function.

The Bulk Space Domain Type IV8
corresponds to the Symmetric Space Spin(10) / Spin(8)xU(1)
and is a Lie Ball whose Shilov Boundary RP1 x S7 is a Lie Sphere 8-dim Spacetime.

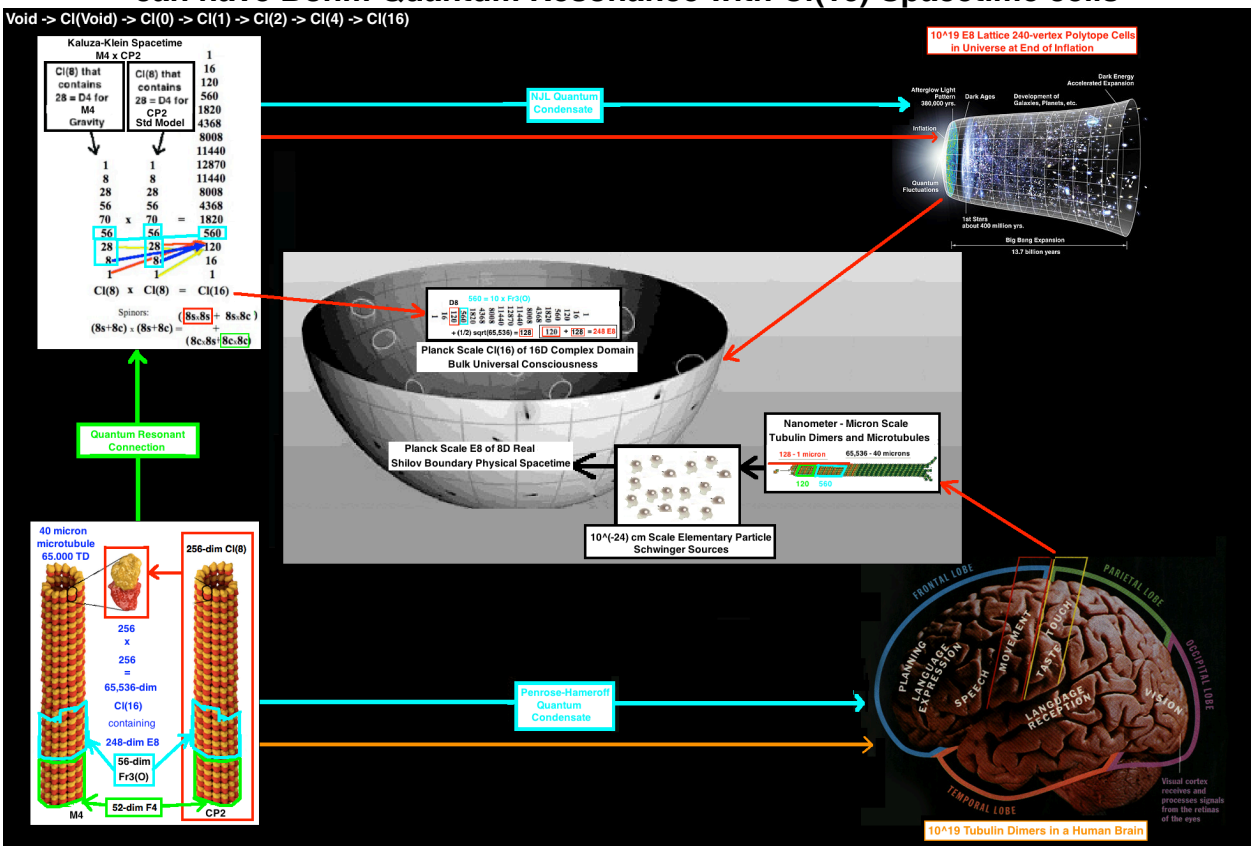
It is related to
the Stiefel Manifold V(10,2) = Spin(10) / Spin(8) of dimension 20-3 = 17 by the fibration
Spin(10) / Spin(8)xU(1) -> V(10,2) -> U(1)
It can also be seen as a tube z = x + iy
whose imaginary part is physically inverse momentum
so that its points give both position and momentum
(R. **Coquereaux** Nuc. Phys. B. 18B (1990) 48-52) "Lie Balls and Relativistic Quantum Fields").

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.

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)

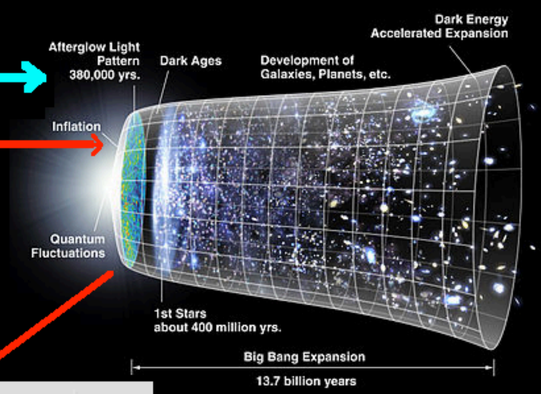
52-dim F4

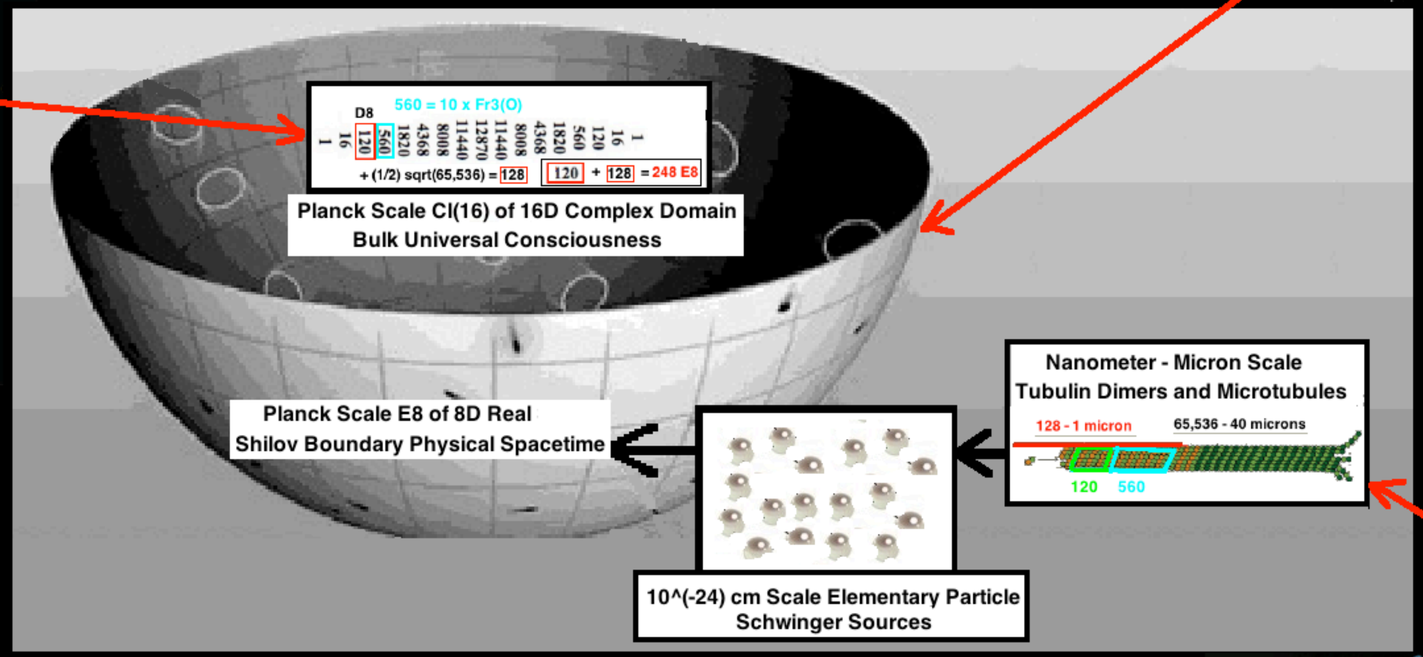
M4

CP2

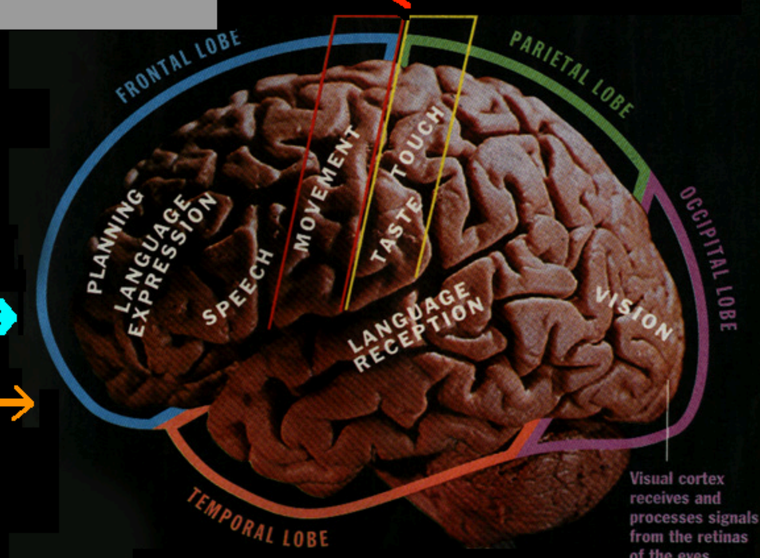
NJL Quantum Condensate

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

Results of E8 Physics Calculations:

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.

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

(**for calculation details see viXra 1804.0121**)

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

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

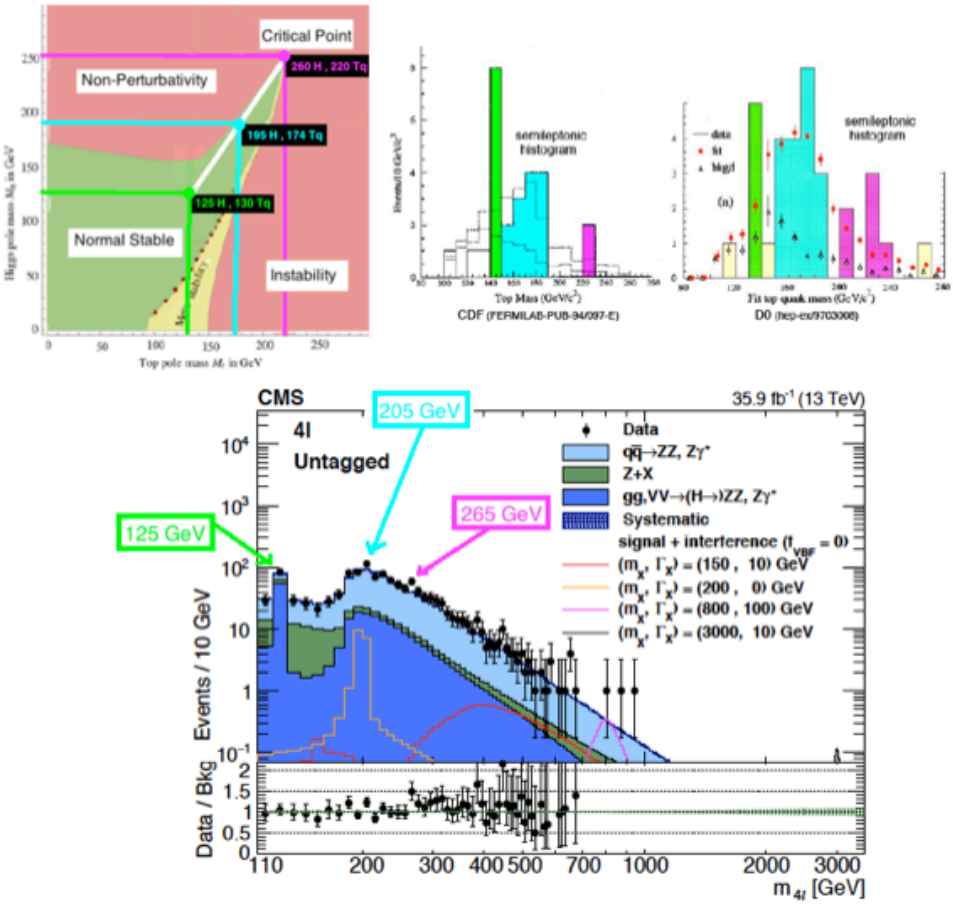
The phase angle d13 is taken to be 1 radian.

E8 Physics: Higgs and Truth Quark = 3-Mass-State Nambu-Jona-Lasinio System:

Higgs at 125 GeV and Truth Quark at 130 GeV

Higgs at 200 GeV and Truth Quark at 174 GeV

Higgs at 250 GeV and Truth Quark at 220 GeV



Upper Left = Higgs-Truth Quark mass state phase diagram

Upper Center = CDF semileptonic histogram of 3 Truth Quark Mass States
FERMILAB-PUB-94/097E

Upper Right = D0 semileptonic histogram of 3 Truth Quark Mass States
hep-ex/9703008

Lower = CMS H -> ZZ* -> 4l histogram of 3 Higgs Mass States
arXiv 1804.01939

(**for detailed comparison with experiments see viXra 1804.0121**)