# E8 Physics: PDF Slide Show Introductory Overview

Frank Dodd (Tony) Smith, Jr. - 2018

## Table of Contents:

Cl(8) Cellular Automata, D4, F4 ... pages 2-9

Cl(8)xCl(8) = Cl(16), E8 Root Vector 8D Lagrangian ... pages 10-28

4D Lagrangian from 8D Lagrangian ... pages 29-31

E8 World-Lines = Strings 26D String Theory ... pages 32-38

Schwinger Sources ... pages 39-44

Lagrangian Structures and some E8 Physics Calculations ... pages 45-55
( more Calculations and details are in viXra 1804.0121 )

E8 Physics Algebraic Quantum Field Theory ... pages 56-57

Sarfatti-Sutherland-Bohm Quantum Potential Lagrangian ... pages 58-60

Results of E8 Physics Calculations ... page 61

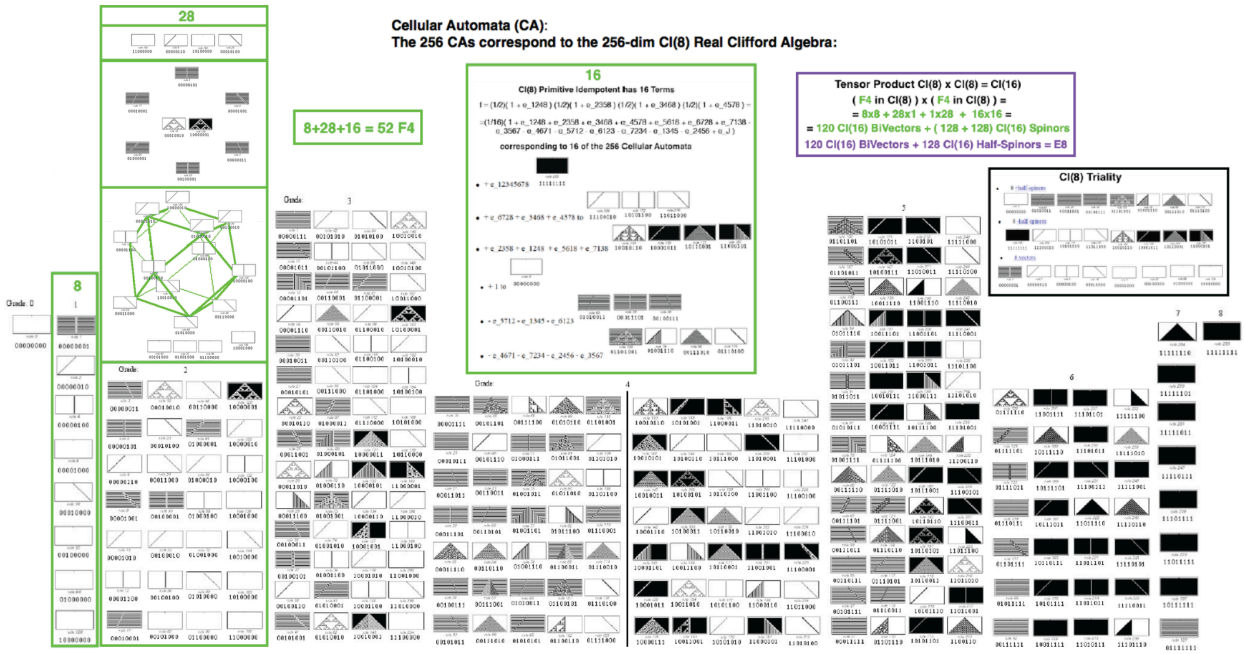
Fermilab and LHC observations of Higgs and Truth Quark .... page 62

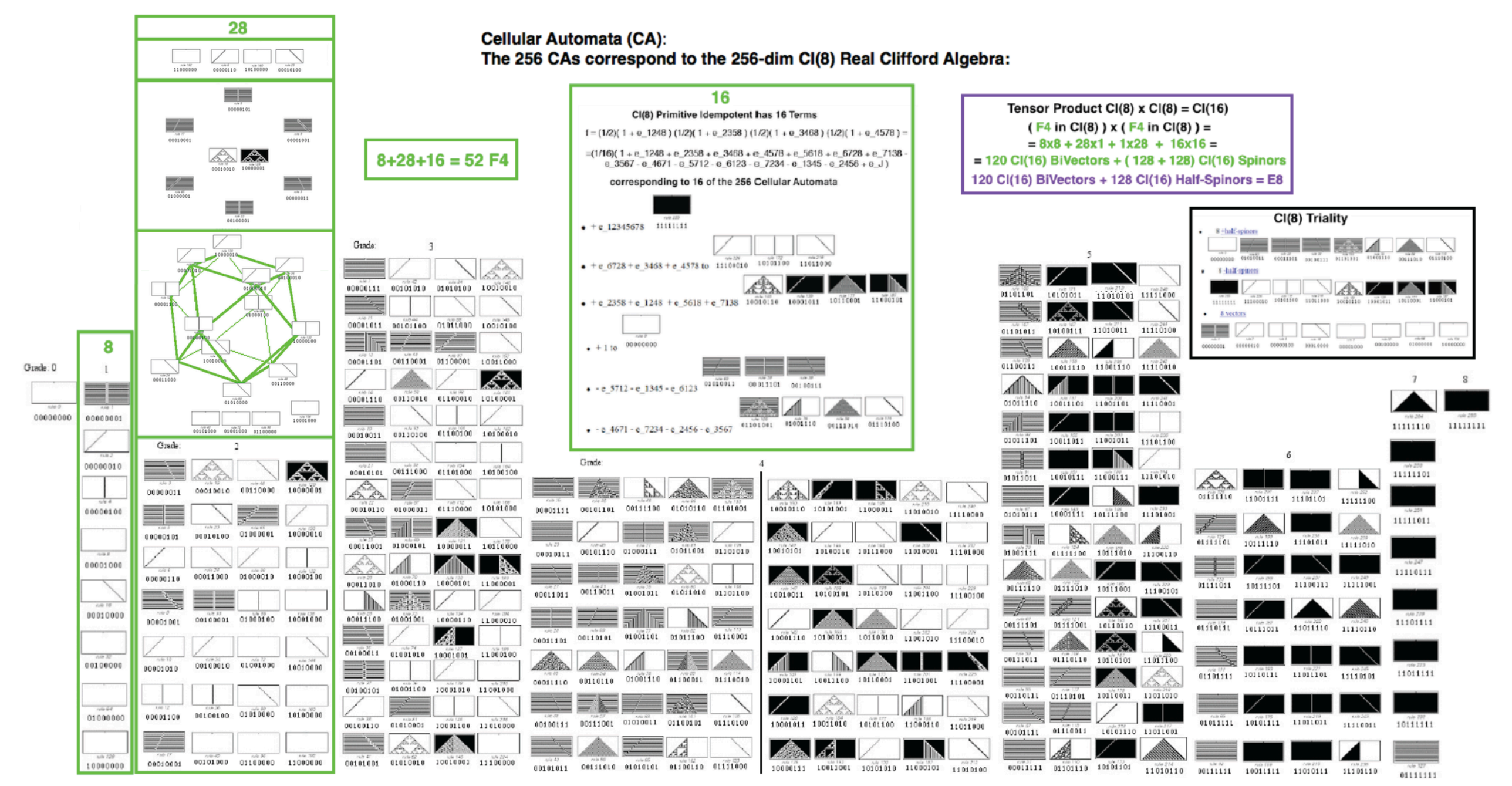
T**here is a longer version of this pdf slide-show paper at viXra 1806.0361**
It is 115 pages and contains, in addition to the material here:
discussion about African Origin of E8, Giza Pyramids and Sphinx;
more calculations (K-M Parameters, Masses of Neutrinos, Pions,
Proton-Neutron Mass Difference, and Planck Mass);
discussion about Quantum Consciousness of Humans and Our Universe.

The Table of Contents of the 115-page paper is:

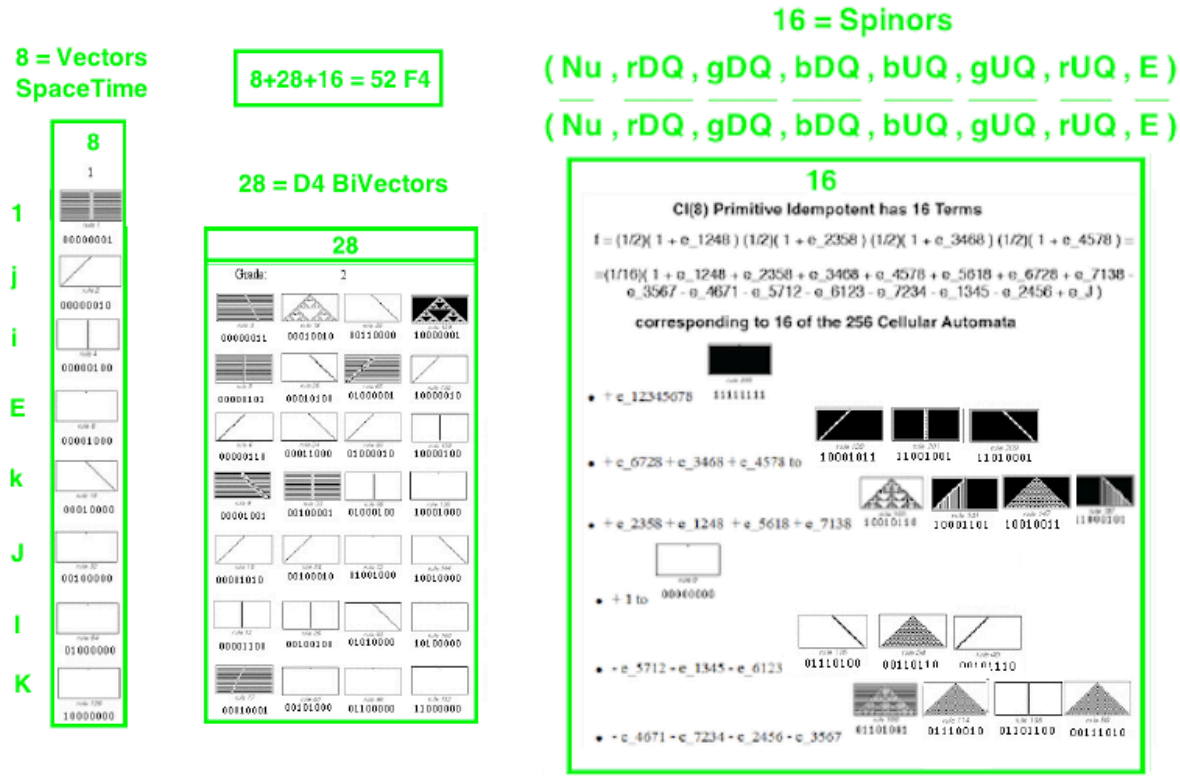
Summary of Results ... pages 2-3
African Origin, Cellular Automata, Giza Pyramids and Sphinx ... pages 4-23
Cl(8), D4 to F4, Cl(8)xCl(8) = Cl(16) and E8, E8 Root Vector Lagrangian ... pages 24-51
E8 Physics World-Lines = Strings of 26D String Theory
Bohm Quantum Potential, and Schwinger Sources ... pages 52-64
Calculations of Force Strengths, Particle Masses, K-M Parameters ... pages 65-80
E8-Cl(16) Algebraic Quantum Field Theory (AQFT) ... pages 81-91
Sarfatti-Sutherland-Bohm Back-Reaction Quantum Lagrangian
and Penrose-Hameroff Quantum Consciousness ... pages 92-115

## Cellular Automata (CA):
## The 256 CAs correspond to the 256-dim Cl(8) Real Clifford Algebra:




Cellular Automata (CA):
The 256 CAs correspond to the 256-dim Cl(8) Real Clifford Algebra:
28
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
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
8
Grade: 0
1
2
3
4
5
6
7
8

## 8 Vectors, 28 BiVectors, and 16 Spinors of Cl(8) form the 52-dim F4 Lie Algebra:

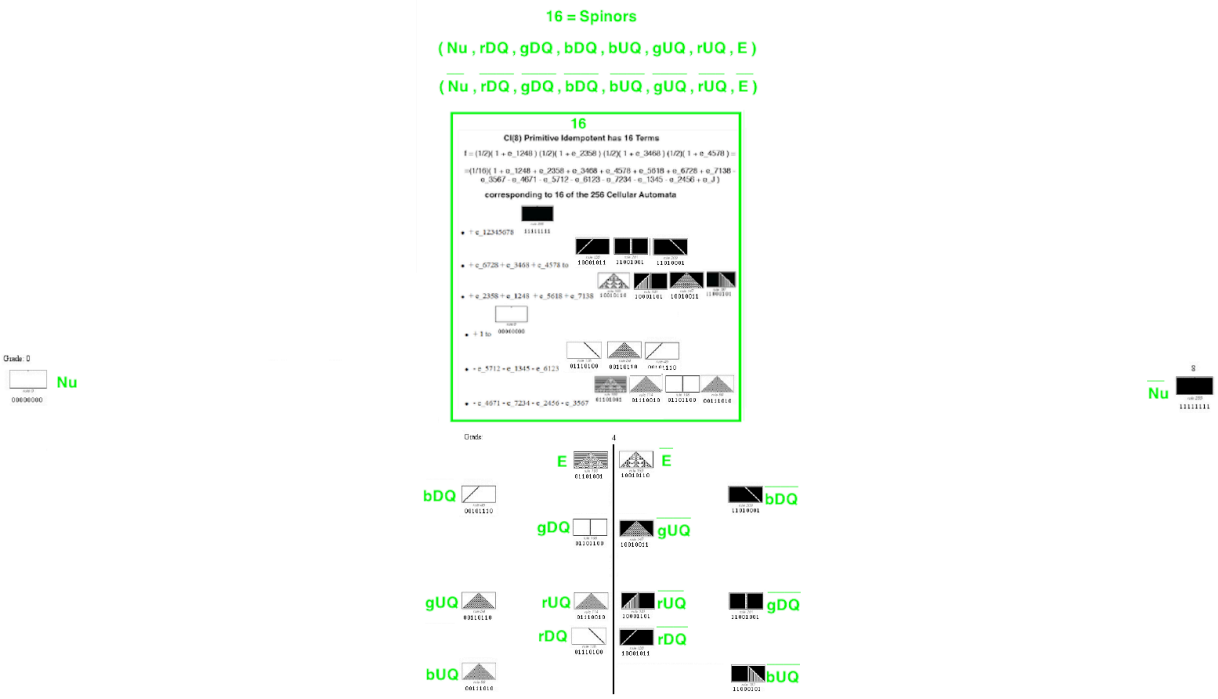



**8 Vectors correspond to 8-dim Spacetime ( M4 x CP2 Kaluza-Klein )**

**28 BiVectors correspond to D4 Gauge Bosons and Ghosts**

**16 = 8L + 8R Spinors correspond to first-generation Fermions**
**( 8L left-handed Particles + 8R right-handed AntiParticles )**

**16 = 8L + 8R Spinors correspond to first-generation Fermions**
**( 8L left-handed Particles + 8R right-handed AntiParticles )**

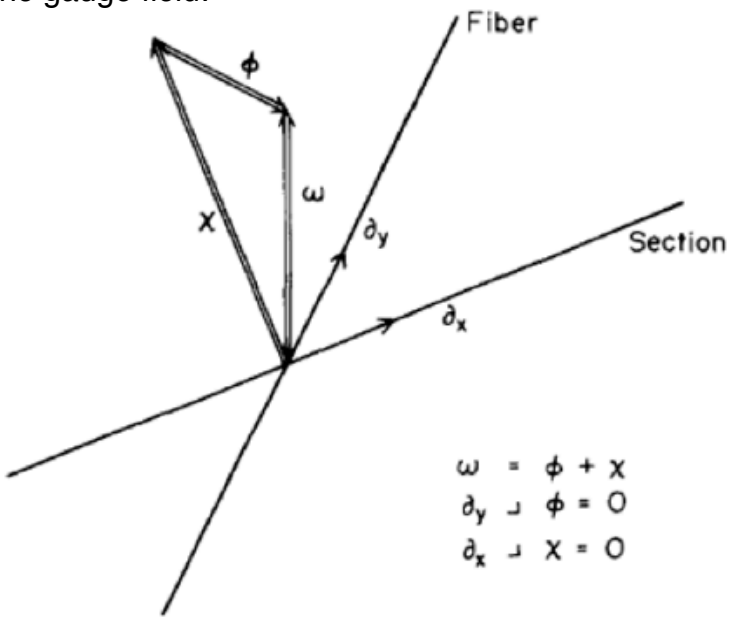



**Pierre Ramond has shown in hep-th/0112261 that**
**the Spinor part of F4 need not be written as Commutators**
**but can also be written as Fermionic AntiCommutators**
**so**
**F4 Spinors can physically represent Fermions.**

**Since the Cl(16) Half-Spinors of E8**
**come from the tensor product Cl(16) = Cl(8)xCl(8)**
**and**
**each copy of Cl(8) contains an F4**
**with the E8 Half-Spinors being based on F4 Spinors**

**the E8 Half-Spinors can be written as Fermionic AntiCommutators**
**and can physically represent Fermions**

**The 28 D4 elements of BiVectors of Cl(8) can be either Gauge Bosons or Ghosts**.
Jean Thierry-Mieg in J. Math. Phys. 21 (1980) 2834-2838 said:
"... The ghost and the gauge field:




The single lines represent a local coordinate system of a principal fiber bundle of base space-time. The double lines are 1 forms. The connection of the principle bundle w is assumed to be vertical. Its contravariant components PHI and X are recognized, respectively, as the Yang-Mills gauge field and the Faddeev-Popov ghost form ...".

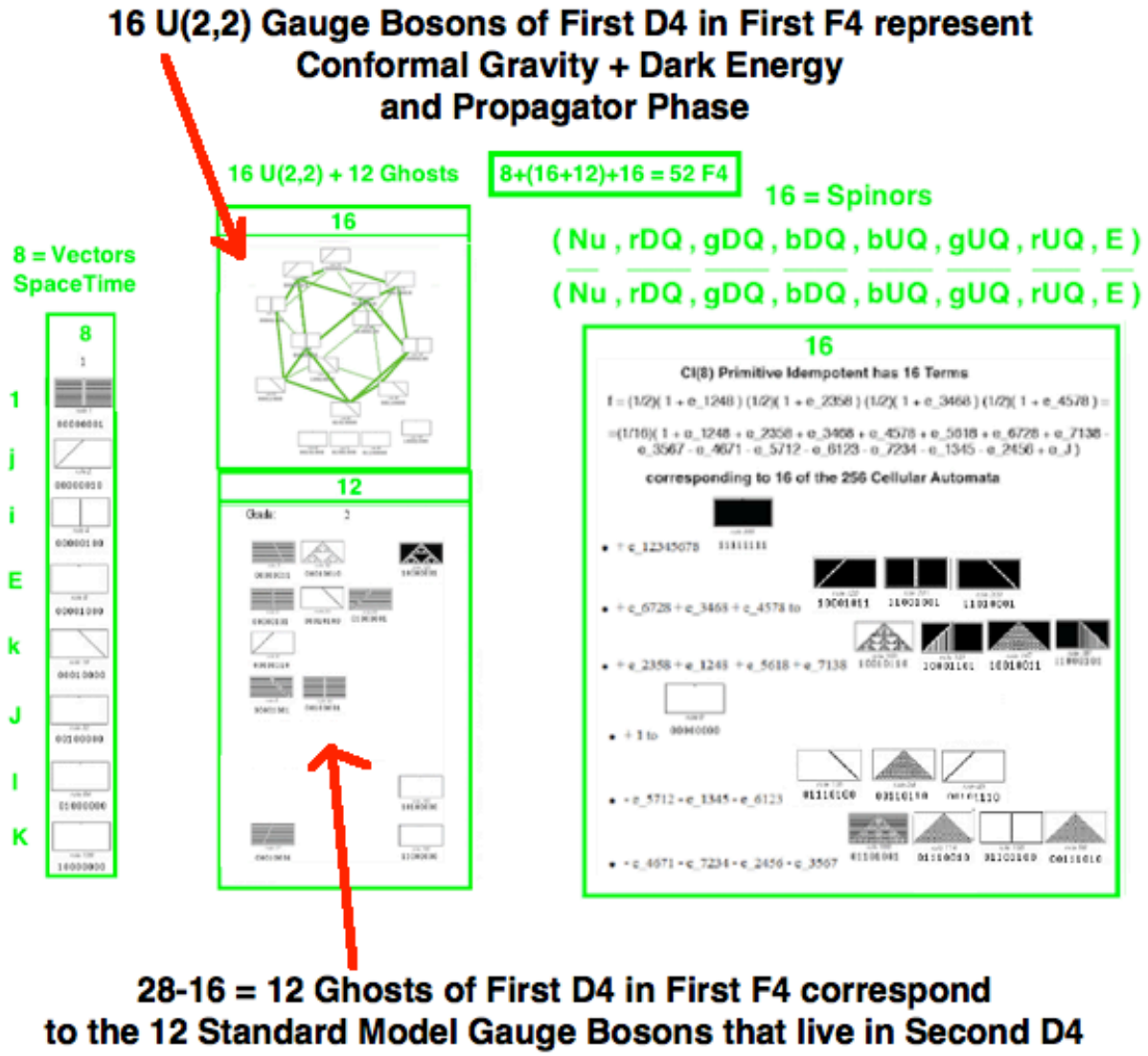
Steven Weinberg in The Quantum Theory of Fields Volume II Section 15.7 said:
"... there is a beautiful geometric interpretation of the ghosts and the BRST symmetry ...
The gauge fields A_a^u may be written as one-forms A_a = A_a_u dx_u,
where dx_μ are a set of anticommuting c-numbers. ... This can be combined with the ghost to compose a one-form *A*_a = A_a + w_a in an extended space.
Also, the ordinary exterior derivative d = dx^u d/dx^u may be combined with the BRST operator s to form an exterior derivative D = d + s in this space,
which is nilpotent because s^2 = d^2 = sd + ds = 0 ...".

**16 of the 28 D4 elements represent**
**16-dim U(2,2) of Conformal Gravity+Dark Energy**
They can be either Gauge Bosons or Ghosts.
If they are Gauge Bosons in a D4, the other 28-16 = 12 are Ghosts.
If they are Ghosts in a D4, the other 28-16 = 12 are Gauge Bosons.

**The 28-16 = 12 D4 elements represent**
**12-dim Standard Model SU(3)xSU(2)xU(1)**

**There are two ways that 28 BiVectors of Cl(8) can form Gauge Bosons and Ghosts**
**so**
**there are two ways F4 can sit inside Cl(8)**

**First:**
16 of the 28 D4 elements represent 16-dim U(2,2) of Conformal Gravity+Dark Energy
( plus a U(1) for propagator phase )
12 of the 28 D4 elements represent 12-dim Standard Model SU(3)xSU(2)xU(1)



## Second:

12 of the 28 D4 elements represent Standard Model SU(3)xSU(2)xU(1) Gauge Bosons
16 of the 28 D4 elements represent U(2,2) Ghosts

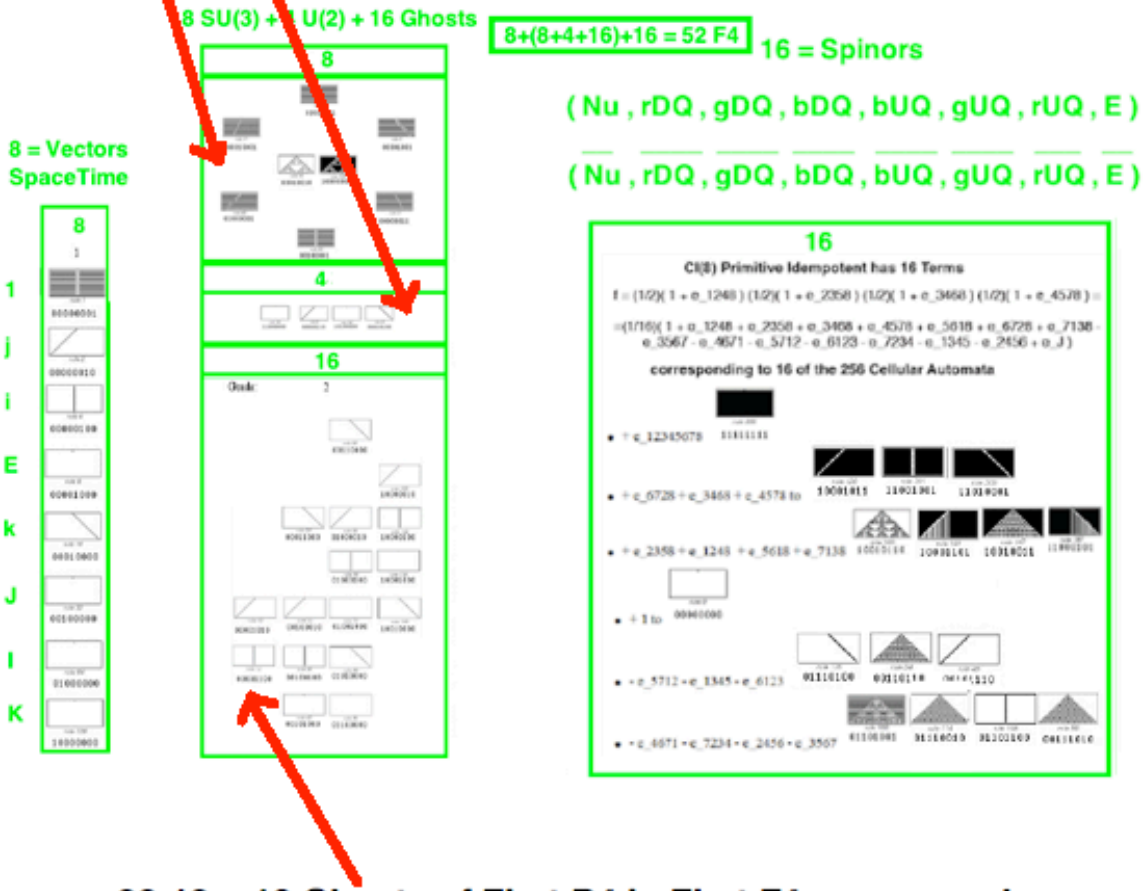
**8 + 4 = 12 Gauge Bosons of Second D4 in Second F4 represent Standard Model SU(3)xSU(2)xU(1)**

**SU(3) as subgroup of SU(4) subgroup of D4**
**and SU(2)xU(1) as little group of CP2 = SU(3) / SU(2)xU(1)**

**where CP2 = Internal Symmetry Space of Kaluza-Klein M4 x CP2**

SO

**Second F4 describing the Standard Model**
**has 16 Spinors = 8L (left-handed) + 8R (right-handed)**




**28-12 = 16 Ghosts of First D4 in First F4 correspond to the 16 Gravity+Dark Energy plus Propagator Phase Gauge Bosons which Gauge Bosons live in the First D4**

**First Cl(8) x Second Cl(8) = Cl(16)**

( tensor product )

**Cl(16) contains E8**

**E8 contains** and **First D4 First F4** **x** **plus** **Second D4 Second F4**

## First F4 of First D4 in First Cl(8)

**16 U(2,2) Gauge Bosons of First D4 in First F4 represent Conformal Gravity + Dark Energy and Propagator Phase**

16 U(2,2) + 12 Ghosts

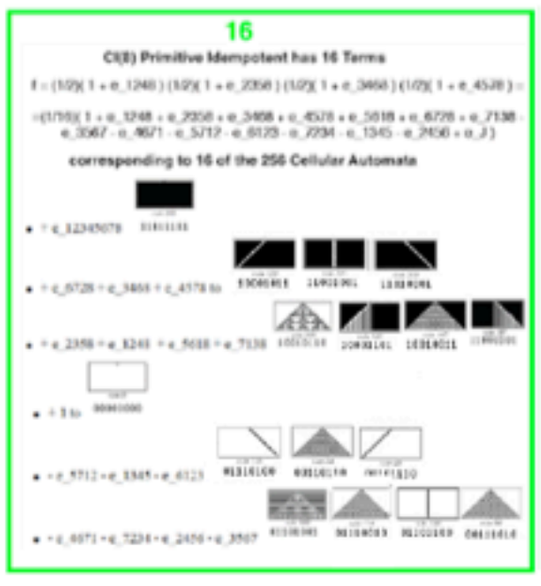
8+(16+12)+16 = 52 F4

8 = Vectors SpaceTime

16 = Spinors

( Nu , rDQ , gDQ , bDQ , bUQ , gUQ , rUQ , E )

( Nu , rDQ , gDQ , bDQ , bUQ , gUQ , rUQ , E )




**28-16 = 12 Ghosts of First D4 in First F4 correspond to the 12 Standard Model Gauge Bosons that live in Second D4**

## Second F4 of Second D4 in Second Cl(8)

**8 + 4 = 12 Gauge Bosons of Second D4 in Second F4 represent Standard Model SU(3)xSU(2)xU(1)**

**SU(3) as subgroup of SU(4) subgroup of D4**
**and SU(2)xU(1) as little group of CP2 = SU(3) / SU(2)xU(1)**

**where CP2 = Internal Symmetry Space of Kaluza-Klein M4 x CP2**

SO

**Second F4 describing the Standard Model has 16 Spinors = 8L (left-handed) + 8R (right-handed)**

8 SU(3) + 4 U(2) + 16 Ghosts

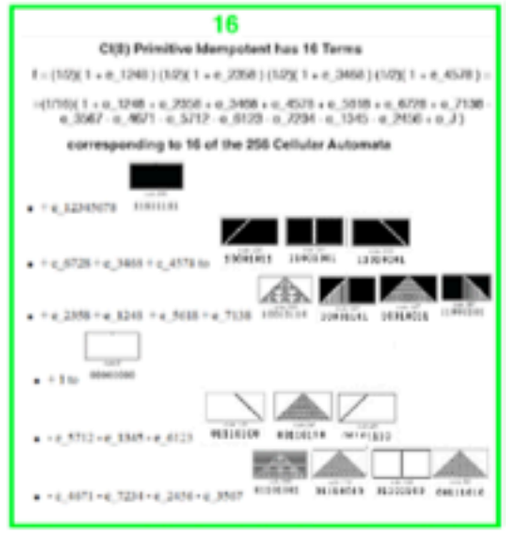
8+(8+4+16)+16 = 52 F4

8 = Vectors SpaceTime

16 = Spinors

( Nu , rDQ , gDQ , bDQ , bUQ , gUQ , rUQ , E )

( Nu , rDQ , gDQ , bDQ , bUQ , gUQ , rUQ , E )




**28-12 = 16 Ghosts of First D4 in First F4 correspond to the 16 Gravity+Dark Energy plus Propagator Phase Gauge Bosons which Gauge Bosons live in the First D4**

**There are two ways**
**that 28 D4 BiVectors of Cl(8) can form Gauge Bosons and Ghosts**
**so**
**there are two ways that F4 can sit inside Cl(8)**

**16 U(2,2) Gauge Bosons of First D4 in First F4 represent**
**Conformal Gravity + Dark Energy**
**and Propagator Phase**

16 U(2,2) + 12 Ghosts

8+(16+12)+16 = 52 F4

16 = Spinors

( Nu , rDQ , gDQ , bDQ , bUQ , gUQ , rUQ , E )

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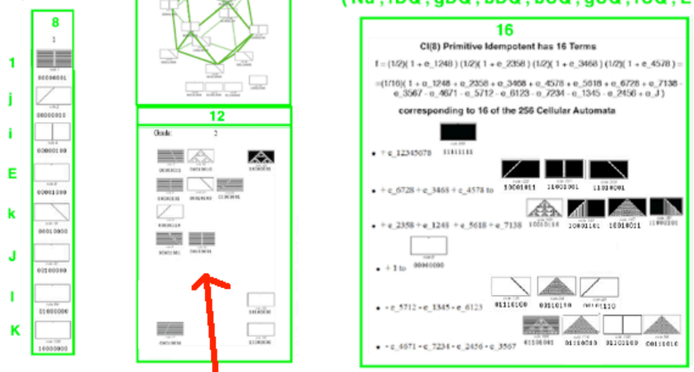
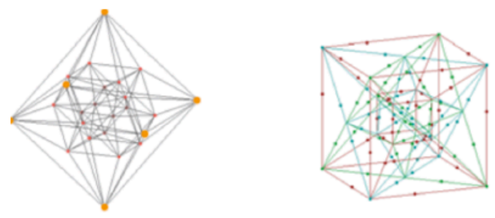
8 = Vectors SpaceTime




1 j i E k J I K

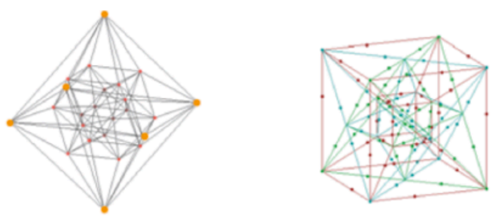
**28-16 = 12 Ghosts of First D4 in First F4 correspond**
**to the 12 Standard Model Gauge Bosons that live in Second D4**

**The First F4 has 48 Root Vectors:**
**Vertices of a 4-dim 24-cell and its Dual 24-cell**



**24 + 96 Dual Edge Golden Ratio Points =**
**= 120 Vertices of First H4 600-cell**

**The Second F4 also has 48 Root Vectors:**
**Vertices of a 4-dim 24-cell and its Dual 24-cell**



**24 + 96 Dual Edge Golden Ratio Points =**
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**8 + 4 = 12 Gauge Bosons of Second D4 in Second F4 represent**
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**where CP2 = Internal Symmetry Space of Kaluza-Klein M4 x CP2**
**so**
**Second F4 describing the Standard Model**
**has 16 Spinors = 8L (left-handed) + 8R (right-handed)**

8 SU(3) + U(2) + 16 Ghosts

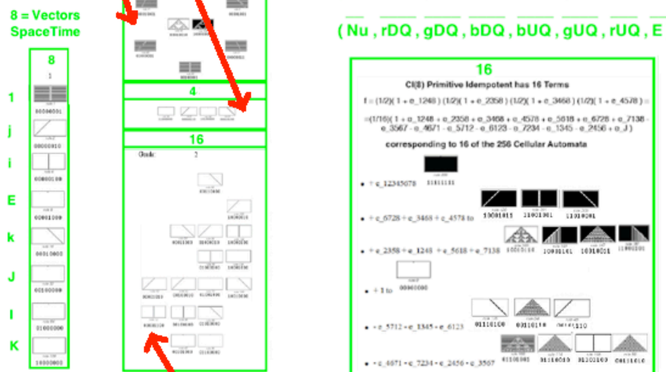
8+(8+4+16)+16 = 52 F4

16 = Spinors

( Nu , rDQ , gDQ , bDQ , bUQ , gUQ , rUQ , E )

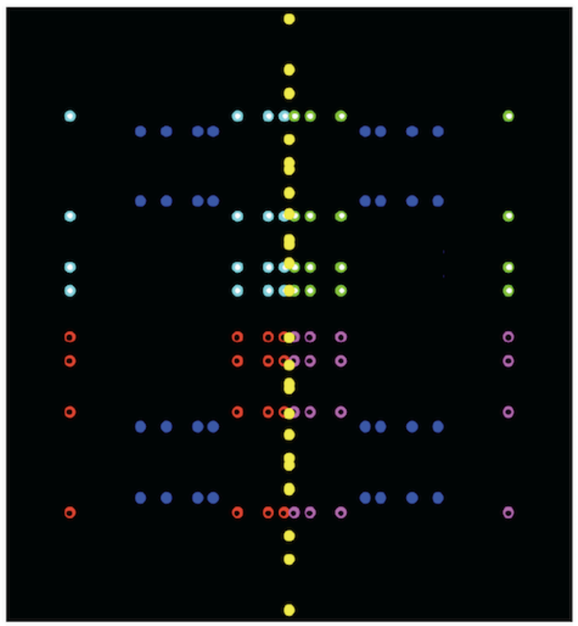
( Nu , rDQ , gDQ , bDQ , bUQ , gUQ , rUQ , E )

8 = Vectors SpaceTime

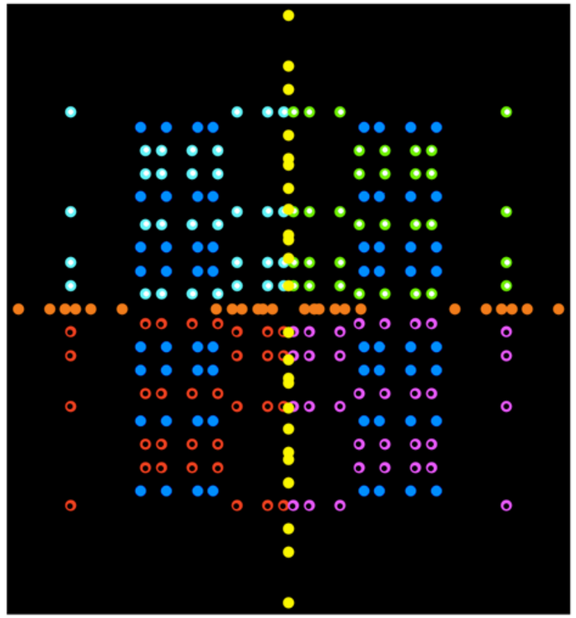



1 j i E k J I K

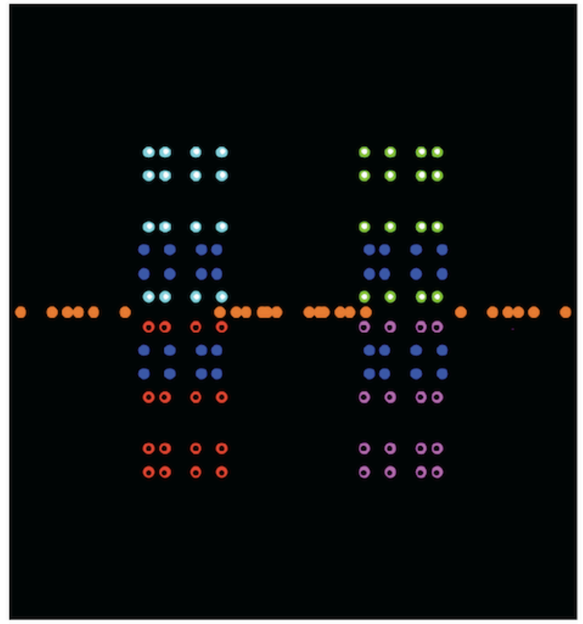
**28-12 = 16 Ghosts of First D4 in First F4 correspond**
**to the 16 Gravity+Dark Energy plus Propagator Phase Gauge Bosons**
**which Gauge Bosons live in the First D4**



**120 Root Vectors of First H4**
**from First F4 in First Cl(8)**

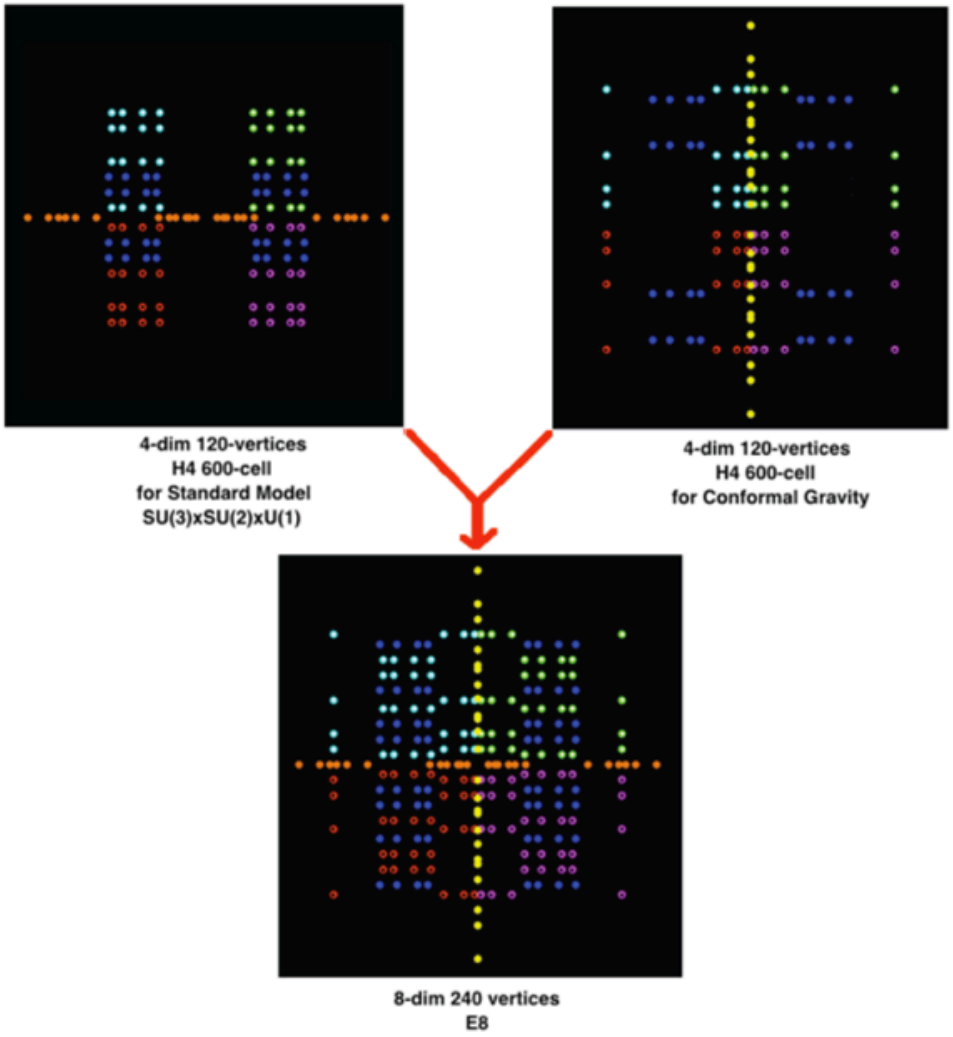


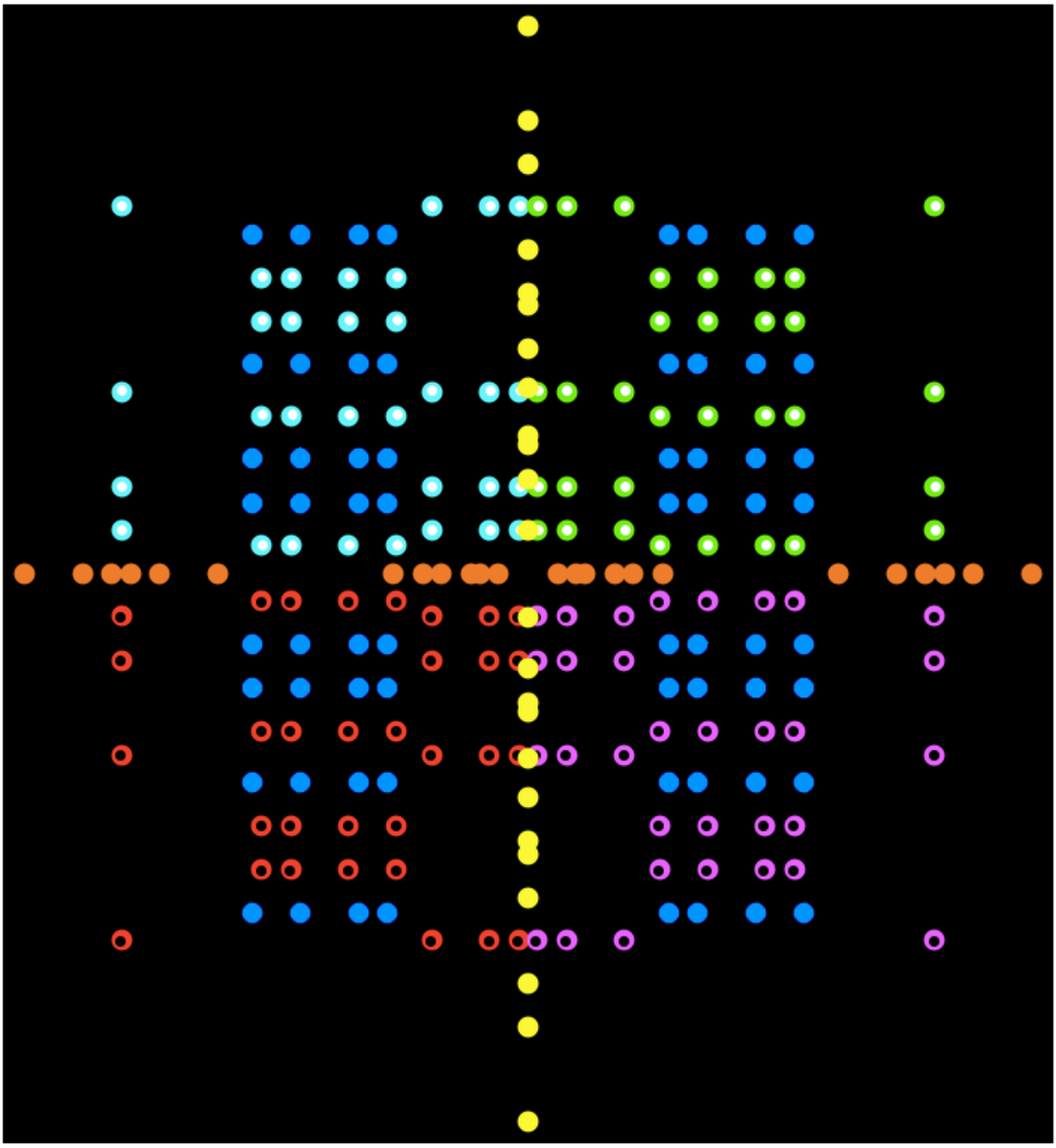
**tensor product First Cl(8) x Second Cl(8) = Cl(16)**
**Cl(16) contains E8 with 240 Root Vectors**
**Induced tensor-type product First F4 x Second F4 = E8**



**120 Root Vectors of Second H4**
**from Second F4 in Second Cl(8)**

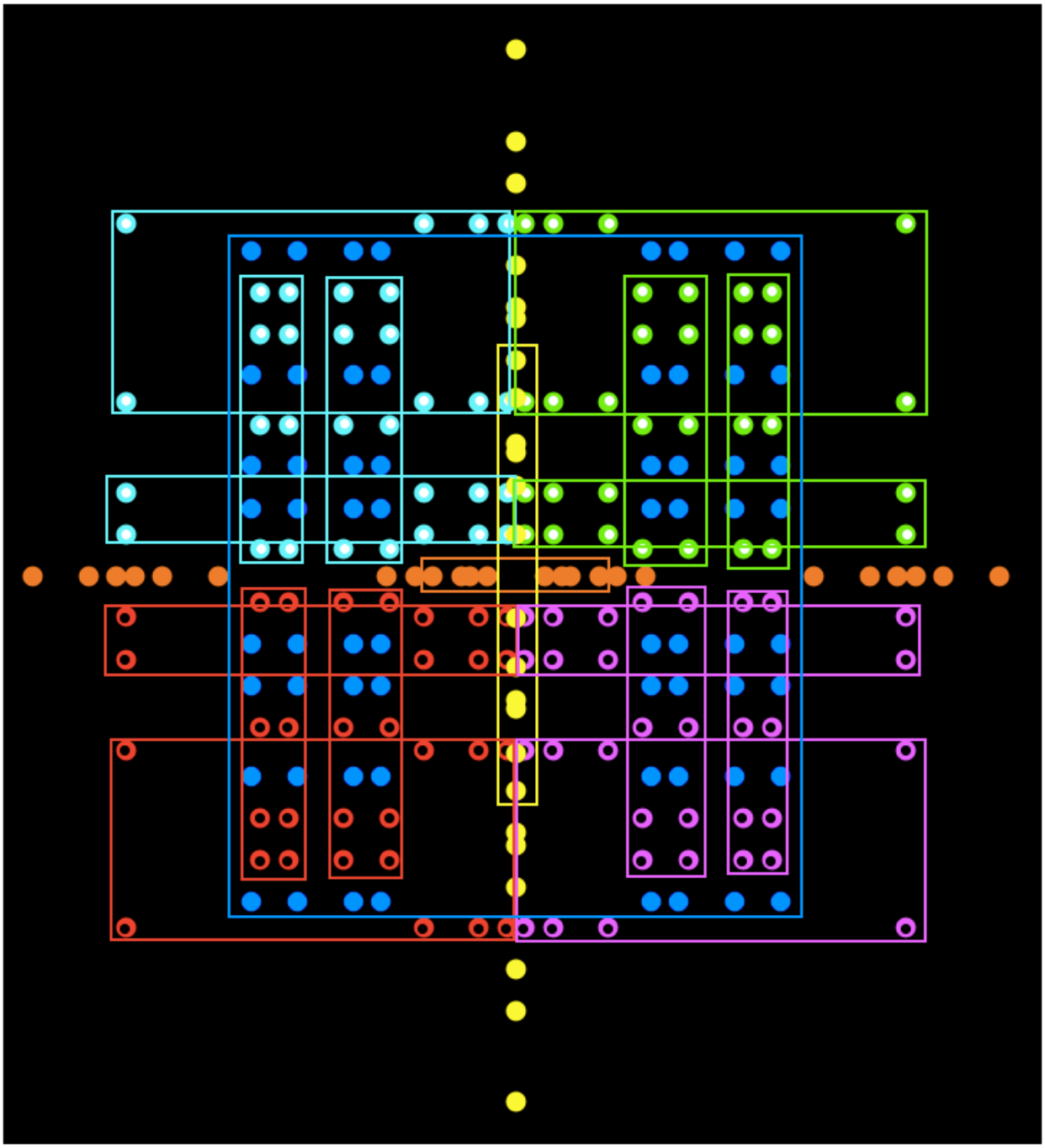
**248-dim E8 in Cl(16) has 240 Root Vectors -**
**- first shell of 8-dim E8 Lattice.**
**Since it is hard to visualize points on S7 in 8-dim space,**
**I prefer to represent the 240 E8 Root Vectors**
**in this 2D representation by Ray Aschheim**





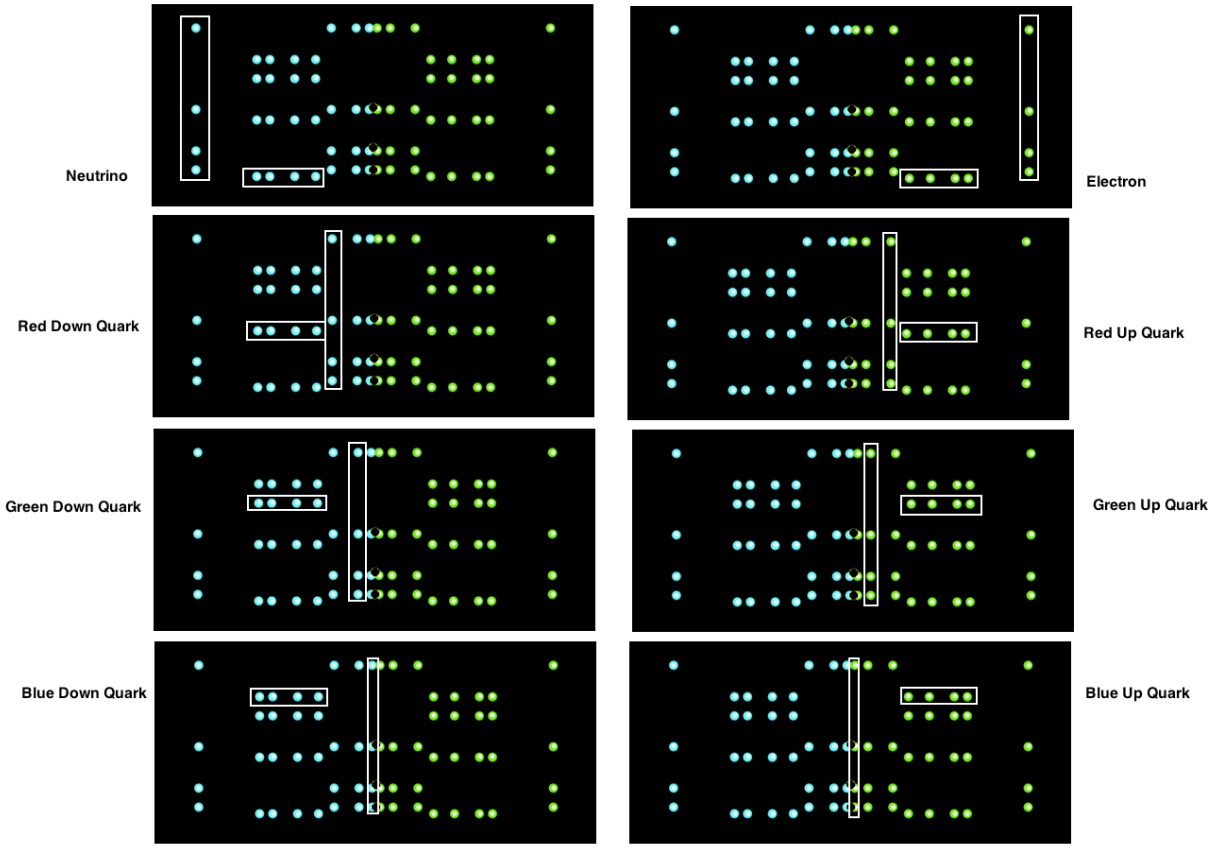
**To understand the Geometry related to the 240 E8 Root Vectors, consider that**
**248-dim E8 = 120-dim Spin(16) D8 + 128-dim half-spinor of Spin(16) D8**
**240 E8 Root Vectors = 112 D8 Root Vectors + 128 D8 half-spinors**
**112 D8 Root Vectors = 24 D4 (orange) + 24 D4 (yellow) + 64 (blue)**
**128 D8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

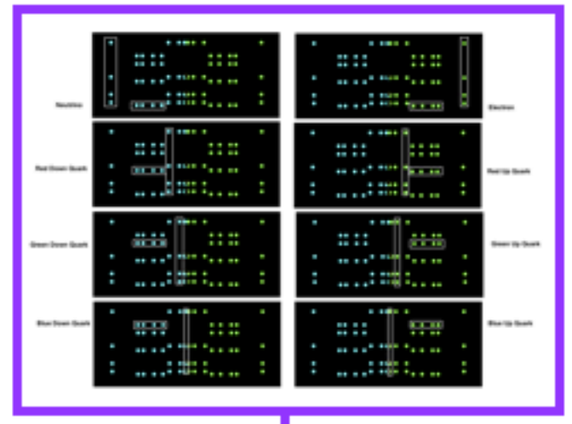
**Green and Cyan dots with white centers (32+32 = 64 dots) and**
**Red and Magenta dots with black centers (32+32 = 64 dots)**
**correspond to the 128 elements of E8 / D8.**



**240 = 64 + 64 + 64 + 24 + 24**

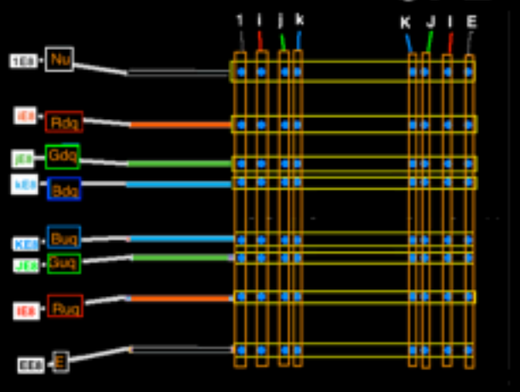
**The 64 Green and Cyan Root Vectors represent half of the First Generation Fermion Particles of E8 / D8 as the 8 = 4+4 M4 x CP2 Kaluza-Klein components of each of 8 Particles. The White Centers of their dots indicate that they are Particles.**





8 Components of 8 Fermion Particles

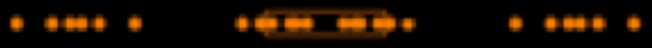
$$\int$$




A7+1
D8 / D4xD4

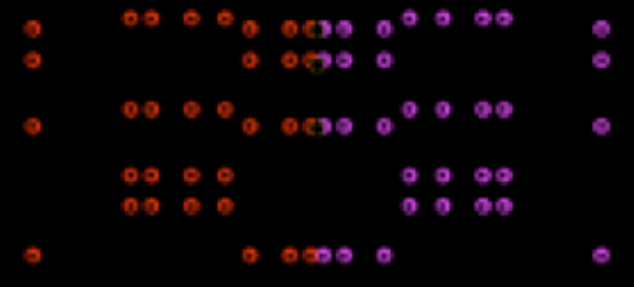
First D4

+



Second D4

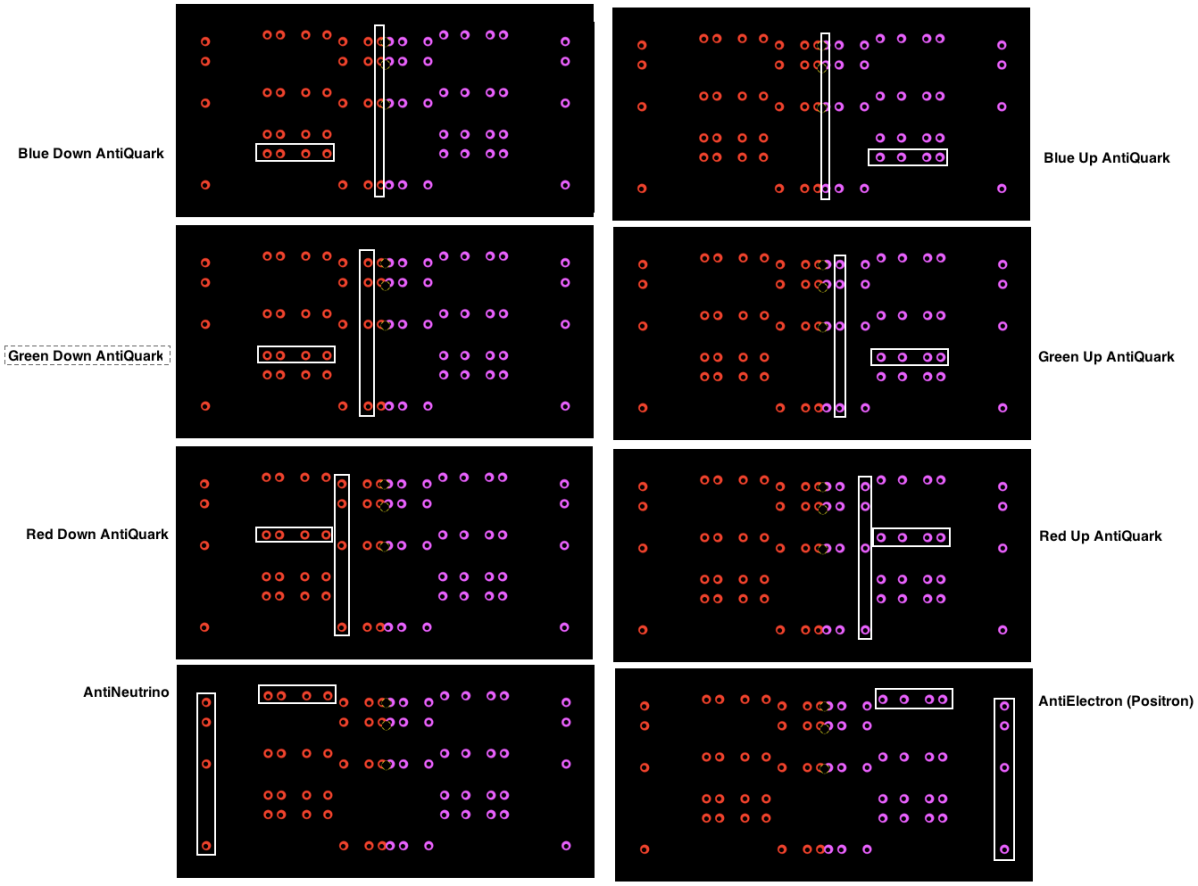
+

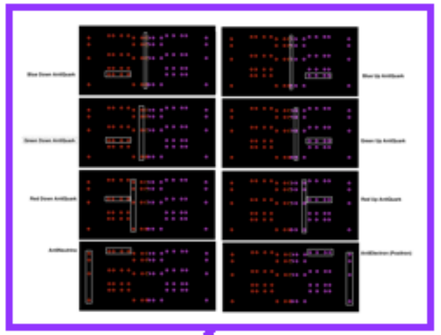


E8 / D8

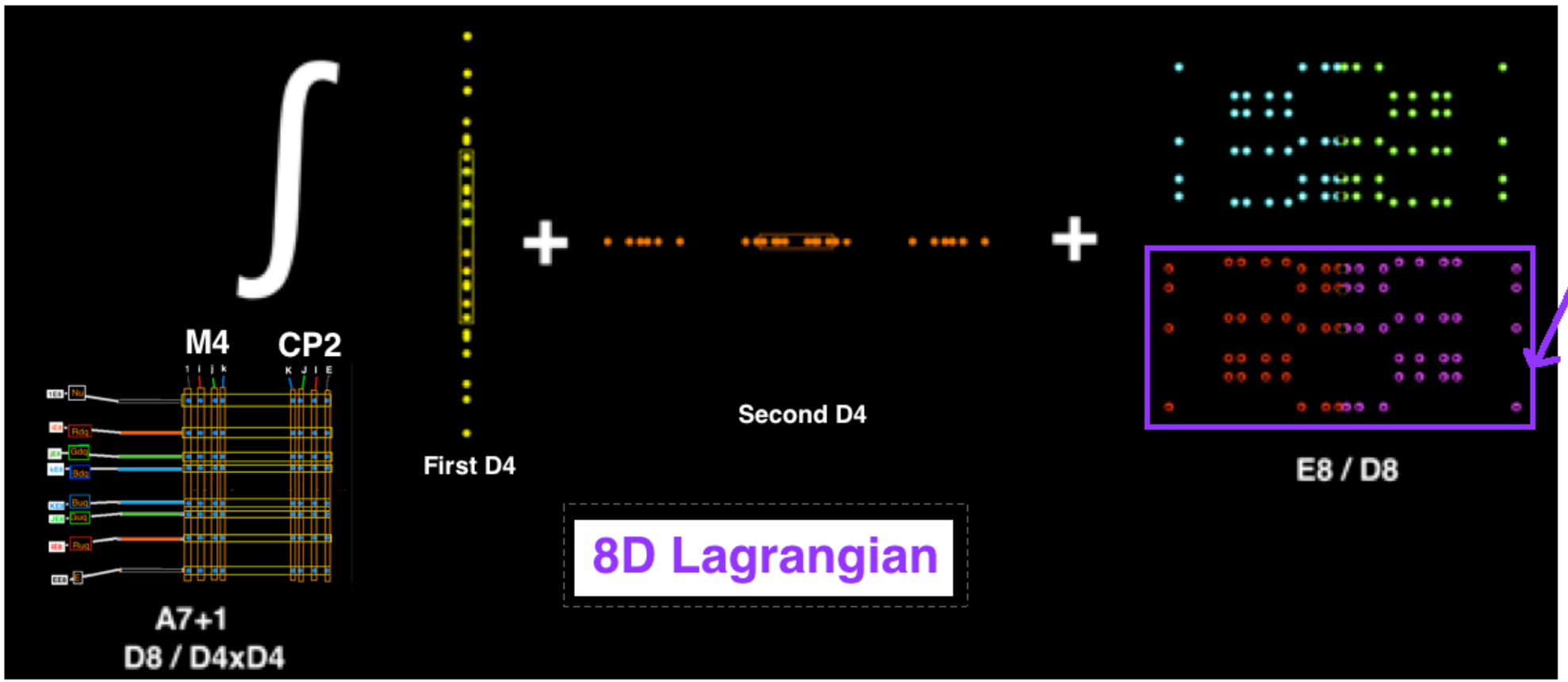
**8D Lagrangian**

**The 64 Red and Magenta Root Vectors represent the other half of the First Generation Fermion AntiParticles of E8 / D8**
**8 = 4+4 M4 x CP2 Kaluza-Klein components of each of 8 AntiParticles.**
**The Black Centers of their dots indicate that they are AntiParticles.**



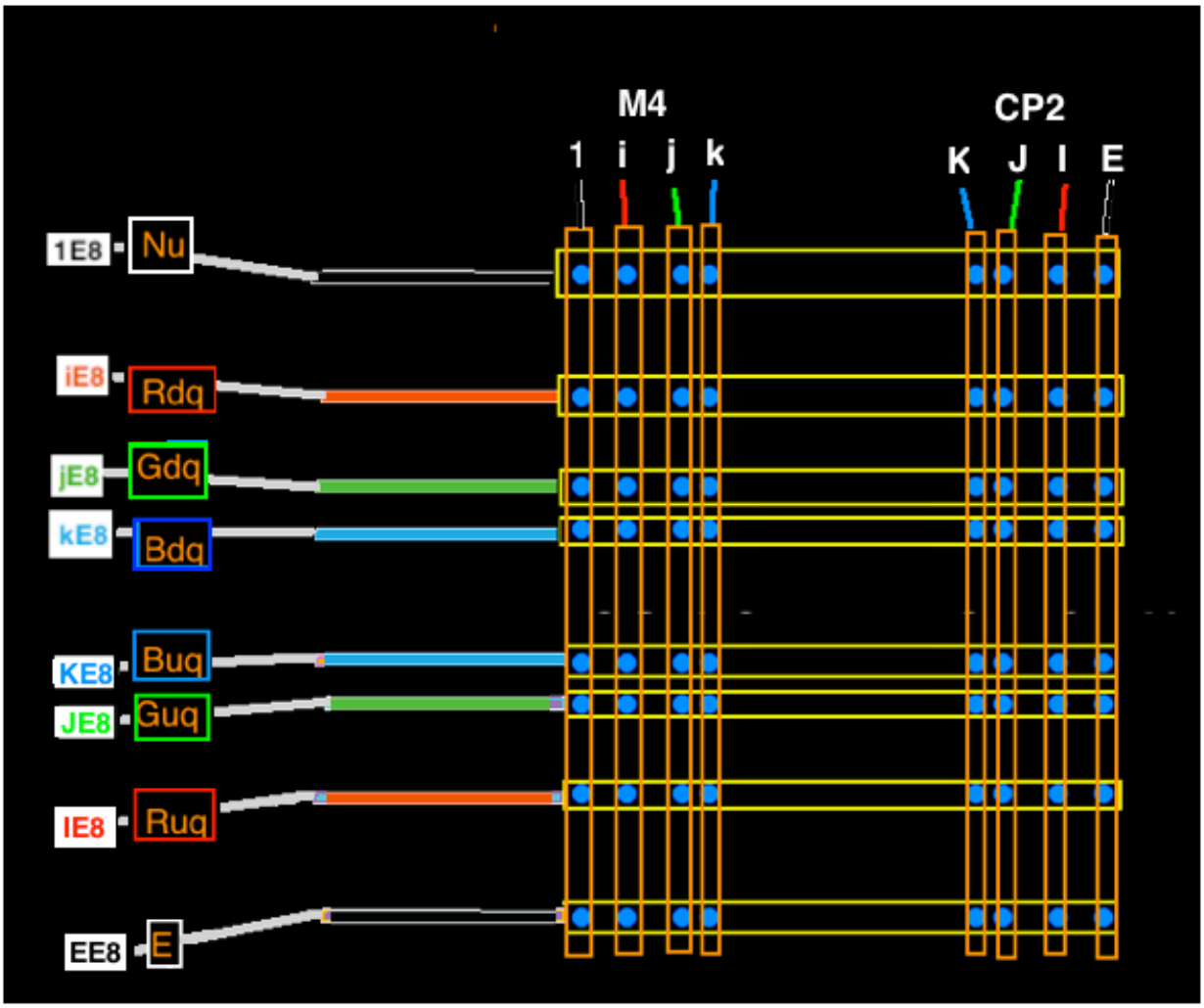


8 Components of 8 Fermion AntiParticles



## Spacetime

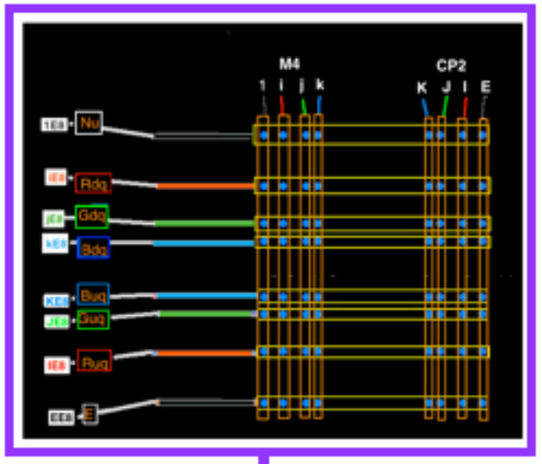
**The 64 Blue Root Vectors of D8 / D4xD4 are a Superposition of 8 E8 Lattices (7 being Integral Domains) corresponding to the 8 fundamental Fermion Types, each of which has 8-dim M4 x CP2 Kaluza-Klein structure. Effectively, each Fermion Type propagates within its own E8 Lattice within the Superposition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



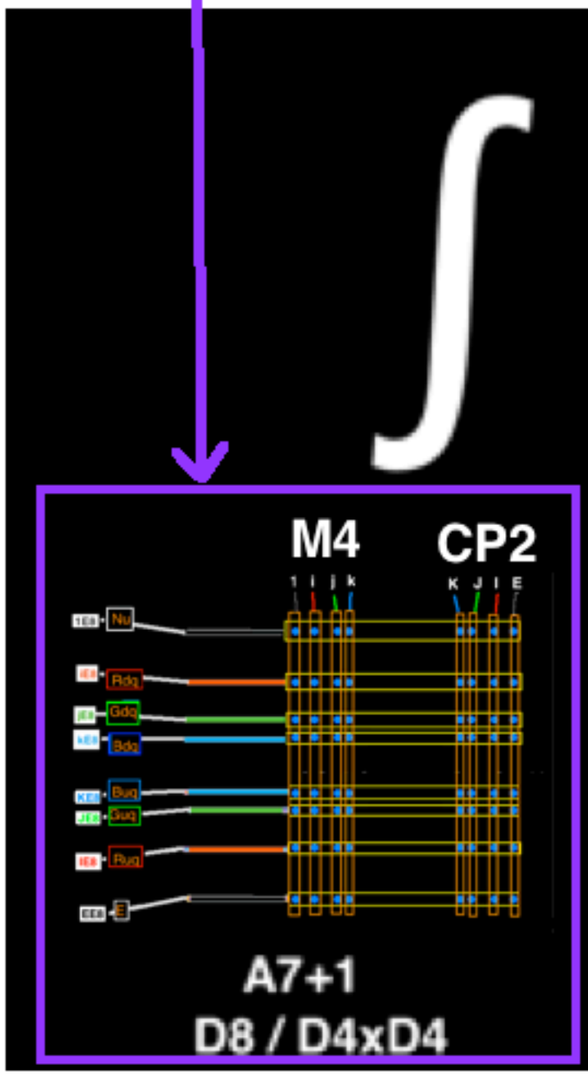

**The 64 of D8 / D4xD4 also represent the A7+1 central grade of the Maximal Contraction Heisenberg Algebra of E8 with structure 28 + 64 + (A7+1) = 64 + 28.**

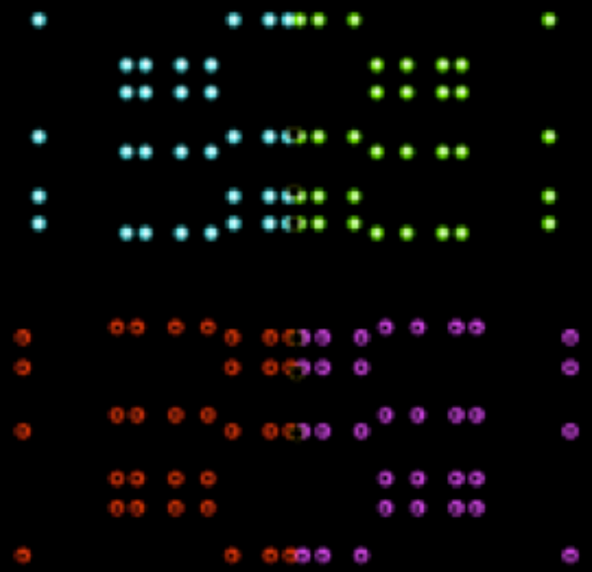
(see Rutwig Campoamor-Stursberg in "Contractions of Exceptional Lie Algebras and SemiDirect Products" (Acta Physica Polonica B 41 (2010) 53-77)

**A7+1 SpaceTime is related by Triality to 64 + 64 Fermion Components of E8 / D8**



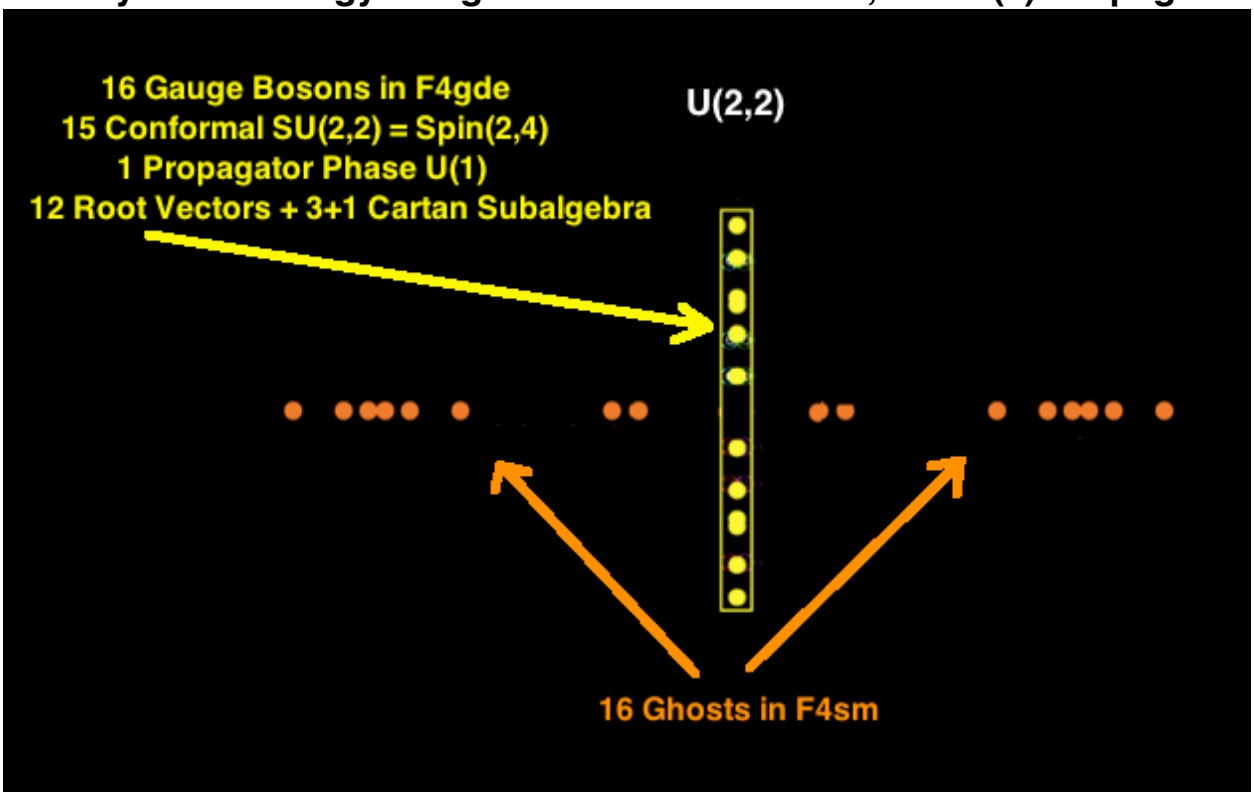

Base | Manifold



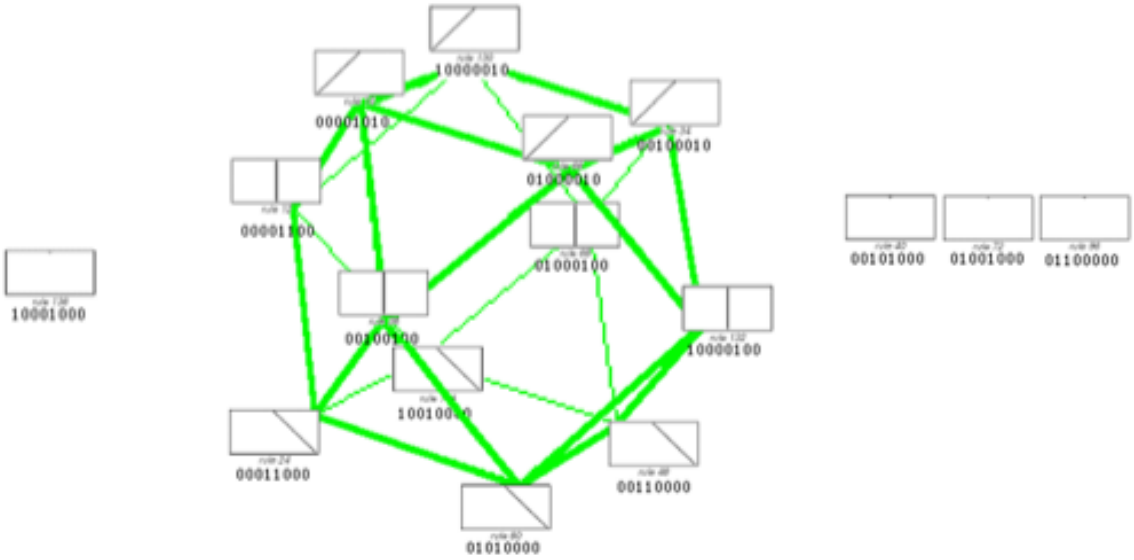



8D Lagrangian

## Gravity+Dark Energy Gauge Bosons and Ghosts, and U(2,2) 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 basis for calculating the ratio**

**Dark Energy : Dark Matter : Ordinary Matter**

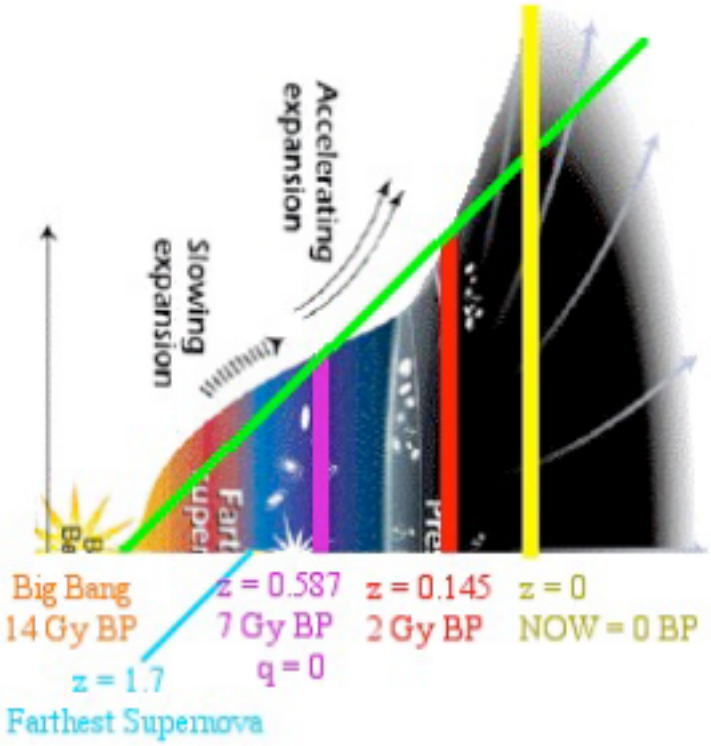
**is the structure of the Conformal Group SU(2,2) = Spin(2,4) whose 15 generators are:**

**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**

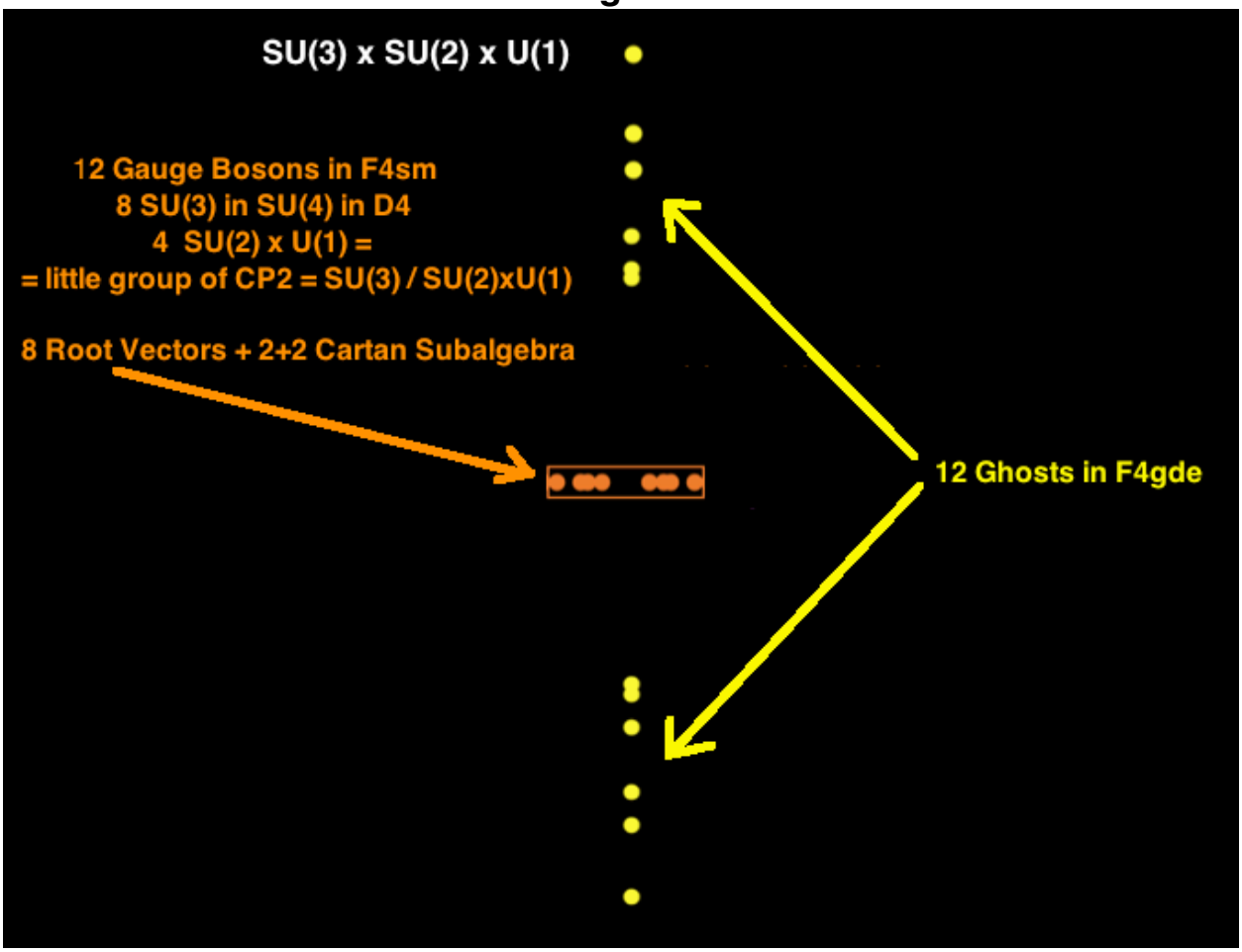
**Taking Account of differences between Radiation and Matter Eras in the Evolution of Our Universe**



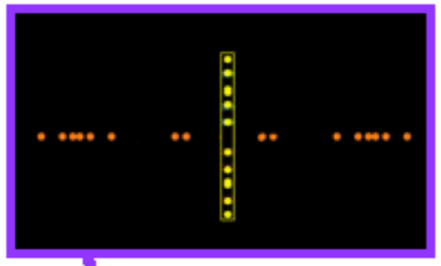

**gives the E8 Physics calculated ratio**

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

## Standard Model Gauge Bosons and Ghosts



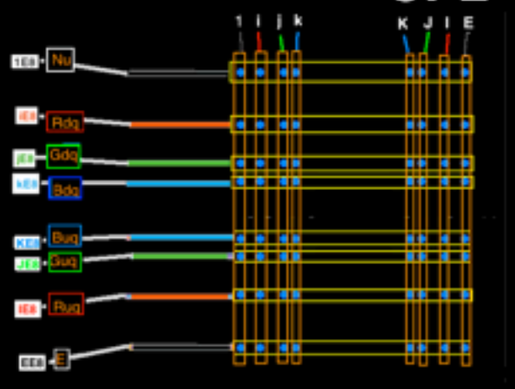
**These 1 + 3 + 8 = 12 grade-2 Cellular Automata correspond to U(1) , SU(2) , SU(3) of the Standard Model**



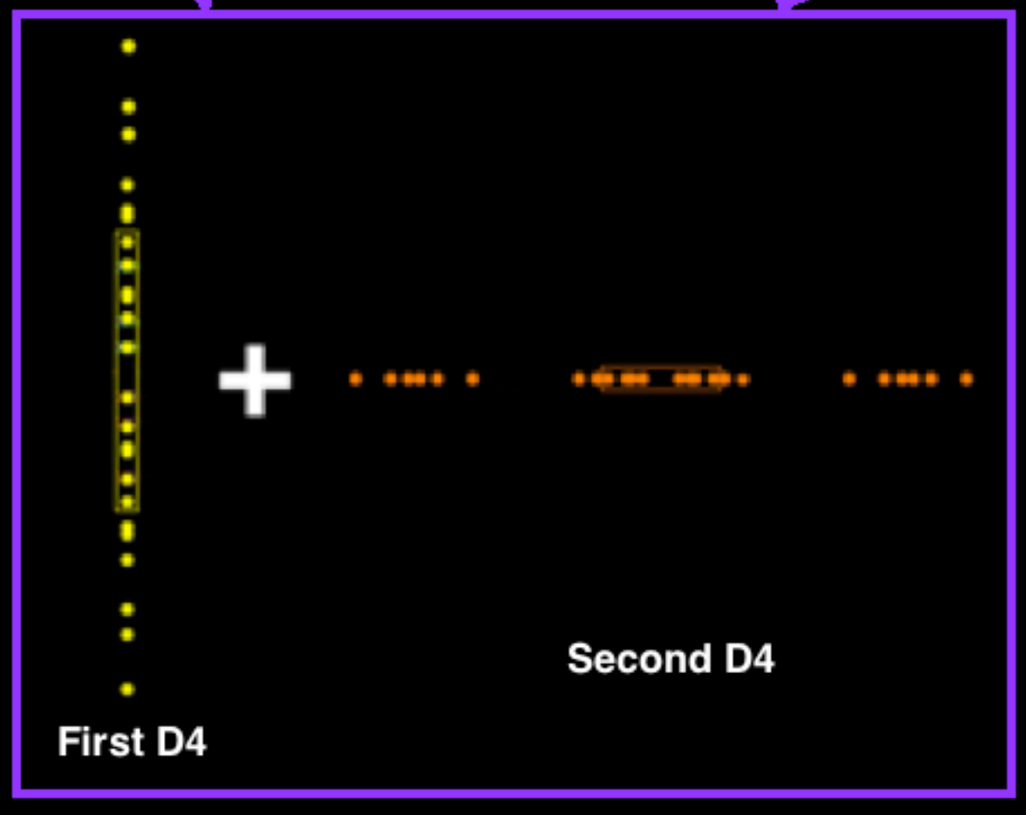
Gravity + Dark Energy
Gauge Bosons and Ghosts
plus propagator phase

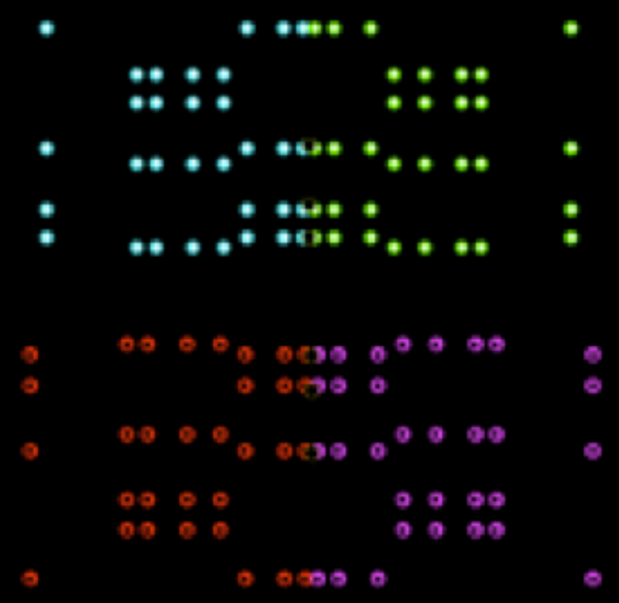
Standard Model
Gauge Bosons and Ghosts

$$\int$$




A7+1
D8 / D4xD4

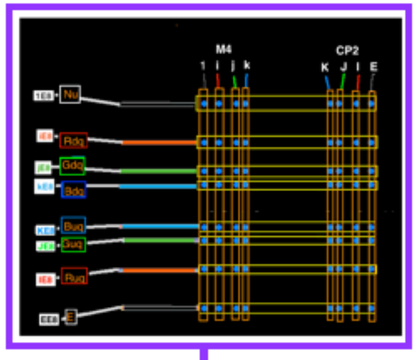


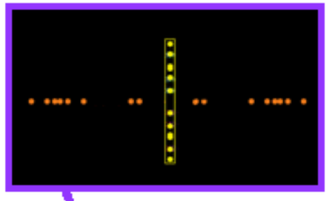
E8 / D8

**8D Lagrangian**

# 8D Lagrangian

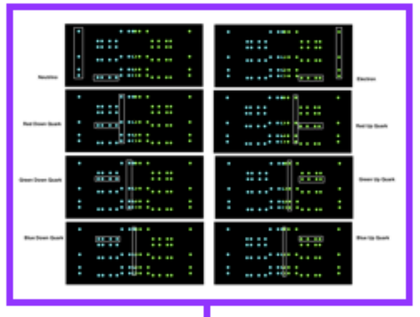



Base Manifold

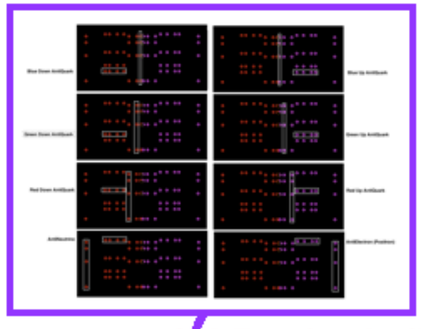


Gravity + Dark Energy
Gauge Bosons and Ghosts
plus propagator phase

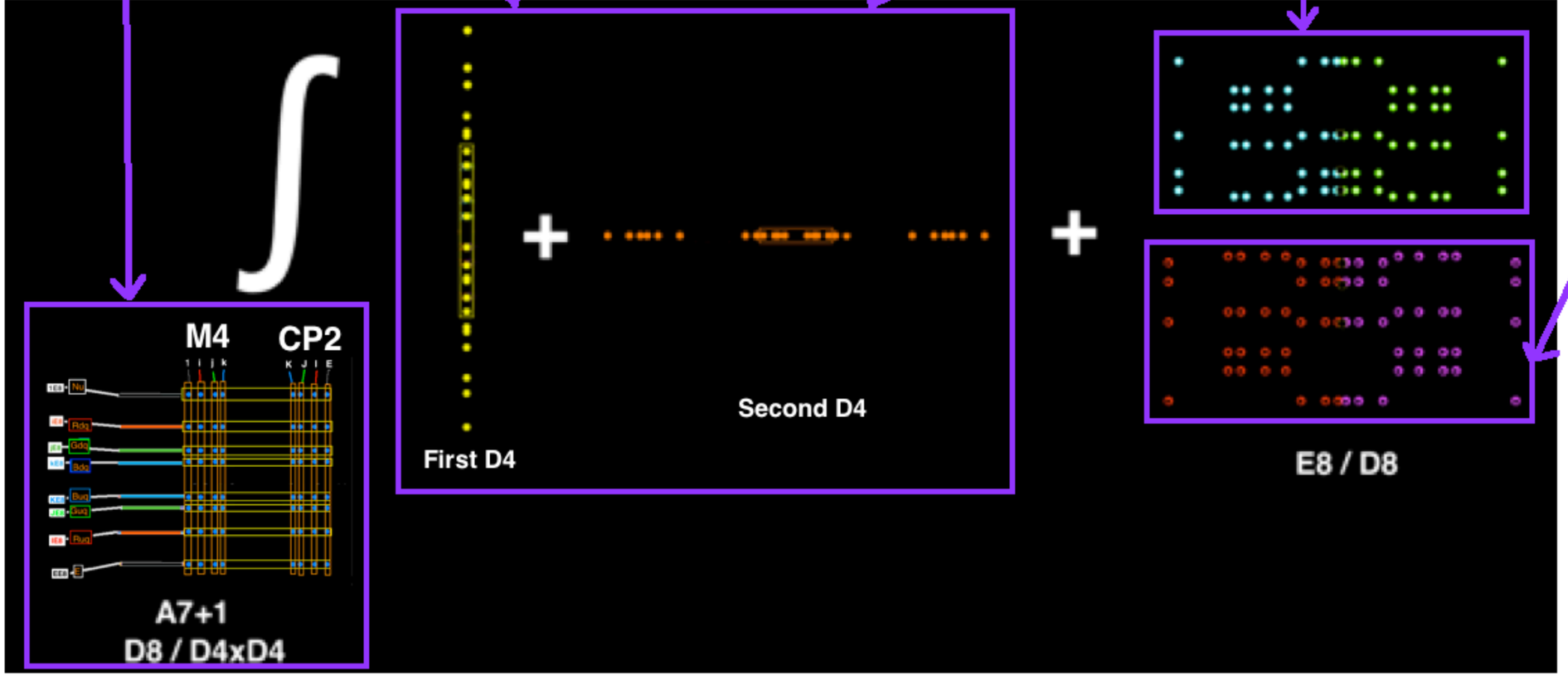
Standard Model
Gauge Bosons and Ghosts

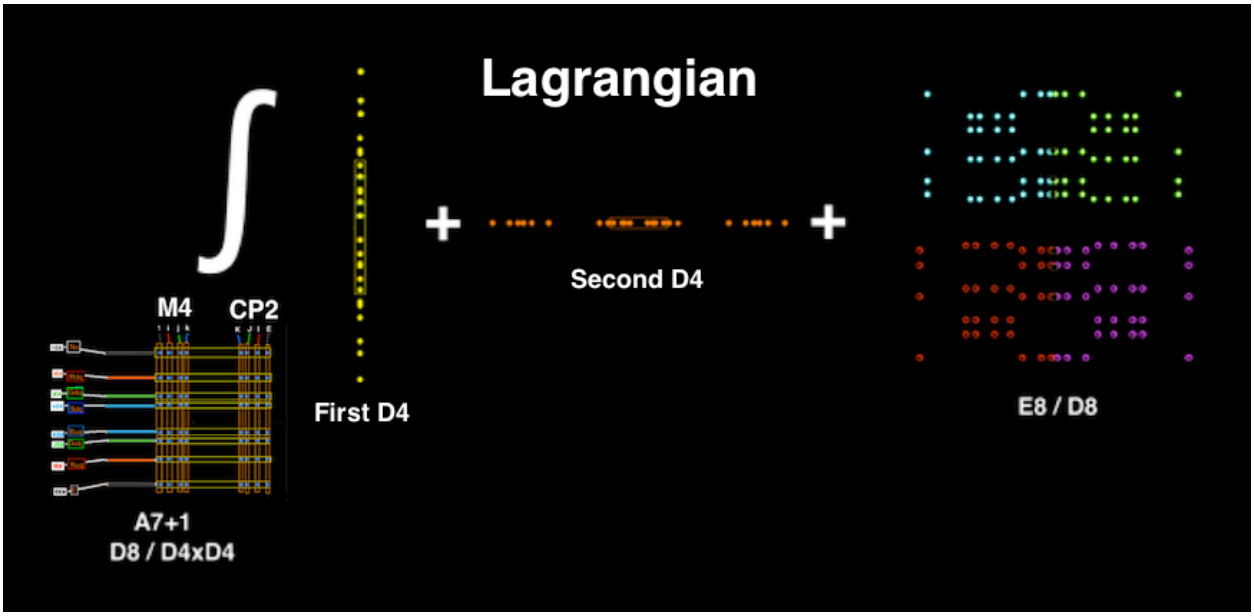


8 Components of 8 Fermion Particles



8 Components of 8 Fermion AntiParticles






**The 8D Lagrangian Density of E8 Physics has 3 fundamental terms**

**Generation-1 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**

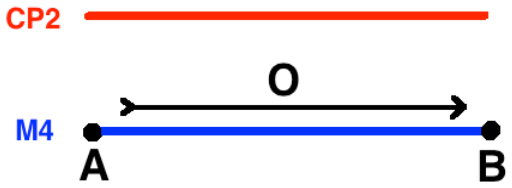
**8D Lagrangian 8-dim Lorentz structure satisfies Coleman-Mandula because its Fermionic fundamental spinor representations are built with respect to spinor representations for 8-dim Spin(1,7) spacetime.**

**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.**

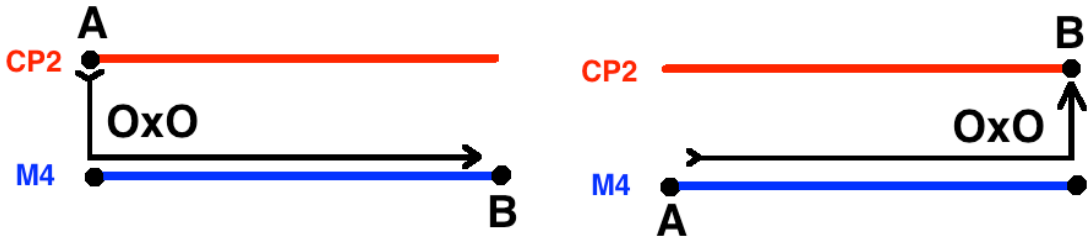
## 3 Generations of Fermions

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

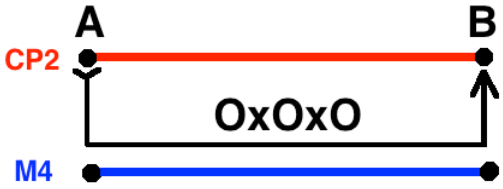
**1 - A and B are both in M4: First Generation Fermion represented by single O basis element**



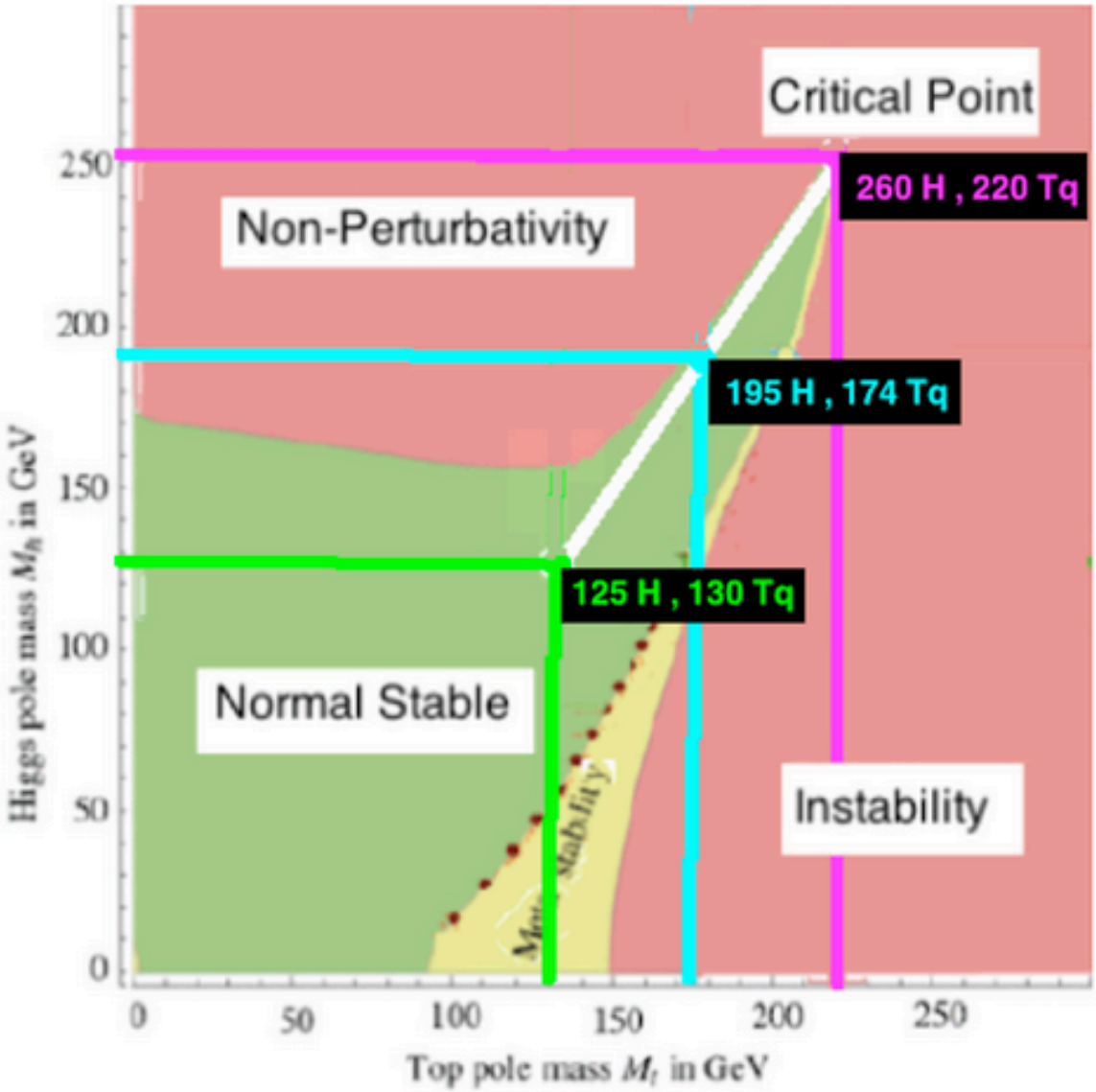

**2 - Either A or B, but not both, is in CP2: Second Generation Fermion whose path must be augmented by one projection from CP2 to M4, which projection can be represented by a second O basis element so that Second Generation Fermions are Octonion Pairs OxO.**




**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**



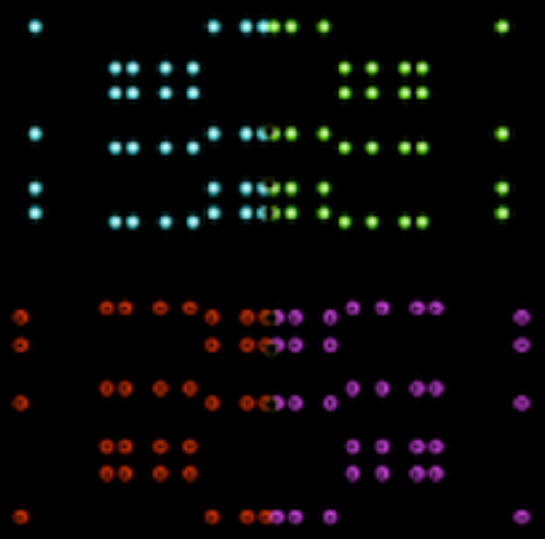
# Lagrangian

$\int$

+

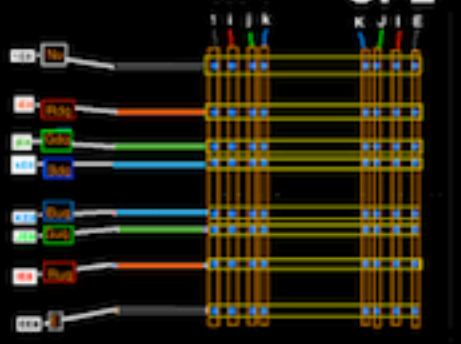
+

Second D4



E8 / D8

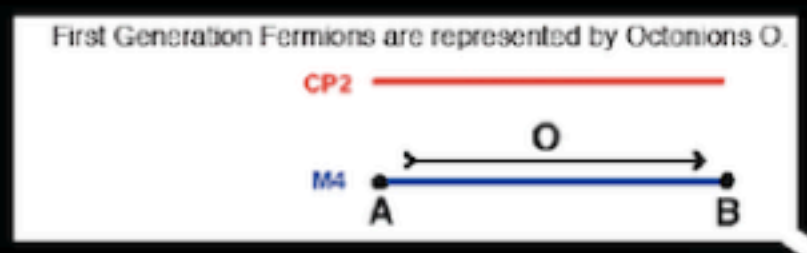
M4 CP2



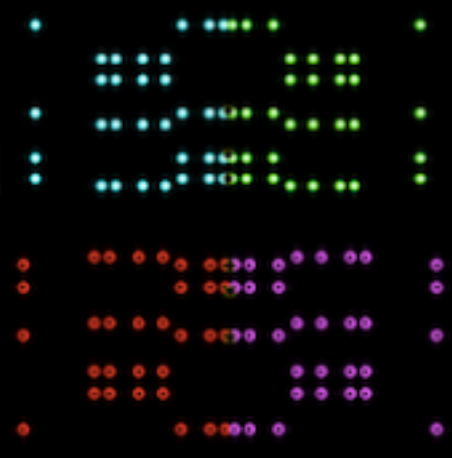
First D4

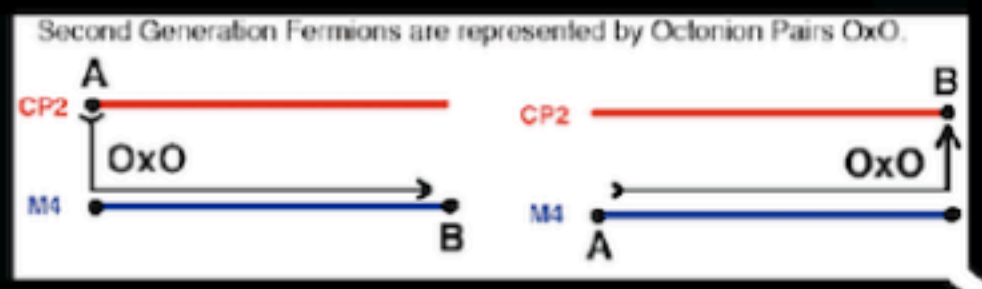
A7+1
D8 / D4xD4

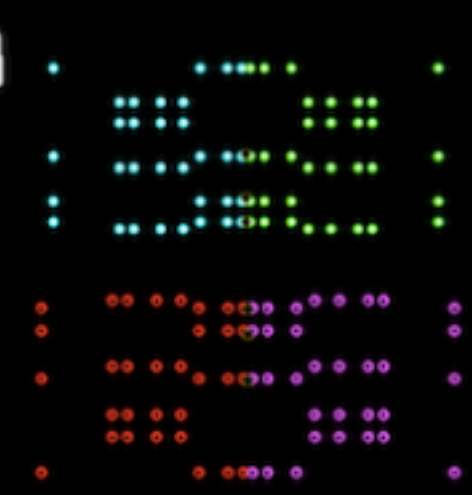
Mayer Mechanism




3 Kaluza-Klein
Fermion Generations





$\int$

HIGGS

+

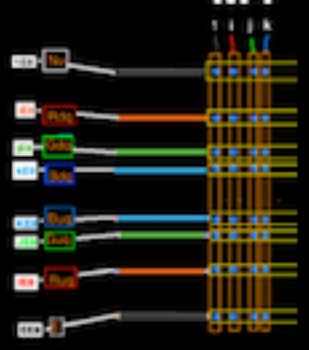
$D4_{sm}$

+

+

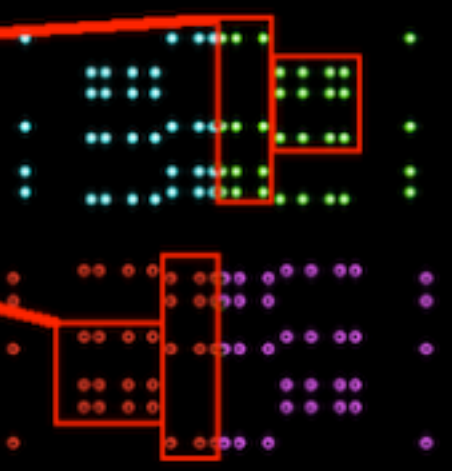
$D4_{gde}$

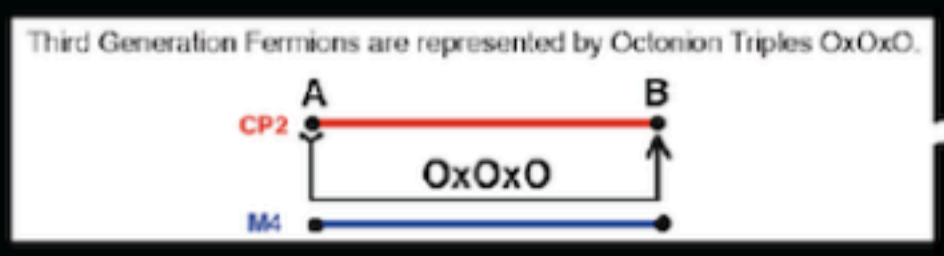
M4



RGB Truth Quarks

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



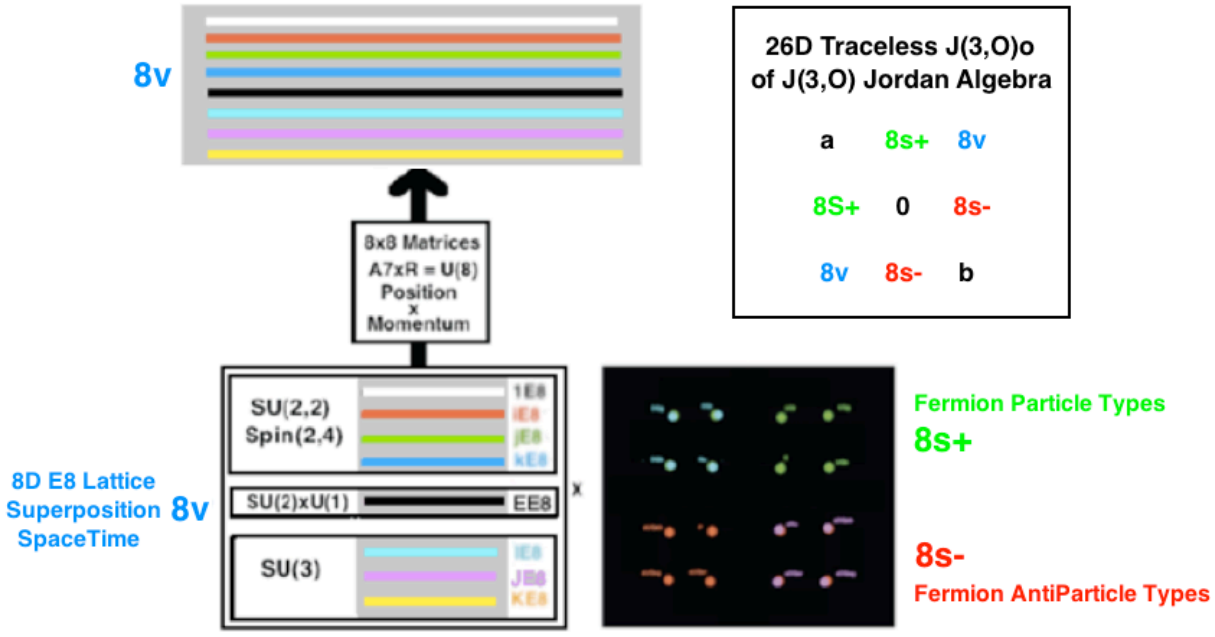



RGB Truth AntiQuarks

## E8 Physics as 26D String Theory

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

**26D E8 String Theory**




**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 ...".**

With that in mind, here is the construction:

Step 1:
Consider the 26 Dimensions of Bosonic String Theory as
the 26-dimensional traceless part J3(O)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 D3 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 D3, to get D7.

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 D7, to get D8.
D8, our basic Brane, looks like two layers (past and future) of D7s.
Beyond D8 our String Theory has 26 - 8 = 18 dimensions, of which 25 - 8 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 the D8 branes containing spacelike D3s 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 D7 layer of D8.

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 D7 layer of D8.

The 8 components of the 8 fundamental first-generation fermion p
articles = 8x8 = 64 correspond to the 64 of the 128-dim half-spinor D8 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 the D8 branes containing spacelike D3s 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 D7 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 D7 layer of D8.

The 8 components of 8 fundamental first-generation fermion anti-particles = 8x8 = 64 correspond to the 64 of the 128-dim half-spinor D8 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 the D8 branes containing spacelike D3s 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 D8 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 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 8-dim lattice 1E8 with 240 first-shell vertices related to
the E8 adjoint part of E8 is related to the 7 octonion imaginary lattices.
Give each D8 brane structure based on Planck-scale E8 lattices so that
each D8 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 D8 from its 1E8 and EE8 lattices is
a U(2) ElectroWeak boson thus accounting for the photon and W+, W- and Z0 bosons.

a gauge boson emanating from D8 from its IE8, JE8, and KE8 lattices is
a U(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 D8 parts of E8.

a gauge boson emanating from D8 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 D8 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 'noncummutative geometry' ...[may be]... an important hint
about the nature of spacetime. ...",

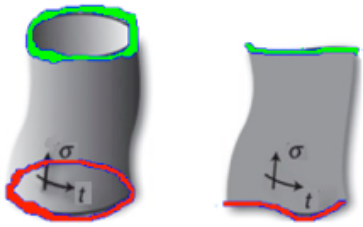
make the following assignment:

The 8x8 matrices for the collective coordinates
linking a D8 brane to the next D8 brane in the stack
are needed to connect the eight E8 lattices of the D8 brane
to the eight E8 lattices of the next D8 brane in the stack.

The 8x8 = 64 correspond to the 64 of the 120 adjoint D8 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 ...".

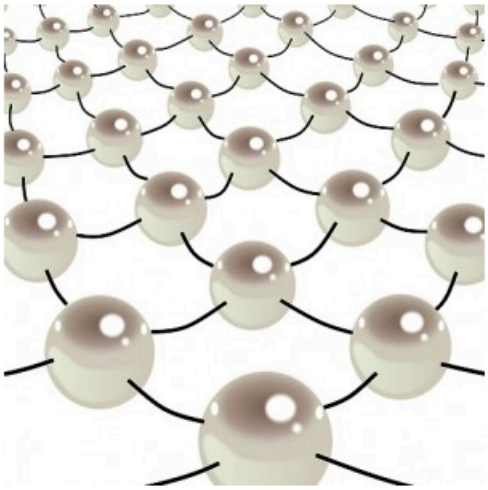
The idea of Schwinger Sources as more than mere points is in **David Finkelstein's Space-Time Code 1968** in which David said "... "... What is too simple about general relativity is the space-time point ... **each point of space-time is some kind of assembly of some kind of thing ... Each point, as 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/ )

From https://hbr.org/2017/01/the-truth-about-blockchain "... **How Blockchain Works ...**

**1. Distributed Database**

Each party on a blockchain has access to the entire database and its complete history.

**2. Peer-to-Peer Transmission**

Communication occurs directly between peers ...

**3. Transparency with Pseudonymity**

Every transaction and its associated value are visible to anyone ...

**4. Irreversibility of Records**

... transaction[s] ... cannot be altered ... they're linked to every ...transaction ... that came before them ...

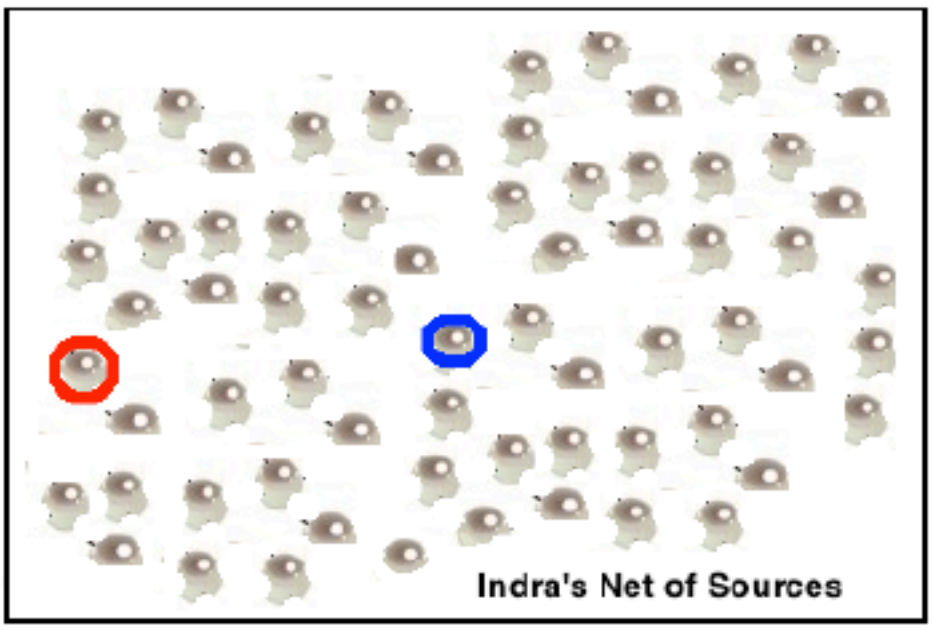
**5. Computational Logic**

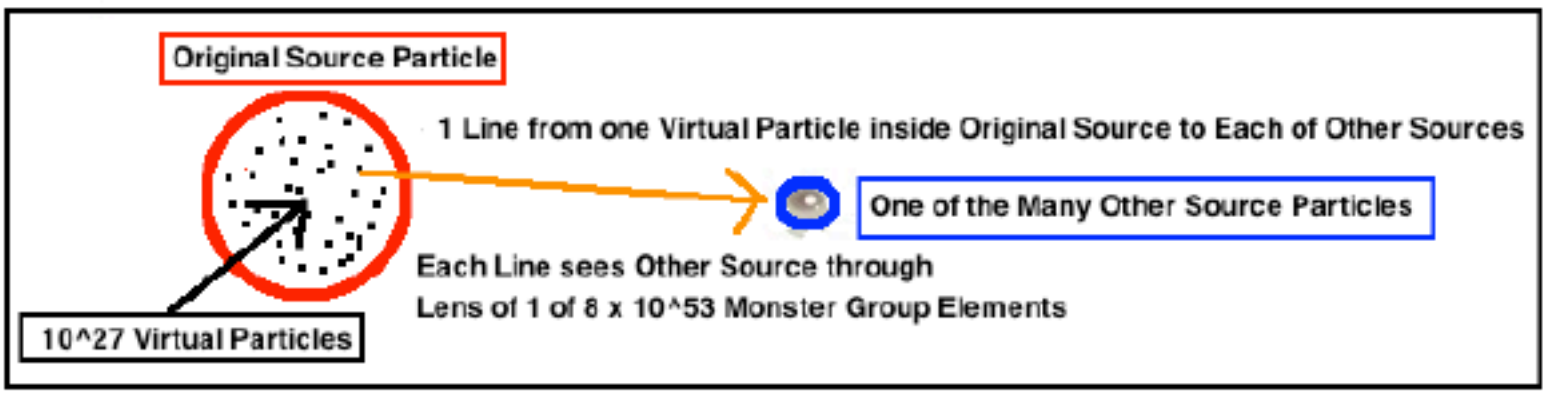
... blockchain transactions can be tied to computational logic and in essence programmed ...".

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

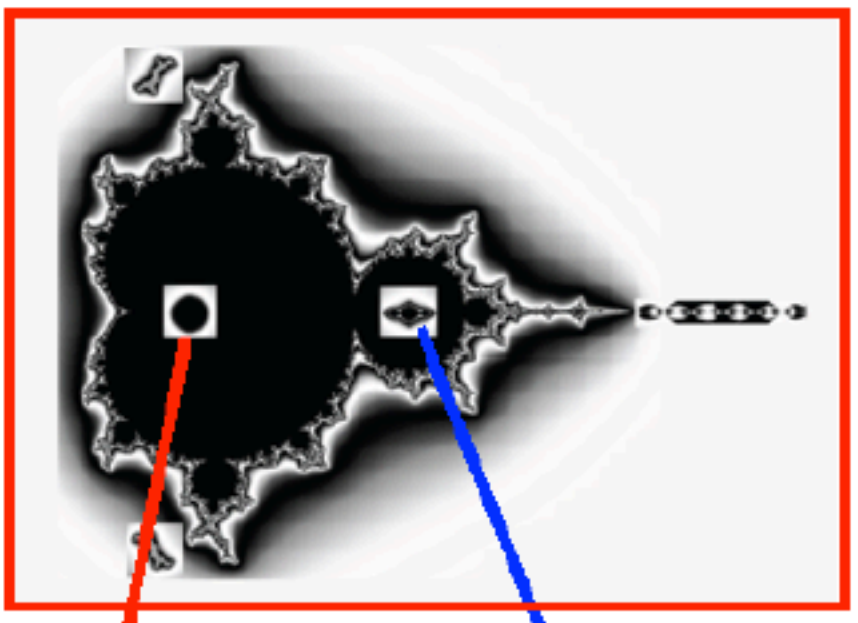
Each Node is a Schwinger Source that is connected by Bohm Quantum Potential
to all other Schwinger Source Nodes in our Universe
They are all governed by the E8 Physics Lagrangian
and the Algebraic Quantum Field Theory arising from
**Completion of Union of All Tensor Products of Cl(1,25) = hyperfinite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

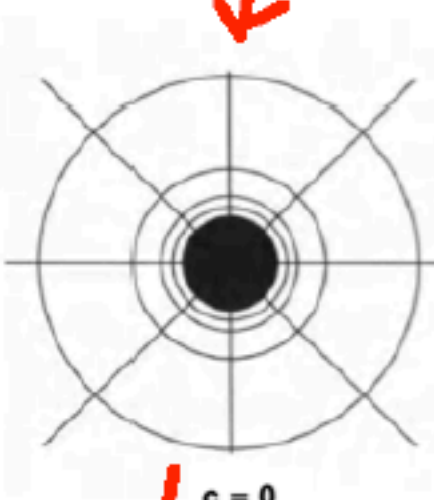
**Each of 10^27 Schwinger Source particle-antiparticle pairs sees the rest of our Universe by way of 8 x 10^53 Monster Symmetry**
**so**
**a Schwinger Source acting as a Jewel of Indra's Net**
**can see / reflect**
**10^27 x 8 x 10^53 = 8 x 10^80 Other Schwinger Source Jewels.**

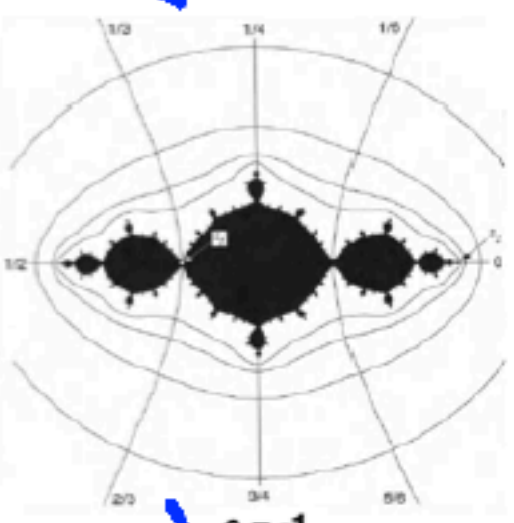



**Mandelbrot Set for Original Source**
**correlates Monster Group Lens Elements with Perceived Type of Julia Set**
**Self-Perception is always c = 0 Circle Julia Set**

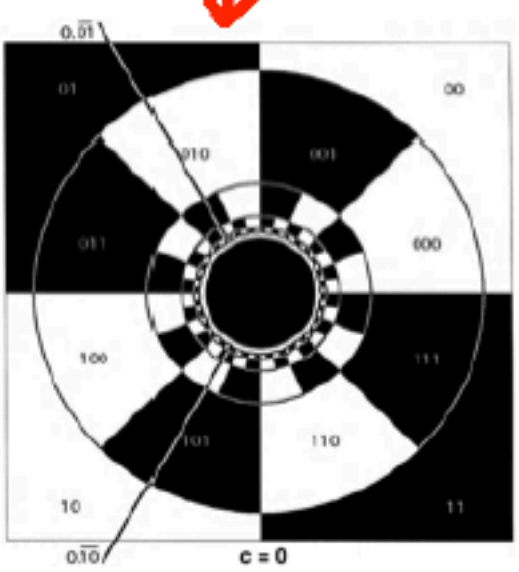


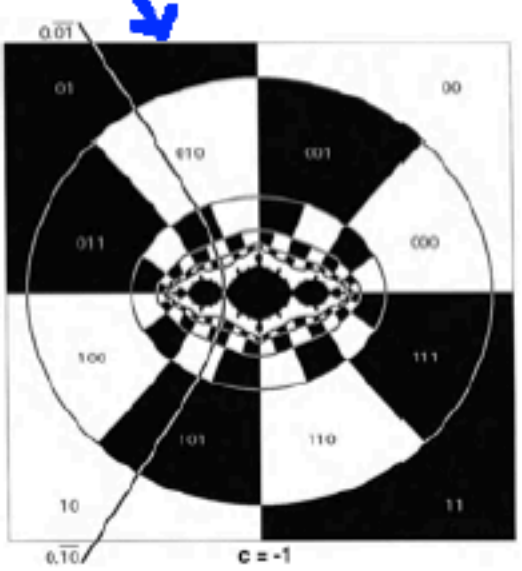





c = 0

c = -1



**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.**

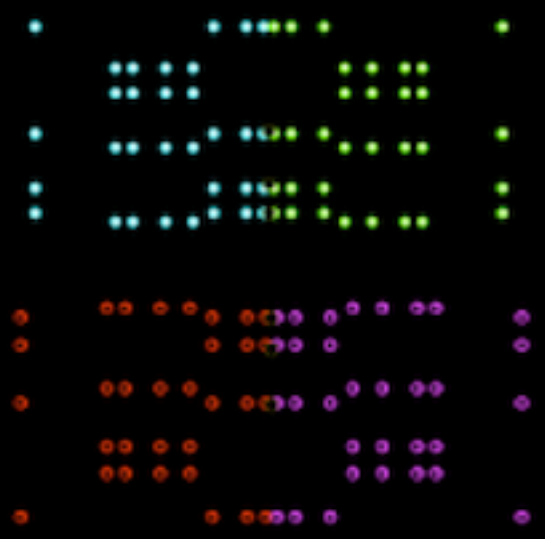
# Lagrangian

$\int$

+

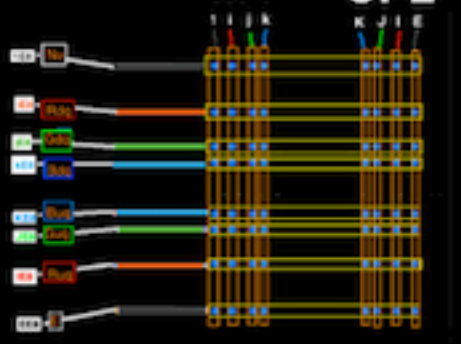
+

Second D4



E8 / D8

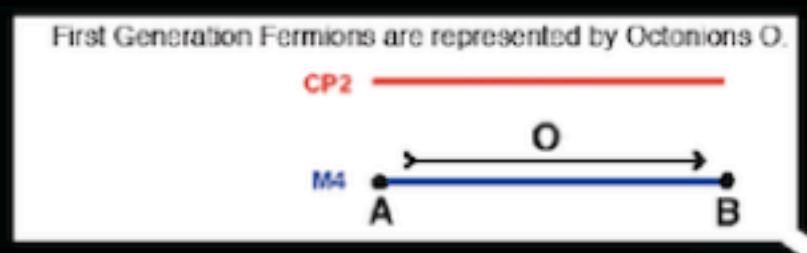
M4 CP2



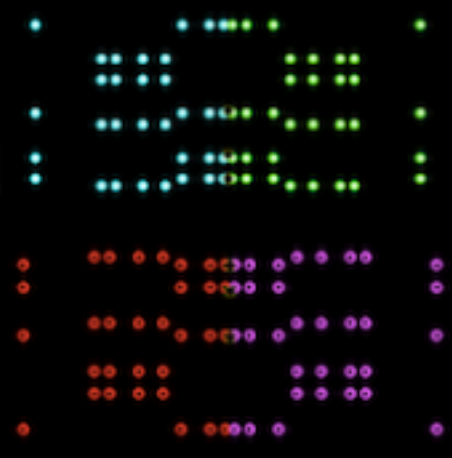
First D4

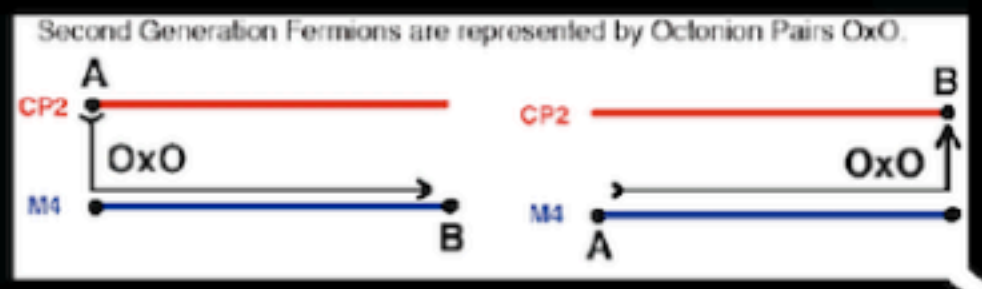
A7+1
D8 / D4xD4

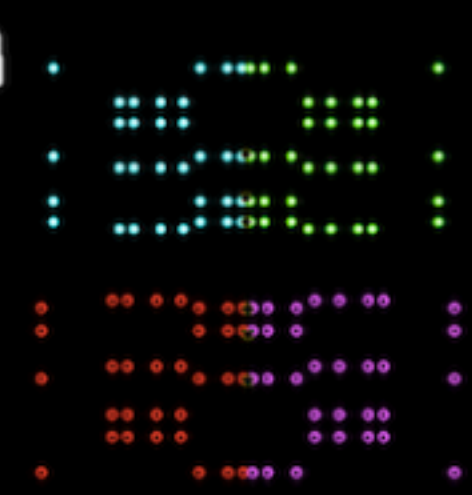
Mayer Mechanism




3 Kaluza-Klein
Fermion Generations





$\int$

HIGGS

+

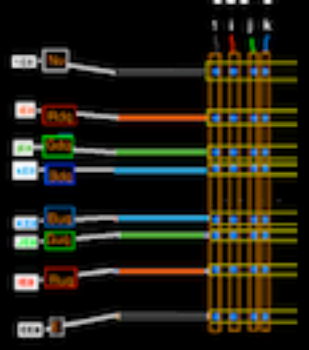
$D4_{sm}$

+

+

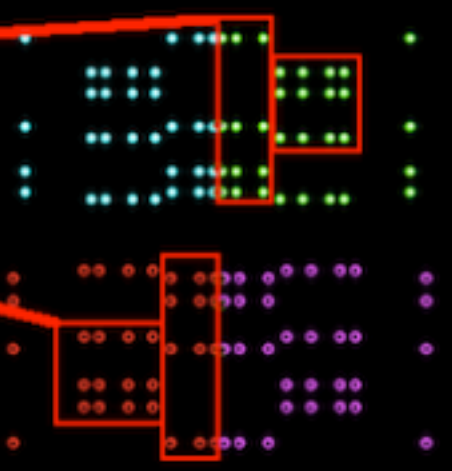
$D4_{gde}$

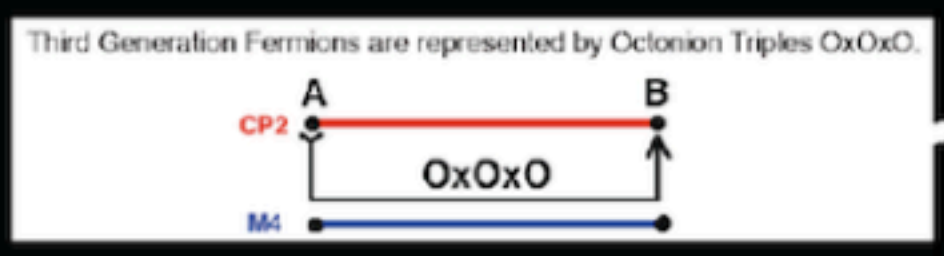
M4



RGB Truth Quarks

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






RGB Truth AntiQuarks

**The 4D Gauge Boson - Ghost terms emerge from the 8D Terms by Integration over the CP2 Internal Symmetry Space.**

**The process of breaking Octonionic 8-dim SpaceTime down to Quaternionic (4+4)-dim M4 x CP2 Kaluza-Klein creates differences in the way gauge bosons "see" 4-dim Physical SpaceTime. There 4 equivalence classes of 4-dim Riemannian Symmetric Spaces with Quaternionic structure for 4-dim Physical SpaceTime:**

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

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

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

**S1 x S1 x S1 x S1 = U(1) x U(1) x U(1) x U(1) = 4 components of the U(1) of the EM Photon**

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

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

**an integral over SpaceTime S4.**

**The Schwinger Sources for Gravity Gauge Bosons**
**are the Complex Bounded Domains and Shilov Boundaries**
**for Spin(5) MacDowell-Mansouri Gravity bosons.**

**However, due to Stabilization of Condensate SpaceTime**
**by virtual Planck Mass Gravitational Black Holes,**
**for Gravity the effective force strength that we see in our experiments**
**is not just composed of the S4 volume and the Spin(5) Schwinger**
**Source volume but is suppressed by the square of the Planck Mass.**
**The unsuppressed Gravity force strength**
**is the Geometric Part of the force strength.**

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

$\int$ **SU(3) Color Force Gauge Boson Term**
**CP2 .**

**an integral over SpaceTime CP2.**
**The Schwinger Sources for SU(3) bosons**
**are the Complex Bounded Domains and Shilov Boundaries**
**for SU(3) Color Force bosons.**

**The Color Force Strength is given by**
**the SpaceTime CP2 volume and the SU(3) Schwinger Source volume.**
**Note that since the Schwinger Source volume**
**is dressed with the particle/antiparticle pair cloud,**
**the calculated force strength is for the characteristic energy level**
**of the Color Force (about 245 MeV).**

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

$\int$ **SU(2) Weak Force Gauge Boson Term**
**S2xS2 .**

**an integral over SpaceTime S2xS2.**
**The Schwinger Sources for SU(2) bosons**
**are the Complex Bounded Domains and Shilov Boundaries**
**for SU(2) Weak Force bosons.**

**However, due to the action of the Higgs mechanism,**
**for the Weak Force the effective force strength**
**that we see in our experiments is not just composed of**
**the S2xS2 volume and the SU(2) Schwinger Source volume,**
**but is suppressed by the square of the Weak Boson masses.**
**The unsuppressed Weak Force strength**
**is the Geometric Part of the force strength.**

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

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

**an integral over SpaceTime T4.**

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

**Ignoring technicalities for exposition geometric factors for force strengths are:**
(detailed calculations are in viXra 1804.0121)

Each gauge group is the global symmetry of a symmetric space

S1 for U(1)
S2 = SU(2)/U(1) = Spin(3)/Spin(2) for SU(2)
CP2 = SU(3)/SU(2)xU(1) for SU(3)
S4 = Spin(5)/Spin(4) for Spin(5)

Each gauge group is the local symmetry of a symmetric space

U(1) for itself
SU(2) for Spin(5) / SU(2)xU(1)
SU(3) for SU(4) / SU(3)xU(1)
Spin(5) for Spin(7) / Spin(5)xU(1)

The nontrivial local symmetry symmetric spaces correspond to bounded complex domains

SU(2) for Spin(5) / SU(2)xU(1) corresponds to IV3
SU(3) for SU(4) / SU(3)xU(1) corresponds to B^6 (ball)
Spin(5) for Spin(7) / Spin(5)xU(1) corresponds to IV5

The nontrivial bounded complex domains have Shilov boundaries

SU(2) for Spin(5) / SU(2)xU(1) corresponds to IV3 Shilov = RP^1xS^2
SU(3) for SU(4) / SU(3)xU(1) corresponds to B^6 (ball) Shilov = S^5
Spin(5) for Spin(7) / Spin(5)xU(1) corresponds to IV5 Shilov = RP^1xS^4

Very roughly, think of the force strength as
integral over global symmetry space of physical (ie Shilov Boundary) volume =
= strength of the force.
That is:
the geometric strength of the force is given by the product of
the volume of a 4-dim thing with global symmetry of the force and
the volume of the Shilov Boundary for the local symmetry of the force.

When you calculate the product volumes (using some tricky normalization stuff),
you see that roughly:

Volume product for gravity is the largest volume
so since (as Feynman says) force strength = probability to emit a gauge boson means
that the highest force strength or probability should be 1
the gravity Volume product is normalized to be 1, and so (approximately):

Volume product for gravity = 1
Volume product for color = 2/3
Volume product for weak = 1/4
Volume product for electromagnetism = 1/137.03608

There are two further main components of a force strength:
1 - for massive gauge bosons, a suppression by a factor of 1 / M^2
2 - renormalization running (important for color force)

Consider Massive Gauge Bosons:
Gravity as curvature deformation of SpaceTime, with SpaceTime as a condensate of
Planck-Mass Black Holes, must be carried by virtual Planck-mass black holes,
so that the geometric strength of gravity should be reduced by 1/Mp^2n
to about 5 x 10^(-39)

The weak force is carried by weak bosons,
so that the geometric strength of the weak force should be reduced by 1/MW^2
That gives the result (approximate):
gravity strength = G (Newton's G)
color strength = 2/3
weak strength = G_F (Fermi's weak force G)
electromagnetism = 1/137.03608

Consider Renormalization Running for the Color Force:: That gives the result:
gravity strength = G (Newton's G)
color strength = 1/10 at weak boson mass scale
weak strength = G_F (Fermi's weak force G)
electromagnetism = 1/137.03608

The use of compact volumes of Domains and Shilov Boundaries is a calculation device,
because it would be more nearly correct,
instead of the integral over the compact global symmetry space of
the compact physical (ie Shilov Boundary) volume = strength of the force
to use the integral over the hyperbolic spacetime global symmetry space
of the noncompact invariant measure of the gauge force term.

However, since the strongest (gravitation) geometric force strength is to be normalized
to 1, the only thing that matters is ratios, and the compact volumes (finite and easy to look up in the book by Hua) have the same ratios as the noncompact invariant measures.

In fact, I should go on to say that continuous spacetime
and gauge force geometric objects are themselves also calculational devices,
and that it would be even more nearly correct to do the calculations
with respect to a discrete generalized hyperdiamond Feynman checkerboard.

Calculation of Higgs and Weak Boson masses are given in viXra 1804.0121.
For example, the triplet { W+, W-, W0 } total mass at the electroweak unification
is equal to the total mass of a T - Tbar pair, 259.031 GeV
and the triplet { W+, W-, Z0 } total mass is equal to
the vacuum expectation value v of the Higgs scalar field, v = 252.514 GeV.

## Fermion Mass Calculations

(detailed calculations are in viXra 1804.0121)

In the conventional picture, the spinor fermion term is of the form m S S* where m is the fermion mass and S and S* represent the given fermion.
The Higgs coupling constants are, in the conventional picture, ad hoc parameters, so that effectively the mass term is, in the conventional picture, an ad hoc inclusion.

The Cl(1,25) E8 model constructs the Lagrangian integral such that the mass m emerges as the integral over the Schwinger Source spacetime region of its Kerr-Newman cloud of virtual particle/antiparticle pairs plus the valence fermion so that the volume of the Schwinger Source fermion defines its mass, which, being dressed with the particle/antiparticle pair cloud, gives quark mass as constituent mass.

Fermion Schwinger Sources correspond to the Lie Sphere Symmetric space

Spin(10) / Spin(8)xU(1)

which has
local symmetry of the Spin(8) gauge group from which the first generation spinor fermions are formed as +half-spinor and -half-spinor spaces
and
Bounded Complex Domain D8 of type IV8 and Shilov Boundary Q8 = RP1 x S7

In E8 Physics, the first generation spinor fermions are
seen as +half-spinor and -half-spinor spaces of Cl(1,7) = Cl(8).
Due to Triality, Spin(8) can act on those 8-dimensional half-spinor spaces similarly to the way it acts on 8-dimensional vector spacetime.

Take the the spinor fermion volume to be the Shilov boundary corresponding to the same symmetric space on which Spin(8) acts as a local gauge group that is used to construct 8-dimensional vector spacetime:

the symmetric space Spin(10) / Spin(8)xU(1)
corresponding to a bounded domain of type IV8
whose Shilov boundary is RP^1 x S^7

Since all first generation fermions see the spacetime over which the integral is taken in the same way ( unlike what happens for the force strength calculation ), the only geometric volume factor relevant for calculating first generation fermion mass ratios is in the spinor fermion volume term.

**E8 Physics model fermions correspond to**
**Schwinger Source Kerr-Newman Black Holes,**
**so the quark mass in E8 Physics is a constituent mass.**

## Fermion masses are calculated as a product of four factors:

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

V(Qfermion) is the volume of the part of the half-spinor fermion particle manifold S^7 x RP^1 related to the fermion particle by photon, weak boson, or gluon interactions.

N(Graviton) is the number of types of Spin(0,5) graviton related to the fermion.
The 10 gravitons correspond to the 10 infinitesimal generators of Spin(0,5) = Sp(2).
2 of them are in the Cartan subalgebra.
6 of them carry color charge, and therefore correspond to quarks.
The remaining 2 carry no color charge, but may carry electric charge and so may be considered as corresponding to electrons. One graviton takes the electron into itself, and the other can only take the first generation electron into the massless electron neutrino. Therefore only one graviton should correspond to the mass of the first-generation electron.
**The graviton number ratio of the down quark to the first-generation electron is therefore 6/1 = 6.**

N(octonion) is an octonion number factor relating up-type quark masses to down-type quark masses in each generation.

Sym is an internal symmetry factor, relating 2nd and 3rd generation massive leptons to first generation fermions. It is not used in first-generation calculations.

The first generation down quark constituent mass : electron mass ratio can be calciated as follows:

The electron, E, can only be taken into the tree-level-massless neutrino, 1, by photon, weak boson, and gluon interactions.

The electron and neutrino, or their antiparticles, cannot be combined to produce any of the massive up or down quarks.

The neutrino, being massless at tree level, does not add anything to the mass formula for the electron.

Since the electron cannot be related to any other massive Dirac fermion, its volume V(Qelectron) is taken to be 1.

## Next consider a red down quark i.

By gluon interactions, i can be taken into j and k, the blue and green down quarks.
By also using weak boson interactions,
it can also be taken into I, J, and K, the red, blue, and green up quarks.
Given the up and down quarks, pions can be formed from quark-antiquark pairs,
and the pions can decay to produce electrons and neutrinos.
Therefore the red down quark (similarly, any down quark)
is related to all parts of S^7 x RP^1,
the compact manifold corresponding to { 1, i, j, k, E, I, J, K }
and therefore a down quark should have
a spinor manifold volume factor V(Qdown quark) of the volume of S^7 x RP^1.
**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.**

**Since the first generation graviton factor is 6,**
**md / me = 6 V(S^7 x RP^1) = 2 pi^5 = 612.03937**

As the up quarks correspond to I, J, and K, which are the octonion transforms under
E of i, j, and k of the down quarks, the up quarks and down quarks have the
same constituent mass mu = md.
Antiparticles have the same mass as the corresponding particles.
Since the model only gives ratios of masses,
the mass scale is fixed so that the electron mass me = 0.5110 MeV.
Then, the constituent mass of the down quark is md = 312.75 MeV,
and the constituent mass for the up quark is mu = 312.75 MeV.
These results when added up give a total mass of first generation fermion particles:

Sigmaf1 = 1.877 GeV

As the proton mass is taken to be the sum of the constituent masses of its
constituent quarks
mproton = mu + mu + md = 938.25 MeV
which is close to the experimental value of 938.27 MeV.

First Generation Fermions corrspond to Octonion Basis Elements while
Second and Third Generation Fermions correspond to Pairs and Triples of them

The Sym symmetry factor is Combinatorial related to Pairs and Triples
and is calculated in full in viXra 1804.0121. For example,
there are 8^3 = 512 Triples for Third Generation Fermion,
1 of which represents tau-Neutrino, 7 of which represent the tauon,
21 of which represent the red, green, and blue Beauty Quarks,
and 483 of which represent the red, green, and blue Truth Quarks.

**483 / 21 = 23 = 130 GeV / 5.63 GeV = Mass Ratio of Truth Quark / Beauty Quark**

**E8 Algebraic Quantum Field Theory as Third Grothendieck Universe**

**The First Grothendieck Universe is the Empty Set.**

**The Second Grothendieck Universe is Hereditarily Finite Sets such as a Generalized Feynman Checkerboard Quantum Theory based on E8 Lattices and Discrete Cl(1,25) Clifford Algebra.**

**The Third Grothendieck Universe is the Completion of the Union of all tensor products of Cl(1,25) Real Clifford algebra**

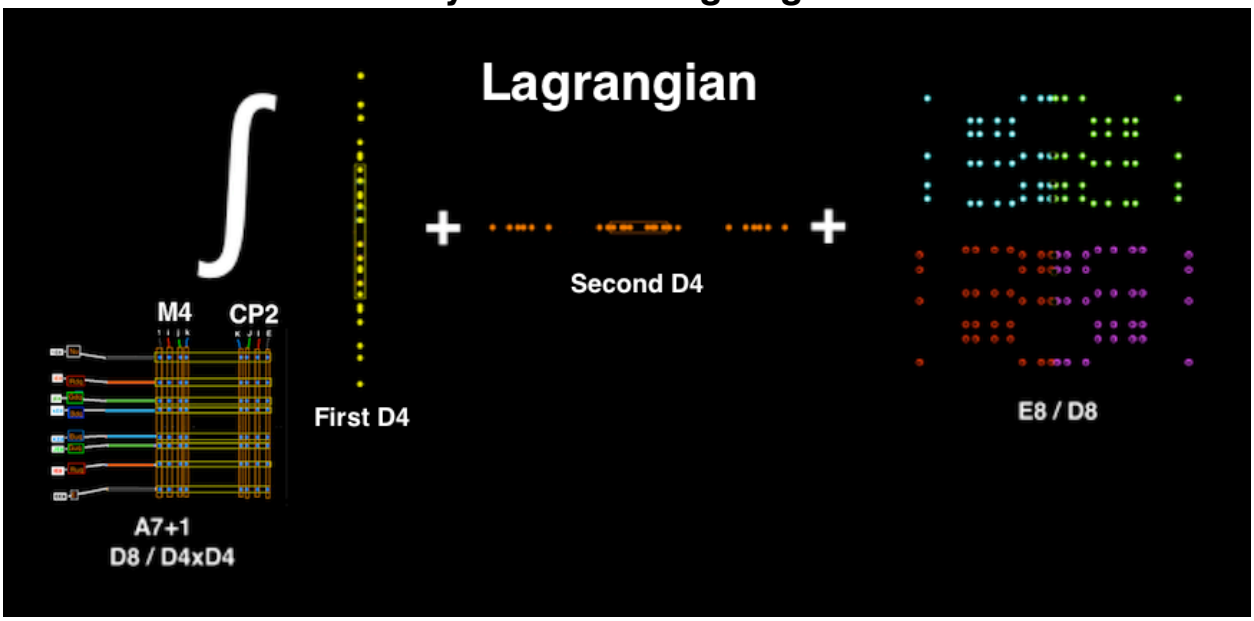
Cl(1,25) emerges from the Creation Sequence of Real Clifford Algebras:
0 -> Cl(0,0) -> Cl(0,1) -> Cl(0,2) -> Cl(0,4) -> Cl(0,16) = Cl(0,8) x Cl(0,8) ->
-> Cl(0,16) x Cl(0,8) = Cl(0,24) -> M(2,Cl(0,24)) = Cl(1,25)

**Completion of Union of All Tensor Products of Cl(1,25) =**
**= 2x2 matrices of Cl(0,24)**
**is String Theory formulation of the hyperfinite AQFT for E8 Physics**

Its consistency is due to Periodicity-8 of Real Clifford Algebras.
It is a generalization of the usual Hyperfinite II1 von Neumann factor for creation and annihilation operators on Fermionic Fock Space over C^(2n) that is the completion of the union of all tensor products of
2x2 Complex Clifford algebra matrices, which have Periodicity 2.

**The Creation-Annihilation Operator structure of Cl(1,25) 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)**
**The Maximal E8 Contraction A7 x h92 can be written as**
**a 5-Graded Lie Algebra  28 + 64 + (SL(8,R) + 1) + 64 + 28**
**Central Even Grade 0 = SL(8,R) + 1**
**The 1 is a scalar and**
**SL(8,R) = Spin(8) + Traceless Symmetric 8x8 Matrices,**
**so SL(8,R) represents a local 8-dim SpaceTime in Polar Coordinates.**
**Odd Grades -1 and +1 = 64 + 64**
**Each 64 = 8x8 = Creation/Annihilation Operators for 8 components of 8 Fundamental Fermions.**
**Even Grades -2 and +2 = 28 + 28**
**Each 28 = Creation/Annihilation for Gauge Bosons and Ghosts**
**of Standard Model and Gravity+Dark Energy plus Propagator Phase**

**The Algebraic Quantum Field Theory ( AQFT ) structure of the Bohm Quantum Potential of 26D String Theory is given by the Cl(1,25) E8 Physics Local Lagrangian**




**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)**

## Lagrangian for Bohm Quantum Potential

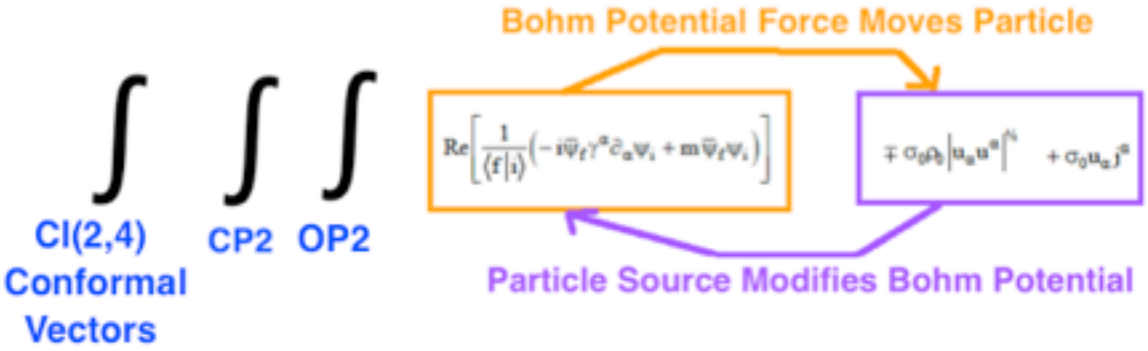
## Sarfatti-Bohm Quantum Potential emerges from 26D E8 World-Line String Theory so is treated separately from the Local Classical E8 Lagrangian in 8D (or in 4D) describing the Standard Model and Gravity+Dark Energy plus Propagator Phase.

**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 ...

orthodox statistical quantum theory,
with no-signaling ...[is derived]... in two steps,

first arbitrarily set the back-reaction (of particles and classical gauge field on their pilot waves) to zero. This is analogous to setting the curvature equal to zero in general relativity, or more precisely in setting G to zero.

Second, integrate out the final boundary information, thereby adding the statistical Born rule to the mix. ...

the mathematical condition for zero post-quantum back-reaction
of particles and classical fields (aka "beables" J.S. Bell's term) is exactly de Broglie's guidance constraint. That is, in the simplest case, the classical particle velocity is proportional to the gradient of the phase of the quantum pilot wave. It is for this reason, that the independent existence of the classical beables can be ignored in most quantum calculations.

However, orthodox quantum theory assumes that the quantum system is thermodynamically closed between strong von Neumann projection measurements that obey the Born probability rule.

**The new post-quantum theory in the equations of Sutherland,
prior to taking the limit of orthodox quantum theory,
should apply to pumped open dissipative structures**.
Living matter is the prime example. ...".
Jack Sarfatti (email 31 January 2016) said:

"... **post-quantum theory with action-reaction
between quantum information pilot wave and its be-able
is compatible with free wil**l. ...".

# 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.**

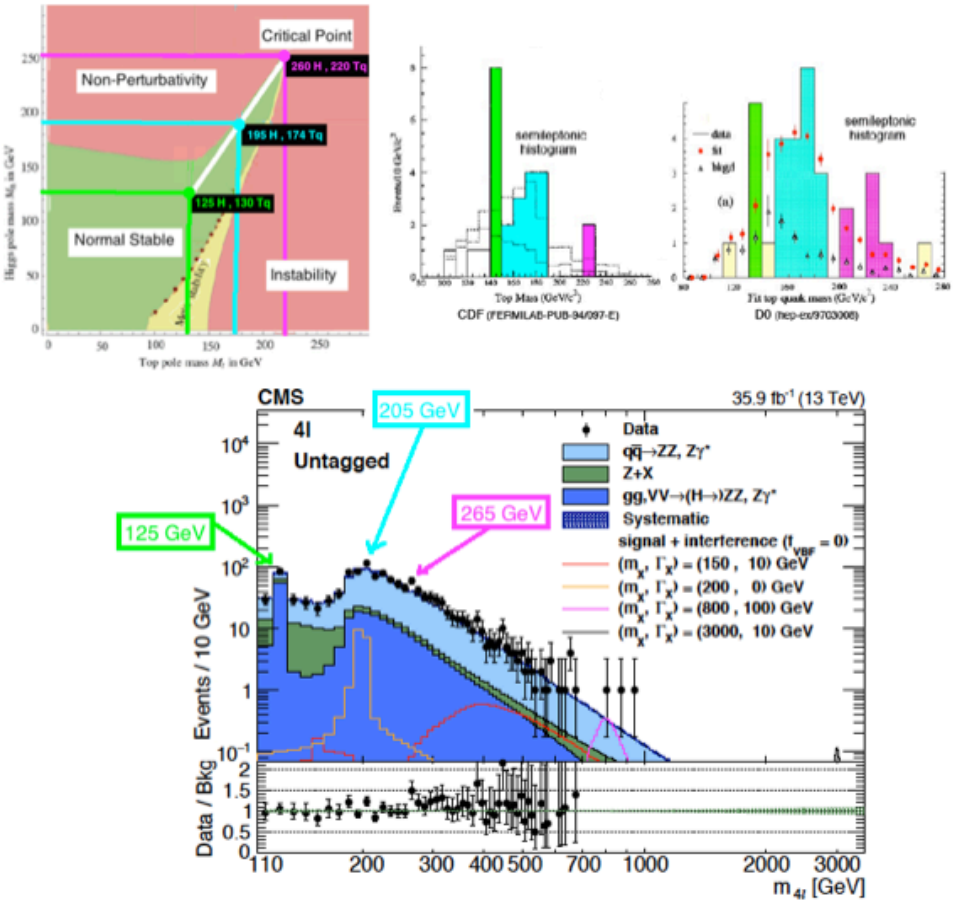
**E8 Physics:**

**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