

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

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## **Abstract**

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

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## VOID to Cl(16) - Octonionic Lagrangian

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

**Cl(Void) = Clifford Algebra of Void = 0**

**Cl(0) =  $2^0$  dimensions = 1**

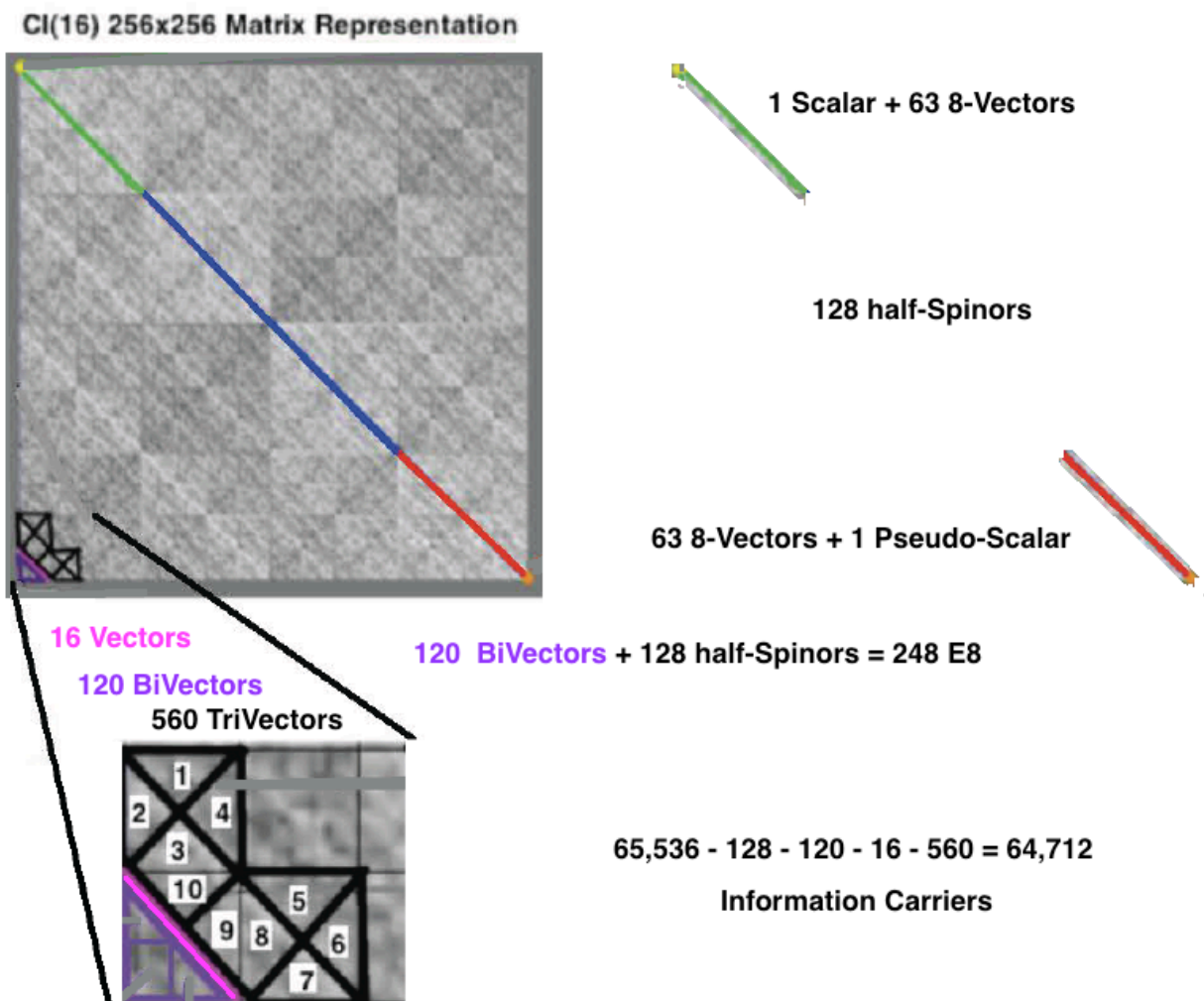
**Cl(1) =  $2^1 = 2$**

**Cl(2) =  $2^2 = 4$**

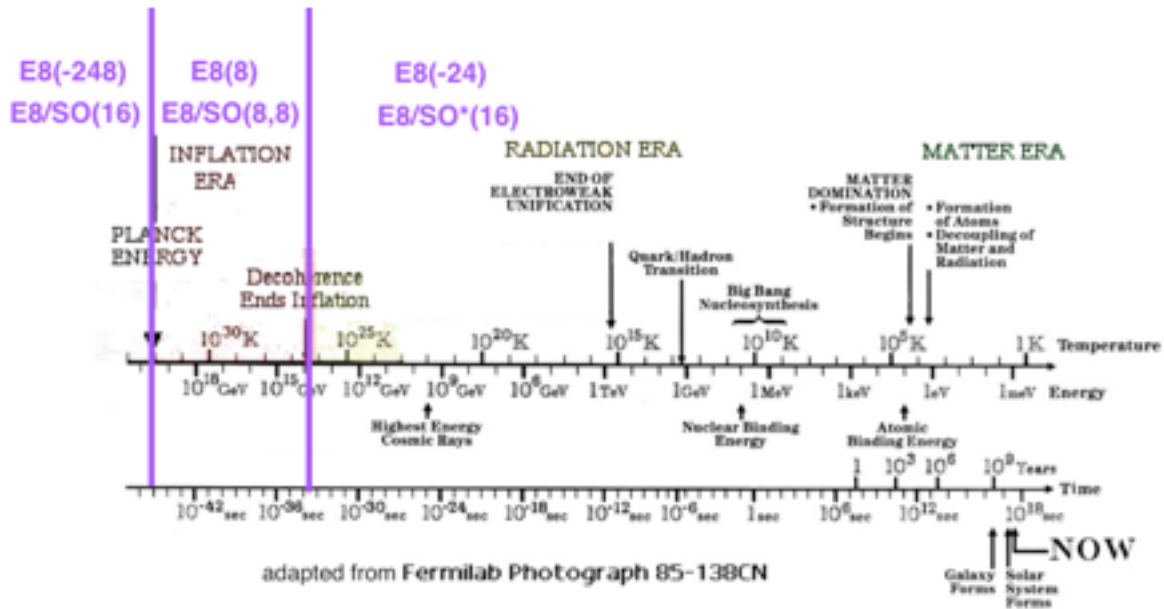
**Cl(4) =  $2^4 = 16$**

**Cl(16) =  $2^{16} = 65,536 = 256 \times 256$  Real Matrices  $M(256, R)$ :**

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



## E8 has 3 Real Forms

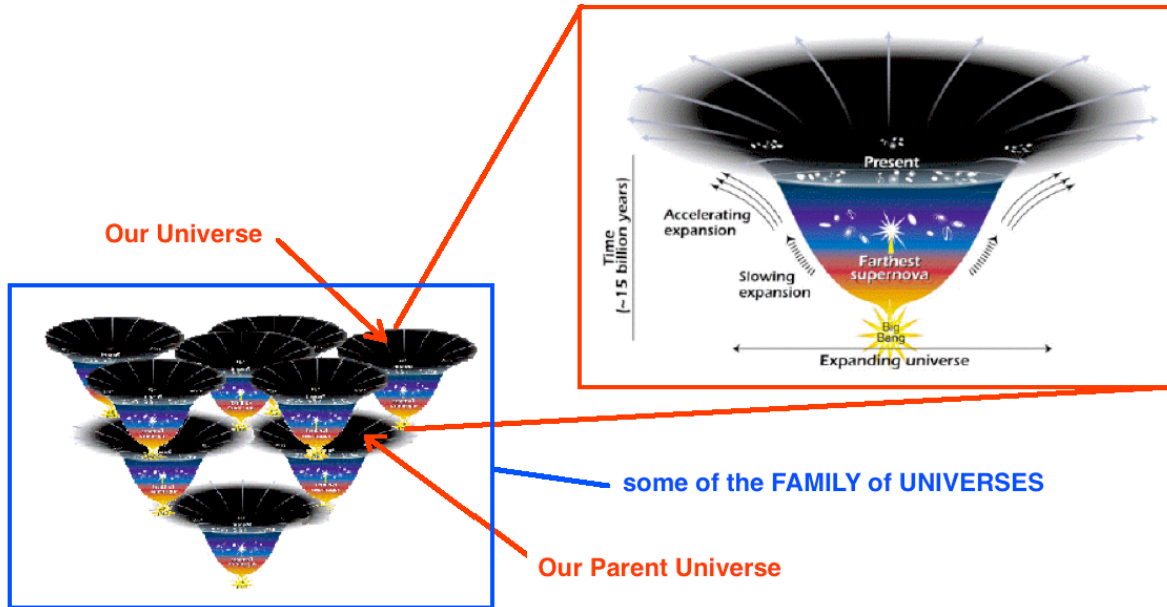


The compact form ... E8(-248) ... has symmetric space **E8/SO(16)**  
for Clifford Iteration from VOID to CI(16)

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

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

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



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



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

**E8 is a recipe for a Lagrangian of**  
**8-dimensional Spacetime** = Shilov Boundary of Cl(16) Vectors  
 and

**First-Generation Fermions** = Cl(16) half-Spinors  
 and

**Gauge Bosons and Ghosts** = 28+28 of 120 Cl(16) BiVectors

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

**Maximal Contraction of E8** was shown by Rutwig Campoamor-Stursberg in Acta Physica Polonica B 41 (2010) 53-77 , “Contractions of Exceptional Lie Algebras and SemiDirect Products” , to be semi-direct product  $H_{92} \times A_7 + R$  where  $H_{92}$  is  $(8+28+56 +1+ 56+28+8)$ -dim Heisenberg Creation/Annihilation Algebra and E8 Max Contraction has graded structure  $8 + 28 + 56 + 64 + 56 + 28 + 8$

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

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

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

grade 0 =  $A_7 + R = 63 + 1 = 64$ -dim  
Creation/Annihilation of 8-dim SpaceTime of HyperVolume Elements

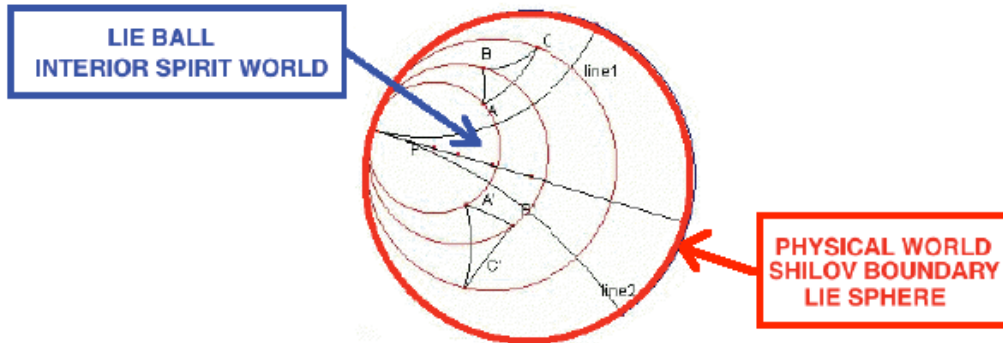
grade 1 = Annihilation of 7 massive Dirac fermions  
each with 8 SpaceTime Components for a total of 56 fermion component annihilators

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

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

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

**16 Vectors** = 16-dim Lie Ball  $\text{Spin}(10) \text{ Spin}(8) \times U(1)$   
with Bounded Complex Domain of Hua Type IV(8)  
whose Lie Sphere Shilov Boundary is 8-dim Spacetime  
that is the Base Manifold for the CI(16) Lagrangian



The 8-dim Spacetime has a Kaluza-Klein  $M_4 \times CP^2$  structure  
with  $CP^2 = SU(3) / SU(2) \times U(1)$  Internal Symmetry Space  
and  $M_4$  = Minkowski Physical Spacetime that is seen by Gauge Groups as  
 $S_4$  by Gravity  
 $CP^2$  by Color Force  
 $S_2 \times S_2$  by Weak Force  
 $T_4 = S_1 \times S_1 \times S_1 \times S_1$  by Electromagnetism

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

Weak Force

$SU(2)$  for  $\text{Spin}(5) / SU(2) \times U(1)$  - Type IV Domain with Shilov Boundary =  $RP^1 \times S^2$

Color Force

$SU(3)$  for  $SU(4) / SU(3) \times U(1)$  - Type I Domain  $B^6$  (ball) with Shilov Boundary  $S^5$

Gravity

$\text{Spin}(5)$  for  $\text{Spin}(7) / \text{Spin}(5) \times U(1)$  - Type IV Domain with Shilov Boundary  $RP^1 \times S^4$

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

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

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

For Cl(8) Triality gives

8-dim Vectors  $V$  = 8-dim +half-Spinors  $S_+$  = 8-dim -half-Spinors  $S_-$   
which are also the off-diagonal terms of 26-dim traceless  $J_3(O)$   
that defines the structure of 26-dim Cl(1,25) Strings=World-Lines Theory  
of Cl(16) TriVectors = 10 copies of 56-dim Fr<sub>3</sub>(O) Freudenthal Algebra each  
of which is a complexification of the 27-dim  $J_3(O)$  Jordan Algebra.

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

Gauge Bosons = 28 of 120 Cl(16) BiVectors

Ghosts = 28 of 120 Cl(16) BiVectors

First-Generation Fermion Particles = Cl(16) ++quarter-Spinors

First-Generation Fermion AntiParticles = Cl(16) --quarter-Spinors

The Cl(16) Relation is between

Components of 28 Gauge Bosons of the 120-dim BiVectors

$8 \times 28 = 224$  each with Lagrangian weight 1

for total of 224

and

Components of 28 Ghosts of the 120-dim BiVectors

$8 \times 28 = 224$  each with Lagrangian weight 1

for total of 224

and

Components of ++quarter-Spinor Fermion Particles

$8 \times 8 = 64$  each with Lagrangian weight  $7/2$

for a total of  $32 \times 7 = 224$

and

Components of --quarter-Spinor Fermion AntiParticles

$8 \times 8 = 64$  each with Lagrangian weight  $7/2$

for a total of  $32 \times 7 = 224$

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

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

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

alf-

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

$$\begin{aligned} 1 \text{ Scalar} + 63 \text{ 8-Vectors} + 63 \text{ 8-Vectors} + 1 \text{ Pseudo-Scalar} &= 128 \\ &= \text{half-Spinors of Cl(16)} \\ 128 &= \text{E8 / D8 Symmetric Space} \end{aligned}$$

E8 is made up of Bosonic D8 and half-Spinor 128

Lie Algebras are usually represented by Bosonic commutators

**Bosonic D8 part of E8 is represented by commutators**

and half-spinor 128 can be represented by commutators

but

**half-Spinor 128 can also be represented by anti-commutators**

and therefore **half-Spinor 128 can physically represent Fermions.**

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

The **half-Spinor Fermions are physically not point particles**

because as soon as they appear in Spacetime

the Tachyons of World-Line = String Theory of Cl(16) Fr3(O) TriVectors

form a particle-antiparticle cloud around the original Valence Particle so

that **they become Schwinger Sources**

**whose Green's Function Propagator is determined by Bergman Kernel of Hua Domains of Gauge Forces.**

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



## Calculation Results

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

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

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

Particle/Force	Tree-Level	Higher-Order
e-neutrino	0	0 for nu_1
mu-neutrino	0	$9 \times 10^{-3}$ eV for nu_2
tau-neutrino	0	$5.4 \times 10^{-2}$ 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	
<b>truth quark (low state)</b>	<b>130 GeV</b>	<b>(middle state) 174 GeV</b> <b>(high state) 220 GeV</b>
W+	80.326 GeV	
W-	80.326 GeV	
W0	98.379 GeV	Z0 = 91.862 GeV
Mplanck	$1.217 \times 10^{19}$ GeV	
Higgs VEV (assumed)	252.5 GeV	
<b>Higgs (low state)</b>	<b>125 GeV</b>	<b>(middle state) 195 GeV</b> <b>(high state) 250 GeV</b>

Particle/Force	Tree-Level	Higher-Order
Gravity $G_g$ (assumed) 1 $(G_g)(M_{\text{proton}}^2 / M_{\text{planck}}^2)$		$5 \times 10^{(-39)}$
EM fine structure	1/137.03608	
Weak $G_w$ $G_w(M_{\text{proton}}^2 / (M_{W^+}^2 + M_{W^-}^2 + M_{Z^0}^2))$	0.2535	$1.05 \times 10^{(-5)}$
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  $d_{13}$  is taken to be 1 radian.

### **Coleman-Mandula**

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

### **Chirality**

Lagrangian is Chiral because

E8 contains  $\text{Cl}(16)$  half-spinors ( $64+64$ ) for a Fermion Generation but does not contain  $\text{Cl}(16)$  Mirror Fermion AntiGeneration half-spinors.

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

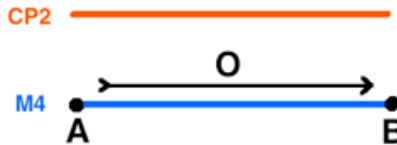
Fermion -half-spinor AntiParticles with high enough velocity  
are seen as right-handed.

### 3 Generations

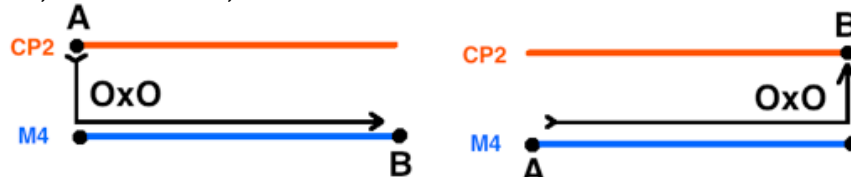
When 8-dim Octonionic Symmetry of Spacetime breaks down below Planck Energy to (4+4)-dim Quaternionic  $M_4 \times CP^2$  Kaluza-Klein with  $CP^2 = SU(3) / SU(2) \times U(1)$  the Higgs and Second and Third Generation Fermions emerge.

In Kaluza-Klein  $M_4 \times CP^2$  there are 3 possibilities for a Fermion represented by an Octonion  $O$  basis element to go from point A to point B:

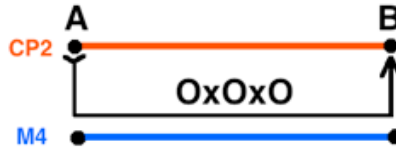
1 - A and B are both in  $M_4$ : First Generation Fermion = Octonion  $O$



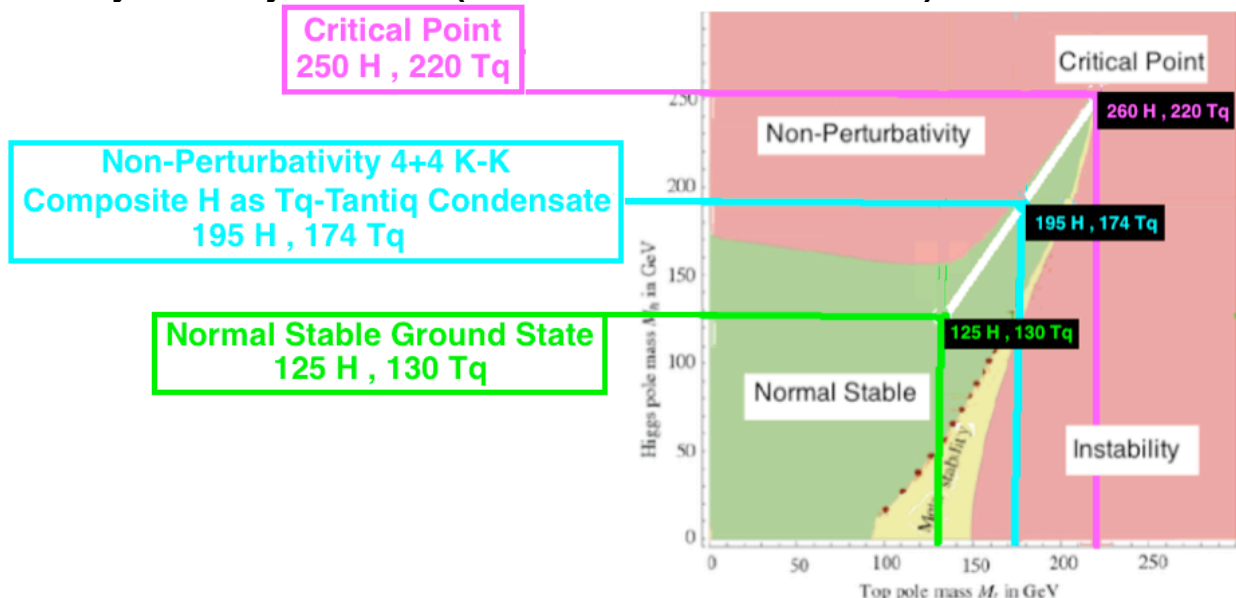
2 - Either A or B, but not both, is in  $CP^2$ : Second Generation Fermion =  $OxO$  Pair



3 - Both A and B are in  $CP^2$ : Third Generation Fermion =  $OxOxO$  Triple of Octonions



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



## Spin-Statistics

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

Prior to Dimensional Reduction from Octonionic Spacetime:

$$m = 1, n_R - n_L = (1/2) \times 1 \times 2 = 1 \text{ for 1 generation}$$

After Reduction to Quaternionic 4+4 Kaluza-Klein:

$$m = 2, n_R - n_L = (1/2) \times 2 \times 3 = 3 \text{ for 3 generations}$$

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

For E8 physics gauge bosons are in the  $28+28=56$ -dim  $D4 \times D4$  subalgebra.  $D4 = SO(8)$  is the Hawking-Pope  $G$  with double covering  $G_{\sim} = Spin(8)$ .

The 8 fermion particles / antiparticles are  $D4$  half-spinors represented within E8 by anti-commutators and so do change sign

while the 28 gauge bosons are  $D4$  adjoint represented within E8 by commutators and so do not change sign.

E8 Lagrangian inherits from F4 the property whereby its Spinor Part need not be written as Commutators but can also be written in terms of Fermionic AntiCommutators - see Pierre Ramond hep-th/0112261

- also, F4 lives in  $Cl(8)$  as Vectors + BiVectors + Spinors

and by 8-Periodicity  $Cl(16) = \text{tensor product } Cl(8) \times Cl(8)$

and E8 lives in  $Cl(16)$  as BiVectors + half-Spinors.

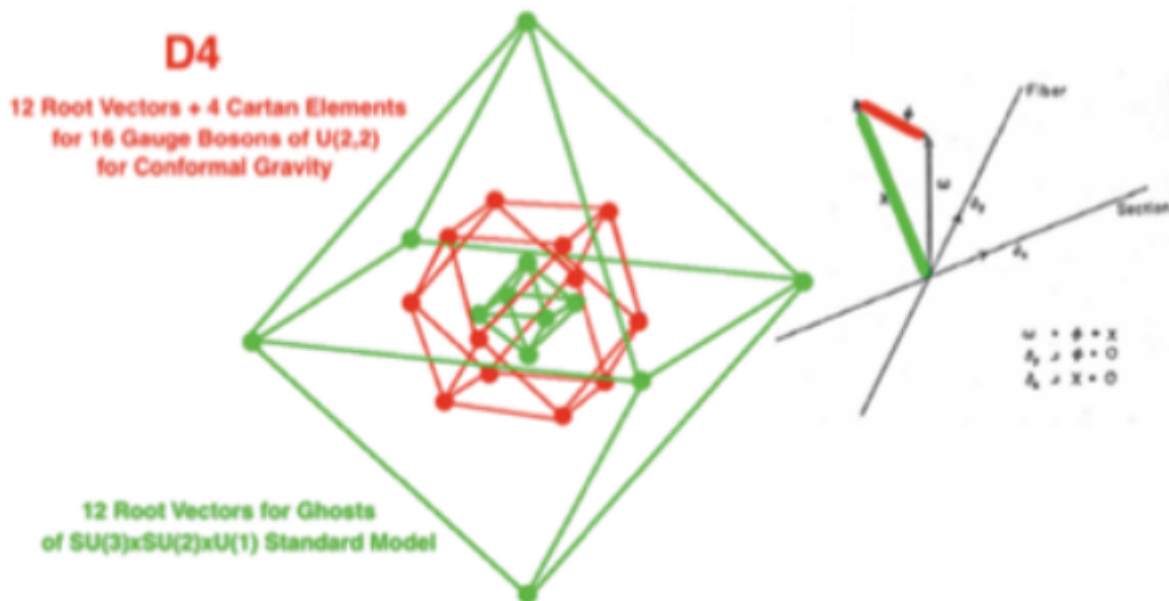
## CI(16) Physical Interpretation - BiVectors Gauge Bosons and Ghosts and Unimodular Spacetime

**120 BiVectors** = D8 subalgebra of E8

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

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

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



Jean Thierry-Mieg in J. Math. Phys. 21 (1980) 2834-2838 said:

“... The ghost and the gauge field:

The single lines represent a local coordinate system  
of a principal fiber bundle of base space-time.

The double lines are 1 forms.

The connection of the principle bundle  $w$  is assumed to be vertical.  
Its contravariant components  $\Phi$  and  $X$  are recognized, respectively,  
as the Yang-Mills gauge field and the Faddeev-Popov ghost form ...”.

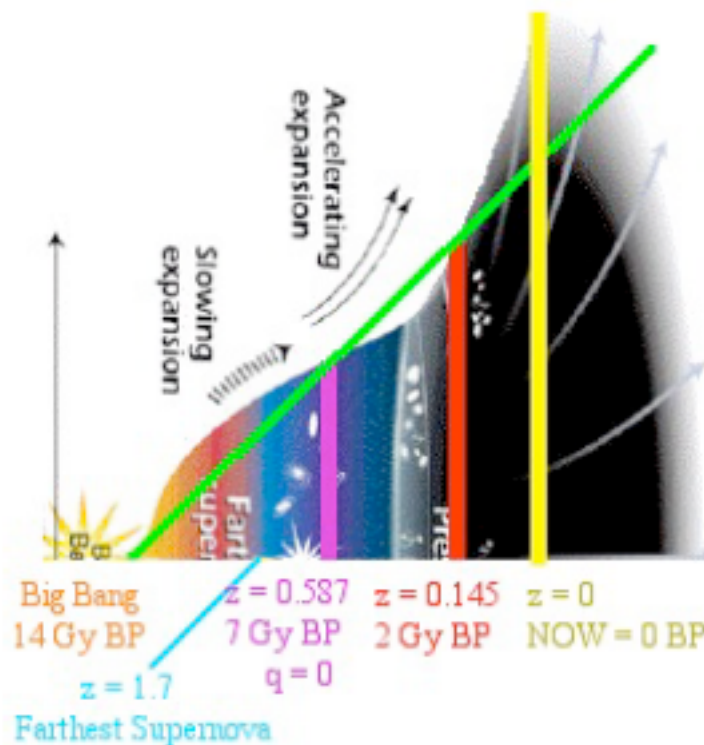
The ratio **Dark Energy : Dark Matter : Ordinary Matter** comes from the structure of the Conformal Group  $SU(2,2) = Spin(2,4)$  whose 15 generators are:

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

giving a tree-level ratio of

$$10 : 4 : 1 = 0.667 : 0.267 : 0.067$$

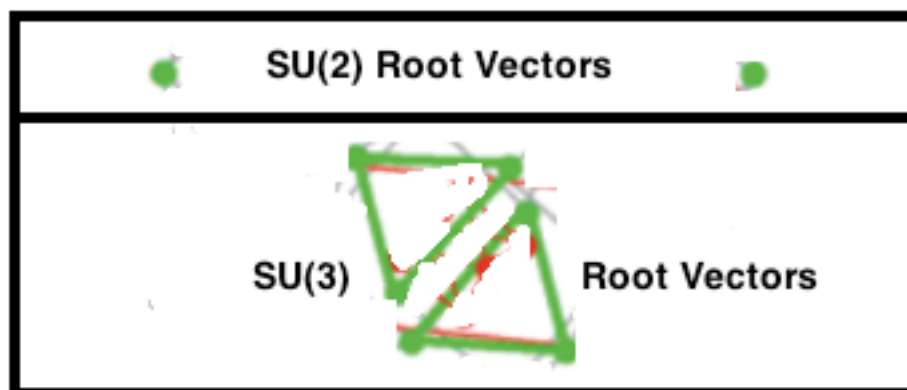
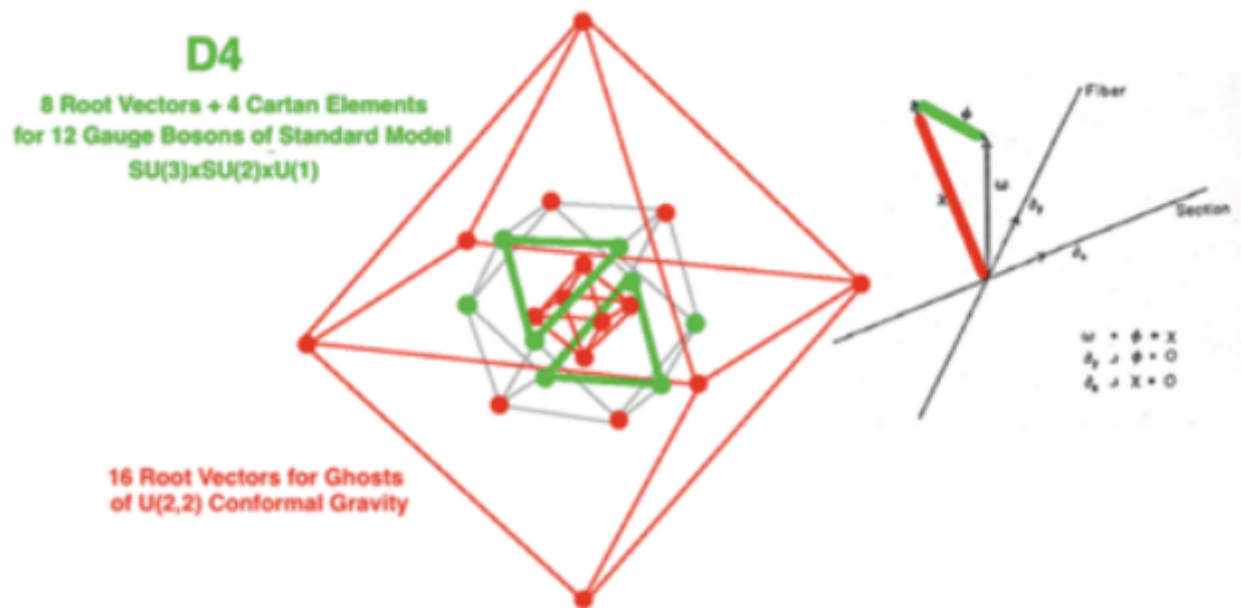
Taking Account of differences between Radiation and Matter Eras in the Evolution of Our Universe



gives

$$\begin{aligned} \text{Dark Energy : Dark Matter : Ordinary Matter} &= \\ &= 0.75 : 0.21 : 0.04 \end{aligned}$$

**Other D4 contains SU(3) of Standard Model with SU(2)xU(1) from CP2**  
 $28 - 12(\text{SU}(3) \times \text{SU}(2) \times \text{U}(1)) = 16\text{-dim} = \text{Ghosts of Gravity+Dark Energy}$



## **A7+R = D8 / D4 x D4 Symmetric Space**

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

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

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

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

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

Bradonjic and Stachel in arXiv 1110.2159 said: "... in ... Unimodular relativity ... the  
metric tensor ... break[s up] ... into the conformal structure represented by a conformal  
metric ... with  $\det = -1$  and a ... volume element ... at each point of space-time ...  
[that]... may be the remnant, in the ... continuum limit, of a more fundamental discrete  
quantum structure of space-time itself ...".

Frampton, Ng, and Van Dam in J. Math. Phys. 33 (1992) 3881-3882 said:  
"... Because of the existence of topologically nontrivial solutions, instantons, of the  
classical field equations associated with quantum chromodynamics (QCD), the  
quantized theory contains a dimensionless parameter  $\vartheta$  ( $0 < \vartheta < 2\pi$ ) ... Since  $\vartheta$   
multiplies an expression odd in CP, QCD predicts violation of ... CP ... symmetry  
unless the phase  $\vartheta$  takes one of the special values ...  $0 \pmod{\pi}$  ... this fine tuning is  
the strong CP problem ... the quantum dynamics of ... unimodular gravity ... may lead to  
the relaxation of  $\vartheta$  to  $\vartheta = 0 \pmod{\pi}$  without the need ... for ... the axion ...".

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

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

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

**Conformal Unimodular Relativity is consistent  
with Conformal Gravity+Dark Energy**



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

**560 TriVectors of Cl(16) represent 10 copies of 56-dim Fr3(O)**  
 56-dim Fr3(O) = Freudenthal Algebra of Zorn vector-matrices

$$\begin{array}{ccccc}
 & & d & S+ & V \\
 & & S+^* & e & S- \\
 a & & V^* & S-^* & f \\
 \\ 
 d' & S'+^* & V'^* & & \\
 S'+ & e' & S'-^* & & b \\
 V' & S'- & f' & & 
 \end{array}$$

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

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

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

26D String Theory with Strings = World-Lines and

**V = 8-dim Spacetime**

the 8-real-dim space  $RP^1 \times S^7$  that is the Shilov Boundary of the 16-real-dim  $IV(8,2)$  Bounded Domain (tube type) of the BDI Symmetric Space  $Spin(10) / Spin(8) \times U(1)$

**S+ = 8 +half-Spinor Fermion Particles**

the real part  $RP^1 \times S^7$  of the Complex Shilov Boundary S of the 32-real-dim V non-tube type.bounded Domain  $(C\alpha O)P_2$  of the EIII Symmetric Space  $E_6 / Spin(10) \times U(1)$ .

**S- = 8 - half-Spinor Fermion AntiParticles**

$RP^1 \times S^7$  in the Complex part of the Shilov Boundary S of the 32-real-dim V non-tube type bounded Domain  $(C\alpha O)P_2$  of the EIII Symmetric Space  $E_6 / Spin(10) \times U(1)$

$Fr_3(O)$  has two copies of  $J_3(O)$   
and is a Complexification of  $J_3(O)$  and of 26D String Theory  
so

**$Fr_3(O)$  is the structural basis for E8 World-Lines = Strings Theory**

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

Andrew Gray ( quant-ph/9712037v2 ) said:

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

Luis E. Ibanez and Angel M. Uranga in “String Theory and Particle Physics” said:

“... As a string evolves in time, it sweeps out a two-dimensional surface in spacetime, known as the worldsheet, which is the analog of the ... worldline of a point particle ... for the bosonic string theory ... the classical string action is the total area spanned by the worldsheet ... This is the ... Nambu– Goto action ...”.

The Gray Fine-Grained History Quantum Theory with World-Line = String is equivalent



to the Nambu-Goto action of 26D String Theory. Ibanez and Uranga also said:

“... The string groundstate corresponds to a 26d spacetime tachyonic scalar field  $T(x)$ .

This tachyon ... is ... unstable ...

The massless two-index tensor splits into irreducible representations of  $SO(24)$  ...

Its trace corresponds to a scalar field, the dilaton  $\phi$ , whose vev fixes the string interaction coupling constant  $g_s$  ...

the antisymmetric part is the 26d 2-form field  $B_{MN}$  ...

The symmetric traceless part is the 26d ...  $G_{MN}$  ...”.

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

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

**The symmetric traceless part is the Quantum Bohmion.**

## **Cl(1,25) AQFT**

### **Quantum Consciousness**

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

Fr3(O) is Complexification of J3(O)

**V** = Fr3(O) Spacetime is a Superposition of 8 E8 8-dim Spacetime Lattices  
(7 being Integral Domains)

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

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

The two copies of J3(O) 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

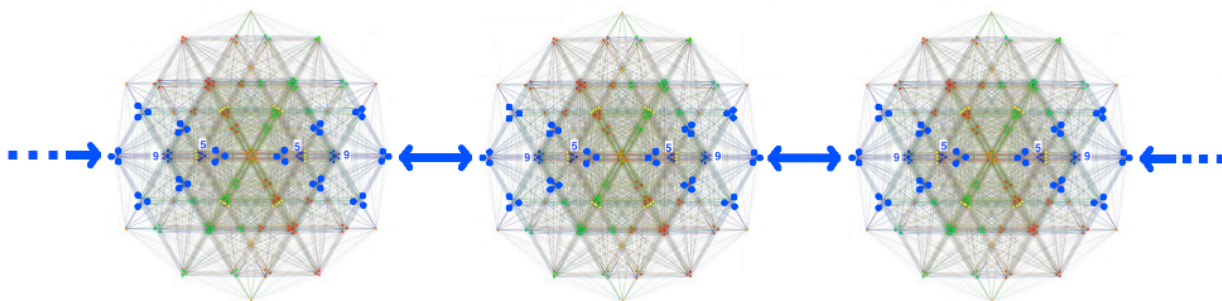
and

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  $E_8$  gives a Lagrangian description of one local spacetime neighborhood.

To get a realistic global spacetime structure, take the tensor product  $Cl(1,25) \times \dots \times Cl(1,25)$  with all  $E_8$  local 8-dim Octonionic spacetimes consistently aligned as described by 64-dim  $D_8 / D_4 \times D_4$  (this visualization uses hexagonal 2D projection of the 240  $E_8$  root vectors)



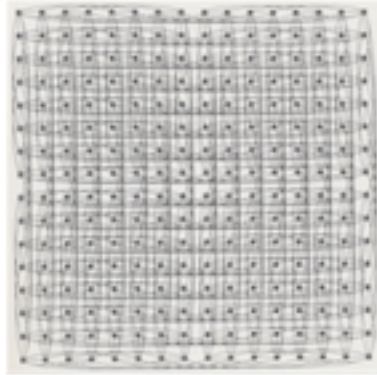
**Completion of the Union of all Tensor Products  
of the form  $Cl(1,25) \times \dots (N \text{ times tensor product}) \dots \times Cl(1,25)$   
gives an Algebraic Quantum Field Theory (AQFT)**

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

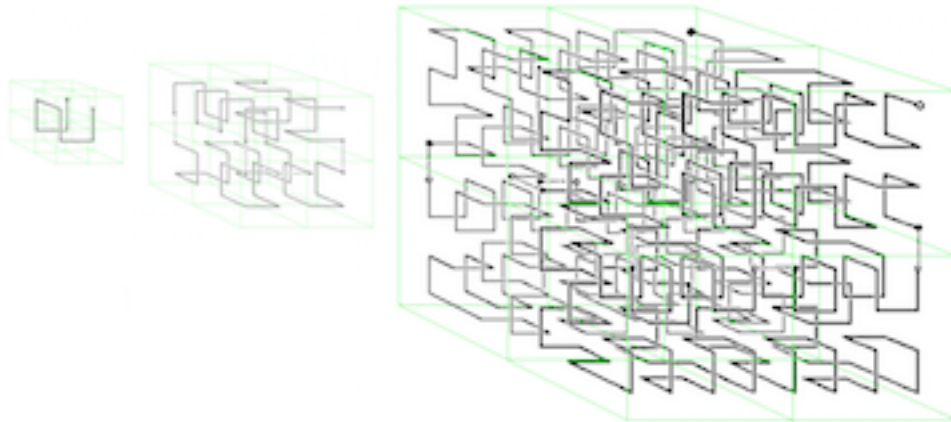
For  $N = 2^{16} = 65,536 = 4^8$  the copies of  $Cl(1,25)$  fill in the 8-dim HyperCube as described by William Gilbert's web page: "... The n-bit reflected binary Gray code will describe a path on the edges of an n- dimensional cube that can be used as the initial stage of a Hilbert curve that will 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  $E_8$  SpaceTime using higher Hilbert curve stages from the 8-bit reflected binary Gray code subdividing the initial 8-dim HyperCube into more and more sub-HyperCubes.



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



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

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

and

contains

**10 copies of 56-dim  $Fr_3(O)$   
are 560 TriVectors of  $Cl(16)$   
to describe a World-Lines = Strings String Theory  
with Bohm Quantum Potential  
arising from Nambu-Goto Action**



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

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

“... Bohm's Quantum Potential can be viewed as  
an internal energy of a quantum system ...”

according to Dennis, de Gosson, and Hiley ( arXiv 1412.5133 )  
and

Bohm Quantum Potential inherits Sarfatti Back-Reaction  
from its similarity to General Relativity

Peter R. Holland says in "The Quantum Theory of Motion": "... the total force ... from the quantum potential ... does not ... fall off with distance ... because ... the quantum potential ... depends on the form of ... [the quantum state] ... rather than ... its ... magnitude ...".

Penrose-Hameroff-type Quantum Consciousness is due to Resonant Quantum Potential Connections among Quantum State Forms.

The Quantum State Form of a Conscious Brain is determined by the configuration of a subset of its  $10^{18}$  to  $10^{19}$  Tubulin Dimers described by a large Real Clifford Algebra.

Paola Zizzi in gr-qc/0007006 describes the Octonionic Inflation Era of Our Universe as a Quantum Consciousness Superposition 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 ... [  $T_{\text{decoh}} = 10^9 T_{\text{planck}} = 10^{(-34)} \text{ sec}$  ] ... and corresponds to a superposed state of ... [  $10^{19} = 2^{64}$  qubits ]. ..".

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

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



## **What about information in the Microtubules of Human Consciousness ?**

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

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

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

The Superposition Separation Energy Difference is the internal energy

$$E_{ssediff} = G m^2 / a$$

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

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

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

$$E_{ssediff} = G (Nm)^2 / a$$

Jack Sarfatti defines coherence length  $L$  by  $L^3 = N a^3$  so that  
the Superposition Energy  $E_N$  of  $N$  superposed Conformation Electrons is

$$E_N = G (Nm)^2 / L = G (Nm)^2 / (a N^{1/3}) = N^{5/3} G m^2 / a =$$
$$= N^{5/3} E_{ssediff}$$

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

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

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  
 $10^{20}$  Tubulin Dimers in Human Brain

$10^{16}$                        $10^{(-27 + 26)} = 10^{(-1)}$  sec - 10 Hz

Human Alpha EEG is 8 to 13 Hz

Fundamental Schumann Resonance is 7.8 Hz

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

$Cl(16)$  has 65,536 elements.

10 x 56 Fr3(O) 26D World-Line=String Theory

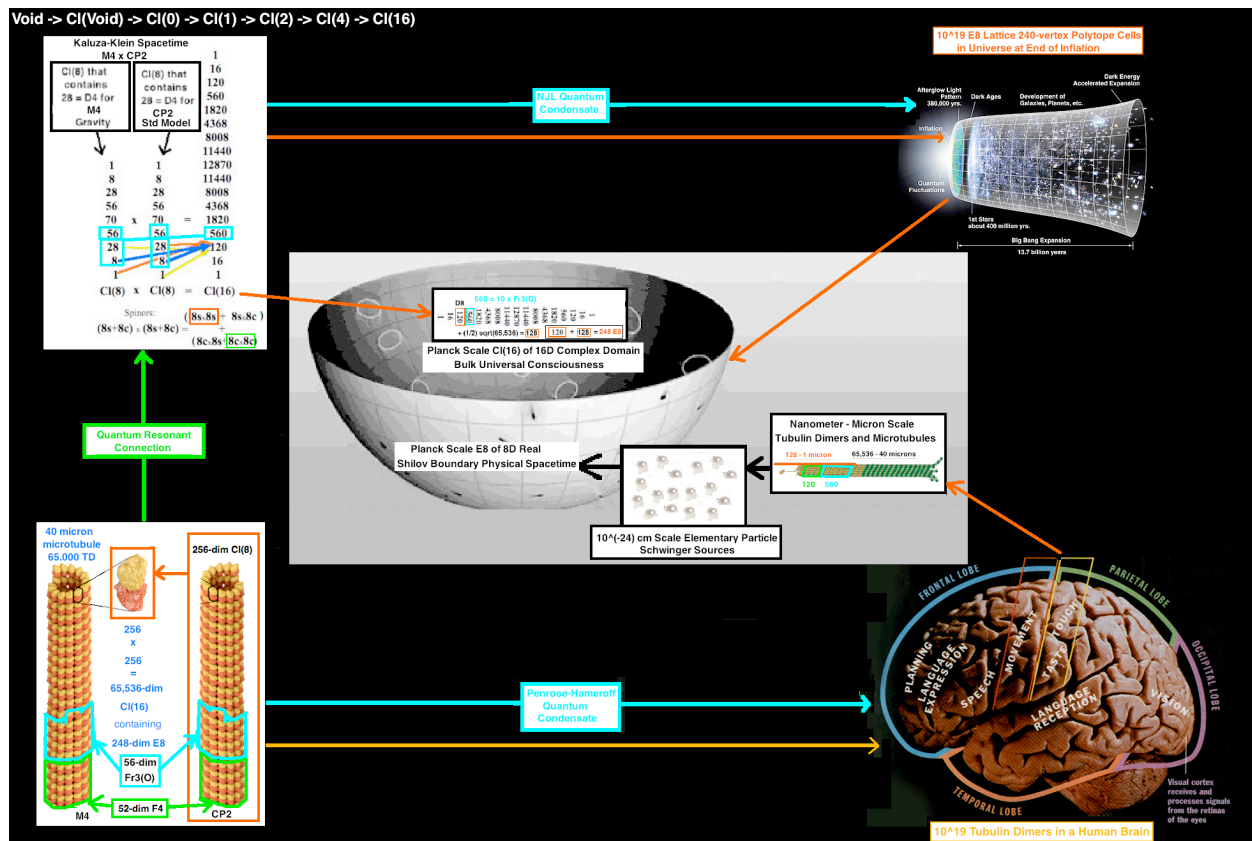
1	16	120	560	1820	4368	8008	11440	12870	11440	8008	4368	1820	560	120	16	1
---	----	-----	-----	------	------	------	-------	-------	-------	------	------	------	-----	-----	----	---

$D8 + (1/2) \sqrt{65,536} = 128$        $120 + 128 = 248 E8$

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



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



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

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

## Appendix: History of Real Clifford Algebras

Real Clifford Algebras have 8-Periodicity whereby

$$Cl(8N) = Cl(8) \times \dots (N \text{ times tensor product}) \dots Cl(8)$$

so that  $Cl(8) = M(16, \mathbb{R}) = 16 \times 16$  Real Matrices is their basic building block.

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

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

M96 went up the Nile River to Giza

Two Giza Pyramids and Sphinx represent  $Cl(8) \times Cl(8)$  and  $Cl(16)$

M89 went across the Red Sea to the Persian Gulf (then fertile land Eden)

Torah has  $613 = 248 + 365$  commandments

248 E8 is in  $Cl(16)$  - 365 center of  $27 \times 27$  Magic Square of  $Fr_3(O)$  in  $C(16)$

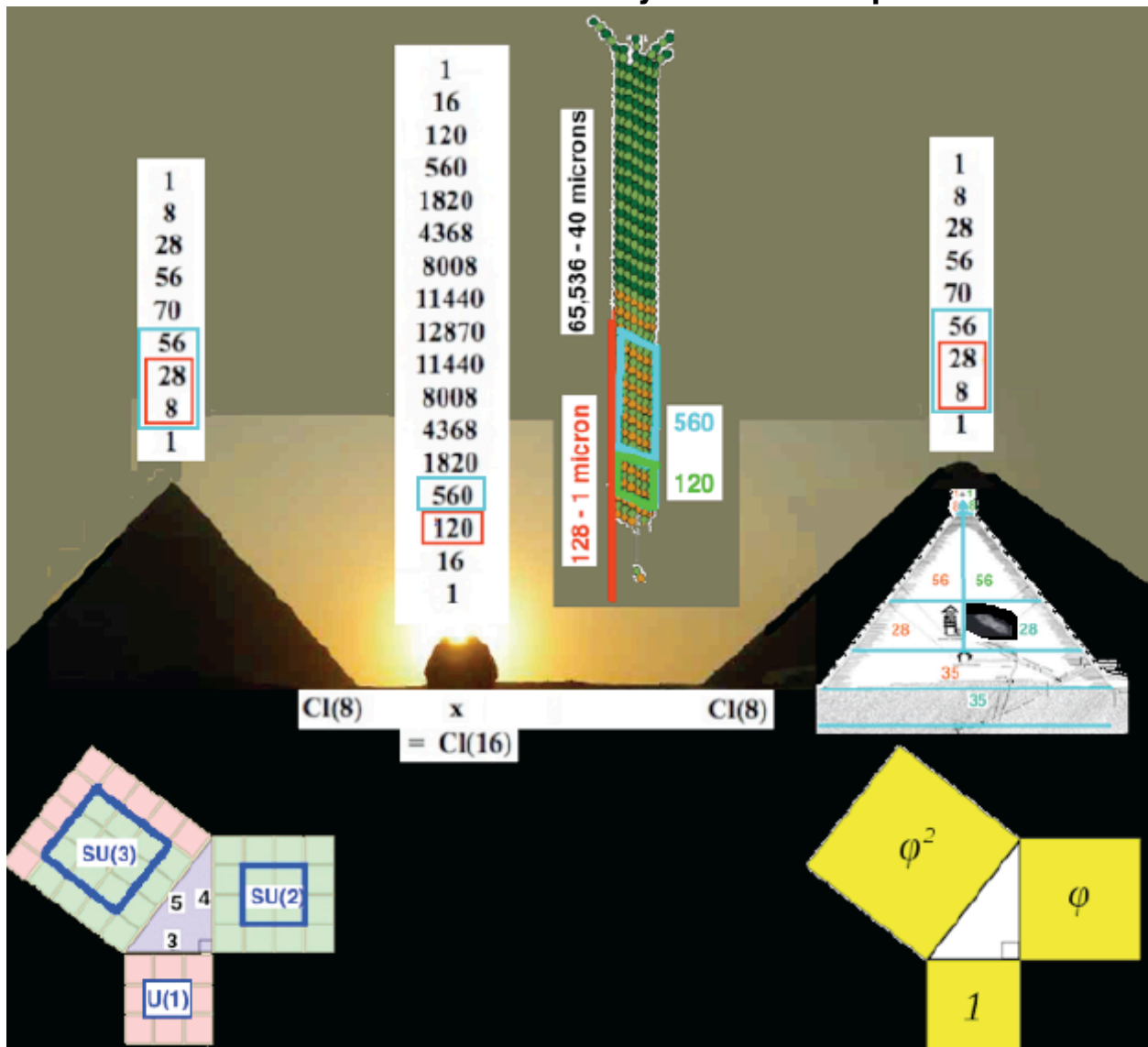
M174 went around the Asian Coast to the Sunda Shelf (then fertile land)  
and on to Japan and Tibet

Angkor Temples Mt. Meru Binomial Triangle of Clifford Algebra Gradings

Rg Veda =  $24 + 24 + 64 + 64 = 64 = 240$  Root Vectors of E8 in  $Cl(16)$



Here are some details about the Giza Pyramids and Sphinx:



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

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

It has a Grand Gallery for Physical World and a Grand Void for Spirit World

Its slope is Golden Ratio Triangle (H4 in E8 has Golden Ratio structure)

The Golden Ratio governs the Gravitational Spiral of Galaxies

The **Second Pyramid** (left in image above) has slope of 3-4-5 Triangle

corresponding to  $U(1)$  -  $SU(2)$  -  $SU(3)$  Standard Model Gauge Groups

The **Sphinx** represents  $Cl(16) = Cl(8) \times Cl(8) = \text{Great} \times \text{Second Pyramids}$

and shows correspondence between 65,536-dim  $Cl(16)$  Physics cell

and 65,536 Tubulins of maximal Microtubule Quantum Consciousness cell

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

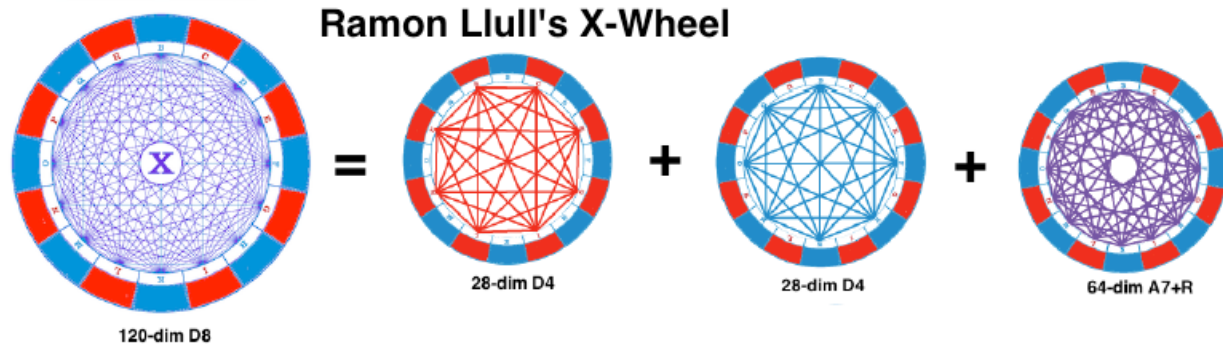


24 First Richa Syllables + 24 First Richa Gaps = D4sm + D4gde (purple)  
 8x8 = 64 Last-8 Syllables of Last 8 lines = D8 / D4sm x D4gde (blue)  
 8x8 = 64 (red) plus 8x8 = 64 (green) give 128 = E8 / D8 = Fermions  
 Middle-8 Syllables of Last 8 lines plus First-8 Syllables of Last 8 Lines  
 24+24+64+64+64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



## Here are some details about Ramon Llull's X-wheel and D8:

Around 1300 AD Ramon Llull constructed his X-wheel with 16 vertices (Vectors of  $Cl(16)$  and D8) and 120 diameter lines (BiVectors of  $C(16)$  and D8)



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

$A7+R = D8 / D4 \times D4$  Symmetric Space

One D4 contains  $D3 = \text{Spin}(2,4)$  of Conformal Gravity+Dark Energy

Other D4 contains  $SU(3)$  of Standard Model with  $SU(2) \times U(1)$  from  $CP^2$

## Here are some details about Clifford's 1878 ideas

### bringing Real Clifford Algebras to the Europeans:

William Kingdon Clifford (1845 - 1879), according to Wikipedia - (1878, "On the Nature of Things-in-Themselves", Mind, Vol. 3, No. 9, pp. 57–67), said:

“... That element of which ... even the simplest feeling is a complex, I shall call **Mind-stuff**. A moving molecule of inorganic matter does not possess mind or consciousness ; but it possesses a small piece of mind-stuff. ... When molecules are ... combined together ... **the elements of mind-stuff** which go along with them ... combine ... to form the ... beginnings of Sentience. When the molecules are so combined as to form the brain and nervous system ... the corresponding elements of mind-stuff are so combined as to form some kind of consciousness ... changes in the complex which take place at the same time get so linked together that the repetition of one implies the repetition of the other. When matter takes the complex form of a living human brain,

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

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

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

Tensor Product  $Cl(0,8) \times Cl(p,q) =$   
 $= M(R,16) \times Cl(p,q) = Cl(p,q+8)$

Real Clifford Algebras  
 $Cl(p,q)$

8	$M_{16}(R)$	$M_{16}(C)$	$M_{32}(H)$	$M_{32}(H) \oplus M_{16}(H)$	$M_{64}(R)$	$M_{64}(R) \oplus M_{32}(R)$	$M_{128}(C)$	$M_{128}(H)$	$M_{256}(H) \oplus M_{128}(H)$	$M_{512}(R)$	$M_{512}(R) \oplus M_{256}(R)$	$M_{1024}(C)$	$M_{1024}(H)$	$M_{2048}(H) \oplus M_{1024}(H)$	$M_{4096}(R)$	$M_{4096}(R) \oplus M_{2048}(R)$	
7	$M_8(C)$	$M_8(H)$	$M_{16}(H)$	$M_{16}(C)$	$M_{32}(R)$	$M_{32}(H)$	$M_{64}(H)$	$M_{128}(H)$	$M_{256}(R)$	$M_{256}(R) \oplus M_{128}(R)$	$M_{512}(C)$	$M_{512}(H)$	$M_{1024}(H)$	$M_{2048}(R)$	$M_{4096}(H)$	$M_{8192}(H)$	
6	$M_4(H) \oplus M_4(H)$	$M_8(H)$	$M_{16}(C)$	$M_{16}(R)$	$M_{32}(R)$	$M_{32}(H)$	$M_{64}(H)$	$M_{128}(H)$	$M_{256}(R)$	$M_{256}(R) \oplus M_{128}(R)$	$M_{512}(C)$	$M_{512}(H)$	$M_{1024}(H)$	$M_{2048}(R)$	$M_{4096}(H)$	$M_{8192}(H)$	
5	$M_2(H) \oplus M_2(H)$	$M_4(H)$	$M_8(C)$	$M_8(R)$	$M_{16}(R)$	$M_{16}(H)$	$M_{32}(H)$	$M_{64}(H)$	$M_{128}(R)$	$M_{128}(R) \oplus M_{64}(R)$	$M_{256}(C)$	$M_{256}(H)$	$M_{512}(H)$	$M_{1024}(R)$	$M_{2048}(H)$	$M_{4096}(H)$	
4	$M_2(C)$	$M_4(C)$	$M_8(R) \oplus M_2(R)$	$M_8(R)$	$M_{16}(H)$	$M_{16}(H)$	$M_{32}(H)$	$M_{64}(H)$	$M_{128}(R)$	$M_{128}(R) \oplus M_{64}(R)$	$M_{256}(C)$	$M_{256}(H)$	$M_{512}(H)$	$M_{1024}(R)$	$M_{2048}(H)$	$M_{4096}(H)$	
3	$M_2(C)$	$M_4(R) \oplus M_2(R)$	$M_8(R)$	$M_8(R)$	$M_{16}(H)$	$M_{16}(H)$	$M_{32}(H)$	$M_{64}(H)$	$M_{128}(R)$	$M_{128}(R) \oplus M_{64}(R)$	$M_{256}(C)$	$M_{256}(H)$	$M_{512}(H)$	$M_{1024}(R)$	$M_{2048}(H)$	$M_{4096}(H)$	
2	$M_2(R) \oplus M_2(R)$	$M_4(R)$	$M_4(C)$	$M_8(H)$	$M_8(H)$	$M_{16}(C)$	$M_{16}(H)$	$M_{32}(H)$	$M_{64}(H)$	$M_{128}(R)$	$M_{128}(R) \oplus M_{64}(R)$	$M_{256}(C)$	$M_{256}(H)$	$M_{512}(H)$	$M_{1024}(R)$	$M_{2048}(H)$	
1	$R \oplus R$	$M_2(R)$	$M_2(C)$	$M_4(H)$	$M_4(H)$	$M_8(C)$	$M_8(H)$	$M_{16}(H)$	$M_{32}(H)$	$M_{64}(H)$	$M_{128}(R)$	$M_{128}(C)$	$M_{256}(H)$	$M_{512}(H)$	$M_{1024}(R)$	$M_{2048}(H)$	
0	$R$	$C$	$H \oplus H$	$M_2(H)$	$M_4(C)$	$M_8(R)$	$M_{16}(R)$	$M_{32}(R)$	$M_{64}(H)$	$M_{128}(H)$	$M_{256}(H)$	$M_{512}(C)$	$M_{1024}(H)$	$M_{2048}(H)$	$M_{4096}(H)$	$M_{8192}(H)$	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
$\uparrow$																	
<b>p</b>																	

H = Quaternions

C = Complex

R = Real