Cellular Automata and E8 Root Vector Physics

Frank Dodd (Tony) Smith, Jr. - June 2018

Abstract

This paper discusses the relationship between the 256 Elementary Cellular Automata and the 240 Root Vectors of E8 and the E8 Physics Lagrangian. For futher aspects of E8 Physics see these papers: viXra 1804.0121 (441 pages); viXra 1806.0361 (115 pages); and my web site at http://valdostamuseum.com/hamsmith/ and files thereon including http://valdostamuseum.com/hamsmith/E8ResultsOriginVSHORT.pdf (62 pages).



The 256 Elementary Cellular Automata

represent the Real Clifford Algebra Cl(8)





Glade.	4
Ability <t< th=""><th>0 01101001</th></t<>	0 01101001
Nulle 23 Nulle 46 Nulle 71 Nulle 89 000101111 001011110 010001111 010111001	
00011011 00110011 01001011 01011011	0 01101100
Avie 29 Avie 50 Other 50 <	Contraction of the second seco
	01110010
Adde 30 Adde 50 <t< th=""><th>nule 116 01110100</th></t<>	nule 116 01110100
Adde 43 Adde 56 Adde 85 Adde 85 00101011 001111010 01010101 01100110	01111000
10010110 10101001 11000011 11010010	nule 240
Image: 160 mode 100 mode 1	nule 240 11110000
$\begin{array}{c} & & & & & & & & & & & & & & & & & & &$	nule 240 11110000 nule 232 11101000 nule 232 11101000
$\begin{array}{c} & & & & & & & & & & & & & & & & & & &$	nule 240 11110000 nule 232 11101000 Nule 232 11101000 Nule 228 11100100
$\begin{array}{c} & & & & & & & & & & & & & & & & & & &$	Adde 228 11110000 11110000 11101000 11100100 Adde 228 11100100 11100010 11100010 11100010 11100001
$\begin{array}{c} & & & & & & & & & & & & & & & & & & &$	Adde 240 11110000 11110000 11101000 11100100 Adde 228 11100100 11100010 11100010 11100001 11100001 11100001

	Grade:		5
al lis			
01101101	10101011	11010101	111111000
El and a second			
01101011	10100111	11010011	11110100
ALIE 103		auk 208	100 242
01100111	10011110	11001110	11110010
AND 54	1/10/157	rule 208	rule 241
01011110	10011101	11001101	11110001
211 A.Ve 83	rule 155	rule 203	rule 236
01011101	10011011	11001011	11101100
01011011	10010111	11000111	11101010
01010111	10001111	10111100	11101001
01001111	01111100	10111010	11100110
Tale 67	- nie 122	rule 185	100 229
00111110	01111010	10111001	11100101
rule 61	1/10 121	cule 182	n/w 227
00111101	01111001	10110110	11100011
		AA	
00111011	01110110	10110101	11011100
nde 55	100 107	c.la 178	AAAA
00110111	01110101	10110011	11011010
nie 47	Avie 115	ed# 174	nule 217
00101111	01110011	10101110	11011001
rule 31	A40 110	rule 173	nue 214
00011111	01101110	10101101	11010110





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



form the 28-dim D4 Lie Algebra

that represents Gauge Bosons and Ghosts

The 28 can represent either of two types:

16 Gauge Bosons and 12 Ghosts or 12 Gauge Bosons and 16 Ghosts First consider the case

16 Gauge Bosons and 12 Ghosts

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

12 Ghosts represent SU(3)xSU(2)xU(1) Standard Model but they are NOT effective as Gauge Bosons

in the First Copy of Cl(8) Clifford Algebra so they are only "Ghosts" of the true Standard Model Gauge Bosons that we will see to be effective in a Second Copy of Cl(8)

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

whose 240 Root Vectors are a recipe for a realistic Lagrangian

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

one F4 from the First Cl(8) and the Second F4 from the Second Cl(8) The First 52-dim F4 comes from the First Cl(8) by adding to the First 28-dim D4 (purple dots)



8 Vectors (blue dots) for 8-dim Spacetime

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

8 -half-Spinors (red dots) for 8 Fermion AntiParticles of the First Generation The Second 52-dim F4 comes from the Second CI(8) by adding to the Second 28-dim D4 (orange dots) for 12 Standard Model Gauge Bosons and 16 Ghosts of U(2,2) from the First D4



8 Vectors (blue dots) for 8-dim Spacetime

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

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



28 + 28 + 64 =120 = D8 Lie Algebra

Cl(16) Spinors =

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



64 + 64 = 128 = CI(16) +half-Spinors + CI(16) -half-Spinors

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





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

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

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



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





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





	:	:
Bur loss Sollars		
Iner fost killjast		
Red (som Artificant		1 1
		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

8 Components of 8 Fermion AntiParticles

The 64 Blue Root Vectors of D8 / D4xD4 are a Superposition of 8 E8 Spacetime Lattices (7 being Integral Domains) corresponding to the 8 fundamental Fermion Types,

each of which has 8-dim M4 x CP2 Kaluza-Klein structure. Effectively, each Fermion Type propagates within its own E8 Lattice within the Superposition

forming an 8-dim Generalized Feynman Checkerboard







8 Components of 8 Fermion AntiParticles

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



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



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

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

10 = 6 Lorentz + 4 Special Conformal for Dark Energy 4 = Translations for Primordial Black Hole Dark Matter 1 = Dilation for Higgs Ordinary Matter giving a tree-level ratio of 10 : 4 : 1 = 0.667 : 0.267 : 0.067

10 : 4 : 1 = 0.667 : 0.267 : 0.067 Taking Account of differences between Radiation and Matter Eras in the Evolution of Our Universe



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

Standard Model Gauge Bosons and Ghosts



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











8 Components of 8 Fermion AntiParticles



The 8D Lagrangian Density has 3 fundamental terms

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

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

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

The 8D Lagrangian Base Manifold is M4 x CP2 Kaluza-Klein of Superposition of 8 E8 Lattices $(4+4) \times 8 = 64$ Root Vectors Lagrangian 8-dim Lorentz structure satisfies Coleman-Mandula because its Fermionic fundamental spinor representations are built with respect to spinor representations for 8-dim Spin(1,7) spacetime.

Each Fermionic Term Fermion has in 8-dim Spacetime units of mass^(7/2). Each BosonicTerm Gauge Boson + Ghost has units of mass^(1) Since (8+8)x(7/2) = 56 = 28 + 28the Fermionic Terms cancel the Bosonic Terms so the E8 Physics Lagrangian is UltraViolet finite. Here is how the 8D Lagrangian gives Higgs and 3 Fermion Generations

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

where

M4 is 4D Minkowski Spacetime

and

 $CP2 = SU(3) / SU(2) \times U(1)$



- 3 Generations of Fermions
- In Kaluza-Klein M4 x CP2 there are 3 possibilities for a fermion to go from point A to point B:
- 1 A and B are both in M4: First Generation Fermion represented by single O basis element



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



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



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

with 3 Mass States for Higgs and Truth Quark



E8 Physics 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 ...".

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-l	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
		1	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
Мт	80 326	GoV	
M+ M	00.320	Gev	
w-	00.320	Gev	70 - 01 862 CoV
wo	90.3/9	Gev	20 = 91.862 GeV
Mplanck 1.21	7x10^19	GeV	
Higgs VEV (assumed)	252.5	GeV	
Higgs (low state)	126	GeV	(middle state) 182 GeV
			(high state) 239 GeV
Gravity Gg (assumed)	1		
$(Gg)(Mproton^2)/(Mplanc)$	ב ביים ב		$5 \times 10^{(-39)}$
FM fine structure	1/137	03608	5 x 10 (-59)
Moak Cu	1/13/	535	
weak Gw $(M_{22}+\Delta_2)$	0.2: M ^2	- N-0 ^2\\	$1 0 = - 10^{1}$
Gw(Mproton 2 / (Mw+2 + Galax Barrier at 0.245 Gal	MW-~2 -	$+ MZU^2$	$1.05 \times 10^{10} (-5)$
Color Force at 0.245 Ge	v 0.6	280	0.106 at 91 Gev
Kobayashi-Maskawa param	eters fo	or W+ and	l W- processes are:
d	s		b
u 0.975	0.222		0.00249 -0.00388i
c -0.222 -0.000161i	0.974	-0.00003	65i 0.0423
t 0.00698 -0.00378i	-0.041	8 -0.000	6i 0.999
The phase angle d13 is	taken to	be 1 ra	dian.

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



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* -> 4I histogram of 3 Higgs Mass States arXiv 1804.01939