E8 Physics from Cl(8) via Elementary Cellular Automata Bits

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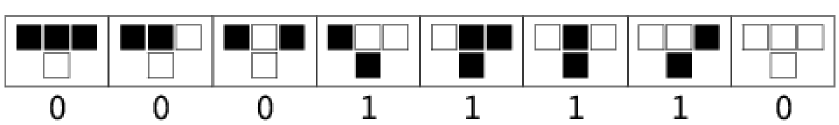
Abstract

In this article, I describe E8 Physics from Cl(8) via pairing elementary cellular automata bits. Tony Smith relates the 256 dimensions of the Cl(8) Clifford Algebra to the 256 rules of Elementary Cellular Automata. The graded dimensions of Cl(8) correspond to graded dimensions of the E8 Lie Algebra used in Smith's physics model. Six Cellular Automata (CA) rules with four one-bits are related to Smith's 8-dim Primitive Idempotent bookended by the single rule with no one-bits and the single rule with all eight bits as ones. The 64 other four one-bit rules are related to E8's 64-dim vector representation used by Smith for Kaca Bradonjic's Unimodular Relativity. The two 28-dim D4 subalgebras of E8 are used for bosons and their ghosts and relate to the CA rules with two one-bits and six one-bits. The two remaining 64-dim spinor representations for E8 are used for eight component fermions/antifermions and relate to the CA rules with one, three, five and seven one-bits.

1. Introduction

Tony Smith [1] relates the 256 dimensions of the Cl(8) Clifford Algebra to the 256 rules of Elementary Cellular Automata [2]. The graded dimensions of Cl(8) correspond to graded dimensions of the E8 Lie Algebra used in Smith's physics model. An 8-dim Primitive Idempotent half spinor along with the 248-dim E8 are embedded in the 256-dim Cl(8). The grading of this Cl(8) is 1 8 28 56 70 56 28 8 1 which sum to the 256 dimensions. This grading gives the quantity of Cellular Automata (CA) rules that have a certain number of one-bits.



The rule above is called rule 30 because the 4 one-bits produce a binary 2+4+8+16=30. The Cl(8) grading indicates there are 70 rules with 4 of the 8 bits being a one. In other words there are 70 ways to place 4 ones in the 8 bits to form a rule. The bits for the rule represent the next state value for the 8 possible values of the current state and the states to the left and right of the current state being evaluated. Via the Cl(8) grading there is one way to have 0 of 8 ones in the

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rule; 8 ways to have a single one; 28 ways to have two ones; 56 ways to have three ones; 70 ways to have four ones; 56 ways to have five ones; 28 ways to have six ones; 8 ways to have seven ones; and one way to have 8 ones.

2. Relating Basis Vectors to Cellular Automata Bits

Two CA bits are related via Smith's model to the Y and X basis vectors of a YX spatial rotation [3].

Y X

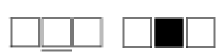
01000000 00001000

Two CA bits are related to the temporal T and spatial Z basis vectors of a Lorentz group TZ boost.

T Z

10000000 00100000

Two CA bits relate to the Conformal group (C) basis vector and an Anti-de Sitter/de Sitter group (A) translation basis vector to form a dilation (CA). This dilation is the Higgs VEV in Smith's physics model.



C A

00000001 00000100

The final two CA bits allow Standard Model Ghosts in Smith's physics using basis vectors M (magenta/minus for strong force anticolor and weak force negative charge) and G (green/greater than zero for strong force color/weak force positive charge). The MG bivector is a propagator phase in Smith's model.

M G

00000010 00010000

3. Rotations and Boosts

The grading of the 248-dim E8 in Smith's physics model is 28 64 64 64 28. The following bivectors are in the 28s of his E8 grading which match to the 28s in the Cl(8) grading. The E8 28s come from two D4 subalgebras which also relate to the four axes and 24 vertices of a 24-cell, D4's root vector polytope. The 28 Cellular Automata with 2 one-bits and the 28 CA with 6 one-bits will match to these two D4s. Here are the three Lorentz Group gravity spatial rotation [3] bivectors/double one-bits.

ZY ZX YX

01100000 00101000 01001000

Here are the three Lorentz group gravity boost bivectors/double one-bits.

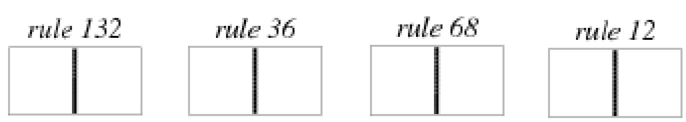
TZ TY TX

10100000 11000000 10001000

4. Translations, Dilation and Special Conformal Transformations

Here are the four Anti-de Sitter/de Sitter group gravity translation bivectors/double one-bits, the dilation (Smith's Higgs VEV), and the four special conformal transformations (dark energy related for Smith).

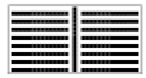
Translations:



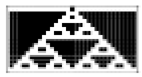
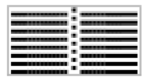
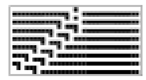
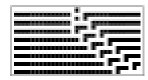
TA ZA YA XA

10000100 00100100 01000100 00001100

Dilation:

rule 5

CA
00000101

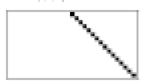
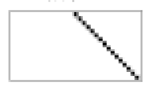
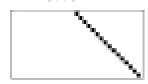
Conformal Transformations:

rule 129	rule 33	rule 65	rule 9
			
TC	ZC	YC	XC
10000001	00100001	01000001	00001001

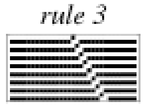
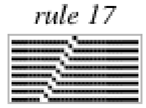
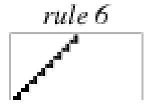
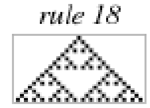
5. Ghosts for the Standard Model Bosons and Propagator Phase

Here are the bivectors/double one-bits for the Standard Model ghosts and propagator phase of Smith's physics model.

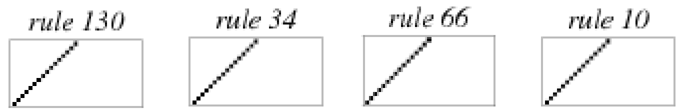
rgb/rg/rb/gb "half" Gluons:

rule 144	rule 48	rule 80	rule 24
			
TG	ZG	YG	XG
10010000	00110000	01010000	00011000

W-/W+/Photon/Z0/Phase:

rule 3	rule 17	rule 6	rule 20	rule 18
				
CM	CG	AM	AG	MG
00000011	00010001	00000110	00010100	00010010

cmy/cm/cy/my “half” Gluons:



TM ZM YM XM

10000010 00100010 01000010 00001010

6. Ghosts for Rotations and Boosts

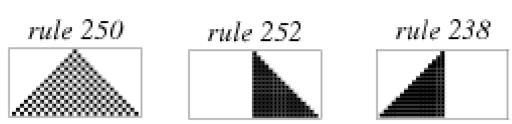
The above conformal gravity and Standard Model ghost bivectors fit with the 28 Cellular Automata rules with double one-bits. These 28 CA relate to the first 28 in the E8 and Cl(8) grading. The conformal gravity ghost and Standard Model bivectors fit with the 28 CA with six one-bits. These CA relate to the second 28 in the E8 and Cl(8) grading. The CA with six one-bits are also the CA with double zero-bits. These double zero-bits will be matched to Smith’s D4 conformal gravity ghost and Standard Model bivectors.

Besides using double zero-bits instead of double one-bits, this ghost boson-actual boson bivector mapping also exchanges XYZT vectors with GMAC vectors thus forming a negative transformation [4]. The ghosts and bosons can also be mapped to each other in a second way via their Hodge Dual [9]. This may relate to how in Smith’s model, the XYZT physical spacetime interacts with the GMAC Kaluza-Klein internal symmetry space. Here are the three Lorentz Group gravity spatial rotation bivectors/double zero-bit ghosts.

AM AG MG

11111001 11101011 11101101

Here are the three Lorentz group gravity boost bivectors/double zero-bit ghosts.



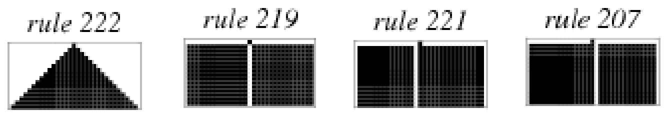
CA CM CG

11111010 11111100 11101110

7. Ghost Translation, Dilation and Special Conformal Transformations

Here are the four Anti-de Sitter/de Sitter group gravity translation bivectors/double zero-bit ghosts, the dilation ghost (for Smith's Higgs VEV), and the four special conformal transformation ghosts (dark energy related for Smith).

Translations:



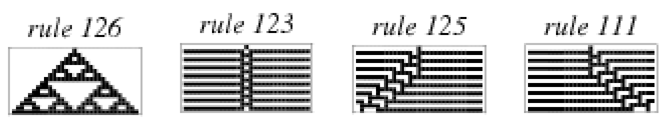
CZ	AZ	MZ	GZ
11011110	11011011	11011101	11001111

Dilation:

TZ

01011111

Conformal Transformations:

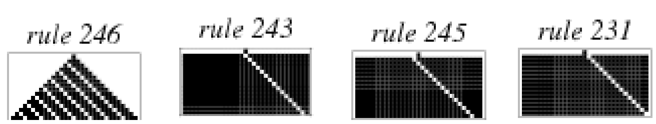


CT	AT	MT	GT
01111110	01111011	01111101	01101111

8. Standard Model Bosons and Propagator Phase Ghost

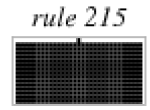
Here are the bivectors/double zero-bits for the Standard Model bosons and propagator phase ghost of Smith's physics model.

rgb/rg/rb/gb "half" Gluons:



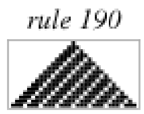
CX	AX	MX	GX
11110110	11110011	11110101	11100111

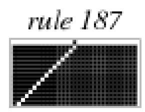
W-/W+/Photon/Z0/Phase:

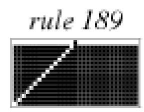


TY	TX	ZY	ZX	YX
00111111	01110111	10011111	11010111	10110111

cmy/cm/cy/my “half” Gluons:







CY	AY	MY	GY
10111110	10111011	10111101	10101111

There’s a pattern where rules (with G vs. M) that slant to the left vs. slanting to the right may relate to charge for the Standard Model bosons and direction change (X vs. Y) for gravity bosons. These reflection transformation [4] bits perhaps relate to how charge, mass, and change of direction are related in Smith’s 4-dim Feynman Checkerboard.

9. The Primitive Idempotent and Spacetime Position and Momentum

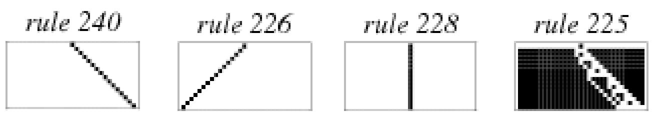
The grading of the 8-dim Primitive Idempotent (PI) half spinor embedded with E8 in Cl(8) is 1 6 1. For Smith, this is a creation plus annihilation operator version of a Higgs scalar plus SU(2). This 6-dim PI middle grade is the lower left to upper right diagonal of the 6x6 matrix below. Subtracting the 6 middle grade of the PI from the 70 Cl(8) middle grade gives the 64 middle grade for E8. This 64 middle grade is the position by momentum 8x8=64-dim vector part of Smith’s E8 physics model [5]. This 64-dim part of E8 thus relates to the 4-vector/four one-bit CA rules not used for the 6-dim PI middle grade though the upper left to lower right diagonals of the two 4x4 matrices below form another PI half spinor that is part of the E8 middle grade. Both PI half spinors fit with the 16 Pertti Lounesto terms using basis vectors MGCATYZX [6]. The position and momentum are 8-dim due to the GMAC Kaluza-Klein internal symmetry space added to the XYZT physical spacetime in Smith’s model.

	0	15-GMAC
15-TZYX		0 
	TZYX	GMAC
	11101000	00010111

Smith relates his spacetime structure to Kaca Bradonjic's Unimodular Relativity [7]. The two rules above would relate to the 4-volume form element [8] for physical spacetime and its Hodge dual, the 4-volume for internal symmetry space. The rule thumbnail columns below closely match the ones for gluon ghosts, translations, and special conformal transformations described earlier. Here they represent an SU(3) Yang-Mills connection [9] and part of a conformal metric G-structure group[8].

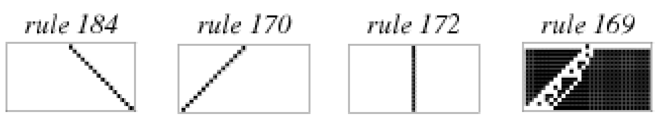
	1-G	2-M	4-A	8-C

14-TZY



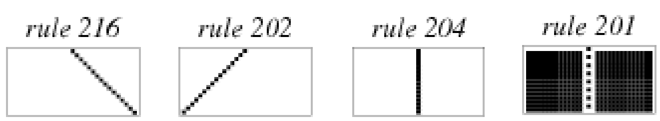
TZYG	TZYM	TZYA	TZYC
11110000	11100010	11100100	11100001

13-TZX



TZXG	TZXM	TZXA	TZXC
10111000	10101010	10101100	10101001

11-TYX

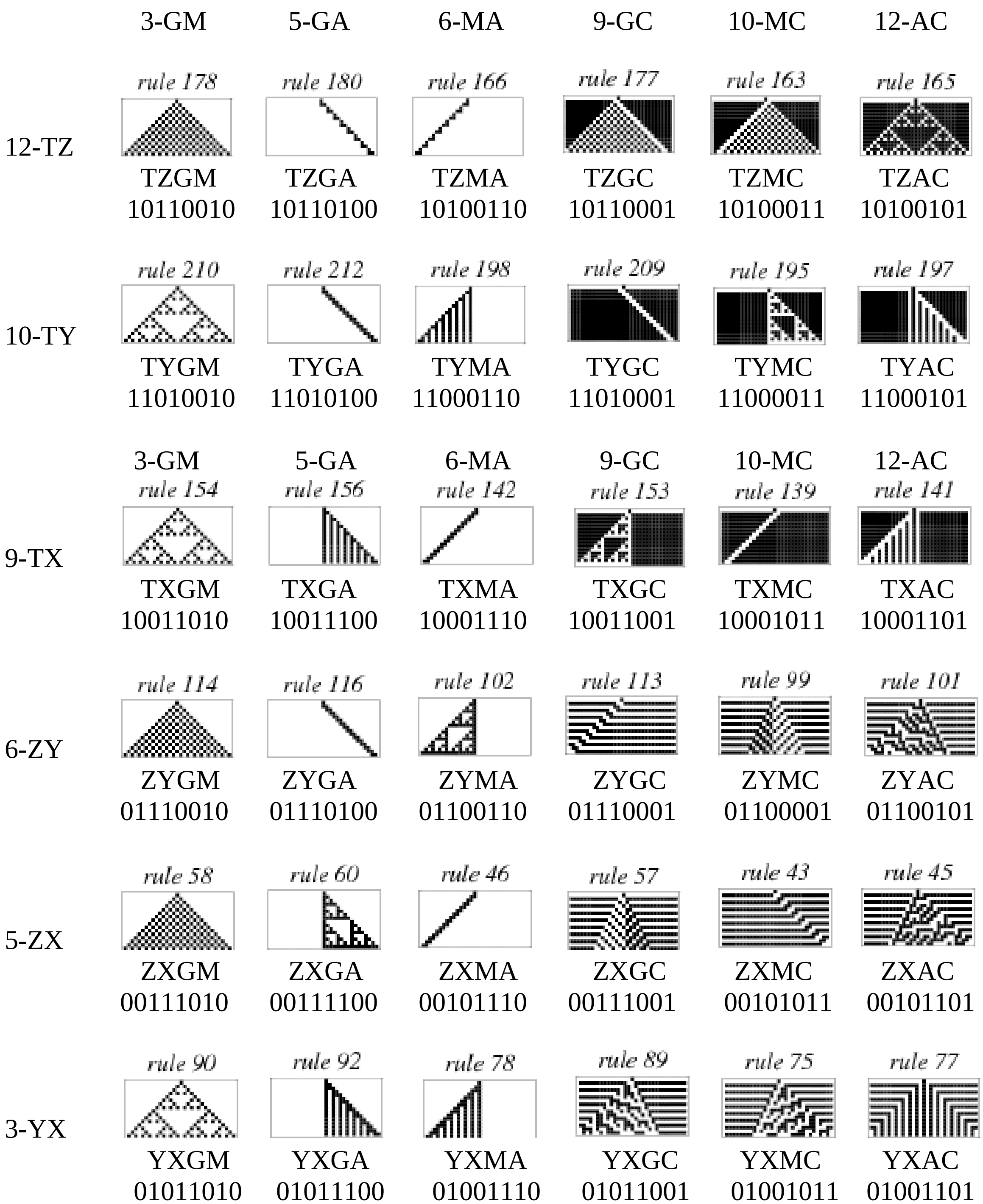


TYXG	TYXM	TYXA	TYXC
11011000	11001010	11001100	11001001

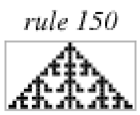
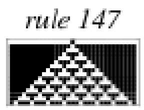
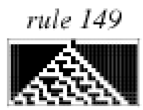
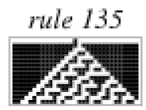
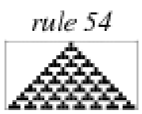
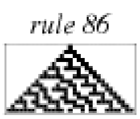
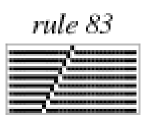
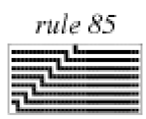
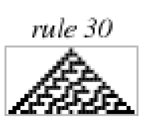
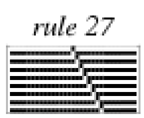
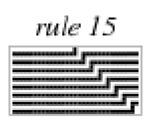
7-ZYX

ZYXG	ZYXM	ZYXA	ZYXC
01111000	01101010	01101100	01101001

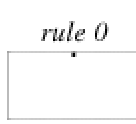
The lower left to upper right diagonal below is the Primitive Idempotent Higgs related structure mentioned earlier. This diagonal splits the 6x6 block into two copies of a 15-dim Unimodular SL(4,R) projective structure [8]. The SL(4,R) aka SO(3,3) structures include a 3x3 block (upper left and lower right) with translations, special conformal transformations, and a dilation plus three each from the adjacent blocks for rotations and boosts. The two copies of SL(4,R) are one each for the four volume form G-structure groups for spacetime and internal symmetry space.



The 4x4 block below has an upper left to lower right conformal metric primitive idempotent diagonal [8]. The right two columns below G-Structure rotations/boosts are the Hodge dual [9] of the left two SU(3) gluon columns above. The left two columns below Yang-Mills propagator phase affine solder one-form [8]/photon/Z0 and Dilation Higgs VEV/W-/W+ are the Hodge dual of the right two G-Structure translations/conformal transformations columns above. The VEV being Yang-Mills instead of G-structure may represent a fixed mass-energy scale [1].

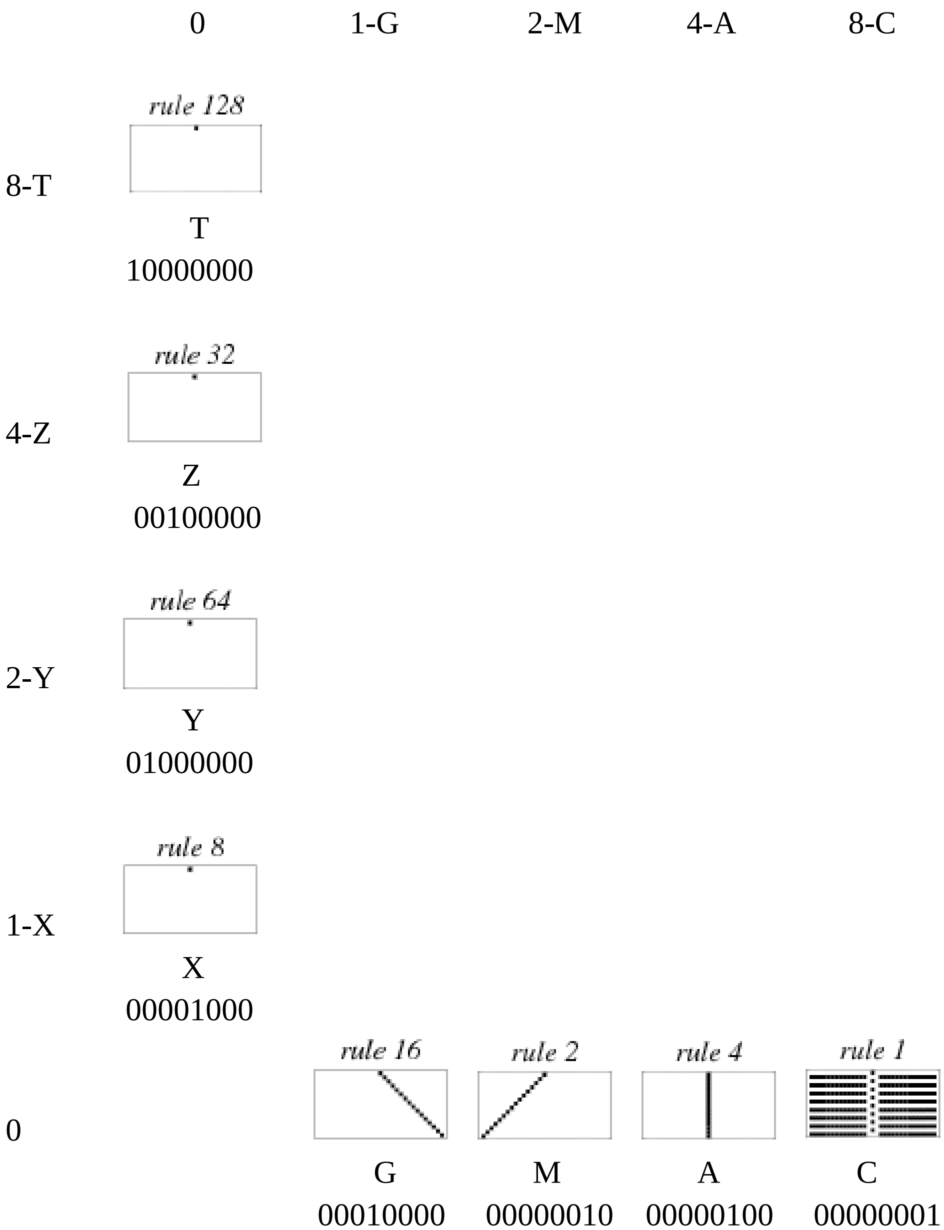
	7-GMA	11-GMC	13-GAC	14-MAC
8-T				
	TGMA	TGMC	TGAC	TMAC
	10010110	10010011	10010101	10000111
4-Z				
	ZGMA	ZGMC	ZGAC	ZMAC
	00110110	00110011	00110101	00100111
2-Y				
	YGMA	YGMC	YGAC	YMAC
	01010110	01010011	01010101	01000111
1-X				
	XGMA	XGMC	XGAC	XMAC
	00011110	00011011	00011101	00001111

The two ones of the PI and Cl(8) grading fit with the CA rules having 0 of 8 ones and 8 of 8 ones and as mentioned earlier are Higgs related:

	
	TZYXGMAC
00000000	11111111

10. Spacetime Components of Fermion Creation Operators

The two remaining 64s in the E8 grading of Smith's model are for 8 spacetime direction angular momentum components of fermion creation operators and 8 spacetime components of antifermion creation operators. The E8 64 grading for fermions comes from the 8 Cl(8) vectors plus the 56 Cl(8) 3-vectors. Thus the fermions relate to the Cellular Automata rules with a single one-bit and the rules with three one-bits. Here are the rules for the neutrino creation operator [10]. X,Y,Z,T,G,M,A and C are the spacetime directions for the angular momentum.



Here are the rules for the electron creation operator. The spacetime direction for the angular momentum would be a zero-bit (i.e. X for TZY or C for GMA).

0   7-GMA   11-GMC   13-GAC   14-MAC

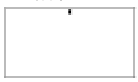
rule 224

14-TZY 

TZY

11100000

rule 168

13-TZX 

TZX

10101000

rule 200

11-TYX 

TYX

11001000

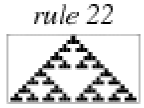
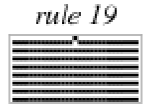
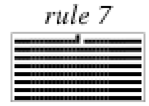
rule 104

7-ZYX 

ZYX

01101000

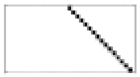
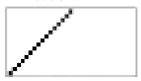
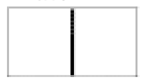
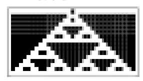
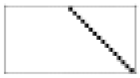
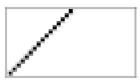
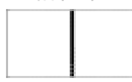
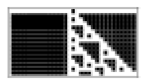
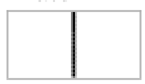
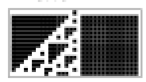
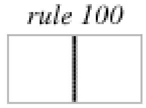
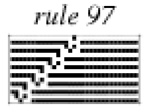
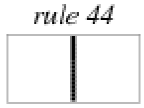
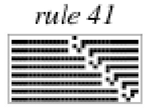
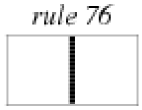
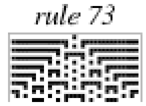
rule 22   *rule 19*   *rule 21*   *rule 7*

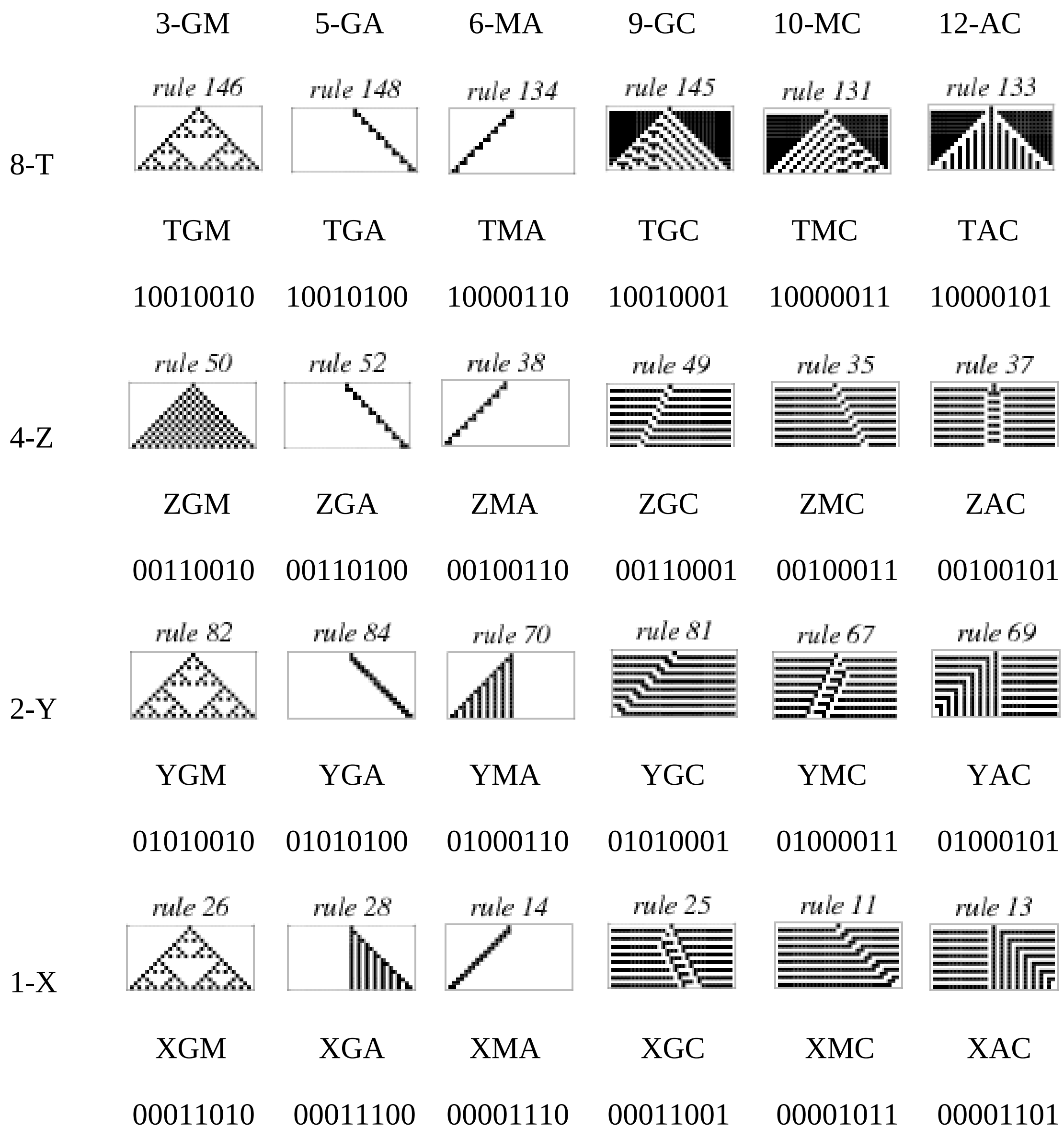
0    

GMA   GMC   GAC   MAC

00010110   00010011   00010101   00000111

Here are the rules for quark creation operators. The spacetime direction for the angular momentum would be the unique bit of a row/column (i.e. the G,M,A and C of the TZG, TZM,TZA and TZC row and the T,Z,Y and X of the TGM, ZGM,YGM and XGM column).

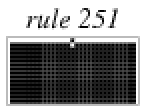
	1-G	2-M	4-A	8-C
	rule 176	*rule 162*	*rule 164*	*rule 161*
12-TZ				
	TZG	TZM	TZA	TZC
	10110000	10100010	10100100	10100001
	rule 208	*rule 194*	*rule 196*	*rule 193*
10-TY				
	TYG	TYM	TYA	TYC
	11010000	11000010	11000100	11000001
	rule 152	*rule 138*	*rule 140*	*rule 137*
9-TX				
	TXG	TXM	TXA	TXC
	10011000	10001010	10001100	10001001
	rule 112	*rule 98*	*rule 100*	*rule 97*
6-ZY				
	ZYG	ZYM	ZYA	ZYC
	01110000	01100010	01100100	01100001
	rule 56	*rule 42*	*rule 44*	*rule 41*
5-ZX				
	ZXG	ZXM	ZXA	ZXC
	00111000	00101010	00101100	00101001
	1-G	2-M	4-A	8-C
	rule 88	*rule 74*	*rule 76*	*rule 73*
3-YX				
	YXG	YXM	YXA	YXC
	01011000	01001010	01001100	01001001



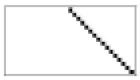
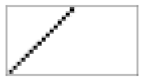
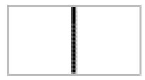
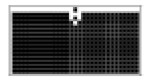
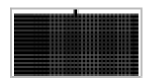
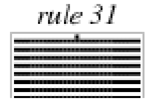
11. Spacetime Components of Antifermion Creation Operators

The E8 64 grading for antifermions comes from the 8 Cl(8) 7-vectors plus the 56 Cl(8) 5-vectors. Thus the related Cellular Automata rules for the spacetime components of each antifermion creation operator have five one-bits or seven one-bits. Like with the ghost boson to actual boson mapping done earlier, the fermion to antifermion mapping is a negative transformation [4]. Also, like with ghost to boson mapping, the Hodge Dual can be used for a second mapping [9].

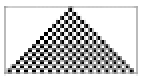
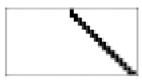
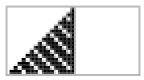
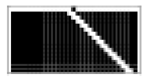
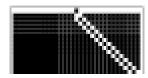
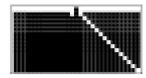
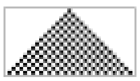
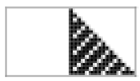
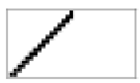
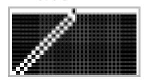
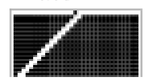
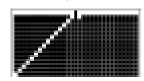
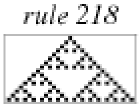
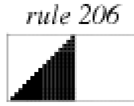
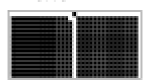
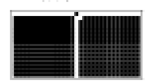
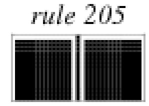
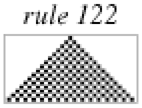
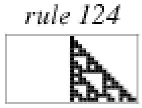
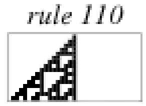
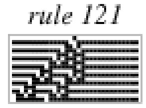
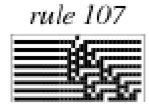
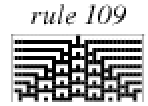
Here are the rules for the antineutrino creation operator. The spacetime direction for the angular momentum would be the zero-bit (i.e. C for TZYXGMA).

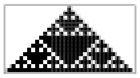
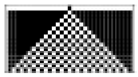
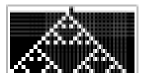
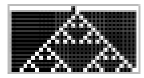
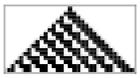
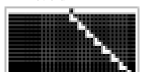
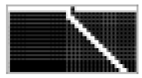
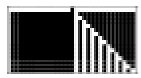
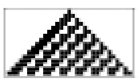
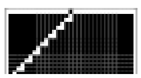
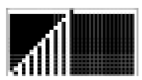
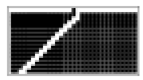
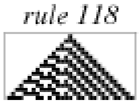
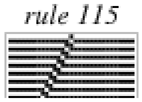
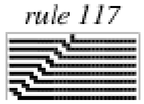
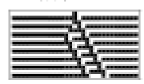
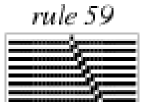
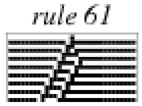
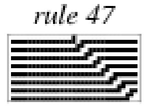
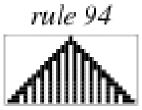
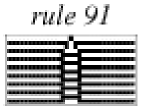
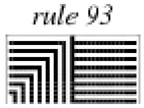
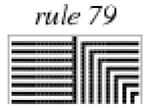
	7-GMA	11-GMC	13-GAC	14-MAC	15-GMAC
15-TZYX	 TZYXGMA 11111110	 TZYXGMC 11111011	 TZYXGAC 11111101	 TZYXMAC 11101111	
14-TZY					 TZYGMAC 11110111
13-TZX					 TZXGMAC 10111111
11-TYX					 TYXGMAC 10111111
7-ZYX					 ZYXGMAC 01111111

Here are the rules for the positron creation operator. The spacetime direction for the angular momentum would be the unique bit of a row/column (the G,M,A and C of the TZYXG, TZYXM,TZYXA and TZYXC row and the T,Z,Y and X of the TGMAC, ZGMAC,YGMAC and XGMAC column).

	1-G	2-M	4-A	8-C	15-GMAC
15-TZYX	*rule 248*  TZYXG 11111000	*rule 234*  TZYXM 11101010	*rule 236*  TZYXA 11101100	*rule 233*  TZYXC 11101001	
8-T					*rule 151*  TGMAC 10010111
4-Z					*rule 55*  ZGMAC 00110111
2-Y					*rule 87*  YGMAC 01010111
1-X					*rule 31*  XGMAC 00011111

Here are the rules for antiquark creation operators. The spacetime direction for the angular momentum would be a zero-bit (i.e. X for TZYGM or C for TZGMA).

	3-GM	5-GA	6-MA	9-GC	10-MC	12-AC
	rule 242	*rule 244*	*rule 230*	*rule 241*	*rule 227*	*rule 229*
14-TZY						
	TZYGM	TZYGA	TZYMA	TZYGC	TZYMC	TZYAC
	11110010	11110100	11100110	11110001	11100011	11100101
	rule 186	*rule 188*	*rule 174*	*rule 185*	*rule 171*	*rule 173*
13-TZX						
	TZXGM	TZXGA	TZXMA	TZXGC	TZXMC	TZXAC
	10111010	10111100	10101110	10111001	10101011	10101101
	3-GM	5-GA	6-MA	9-GC	10-MC	12-AC
	rule 218	*rule 220*	*rule 206*	*rule 217*	*rule 203*	*rule 205*
11-TYX						
	TYXGM	TYXGA	TYXMA	TYXGC	TYXMC	TYXAC
	11011010	11011100	11001110	11011001	11001011	11001101
	rule 122	*rule 124*	*rule 110*	*rule 121*	*rule 107*	*rule 109*
7-ZYX						
	ZYXGM	ZYXGA	ZYXMA	ZYXGC	ZYXMC	ZYXAC
	01111010	01111100	01101110	01111001	01101011	01101101

	7-GMA	11-GMC	13-GAC	14-MAC
12-TZ	*rule 182*  TZGMA 10110110	*rule 179*  TZGMC 10110011	*rule 181*  TZGAC 10110101	*rule 167*  TZMAC 10100111
10-TY	*rule 214*  TYGMA 11010110	*rule 211*  TYGMC 11010011	*rule 213*  TYGAC 11010101	*rule 199*  TYMAC 11000111
9-TX	*rule 158*  TXGMA 10011110	*rule 155*  TXGMC 10011011	*rule 157*  TXGAC 10011101	*rule 143*  TXMAC 10001111
6-ZY	*rule 118*  ZYGMA 01110110	*rule 115*  ZYGMC 01110011	*rule 117*  ZYGAC 01110101	*rule 103*  ZYMAC 01100111
5-ZX	*rule 62*  ZXGMA 00111110	*rule 59*  ZXGMC 00111011	*rule 61*  ZXGAC 00111101	*rule 47*  ZXMAC 00101111
3-YX	*rule 94*  YXGMA 01011110	*rule 91*  YXGMC 01011011	*rule 93*  YXGAC 01011101	*rule 79*  YXMAC 01001111

12. Discussion

The reflection transformation bits mentioned earlier, G vs. M or X vs.Y, may relate to color (with neither/both bits making up the third color) for quarks and antiquarks. The bits may affect slant patterns in general (along with A/Z straight line and C/T periodicity/chaos) for bosons, position-momentum, and fermions/antifermions. Here is the partitioning of rule space [11] associated with this mapping of Cl(8), E8 [12], and Elementary Cellular Automata.

	0	1 G	2 M	4 A	8 C	3 GM	5 GA	6 MA	9 GC	10 MC	12 AC	7 GMA	11 GMC	13 GAC	14 MAC	15 GMAC
15 TZYX	232 PM	248 P	234 P	236 P	233 P	250 BO	252 BO	238 BO	249 RO	235 RO	237 RO	254 AN	251 AN	253 AN	239 AN	255 PI
14 TZY	224 E	240 PM/PI	226 PM	228 PM	225 PM	242 AQ	244 AQ	230 AQ	241 AQ	227 AQ	229 AQ	246 GL	243 GL	245 GL	231 GL	247 AN
13 TZX	168 E	184 PM	170 PM/PI	172 PM	169 PM	186 AQ	188 AQ	174 AQ	185 AQ	171 AQ	173 AQ	190 GL	187 GL	189 GL	175 GL	191 AN
11 TYX	200 E	216 PM	202 PM	204 PM/PI	201 PM	218 AQ	220 AQ	206 AQ	217 AQ	203 AQ	205 AQ	222 TR	219 TR	221 TR	207 TR	223 AN
7 ZYX	104 E	120 PM	106 PM	108 PM	105 PM/PI	122 AQ	124 AQ	110 AQ	121 AQ	107 AQ	109 AQ	126 CO	123 CO	125 CO	111 CO	127 AN
12 TZ	160 BO	176 Q	162 Q	164 Q	161 Q	178 PM	180 PM	166 PM	177 PM	163 PM	165 PI	182 AQ	179 AQ	181 AQ	167 AQ	183 PR
10 TY	192 BO	208 Q	194 Q	196 Q	193 Q	210 PM	212 PM	198 PM	209 PM	195 PI	197 PM	214 AQ	211 AQ	213 AQ	199 AQ	215 EW
9 TX	136 BO	152 Q	138 Q	140 Q	137 Q	154 PM	156 PM	142 PM	153 PI	139 PM	141 PM	158 AQ	155 AQ	157 AQ	143 AQ	159 EW
6 ZY	96 RO	112 Q	98 Q	100 Q	97 Q	114 PM	116 PM	102 PI	113 PM	99 PM	101 PM	118 AQ	115 AQ	117 AQ	103 AQ	119 EW
5 ZX	40 RO	56 Q	42 Q	44 Q	41 Q	58 PM	60 PI	46 PM	57 PM	43 PM	45 PM	62 AQ	59 AQ	61 AQ	47 AQ	63 EW
3 YX	72 RO	88 Q	74 Q	76 Q	73 Q	90 PI	92 PM	78 PM	89 PM	75 PM	77 PM	94 AQ	91 AQ	93 AQ	79 AQ	95 DI
8 T	128 N	144 GL	130 GL	132 TR	129 CO	146 Q	148 Q	134 Q	145 Q	131 Q	133 Q	150 PM/PI	147 PM	149 PM	135 PM	151 P
4 Z	32 N	48 GL	34 GL	36 TR	33 CO	50 Q	52 Q	38 Q	49 Q	35 Q	37 Q	54 PM	51 PM/PI	53 PM	39 PM	55 P
2 Y	64 N	80 GL	66 GL	68 TR	65 CO	82 Q	84 Q	70 Q	81 Q	67 Q	69 Q	86 PM	83 PM	85 PM/PI	71 PM	87 P
1 X	8 N	24 GL	10 GL	12 TR	9 CO	26 Q	28 Q	14 Q	25 Q	11 Q	13 Q	30 PM	27 PM	29 PM	15 PM/PI	31 P
0	0 PI	16 N	2 N	4 N	1 N	18 PR	20 EW	6 EW	17 EW	3 EW	5 DI	22 E	19 E	21 E	7 E	23 PM

PI: Primitive Idempotent | RO: Rotation boson/ghost | BO: Boost boson/ghost | TR: Translation boson/ghost
CO: Conformal boson/ghost | DI: Dilation boson/ghost | EW: Electroweak boson/ghost | GL: Gluon boson/ghost
PR: Propagator Phase | Q: Quark creation | E: Electron creation | N: Neutrino creation
AQ: Antiquark creation | P: Positron creation | AN: Antineutrino creation | PM: Position-Momentum
Wolfram Class 1 Rule | Wolfram Class 2 Rule | Wolfram Class 3 Rule | Wolfram Class 4 Rule

The line of symmetry for the Wolfram Rule Classes (diagonal line from rule 232 to rule 23) has the same rules as the line of symmetry for Rodrigo Obando's [13] rule space partitioning. However, the two lines of symmetry have the rules in different locations on the line. These line of symmetry rules are the rules that are their own negative transformation [4].

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