**Deriving E8 from Cl(8) through Pairing up Elementary Cellular Automata Bits**

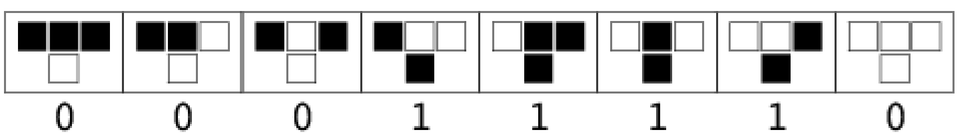
**By John C. Gonsowski**

## Abstract

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 a spacetime 8-dim position by 8-dim momentum. 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. Paired up CA bits are related to the Cartan subalgebras of these D4s. 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.

## Introduction

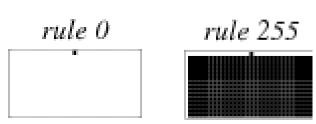
Tony Smith [1] relates the 256 dimensions of the Cl(8) Clifford Algebra to the 256 rules of Elementary Cellular Automata [2]. The graded dimensions of Cl(8) correspond to graded dimensions of the E8 Lie Algebra used in Smith's physics model. An 8-dim Primitive Idempotent half spinor along with the 248-dim 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 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.

## The Primitive Idempotent and Paired Up Cellular Automata

The grading of the 248-dim E8 in Smith's physics model is 28 64 64 64 28. The grading of the 8-dim Primitive Idempotent (PI) half spinor embedded with E8 in Cl(8) is 1 6 1. In Smith's physics, the PI performs a Standard Model Higgs-like role. The two ones of the PI grading fit with the rules having 0 of 8 ones and 8 of 8 ones:




00000000 11111111

The middle 6 of the PI grading adds to the middle 64 of the E8 grading to get the middle 70 of the Cl(8) grading. This middle 6 grading thus fits with 6 rules having four one-bits. It specifically fits with the 3+2+1=6 rules that have two pairs of bits that can pair up to form the Cartan subalgebra bivectors of Smith's model. The first two bits that pair up form the Y and X of an YX spatial rotation.

Y X

01000000 00001000

The next two bits to pair up form the temporal T and spatial Z of a Lorentz group TZ boost.

T Z

10000000 00100000

The next two bits to pair up use a Conformal group (C) basis vector and an Anti-DeSitter group (A) translation basis vector to form a dilation (CA). This dilation is the Higgs VEV in Smith's physics model.

C A

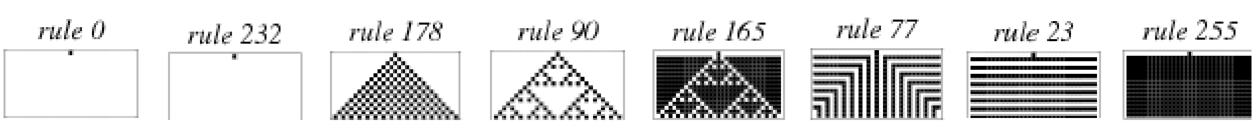
00000001 00000100

The final two bits to pair up 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).

M G

00000010 00010000

Using these paired up bits gives the following rules with four one-bits for the middle 6 grading of the 8-dim Primitive Idempotent bookended by the single rule with no one-bits and the single rule with all eight bits as ones.




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | TZYX | TZGM | YXGM | TZAC | YXAC | GMAC | TZYXGMAC |
| 00000000 | 11101000 | 10110010 | 01011010 | 10100101 | 01001101 | 00010111 | 11111111 |

**Rotations and Boosts**

As mentioned earlier, these paired up bits (TZ, YX, GM, and AC) are to be used for the Cartan subalgebra in Smith's physics model. Smith uses the Cartan subalgebra bivectors for the 28s in his E8 grading which match to the 28s in the Cl(8) grading. The E8 28s come from two D4 subalgebras. The Cartan subalgebra bivectors thus also relate to the axes of a 24-vertex, 4-dim 24-cell, D4's root vector polytope. The 28 Cellular Automata with 2 one-bits and the 28 CA with 6 one-bits will contain the Cartan subalgebra bivectors. Here are the three Lorentz Group gravity spatial rotation bivectors/double one-bits including the YX Cartan subalgebra one.


ZY ZX YX

01100000 00101000 01001000

Here are the three Lorentz group gravity boost bivectors/double one-bits including the TZ Cartan subalgebra one.


TZ TY TX

10100000 11000000 10001000

**Translations, Dilation and Special Conformal Transformations**

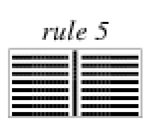
Here are the four Anti-DeSitter group gravity translation bivectors/double one-bits, the CA Cartan subalgebra dilation (Smith's Higgs VEV), and the four special conformal transformations (dark energy related for Smith).

Anti-DeSitter Translations:


TA ZA YA XA

10000100 00100100 01000100 00001100

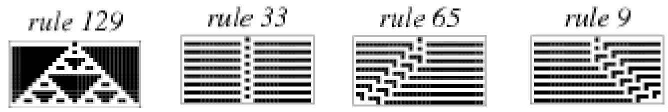
Cartan subalgebra Dilation:




CA

00000101

Conformal Transformations:

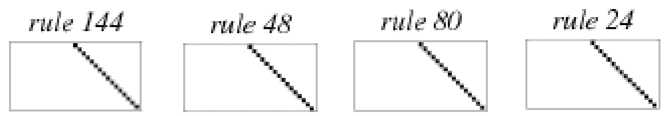



| TC | ZC | YC | XC |
|---|---|---|---|
| 10000001 | 00100001 | 01000001 | 00001001 |

**Ghosts for the Standard Model Bosons**

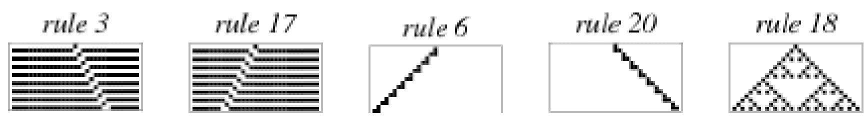
Here are the bivectors/double one-bits for the Standard Model Ghosts of Smith’s physics model plus the MG Cartan subalgebra propagator phase.

rgb/rg/rb/gb “half” Gluons:



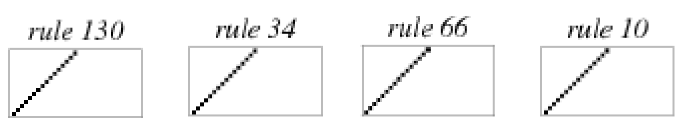

| TG | ZG | YG | XG |
|---|---|---|---|
| 10010000 | 00110000 | 01010000 | 00011000 |

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




| CM | CG | AM | AG | MG |
|---|---|---|---|---|
| 00000011 | 00010001 | 00000110 | 00010100 | 00010010 |

cmy/cm/cy/my “half” Gluons:

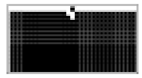


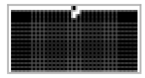

| TM | ZM | YM | XM |
|---|---|---|---|
| 10000010 | 00100010 | 01000010 | 00001010 |

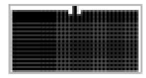
**Ghosts for Rotations and Boosts**

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 including the four Cartan subalgebra bivectors.

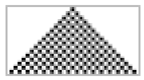
Besides using double zero-bits instead of double one-bits, this ghost boson-actual boson bivector mapping also exchanges XYZT vectors with GMAC vectors.  This may relate to how in Smith's model, the XYZT physical spacetime relates to the GMAC Kaluza-Klein internal symmetry space.  Here are the three Lorentz Group gravity spatial rotation bivectors/double zero-bit ghosts including the MG Cartan subalgebra one.

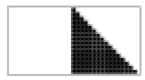
*rule 249*  AM 11111001

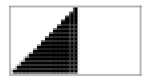
*rule 235*  AG 11101011

*rule 237*  MG 11101101

Here are the three Lorentz group gravity boost bivectors/double zero-bit ghosts including the CA Cartan subalgebra one.

*rule 250*  CA 11111010

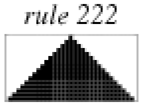
*rule 252*  CM 11111100

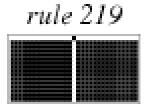
*rule 238*  CG 11101110

**Ghosts for the Translations, Dilation and Special Conformal Transformations**

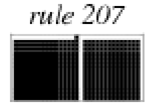
Here are the four Anti-DeSitter group gravity translation bivectors/double zero-bit ghosts, the TZ Cartan subalgebra dilation ghost (for Smith's Higgs VeV), and the four special conformal transformation ghosts (dark energy related for Smith).

Anti-DeSitter Translations:

*rule 222*  CZ 11011110

*rule 219*  AZ 11011011

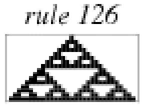
*rule 221*  MZ 11011101

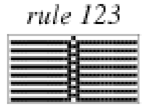
*rule 207*  GZ 11001111

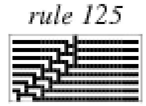
Cartan subalgebra Dilation:

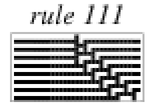
*rule 95*  TZ 01011111

Conformal Transformations:

*rule 126*  CT 01111110

*rule 123*  AT 01111011

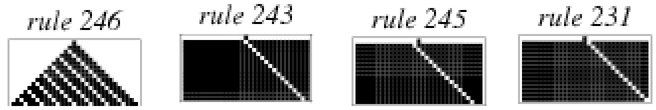
*rule 125*  MT 01111101

*rule 111*  GT 01101111

## Standard Model Bosons

Here are the bivectors/double zero-bits for the Standard Model bosons of Smith’s physics model plus the YX Cartan subalgebra propagator phase ghost.

rgb/rg/rb/gb “half” Gluons:

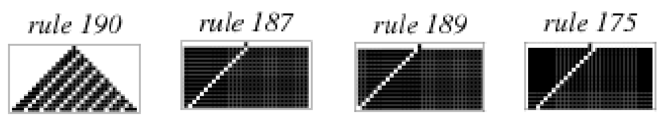



| | | | |
|---|---|---|---|
| CX | AX | MX | GX |
| 11110110 | 11110011 | 11110101 | 11100111 |

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


| | | | | |
|---|---|---|---|---|
| TY | TX | ZY | ZX | YX |
| 00111111 | 01110111 | 10011111 | 11010111 | 10110111 |

cmy/cm/cy/my “half” Gluons:



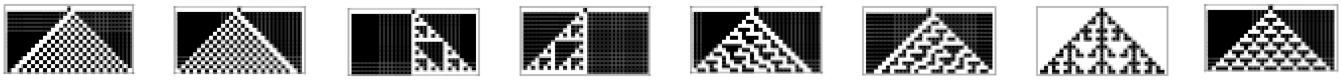

| | | | |
|---|---|---|---|
| CY | AY | MY | GY |
| 10111110 | 10111011 | 10111101 | 10101111 |

There’s a pattern where rules that slant to the left vs. slanting to the right relate to charge for the Standard Model bosons and direction change (like X vs. Y) for gravity bosons. This perhaps relates to how charge, mass, and change of direction are related in Smith’s 4-dim Feynman Checkerboard.

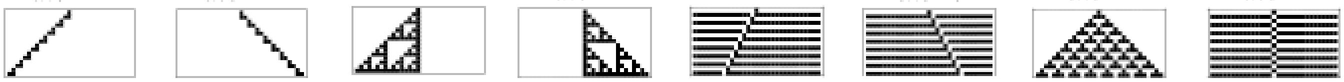
## Spacetime Position and Momentum

Subtracting the 6 middle grade of the Primitive Idempotent 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. This 64-dim part of E8 thus relates to the 4-vector/four one-bit Cellular Automata rules not used for the Primitive Idempotent. The position and momentum are 8-dim due to the GMAC Kaluza-Klein internal symmetry space added to the XYZT physical spacetime.

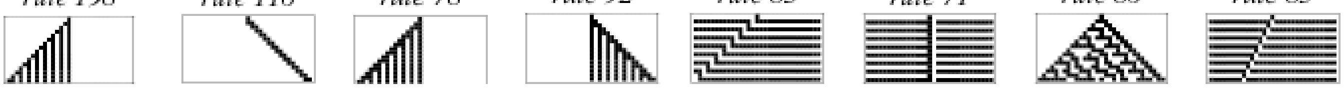
| | T | Z | Y | X | G | M | A | C |
|---|---|---|---|---|---|---|---|---|



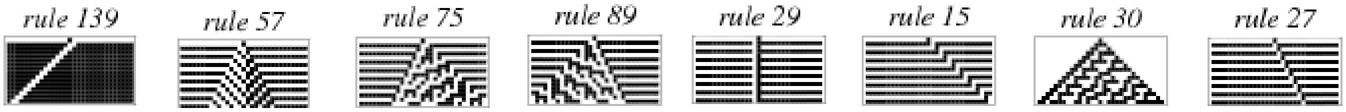
| T | rule 163 | rule 177 | rule 195 | rule 153 | rule 149 | rule 135 | rule 150 | rule 147 |
|---|---|---|---|---|---|---|---|---|
| | TZMC | TZGC | TYMC | TXGC | TGAC | TMAC | TGMA | TGMC |
| | 10100011 | 10110001 | 11000011 | 10011001 | 10010101 | 10000111 | 10010110 | 10010011 |



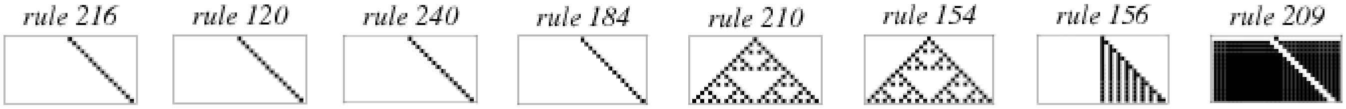
| Z | rule 166 | rule 180 | rule 102 | rule 60 | rule 53 | rule 39 | rule 54 | rule 51 |
|---|---|---|---|---|---|---|---|---|
| | TZMA | TZGA | ZYMA | ZXGA | ZGAC | ZMAC | ZGMA | ZGMC |
| | 10100110 | 10110100 | 01100110 | 00111100 | 00110101 | 00100111 | 00110110 | 00110011 |



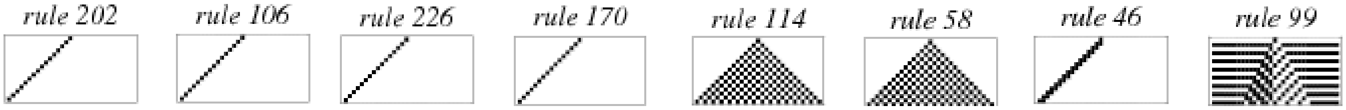
| Y | rule 198 | rule 116 | rule 78 | rule 92 | rule 85 | rule 71 | rule 86 | rule 83 |
|---|---|---|---|---|---|---|---|---|
| | TYMA | ZYGA | YXMA | YXGA | YGAC | YMAC | YGMA | YGMC |
| | 11000110 | 01110100 | 01001110 | 01011100 | 01010101 | 01000111 | 01010110 | 01010011 |



| X | rule 139 | rule 57 | rule 75 | rule 89 | rule 29 | rule 15 | rule 30 | rule 27 |
|---|---|---|---|---|---|---|---|---|
| | TXMC | ZXGC | YXMC | YXGC | XGAC | XMAC | XGMA | XGMC |
| | 10001011 | 00111001 | 01001011 | 01011001 | 00011101 | 00001111 | 00011110 | 00011011 |



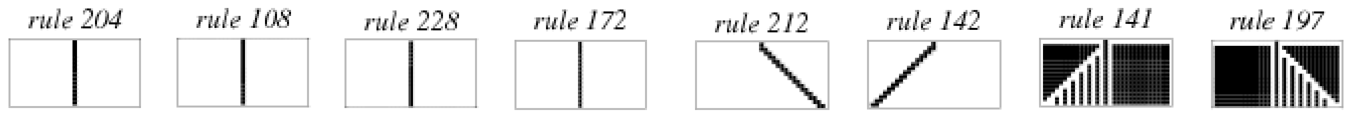
| G | rule 216 | rule 120 | rule 240 | rule 184 | rule 210 | rule 154 | rule 156 | rule 209 |
|---|---|---|---|---|---|---|---|---|
| | TYXG | ZYXG | TZYG | TZXG | TYGM | TXGM | TXGA | TYGC |
| | 11011000 | 01111000 | 11110000 | 10111000 | 11010010 | 10011010 | 10011100 | 11010001 |



| M | rule 202 | rule 106 | rule 226 | rule 170 | rule 114 | rule 58 | rule 46 | rule 99 |
|---|---|---|---|---|---|---|---|---|
| | TYXM | ZYXM | TZYM | TZXM | ZYGM | ZXGM | ZXMA | ZYMC |
| | 11001010 | 01101010 | 11100010 | 10101010 | 01110010 | 00111010 | 00101110 | 01100001 |

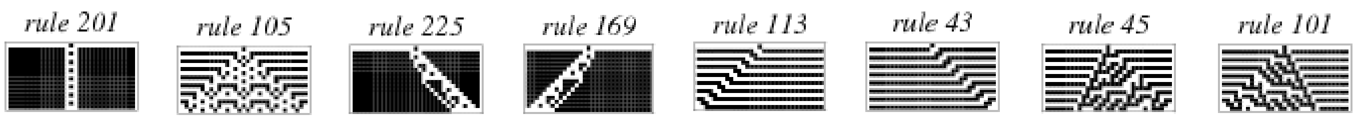
| | T | Z | Y | X | G | M | A | C |
|---|---|---|---|---|---|---|---|---|

A




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TYXA | ZYXA | TZYA | TZXA | TYGA | TXMA | TXAC | TYAC |
| 11001100 | 01101100 | 11100100 | 10101100 | 11010100 | 10001110 | 10001101 | 11000101 |

C



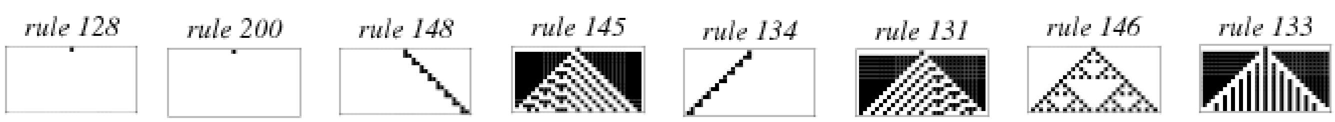

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TYXC | ZYXC | TZYC | TZXC | ZYGC | ZXMC | ZXAC | ZYAC |
| 11001001 | 01101001 | 11100001 | 10101001 | 01110001 | 00101011 | 00101101 | 01100101 |

**Spacetime Components of Fermion Creation Operators**

The two remaining 64s in the E8 grading of Smith's model are for 8 spacetime 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.

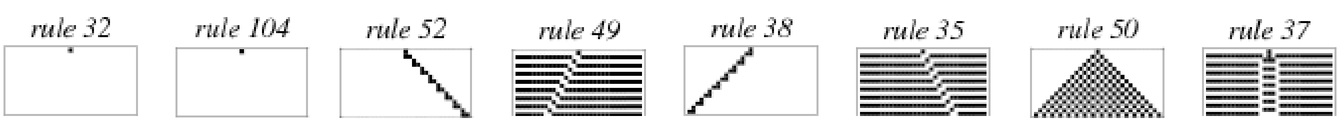
| Neutrino | Quark | Quark | Quark | Quark | Quark | Quark | Electron |
|---|---|---|---|---|---|---|---|

T



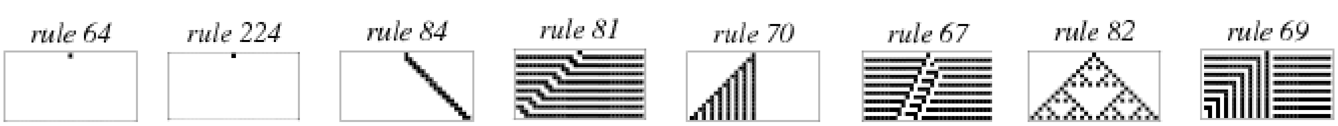

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| T | TYX | TGA | TGC | TMA | TMC | TGM | TAC |
| 10000000 | 11001000 | 10010100 | 10010001 | 10000110 | 10000011 | 10010010 | 10000101 |

Z

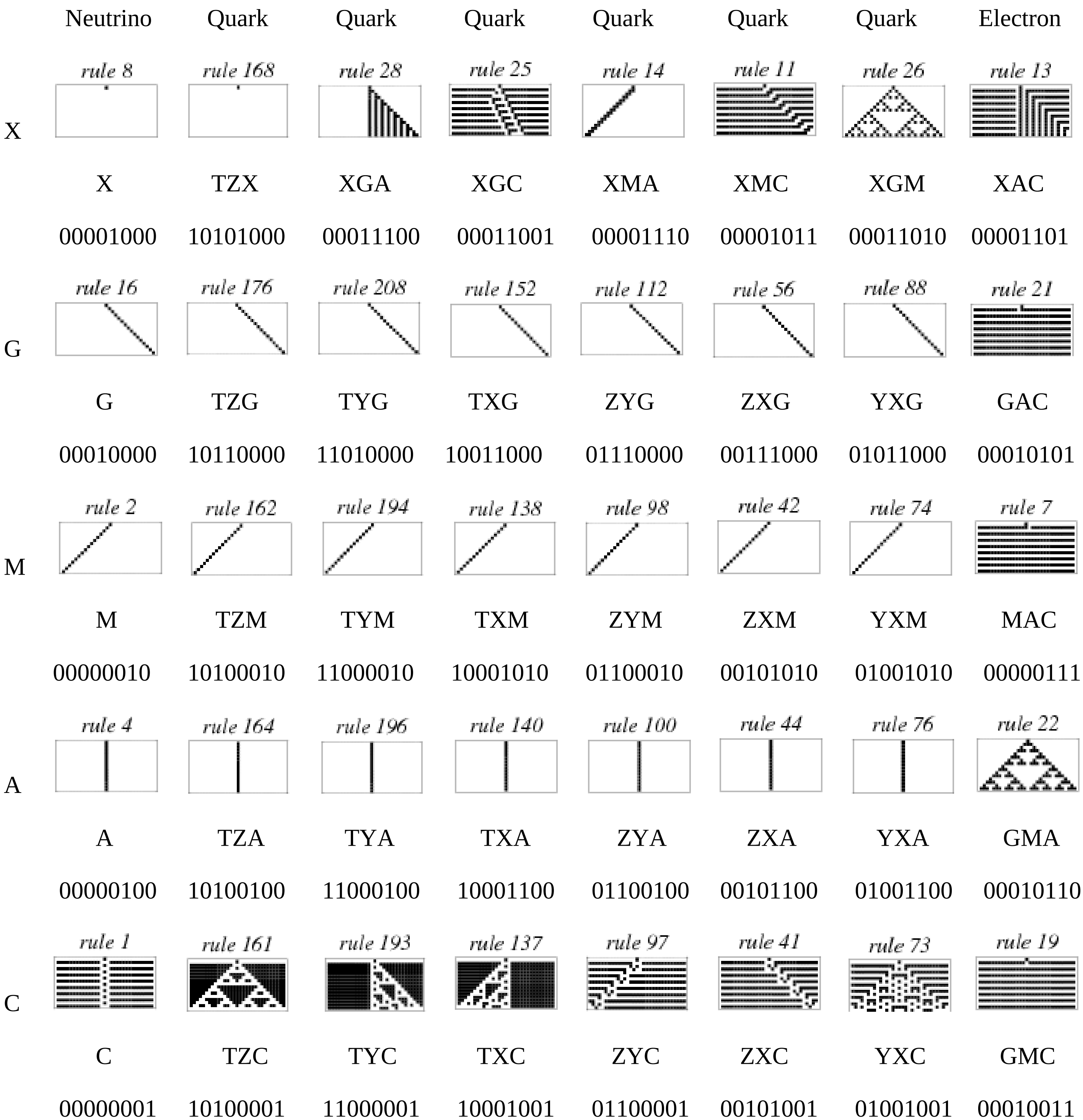



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Z | ZYX | ZGA | ZGC | ZMA | ZMC | ZGM | ZAC |
| 00100000 | 01101000 | 00110100 | 00110001 | 00100110 | 00100011 | 00110010 | 00100101 |

Y



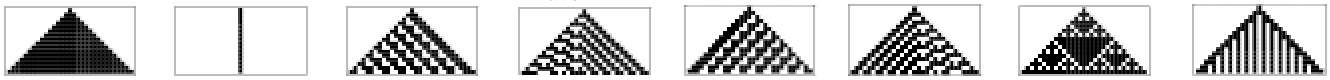

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Y | TZY | YGA | YGC | YMA | YMC | YGM | YAC |
| 01000000 | 11100000 | 01010100 | 01010001 | 01000110 | 01000011 | 01010010 | 01000101 |



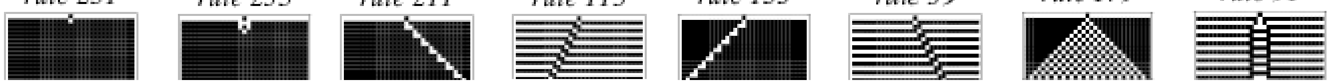

**Spacetime Components of Antifermion Creation Operators**

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 uses zero-bits instead of one-bits and exchanges XYZT vectors with GMAC vectors.

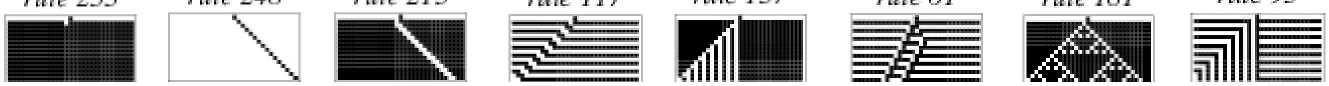
| | Antineutrino | Antiquark | Antiquark | Antiquark | Antiquark | Antiquark | Antiquark | Positron |
|---|---|---|---|---|---|---|---|---|
| | rule 254 | rule 236 | rule 214 | rule 118 | rule 158 | rule 62 | rule 182 | rule 94 |



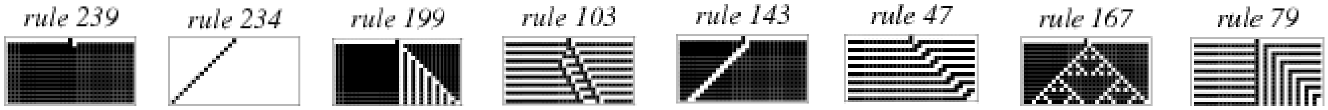
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| T | C | CMG | CXZ | CXT | CYZ | CYT | CXY | CZT |
| | 11111110 | 11101100 | 11010110 | 01110110 | 10011110 | 00111110 | 10110110 | 01011110 |
| | rule 251 | rule 233 | rule 211 | rule 115 | rule 155 | rule 59 | rule 179 | rule 91 |



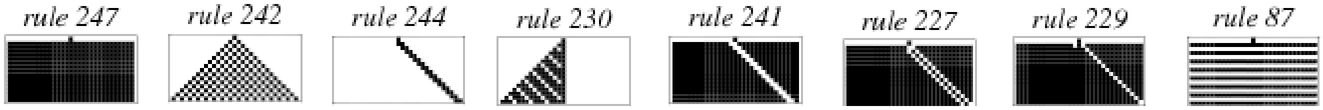
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Z | A | AMG | AXZ | AXT | AYZ | AYT | AXY | AZT |
| | 11111011 | 11101001 | 11010011 | 01110011 | 10011011 | 00111011 | 10110011 | 01011011 |
| | rule 253 | rule 248 | rule 213 | rule 117 | rule 157 | rule 61 | rule 181 | rule 93 |



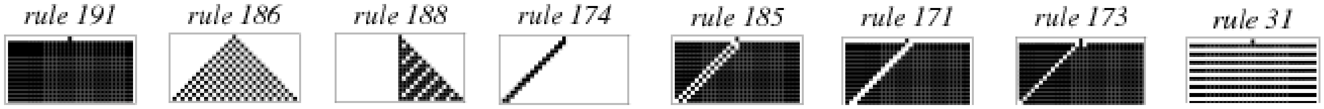
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Y | M | CAM | MXZ | MXT | MYZ | MYT | MXY | MZT |
| | 11111101 | 11111000 | 11010101 | 01110101 | 10011101 | 00111101 | 10110101 | 01011101 |
| | rule 239 | rule 234 | rule 199 | rule 103 | rule 143 | rule 47 | rule 167 | rule 79 |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| X | G | CAG | GXZ | GXT | GYZ | GYT | GXY | GZT |
| | 11101111 | 11101010 | 11000111 | 01100111 | 10001111 | 00101111 | 10100111 | 01001111 |
| | rule 247 | rule 242 | rule 244 | rule 230 | rule 241 | rule 227 | rule 229 | rule 87 |



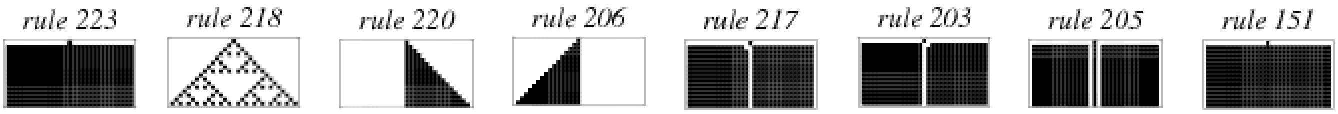
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| G | X | CAX | CMX | CGX | AMX | AGX | MGX | XZT |
| | 11110111 | 11110010 | 11110100 | 11100110 | 11110001 | 11100011 | 11100101 | 01010111 |
| | rule 191 | rule 186 | rule 188 | rule 174 | rule 185 | rule 171 | rule 173 | rule 31 |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| M | Y | CAY | CMY | CGY | AMY | AGY | MGY | YZT |
| | 10111111 | 10111010 | 10111100 | 10101110 | 10111001 | 10101011 | 10101101 | 00011111 |

| Antineutrino | Antiquark | Antiquark | Antiquark | Antiquark | Antiquark | Antiquark | Positron |
|---|---|---|---|---|---|---|---|

A




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Z | CAZ | CMZ | CGZ | AMZ | AGZ | MGZ | XYZ |
| 11011111 | 11011010 | 11011100 | 11001110 | 11011001 | 11001011 | 11001101 | 10010111 |

C


| | | | | | | | |
|---|---|---|---|---|---|---|---|
| T | CAT | CMT | CGT | AMT | AGT | MGT | XYT |
| 01111111 | 01111010 | 01111100 | 01101110 | 01111001 | 01101011 | 01101101 | 00110111 |

The different slants mentioned earlier for the G vs. M and X vs. Y bits may relate to up vs down for quarks and antiquarks as well as effecting patterns in general (along with the A/Z bit's straight line and the C/T bit's chaos) for bosons, position-momentum, and fermions/antifermions. The X-Y-Z and G-M-A bits may relate to color for quarks and antiquarks.

## References

1. http://vixra.org/pdf/1602.0319v3.pdf
2. http://mathworld.wolfram.com/ElementaryCellularAutomaton.html
3. http://vixra.org/pdf/0910.0023v4.pdf