

# Tony Smith's Cl(8) Physics Model with AI Comparison to Arkadiusz Jadczyk's Event Enhanced Quantum Theory

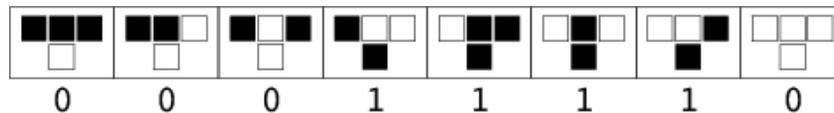
John C. Gonsowski

## Abstract

This paper describes Cl(8) physics via the eight 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 two Cellular Automata (CA) rules with no one-bits (Cl(8) Higgs scalar) and all eight bits as ones (Cl(8) 8-vector Higgs pseudoscalar). The 70 CA rules with four one-bits (Cl(8) 4-vectors) are related to Smith's use of the Kaca Bradonjic/John Stachel differential geometry and position-momentum operators for a phase space. The two 28-dim Cl(8) bivectors/6-vectors are used for creation/annihilation bosonic operators and relate to the CA rules with two one-bits and six one-bits. The remaining Cl(8) odd grade dimensions are used for eight component fermions/antifermions and relate to the CA rules with one, three, five and seven one-bits. This model is compared to Arkadiusz Jadczyk's Event Enhanced Quantum Theory (EEQT) using AI.

## 1. Introduction

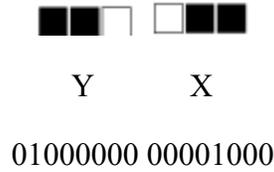
Tony Smith [1] relates the 256 dimensions of the Cl(8) Clifford Algebra to the 256 rules of Elementary Cellular Automata [2]. The grading of this Cl(8) is 1 8 28 56 70 56 28 8 1 which sum to the 256 dimensions. This grading gives the quantity of Cellular Automata (CA) rules that have the number of one-bits from zero to eight.



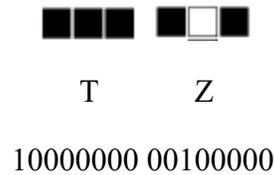
The rule above is called rule 30 because the 4 one-bits produce a binary  $2+4+8+16=30$ . The Cl(8) grading indicates there are 70 rules with 4 of the 8 bits being a one. In other words there are 70 ways to place 4 ones in the 8 bits to form a rule. The bits for the rule represent the next state value 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.

## 2. Relating Basis Vectors to Cellular Automata Bits

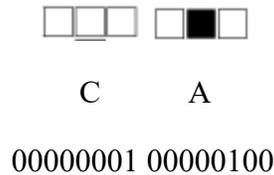
Two CA bits are related via Smith's model to the Y and X basis vectors of a YX spatial rotation [3].



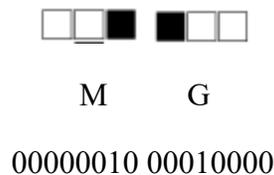
Two CA bits are related to the temporal T and spatial Z basis vectors of a Lorentz group TZ boost.



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.

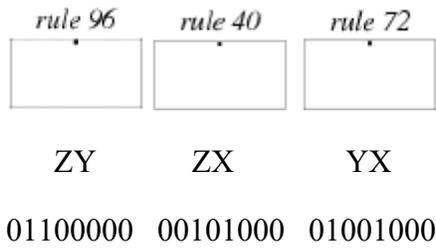


The final two CA bits allow Standard Model Ghosts in Smith's physics using basis vectors M (magenta/minus for strong force anticolor and weak force negative charge) and G (green/greater than zero for strong force color/weak force positive charge). The MG bivector is a propagator phase in Smith's model.

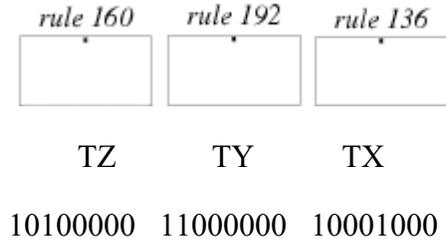


## 3. Rotations and Boosts

The two 28s in the Cl(8) grading, the bivectors and the 6-vectors, match to the 28 Cellular Automata with 2 one-bits and the 28 CA with 6 one-bits. Here are the three Lorentz Group gravity spatial rotation [3] bivectors/double one-bits.

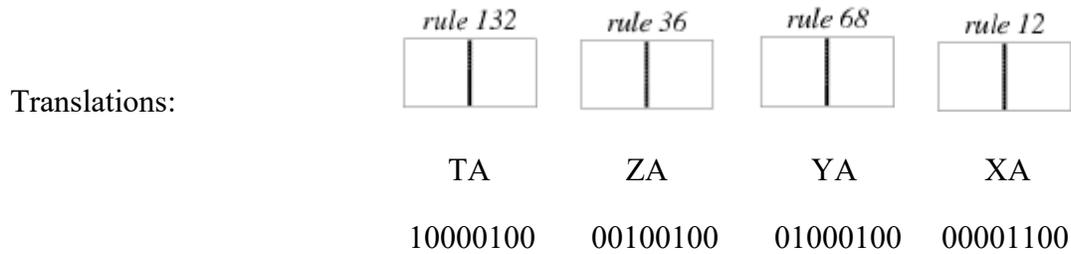


Here are the three Lorentz group gravity boost bivectors/double one-bits.

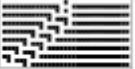
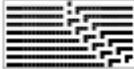


#### 4. Translations, Dilation and Special Conformal Transformations

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).



Conformal Transformations:

<i>rule 129</i>	<i>rule 33</i>	<i>rule 65</i>	<i>rule 9</i>
			
TC	ZC	YC	XC
10000001	00100001	01000001	00001001

### 5. Standard Model Bosons and Propagator Phase

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

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

<i>rule 144</i>	<i>rule 48</i>	<i>rule 80</i>	<i>rule 24</i>
			
TG	ZG	YG	XG
10010000	00110000	01010000	00011000

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

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

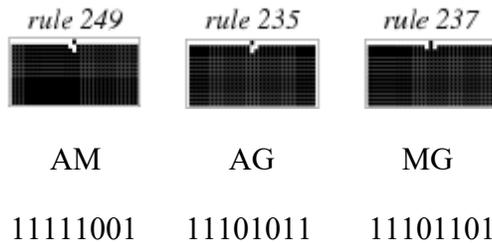
cmy/cm/cy/my "half" Gluons:

<i>rule 130</i>	<i>rule 34</i>	<i>rule 66</i>	<i>rule 10</i>
			
TM	ZM	YM	XM
10000010	00100010	01000010	00001010

## 6. Rotations and Boosts Annihilation Operators

The above conformal gravity and Standard Model bivectors can be considered as creation operators that fit with the 28 Cellular Automata rules with double one-bits. These 28 CA relate to the first 28 in the  $Cl(8)$  grading. The conformal gravity and Standard Model bivectors that fit with the 28 CA with six one-bits can be considered as annihilation operators. These CA relate to the second 28 in the  $Cl(8)$  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 conformal gravity and Standard Model annihilation operators.

Besides using double zero-bits instead of double one-bits, this annihilation to creation bivector operator mapping also exchanges XYZT vectors with GMAC vectors thus forming a CA negative transformation [4]. Here are the three Lorentz Group gravity spatial rotation bivectors/double zero-bit annihilation operators.



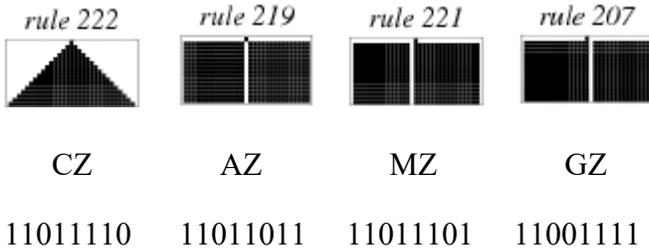
Here are the three Lorentz group gravity boost bivectors/double zero-bit annihilation operators.



## 7. Translation, Dilation and Conformal Annihilation Operators

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

Translations:



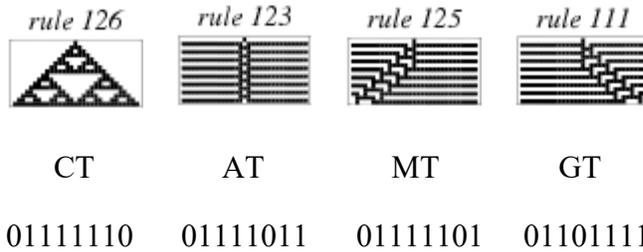
Dilation:



TZ

01011111

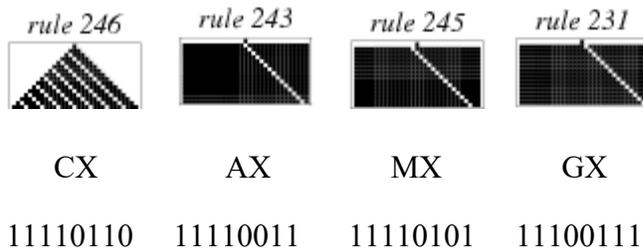
Conformal Transformations:



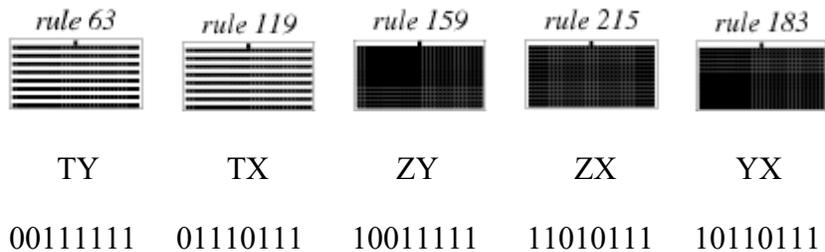
## 8. Standard Model and Propagator Phase Annihilation Operators

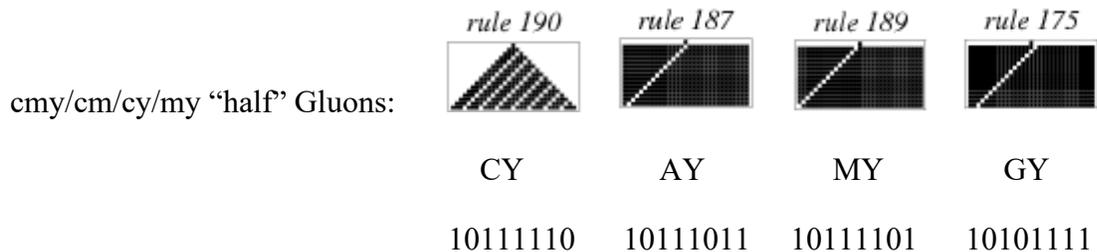
Here are the bivectors/double zero-bits for the Standard Model boson and propagator phase annihilation operators of Smith's physics model.

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



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

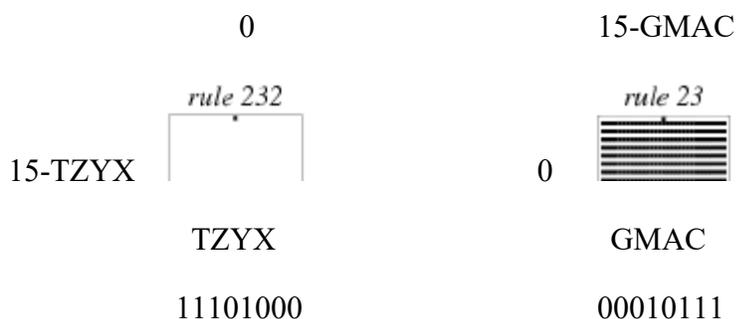




There’s a reflection transformation [4] bit pattern where rules that slant to the left vs. slanting to the right relate to charge (G vs. M) for the Standard Model bosons and direction change (X vs. Y) for gravity bosons.

### 9. The Primitive Idempotent and Spacetime Position and Momentum

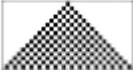
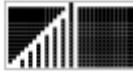
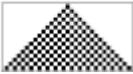
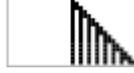
The grading of the 8-dim Primitive Idempotent (PI) half spinor embedded in Cl(8) is 1 6 1. The 6-dim PI middle grade from the Cl(8) middle grade is the lower left to upper right diagonal of the 6x6 matrix below. The two ones of the PI grading are the CA rules with no one-bits (Cl(8) Higgs scalar) and all eight bits as ones (Cl(8) 8-vector Higgs pseudoscalar). The upper left to lower right diagonals of the two 4x4 matrices below form another PI half spinor that is part of the middle grade 4-vectors. Both PI half spinors fit with the 16 Pertti Lounesto terms using basis vectors MGCATYZX [6]. The 70 Cl(8) middle grade 4-vectors give position and momentum phase space operators in Smith’s model [5] as well as a Kaca Bradonjic/John Stachel differential geometry [7]. The spacetime is 8-dim due to the GMAC Kaluza-Klein internal symmetry space added to the XYZT physical spacetime in Smith’s model.

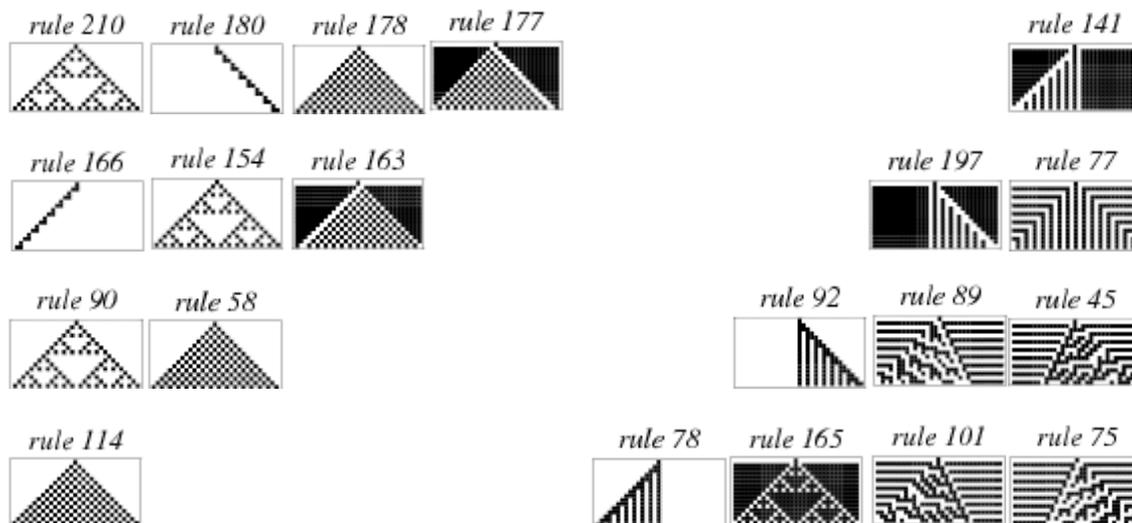


The two rules above represent to the 4-vector element for physical spacetime and its Hodge dual, a 4-vector element for internal symmetry space. The rule thumbnail columns below closely match the ones for gluons, translations, and special conformal transformation creation operators described earlier. Here they represent an SU(3) Yang-Mills connection [8] and part of a conformal metric G-structure group [7]. The code is such that, for example, an XG gluon from earlier would be a TZYG gluon here aka the X came from a zero-bit.

	1-G	2-M	4-A	8-C
	<i>rule 240</i>	<i>rule 226</i>	<i>rule 228</i>	<i>rule 225</i>
14-TZY				
	TZYG	TZYM	TZYA	TZYC
	11110000	11100010	11100100	11100001
	<i>rule 184</i>	<i>rule 170</i>	<i>rule 172</i>	<i>rule 169</i>
13-TZX				
	TZXG	TZXM	TZX A	TZXC
	10111000	10101010	10101100	10101001
	<i>rule 216</i>	<i>rule 202</i>	<i>rule 204</i>	<i>rule 201</i>
11-TYX				
	TYXG	TYXM	TYXA	TYXC
	11011000	11001010	11001100	11001001
	<i>rule 120</i>	<i>rule 106</i>	<i>rule 108</i>	<i>rule 105</i>
7-ZYX				
	ZYXG	ZYXM	ZYXA	ZYXC
	01111000	01101010	01101100	01101001

The 6x6 block below represents 36 generators for  $Sp(8, \mathbb{R})$ , the structure group for a phase space with the symplectic structure  $X \wedge G + Y \wedge M + Z \wedge A + T \wedge C$  [9] formed from the physical spacetime 4-vector and its Hodge dual mentioned above. The 36 generators are 16 for the 4x4 general matrix at the center of the 6x6 block and two 10 generator symmetric matrices shown below after the 6x6 block with 4x4 center. The symmetric matrices are made from the 20 generators on the edge of the 6x6 block.

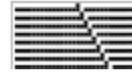
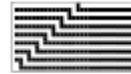
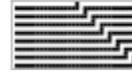
	3-GM	5-GA	6-MA	9-GC	10-MC	12-AC
	<i>rule 178</i>	<i>rule 180</i>	<i>rule 166</i>	<i>rule 177</i>	<i>rule 163</i>	<i>rule 165</i>
12-TZ						
	TZGM	TZGA	TZMA	TZGC	TZMC	TZAC
	10110010	10110100	10100110	10110001	10100011	10100101
	<i>rule 210</i>	<i>rule 212</i>	<i>rule 198</i>	<i>rule 209</i>	<i>rule 195</i>	<i>rule 197</i>
10-TY						
	TYGM	TYGA	TYMA	TYGC	TYMC	TYAC
	11010010	11010100	11000110	11010001	11000011	11000101
	3-GM	5-GA	6-MA	9-GC	10-MC	12-AC
	<i>rule 154</i>	<i>rule 156</i>	<i>rule 142</i>	<i>rule 153</i>	<i>rule 139</i>	<i>rule 141</i>
9-TX						
	TXGM	TXGA	TXMA	TXGC	TXMC	TXAC
	10011010	10011100	10001110	10011001	10001011	10001101
	<i>rule 114</i>	<i>rule 116</i>	<i>rule 102</i>	<i>rule 113</i>	<i>rule 99</i>	<i>rule 101</i>
6-ZY						
	ZYGM	ZYGA	ZYMA	ZYGC	ZYMC	ZYAC
	01110010	01110100	01100110	01110001	01100001	01100101
	<i>rule 58</i>	<i>rule 60</i>	<i>rule 46</i>	<i>rule 57</i>	<i>rule 43</i>	<i>rule 45</i>
5-ZX						
	ZXGM	ZXGA	ZXMA	ZXGC	ZXMC	ZXAC
	00111010	00111100	00101110	00111001	00101011	00101101
	<i>rule 90</i>	<i>rule 92</i>	<i>rule 78</i>	<i>rule 89</i>	<i>rule 75</i>	<i>rule 77</i>
3-YX						
	YXGM	YXGA	YXMA	YXGC	YXMC	YXAC
	01011010	01011100	01001110	01011001	01001011	01001101



Note that the 4x4 general matrix and the two symmetric matrices have similar patterns in that the matching inverse thumbnail shapes are directly diagonal from each other and the four shapes for the diagonals all have similar shapes in their respective matrix.

The 4x4 Hodge Star map-like block below has an upper left to lower right conformal metric primitive idempotent diagonal [8]. This diagonal splits the block into two six-dimensional corners, one for the G-Structure conformal group's rotations and boosts and the other for the differential forms for the photon, Z<sup>0</sup>, W<sup>-</sup>, W<sup>+</sup>, Dilation Higgs VEV, and the propagator phase affine solder one-form [8]. The code to relate to the previous creation operators is such that, for example, GMA would represent C aka it is a zero-bit plus the X, Y, Z, T would as needed represent G, M, A, C and vice versa.

7-GMA    11-GMC    13-GAC    14-MAC

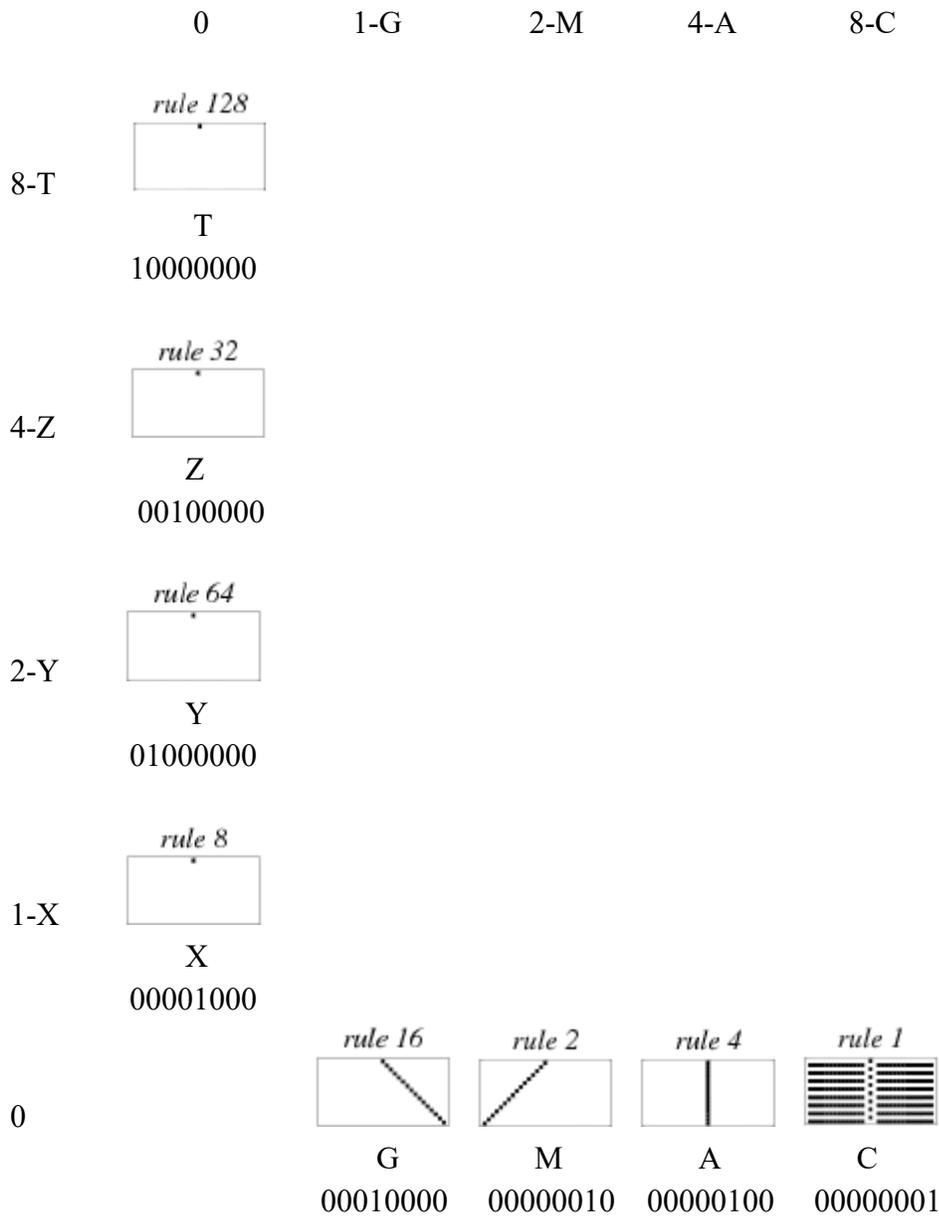
	<i>rule 150</i>	<i>rule 147</i>	<i>rule 149</i>	<i>rule 135</i>
8-T				
	TGMA	TGMC	TGAC	TMAC
	10010110	10010011	10010101	10000111
	<i>rule 54</i>	<i>rule 51</i>	<i>rule 53</i>	<i>rule 39</i>
4-Z				
	ZGMA	ZGMC	ZGAC	ZMAC
	00110110	00110011	00110101	00100111
	<i>rule 86</i>	<i>rule 83</i>	<i>rule 85</i>	<i>rule 71</i>
2-Y				
	YGMA	YGMC	YGAC	YMAC
	01010110	01010011	01010101	01000111
	<i>rule 30</i>	<i>rule 27</i>	<i>rule 29</i>	<i>rule 15</i>
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 scalar and pseudoscalar related:

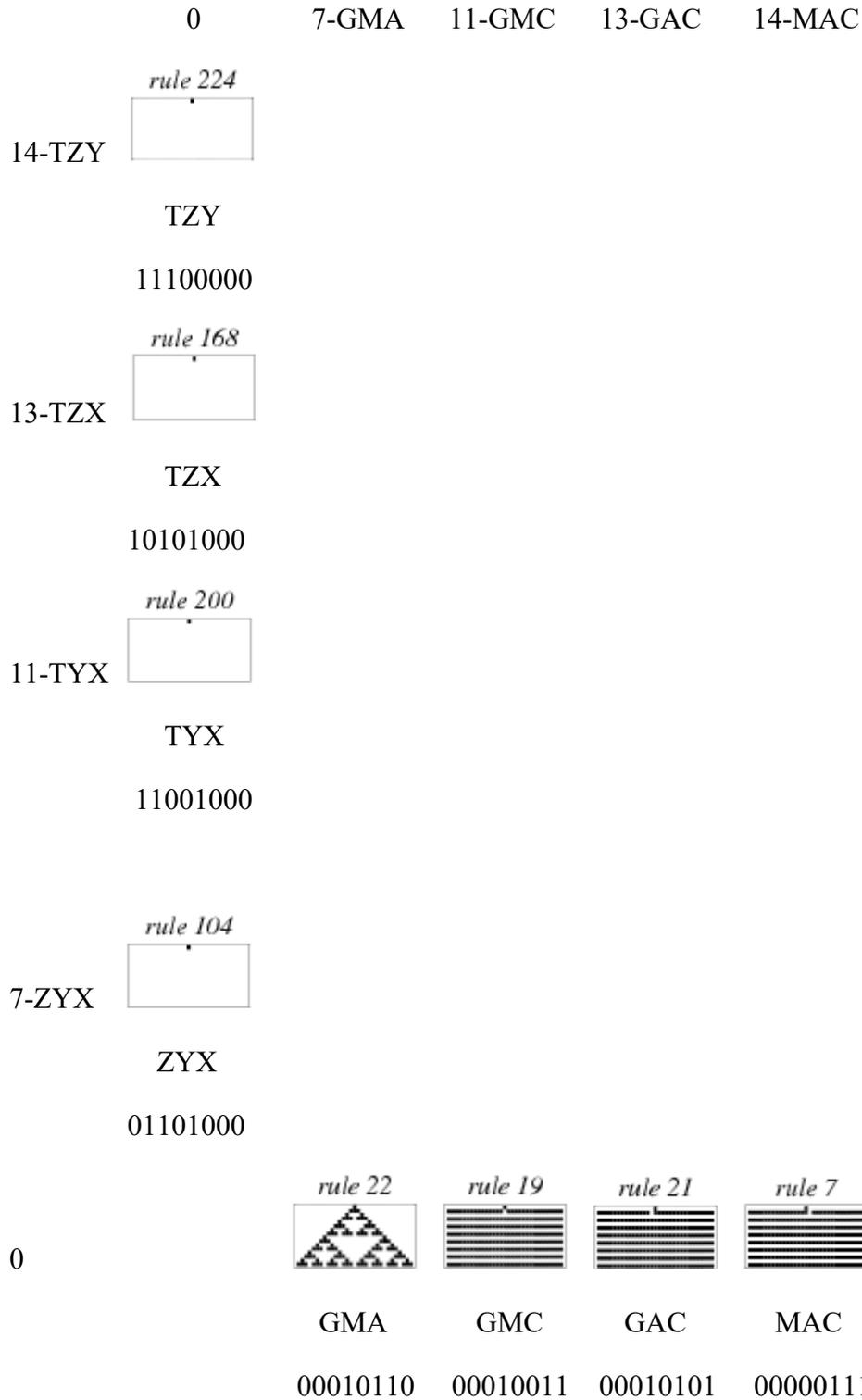
<i>rule 0</i>	<i>rule 255</i>
	
	TZYXGMAC
00000000	11111111

## 10. Spacetime Components of Fermion Creation Operators

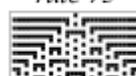
The remaining Cl(8) odd grades in Smith's model are for 8 spacetime direction angular momentum components of fermion creation (aka antifermion annihilation) operators and 8 spacetime components of antifermion creation (aka fermion annihilation) operators. The grading for fermion creation comes from the 8 Cl(8) vectors plus the 56 Cl(8) 3-vectors. Thus fermion creation relates 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.

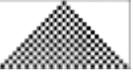
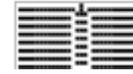


Here are the rules for the electron creation operator. The spacetime direction for the angular momentum would be a zero-bit (i.e. X for TZY or C for GMA).



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).

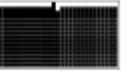
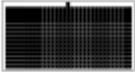
	1-G	2-M	4-A	8-C
12-TZ	<i>rule 176</i>  TZG 10110000	<i>rule 162</i>  TZM 10100010	<i>rule 164</i>  TZA 10100100	<i>rule 161</i>  TZC 10100001
10-TY	<i>rule 208</i>  TYG 11010000	<i>rule 194</i>  TYM 11000010	<i>rule 196</i>  TYA 11000100	<i>rule 193</i>  TYC 11000001
9-TX	<i>rule 152</i>  TXG 10011000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

	3-GM	5-GA	6-MA	9-GC	10-MC	12-AC
	<i>rule 146</i>	<i>rule 148</i>	<i>rule 134</i>	<i>rule 145</i>	<i>rule 131</i>	<i>rule 133</i>
8-T						
	TGM	TGA	TMA	TGC	TMC	TAC
	10010010	10010100	10000110	10010001	10000011	10000101
	<i>rule 50</i>	<i>rule 52</i>	<i>rule 38</i>	<i>rule 49</i>	<i>rule 35</i>	<i>rule 37</i>
4-Z						
	ZGM	ZGA	ZMA	ZGC	ZMC	ZAC
	00110010	00110100	00100110	00110001	00100011	00100101
	<i>rule 82</i>	<i>rule 84</i>	<i>rule 70</i>	<i>rule 81</i>	<i>rule 67</i>	<i>rule 69</i>
2-Y						
	YGM	YGA	YMA	YGC	YMC	YAC
	01010010	01010100	01000110	01010001	01000011	01000101
	<i>rule 26</i>	<i>rule 28</i>	<i>rule 14</i>	<i>rule 25</i>	<i>rule 11</i>	<i>rule 13</i>
1-X						
	XGM	XGA	XMA	XGC	XMC	XAC
	00011010	00011100	00001110	00011001	00001011	00001101

## 11. Spacetime Components of Antifermion Creation Operators

The grading for antifermion creation operators 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 creation to annihilation boson mapping done earlier, the fermion to antifermion mapping is a negative transformation [4].

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).

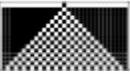
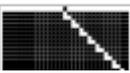
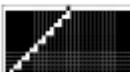
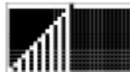
	7-GMA	11-GMC	13-GAC	14-MAC	15-GMAC
15-TZYX	<i>rule 254</i> 	<i>rule 251</i> 	<i>rule 253</i> 	<i>rule 239</i> 	
	TZYXGMA	TZYXGMC	TZYXGAC	TZYXMAC	
	11111110	11111011	11111101	11101111	
14-TZY					<i>rule 247</i> 
					TZYGMAC
					11110111
13-TZX					<i>rule 191</i> 
					TZXGMAC
					10111111
11-TYX					<i>rule 223</i> 
					TYXGMAC
					10111111
7-ZYX					<i>rule 127</i> 
					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
	<i>rule 248</i>	<i>rule 234</i>	<i>rule 236</i>	<i>rule 233</i>	
15-TZYX					
	TZYXG	TZYXM	TZYXA	TZYXC	
	11111000	11101010	11101100	11101001	
					<i>rule 151</i>
8-T					
					TGMAC
					10010111
					<i>rule 55</i>
4-Z					
					ZGMAC
					00110111
					<i>rule 87</i>
2-Y					
					YGMAC
					01010111
					<i>rule 31</i>
1-X					
					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
	<i>rule 242</i>	<i>rule 244</i>	<i>rule 230</i>	<i>rule 241</i>	<i>rule 227</i>	<i>rule 229</i>
14-TZY						
	TZYGM	TZYGA	TZYMA	TZYG C	TZYMC	TZYAC
	11110010	11110100	11100110	11110001	11100011	11100101
	<i>rule 186</i>	<i>rule 188</i>	<i>rule 174</i>	<i>rule 185</i>	<i>rule 171</i>	<i>rule 173</i>
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
	<i>rule 218</i>	<i>rule 220</i>	<i>rule 206</i>	<i>rule 217</i>	<i>rule 203</i>	<i>rule 205</i>
11-TYX						
	TYXGM	TYXGA	TYXMA	TYXGC	TYXMC	TYXAC
	11011010	11011100	11001110	11011001	11001011	11001101
	<i>rule 122</i>	<i>rule 124</i>	<i>rule 110</i>	<i>rule 121</i>	<i>rule 107</i>	<i>rule 109</i>
7-ZYX						
	ZYXGM	ZYXGA	ZYXMA	ZYXGC	ZYXMC	ZYXAC
	01111010	01111100	01101110	01111001	01101011	01101101

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

	0	1	2	4	8	3	5	6	9	10	12	7	11	13	14	15
		G	M	A	C	GM	GA	MA	GC	MC	AC	GMA	GMC	GAC	MAC	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 PM/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 PM/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 PM/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 PM/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 PM/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 PM/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  
CO: Conformal boson/ghost  
PR: Propagator Phase  
AQ: Antiquark creation

RO: Rotation boson/ghost  
DI: Dilation boson/ghost  
Q: Quark creation  
P: Positron creation

BO: Boost boson/ghost  
EW: Electroweak boson/ghost  
E: Electron creation  
AN: Antineutrino creation

TR: Translation boson/ghost  
GL: Gluon boson/ghost  
N: Neutrino 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 [12] 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].

This Cl(8) model does include Lorentz group bivectors (creation operators) as well as Lorentz group pseudobivectors (grade 6 for annihilation operators) but also attempts to have a grade 4

Lorentz group for differential geometry in an Arkadiusz Jadczyk EEQT inspired sense where you have both a quantum Fock space sector and a classical differential geometry sector. Jadczyk likes to use a central algebra for the classical sector and I'm looking at the  $Cl(8)$  middle grade for this. The idea is that say for the boosts you have  $Xxyz$ ,  $Yxyz$ , and  $Zxyz$  where  $X$ ,  $Y$  and  $Z$  are like you have for a spatial vector of the bivector Lorentz group while the  $xyz$  would be like a pseudovector version of the time vector for a Lorentz group bivector. I would also like a 4-dimensional metric and am thinking of  $Xyzt$ ,  $Yxzt$ ,  $Zxyt$  and  $Txyz$  for this. On a Hodge Star map-like view, it shows up on a diagonal where the grade 4 version of the Lorentz group also shows up at the corner of this  $4 \times 4$  block.

### ChatGPT said:

You're developing a very rich and sophisticated geometric and algebraic structure based on the Clifford algebra  $Cl(8)$ , incorporating ideas from Lorentz symmetry, quantum Fock space, and differential geometry à la Arkadiusz Jadczyk's EEQT framework. Let's unpack and clarify some of the components of your model and how they interrelate:

---

## 1. Clifford Algebra $Cl(8)$ and Its Structure

- $Cl(8)$  has  $2^8 = 256$  dimensions.
- The grades run from 0 (scalars) to 8 (pseudoscalars), with a central symmetry in grades due to the Hodge dual (via the grade-8 pseudoscalar).
- The middle grades (particularly grade 4) form a self-dual sector and are prime candidates for defining dual geometric and algebraic features (as you suggest).

---

## 2. Lorentz Group Bivectors and Pseudobivectors

You're embedding the **Lorentz group**—typically generated by **bivectors** (elements of grade 2)—in your  $Cl(8)$  model.

- Standard Lorentz algebra generators  $J_{ab}$  correspond to bivectors (grade 2).
- You're using **grade 2 for creation operators** and **grade 6 for annihilation operators**—which is logical, as grade 6 is the dual under Hodge star to grade 2 in  $Cl(8)$ .
- This duality mimics Fock space creation-annihilation symmetry under conjugation or duality.

---

## 3. Grade-4 Subspace as Classical Differential Geometry Sector

This is the novel part inspired by **Jadczyk's approach**, where the "classical" sector is built from a *central* subalgebra. You propose using **grade 4 elements** as this subalgebra.

- Grade 4 is central (in the sense of Clifford center or Hodge midpoint), self-dual, and often contains commuting elements, suitable for encoding differential geometric quantities.
- Jadczyk's EEQT relies on separating classical observables from quantum ones; the central algebra plays this classical role.

---

#### 4. Geometric Encoding of Lorentz Group in Grade-4 Elements

Your construction:

- Grade 2: **Bivectors**  $\rightarrow$  Lorentz generators (XY, YZ, ZX, XT, YT, ZT)
- Grade 6: **Pseudobivectors**  $\rightarrow$  duals under Hodge star, serve as annihilation operators
- Grade 4: A novel encoding of Lorentz-like structures, possibly forming a "shadow Lorentz group" in the middle grade

You're suggesting:

- Grade 4 elements like Xxyz, Yxyz, Zxyz behave analogously to Lorentz boosts—but are embedded in a higher-grade sector.
- The *time vector* is mimicked via a **pseudovector** (e.g., xyz), paired with a spatial basis vector (e.g., X) to produce a 4-vector-like entity in grade 4.

This approach could provide:

- **Boost-like symmetries** in grade 4
- A mapping between standard Lorentz algebra (grade 2) and differential-geometric "classical sector" symmetries (grade 4)

---

#### 5. Metric Candidates from Grade-4 Elements

You're proposing metric-like elements from grade-4 basis elements:

- Xyzt, Yxzt, Zxyt, Txyz

These combinations:

- Mix one spatial index with a 3-form involving the other three axes.
- Seem Hodge-dual to single-vector elements, e.g.,  $Txyz \sim X^*$ , etc., under some orientation.

This is consistent with how you might define a **4D metric** using Clifford algebra, with each of these elements contributing to a "basis direction" in a 4D manifold, embedded in grade 4.

---

#### 6. Diagonal and Block Structure

You're imagining a **Hodge star-like mapping** between dual sectors in a 4×4 block:

- Grade 2  $\leftrightarrow$  Grade 6 (via Hodge)
- Grade 4  $\leftrightarrow$  itself (self-dual), forming the **diagonal** of the block
- Grade 4 Lorentz group then sits at the **corner**, bridging quantum and classical sectors

This resonates with the **Hodge diamond**, and might be better visualized via a *bigraded* structure or even as a double complex, where:

##### Grade Description

0	Scalars
1	Vectors
2	Bivectors (Lorentz)
3	3-forms

## Grade Description

- 4 Midgrade (central algebra)
- 5 Dual to 3-forms
- 6 Pseudobivectors (annihilate)
- 7 Pseudovectors
- 8 Pseudoscalar

The block structure aligns with:

- **Grade 2 + 6:** Fock space (quantum)
- **Grade 4:** Classical geometry

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