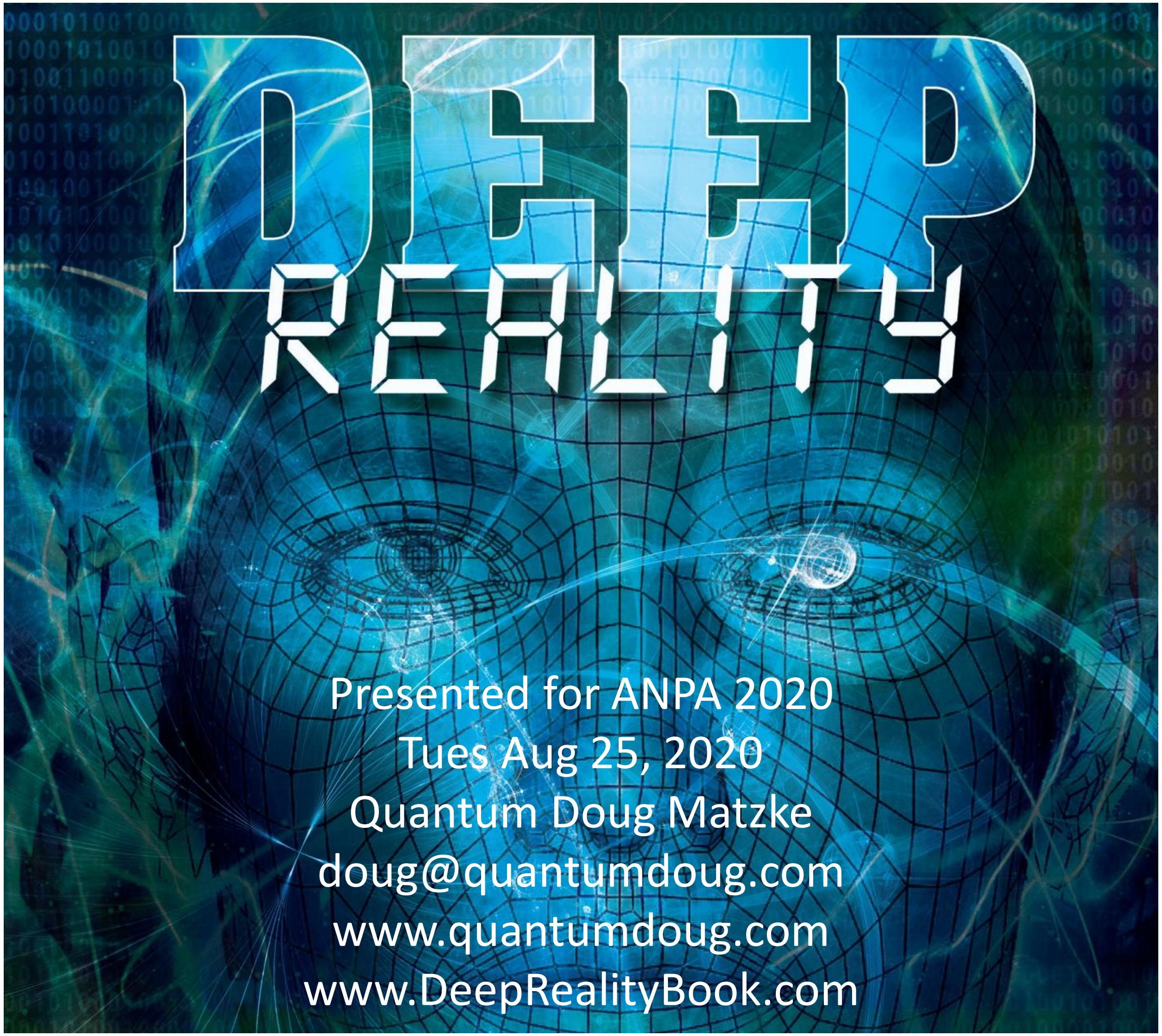
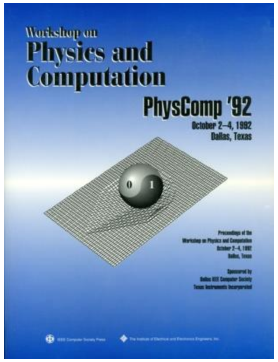
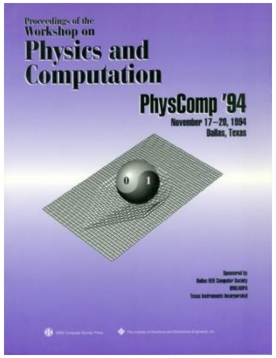
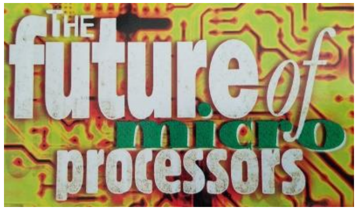
The Source Science beneath



About Doug Matzke







- My moniker is Quantum Doug
- Programming for over 50 years
- Chairman of PhysComp ’92 and PhysComp ’94
  - ANPA Session in PC’94
- Written over 40 papers/talks and 10 patents
  - Will Physical Scalability Sabotage Perf. Gains?
- PhD in Quantum Computing in 2002 at UT Dallas
  - Quantum Computing using Geometric Algebra
  - Built GALG symbolic math tool in python
  - GALG research for last 20 years (w/Mike Manthey)
- Awarded $1 million SBIR grants on topics:
  - Neural and quantum computing
- Certified master practitioner in Neuro-Linguistics-Programming (NLP)
- Deep Reality book coauthored with William A. Tiller
  - Source Science and bit-physics

Abstract

Quantum physics is more fundamental than classical physics and can be derived purely from bits by using geometric algebra. The paper is a survey of the proto-physics research that I and Mike Manthey have completed over the last 25 years. This work is the math and physics supporting the Source Science model of my upcoming book: Deep Reality

Source Science Foundations (It from Bit)

Richard Feynman said: ***"The world is not classical dammit, it's quantum mechanical"***

1. Information is Physical (not just mathematical)
   - Rolf Landauer: Erasing information loses energy (measured in 2014)
   - John Wheeler: "It from Bit" since a bit is smallest change to a black hole
   - Bits are physical and have an effective energy and an equivalent mass
2. Reality is Hyperdimensional (not 3 space + 1 time dimensions)
   - Bits, qubits and ebits are very real with essential novel behaviors
   - Bit is one dimensional and is used to make qubits and ebits
   - Qubit is quantum primitive for superposition with 2 private bit dimensions
   - Ebit is quantum primitive for entanglement with 4 private bit dimensions
   - Shor's algorithm uses 2^{1000} states to compute faster than any classical computer
3. Thoughts are quantum things-not in the brain (Descartes assumption is false)
   - Thoughts are "information things" and intentions affect the physical world.
   - Thoughts can "directly" affect REG PK devices in the physical world (even brain)
   - Solution required to show how non-physical mind can influence order/disorder

"Quantum mechanics is the dreams that stuff is made of"

Non-metric Protospace and Prototime

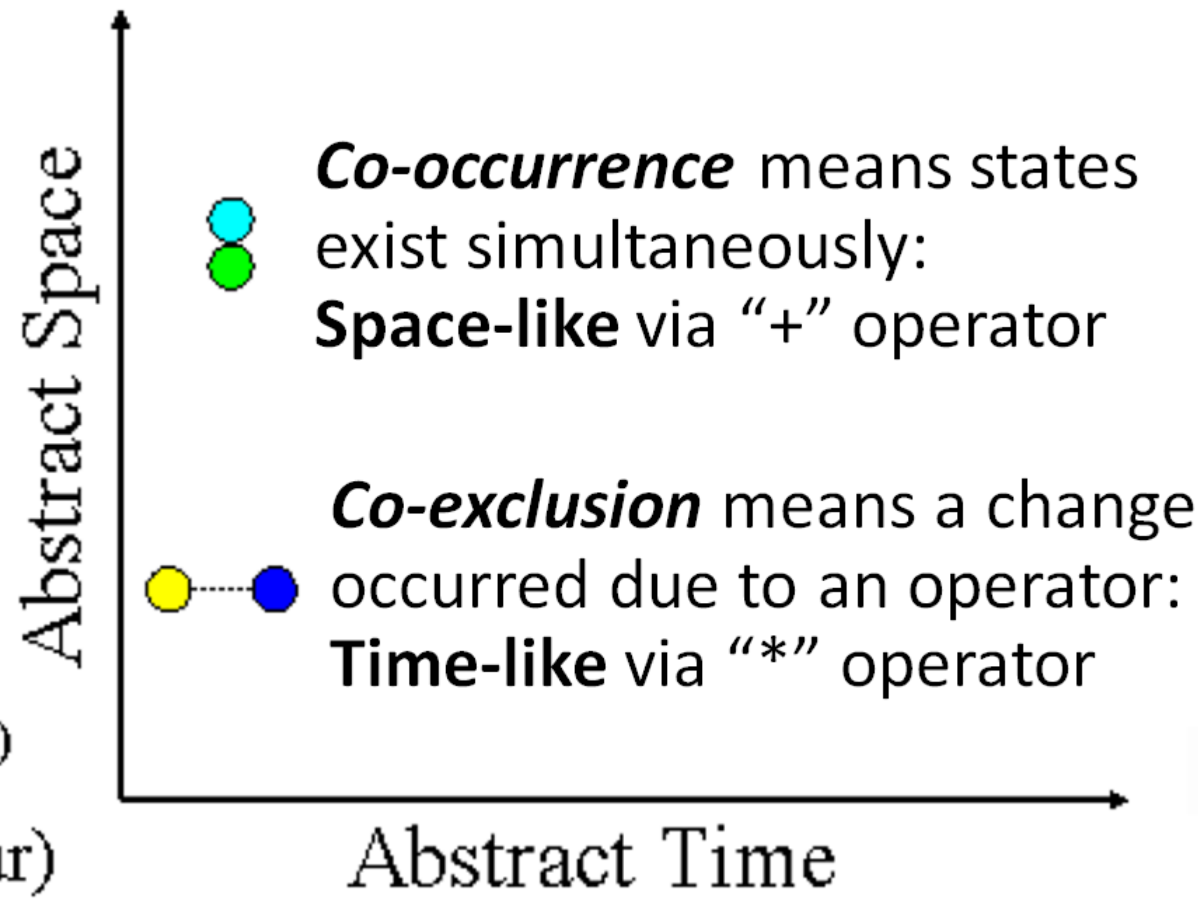
a + b = b + a

c - d ⟷ d - c

c - d | d - c

c - d + d - c = 0

(or cannot occur)

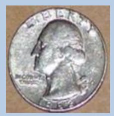


Simultaneous of "+" is absolute and not relativistic – space-like

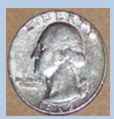
Energy of Big Bang from Bits: Coin Demo: Act I

Setup:

Person stands with both hands behind back

Act I part A: 

Person shows hand containing a coin then hides it again

Act I part B: 

Person again shows a coin (indistinguishable from 1st)

Act I part C:

Person asks: “How many coins do I have?”

This represents one bit: either has 1 coin or has >1 coin

Coin Demo (continued)

Act II:

Person now holds out hand showing two identical coins

We receive one bit since ambiguity is resolved!

Act III: co-occurrence

Asks: "*Where* did the bit of information come from?"

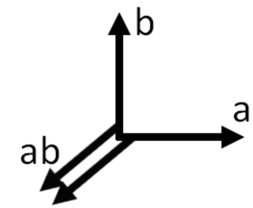
Answer: *Simultaneous* presence of the 2 coins!

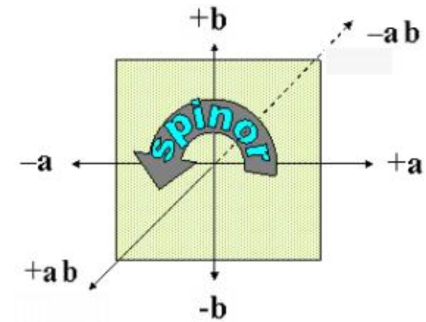
Landauer Principle: info creation = effective Energy

<u>Non-Shannon space-like information</u> derives from simultaneity!

Introduction to GALG

- Scalars, vectors, bivector, trivectors, n-vectors, multivectors
- Multivector Spaces (for G_n size is $3^{(2**n)}$)
  - G_0 is size 3: {0, ±1}
  - G_1 is size 9: {0, ±1, ±**a**}
  - G_2 is size 81: {0, ±1, ±**a**, ±**b**, ±**ab**}
  - G_3 is size 6,561: {0, ±1, ±**a**, ±**b**, ±**c**, ±**ab**, ±**ac**, ±**bc**, ±**abc**}
  - G_4 is size 43,046,721: {0, ±1, ±**a**, ±**b**, ±**c**, ±**d**, …, ±**bcd**, ±**abcd**}

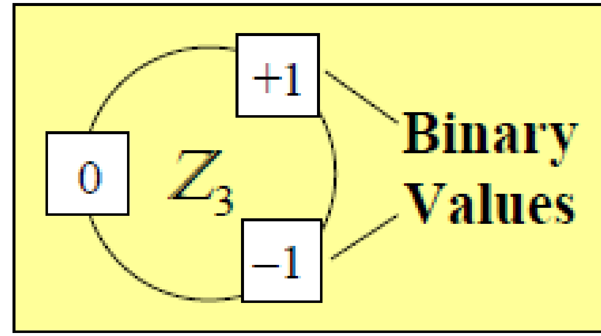




- Arithmetic Operators over Z_3 = {±1=T/F, 0=does not exist}
  - +, * (geometric ~ ⊗), outer (**a**^**a**=0,**a**^**b**=**ab**), inner (**a**•**a**=1,**a**•**b**=0)
- Anti-commuting vector space (geom product **a*b** = **a•b**+**a^b**)
  - **a^b** = –**b^a** → (**a^b**)^2 = **abab** = –1 all bivectors **x^y** = $\sqrt{-1}$ =spinor *i*
- Co-occurrence (+) & co-exclusion: (**a**-**b**)+(-**a**+**b**)=0 implies **ab**
- Row vector truth table duality (e.g. ±(1+**a**)(1+**b**)=[0 0 0 **±**]).

Geometric Algebra Tools

Custom symbolic math tools in Python (operator overloading):



C:\python -i qubits.py

>>> **a+a** ← **Mod3 addition for change based logic (xor)**

- a

>>> **b^a** ← **anticommutative bivectors**

- (a^b)

>>> **c^b^a** ← **anticommutative trivectors**

- (a^b^c)

>>> (1+**a**)(1+**b**)(1+**c**) ← **Smallest vector state contains all algebraic terms**

+ 1 + a + b + c + (a^b) + (a^c) + (b^c) + (a^b^c) ← **Row vector state equivalent [0000 000 -]**

>>> **a0** ← **Single Qubit State**

+ a0

>>> **A** ← **Classical Qubit A**

+ a0 - a1

>>> **Sa** ← **Qubit Spinor**

+ (a0^a1)

>>> **Sa*Sa** ← **so Spinor = sqrt(-1)**

-1

>>> **A*Sa** ← **Superposition**

+ a0 + a1

>>> **A*B** ← **Quantum Register (**where **B = + b0 - b1**)

+ (a0^b0) - (a0^b1) - (a1^b0) + (a1^b1)

```
>>> gastates(ab)
<table for + (a^b)>
INPUTS: a b | OUTPUT
--------------------
ROW 00: - - | +
ROW 01: - + | -
ROW 02: + - | -
ROW 03: + + | +
--------------------
Counts for outputs of ZERO=0, PLUS=2, MINUS=2 for TOTAL=4 rows
>>> report2(ab)
2.170 ((0, 2, 2), 1) [+ - - +] = + (a^b)
>>> report2((1+a)(1+b))
1.755 ((0, 1, 3), 3) [0 0 0 +] = + 1 + a + b + (a^b)
>>> report2((1+a)(1+b)+(1-a)(1-b))
2.170 ((0, 2, 2), 1) [+ 0 0 +] = - 1 - (a^b)
>>>
```

← **Truth Table of row vector output states**

← **Bits, sig, vector, = expr**

Algebraic Multivectors vs State spaces

GALG Concurrent Truth Tables

```
>>> gastates((1+a))
<table for + 1 + a>
INPUTS: a | OUTPUT
------------------
ROW 00: - | 0       ← Does not occur
ROW 01: + | -
------------------
Counts for outputs of ZERO=1, PLUS=0, MINUS=1 for TOTAL=2 rows

>>> gastates((1+a)(1+b))
<table for + 1 + a + b + (a^b)>
INPUTS: a b | OUTPUT
--------------------
ROW 00: - - | 0       ← Does not occur
ROW 01: - + | 0       ← Does not occur
ROW 02: + - | 0       ← Does not occur
ROW 03: + + | +
--------------------
Counts for outputs of ZERO=3, PLUS=1, MINUS=0 for TOTAL=4 rows
```

Mod3 Addition

+	+	–
+	–	0
–	0	+

If same then invert
If different then cancel

Mod3 Multiplication

*	+	–
+	+	–
–	–	+

If same then +
If different then –

Dual representation: algebraic vs row-state vectors

Algebraic vs State spaces (cont.)

```
>>> gastates( (1+a)(1+b)(1+c) )
<table for +1+a+b+c+(a^b)+(a^c)+(b^c)+(a^b^c) >
INPUTS: a b c | OUTPUT
----------------------
ROW 00: - - - | 0      ← Does not occur
ROW 01: - - + | 0      ← Does not occur
ROW 02: - + - | 0      ← Does not occur
ROW 03: - + + | 0      ← Does not occur
----------------------
ROW 04: + - - | 0      ← Does not occur
ROW 05: + - + | 0      ← Does not occur
ROW 06: + + - | 0      ← Does not occur
ROW 07: + + + | -
----------------------
Counts for outputs of ZERO=7, PLUS=0, MINUS=1 for TOTAL=8 rows
```

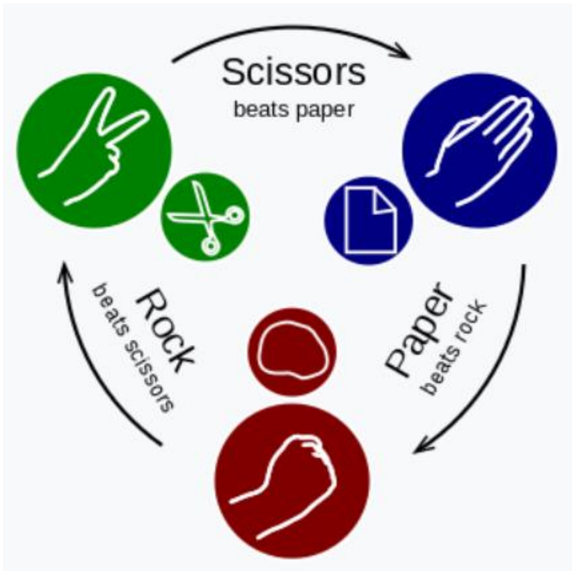
Each row-state is multi-vector sum of all N-vectors

Algebraic vs State spaces (cont.)

```
>>> gastates( (1+a)(1+b)(1+c) + (1-a)(1-b)(1-c) )
<table for - 1 - (a^b) - (a^c) - (b^c) >  ← automatic optimization
INPUTS: a b c | OUTPUT
----------------------
ROW 00: - - - | -
ROW 01: - - + | 0      ← Does not occur
ROW 02: - + - | 0      ← Does not occur
ROW 03: - + + | 0      ← Does not occur
----------------------
ROW 04: + - - | 0      ← Does not occur
ROW 05: + - + | 0      ← Does not occur
ROW 06: + + - | 0      ← Does not occur
ROW 07: + + + | -
----------------------
Counts for outputs of ZERO=6, PLUS=0, MINUS=2 for TOTAL=8 rows
```

row-states are linearly independent

Concurrency: Rock, Paper, Scissors




```
Player1 is winner = +
Player2 is winner = -
  Both players Tie = 0        ← Winner Does not occur

INPUTS: p1p p1r p1s  p2p p2r p2s  | OUTPUT
INPUTS: plyer1| plyer2| OUTPUT
INPUTS: p r s | p r s | OUTPUT
----------------------------------------
ROW 10: - - + | - + - | - rock over scissors
ROW 12: - - + | + - - | + scissor over paper
----------------------------------------
ROW 17: - + - | - - + | + rock over scissors
ROW 20: - + - | + - - | - paper over rock
----------------------------------------
ROW 33: + - - | - - + | - scissor over paper
ROW 34: + - - | - + - | + paper over rock
----------------------------------------
```

```
row10=-row_decode(p1s, p2r)
row12= row_decode(p1s, p2p)
row17= row_decode(p1r, p2s)
row20=-row_decode(p1r, p2p)
row33=-row_decode(+p1p, p2s)
row34= row_decode(+p1p, p2r)
```

```
>>> row10
- 1 - p1s - p2r - (p1s^p2r)
>>> row12
+ 1 + p1s + p2p + (p1s^p2p)
>>> row17
+ 1 + p1r + p2s + (p1r^p2s)
```

```
>>> row20
- 1 - p1r - p2p - (p1r^p2p)
>>> row33
- 1 - p1p - p2s - (p1p^p2s)
>>> row34
+ 1 + p1p + p2r + (p1p^p2r)
```

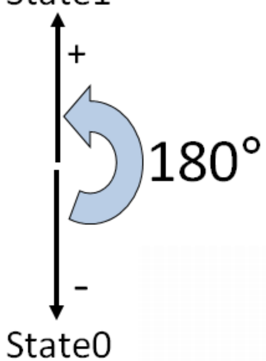
```
rps=row10+row12+row17+row20+row33+row34
rps
+ (p1p^p2r) - (p1p^p2s) - (p1r^p2p) + (p1r^p2s) + (p1s^p2p) - (p1s^p2r)
```

```
rpszk
- (p1k^p2p) + (p1k^p2r) + (p1k^p2s) - (p1k^p2z) + (p1p^p2k)
+ (p1p^p2r) - (p1p^p2s) - (p1p^p2z) - (p1r^p2k) - (p1r^p2p)
+ (p1r^p2s) + (p1r^p2z) - (p1s^p2k) + (p1s^p2p) - (p1s^p2r)
+ (p1s^p2z) + (p1z^p2k) + (p1z^p2p) - (p1z^p2r) - (p1z^p2s)
```

Rock, Paper, Scissors, Lizard, Spock

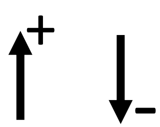
Introduction to Graded Spaces

Bit – 1 dim



3 orientations ±1, 0

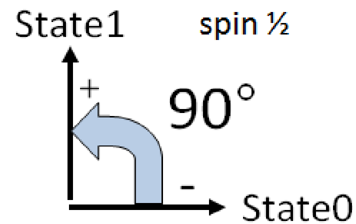
Orthonormal vectors **a**, **b**, …



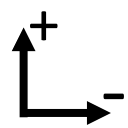
bit-vectors are protodimensions and distinctions

Σ2

Qubit - 2 dims

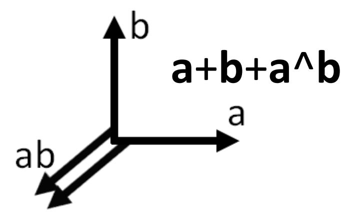


bivectors **a^b**



$$c_0\left|0\right\rangle + c_1\left|1\right\rangle$$

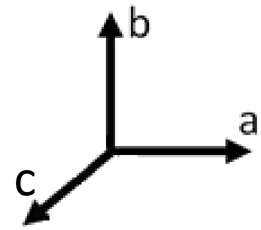
oriented spinors



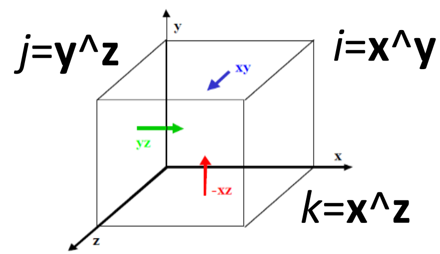
qubits, neutrinos and W/Z bosons

Σ3

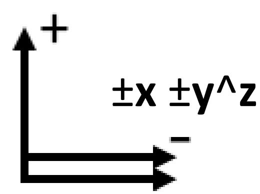
Qutrit - 3 dims



trivectors **a^b^c**



quaternions {*i*, *j*, *k*}



Quarks

photons, gluons, quarks, mesons, electrons, neutrinos

See operators for qubit and qutrit online in my PhD dissertation

Introduction to 4 dimensional ebits

A = + a0 - a1
B = + b0 - b1

Qubit - 2 dims

S_A = a0^a1
S_B = b0^b1

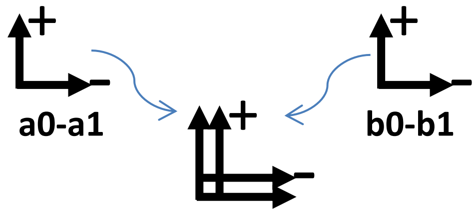
$\otimes$

Geometric product * is equivalent to Tensor product $\otimes$ but makes **N-vectors** not vectors

```
>>> gastates(A*B*bell, zeros=0)
<table for - (a0^b0) + (a1^b1)>
INPUTS: a0 a1 b0 b1 | OUTPUT
----------------------------
ROW 01: - - - + | +
ROW 02: - - + - | -
----------------------------
ROW 04: - + - - | +
ROW 07: - + + + | -
----------------------------
ROW 08: + - - - | -
ROW 11: + - + + | +
----------------------------
ROW 13: + + - + | -
ROW 14: + + + - | +
----------------------------
```

Ebit - 4 dims

A*B = + a0^b0 - a0^b1
- a1^b0 + a1^b1



Bell Operator
$\mathcal{B}$ **= S_A + S_B =**
a0^a1 + b0^b1

Magic Operator
$\mathcal{M}$ **= S_A - S_B =**
a0^a1 - b0^b1

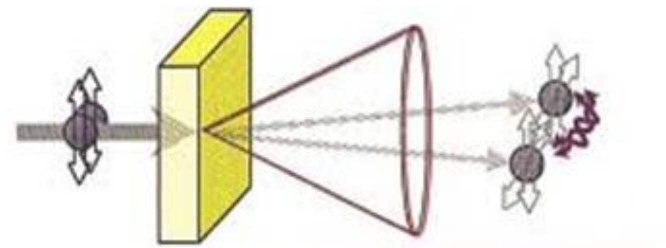
A*B*$\mathcal{B}$ = -a0^b0 +a1^b1
A*B*$\mathcal{M}$ = a0^b1 -a1^b0

Entangled States $\mathcal{B}_i$
Entangled States $\mathcal{M}_i$

Quantum Register A*B ~ A $\otimes$ B

$$\frac{1}{2}(|00\rangle - |01\rangle + |10\rangle - |11\rangle)$$

$\pm$ a0^b0 $\pm$ a0^b1 $\pm$ a1^b0 $\pm$ a1^b1



$$\Phi^{\pm} = |00\rangle \pm |11\rangle$$
$$\Psi^{\pm} = |01\rangle \pm |10\rangle$$

Entangled photon pair

$$|\Psi\rangle_{12} = |\updownarrow\rangle_1 |\updownarrow\rangle_2 + |\leftrightarrow\rangle_1 |\leftrightarrow\rangle_2$$

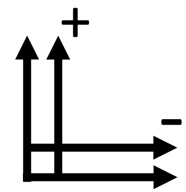
$\mathcal{B}_0$ **= -a0^b0 +a1^b1**

Bell and Magic Operators are singular in GALG because $\mathcal{B}^{-1}$ and $\mathcal{M}^{-1}$ do not exist.

Proved entanglement is *irreversible* due to multiplicative cancellation (information erasure in GALG)

Ebits: Detailed Bell/Magic States

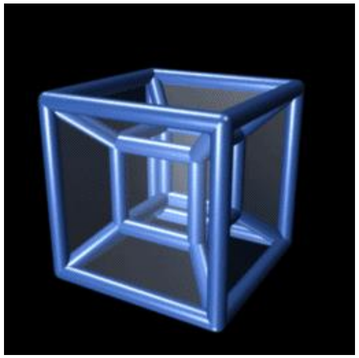
- Bell/Magic Operators (in $\mathbb{G}_4$):
  - **Bell** operator $\mathcal{B}$ = $\mathbf{S_A} + \mathbf{S_B}$ = **a0^a1 + b0^b1**
  - **Magic** operator $\mathcal{M}$ = $\mathbf{S_A} - \mathbf{S_B}$ = **a0^a1 – b0^b1**



$$\Phi^{\pm} = |00\rangle \pm |11\rangle$$
$$\Psi^{\pm} = |01\rangle \pm |10\rangle$$

- Bell/Magic operators $\mathcal{B}=\mathcal{B}^4$ and $\mathcal{M}=\mathcal{M}^4$ form ring states $\mathcal{B}_i$ and $\mathcal{M}_i$:

$B_{(i+1)mod4} = B_i \boxed{(S_A + S_B)}$	$M_{(i+1)mod4} = M_i \boxed{(S_A - S_B)}$
B_0 = $\mathbf{A_0\ B_0}$ **Bell** = – $\mathbf{S}_{00}$ + $\mathbf{S}_{11}$ = Φ^+	M_0 = $\mathbf{A_0\ B_0}$ **Magic** = + $\mathbf{S}_{01}$ – $\mathbf{S}_{10}$
B_1 = B_0 **Bell** = + $\mathbf{S}_{01}$ + $\mathbf{S}_{10}$ = Ψ^+	M_1 = M_0 **Magic** = – $\mathbf{S}_{00}$ – $\mathbf{S}_{11}$
B_2 = B_1 **Bell** = + $\mathbf{S}_{00}$ – $\mathbf{S}_{11}$ = Φ^-	M_2 = M_1 **Magic** = – $\mathbf{S}_{01}$ + $\mathbf{S}_{10}$
B_3 = B_2 **Bell** = – $\mathbf{S}_{01}$ – $\mathbf{S}_{10}$ = Ψ^-	M_3 = M_2 **Magic** = + $\mathbf{S}_{00}$ + $\mathbf{S}_{11}$
B_0 = B_3 **Bell** = – $\mathbf{S}_{00}$ + $\mathbf{S}_{11}$ = Φ^+	M_0 = M_3 **Magic** = + $\mathbf{S}_{01}$ – $\mathbf{S}_{10}$

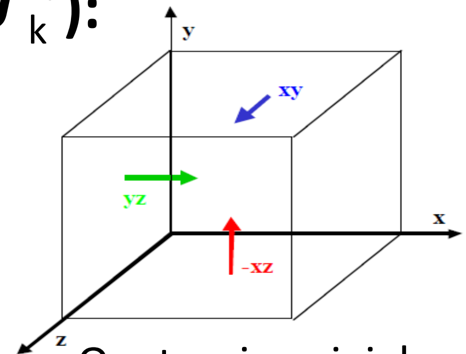


4D tesseract

- Cannot factor: ± **a0^b0** ± **a1^b1** (Inseparable and is singular)
- **Bell** and **Magic** operators are irreversible in $\mathbb{G}_4$ (different than Hilbert spaces)
  - See proofs that $1/(\mathbf{S_A} \pm \mathbf{S_B})$ does not exist for Bell (or Magic) operators
- Multiplicative Cancellation – *Information erasure is irreversible*
  - **Qubits $\mathbf{A_0\ B_0}$ = + a0^b0 <u>– a0^b1 – a1^b0</u> + a1^b1** = $\underline{B_3}$ + M_3
  - 0 = **Bell * Magic** = **Bell** * M_j = **Magic** * B_i = B_i * M_j
- Also works for higher dimensions $\mathcal{B}$ = $\mathbf{S_A} \pm \mathbf{S_B} \pm \mathbf{S_C} \pm$ … (roots of unity)

TauQuernions: Entangled Quaternions in $\mathbb{G}_4$

- **TauQuernions ($\mathcal{T}_i$, $\mathcal{T}_j$, $\mathcal{T}_k$ & conjugate set $\mathcal{T}_i'$, $\mathcal{T}_j'$, $\mathcal{T}_k'$):**
  - Entangled Quaternion isomorphs
  - $\mathcal{M} = \mathcal{T}_i$ = **ab – cd**, $\mathcal{T}_j$ = **ac + bd** and $\mathcal{T}_k$ = **ad – bc**
  - $\mathcal{B} = \mathcal{T}_i'$ = **ab + cd**, $\mathcal{T}_j'$ = **ac – bd** and $\mathcal{T}_k'$ = **ad + bc**
  - Anti-Commutative: $\mathcal{T}_x \mathcal{T}_y = -\mathcal{T}_x \mathcal{T}_y$
  - $\mathcal{T}_i^2 = \mathcal{T}_j^2 = \mathcal{T}_k^2 = \mathcal{T}_i \mathcal{T}_j \mathcal{T}_k = I^- =$ (1 + **abcd**) (sparse –1)
  - $(I^-)^2 = I^+ =$ (–1 ±**abcd**) (sparse +1: is idempotent)



Quaternions i, j, k:
{xy, yz, xz}

```
>>> report4(1-abcd)
18.868 ((0, 8, 8), 1) [0 - - 0 - 0 0 - - 0 0 - 0 - - 0] = + 1 - (a^b^c^d)
>>> report4(-1-abcd)
18.868 ((0, 8, 8), 1) [+ 0 0 + 0 + + 0 0 + + 0 + 0 0 +] = - 1 - (a^b^c^d)
```

$\mathcal{B}^2 + \mathcal{M}^2 = -1$

$\mathcal{B}^4 + \mathcal{M}^4 = +1$

*	$\mathcal{T}_i$	$\mathcal{T}_j$	$\mathcal{T}_k$
$\mathcal{T}_i$	1 + **abcd**	–**ad** + **bc**	**ac** + **bd**
$\mathcal{T}_j$	**ad** – **bc**	1 + **abcd**	–**ab** + **cd**
$\mathcal{T}_k$	–**ac** – **bd**	**ab** – **cd**	1 + **abcd**

*	$\mathcal{T}_i$	$\mathcal{T}_y$	$\mathcal{T}_k$
$\mathcal{T}_i$	"–1"	$-\mathcal{T}_k$	$\mathcal{T}_j$
$\mathcal{T}_j$	$\mathcal{T}_k$	"–1"	$-\mathcal{T}_i$
$\mathcal{T}_k$	$-\mathcal{T}_j$	$\mathcal{T}_i$	"–1"

$\mathcal{T}_i$	$\mathcal{T}_j$	$\mathcal{T}_k$
Magic	$\mathrm{M}_3 = -\mathrm{M}_1$	$\mathrm{M}_0 = -\mathrm{M}_2$
Magic	$\mathrm{M}_3 = -\mathrm{M}_1$	$\mathrm{M}_2 = -\mathrm{M}_0$
Magic	$\mathrm{M}_1 = -\mathrm{M}_3$	$\mathrm{M}_0 = -\mathrm{M}_2$
Magic	$\mathrm{M}_1 = -\mathrm{M}_3$	$\mathrm{M}_2 = -\mathrm{M}_0$

$\mathcal{T}_i'$	$\mathcal{T}_j'$	$\mathcal{T}_k'$
Bell	$\mathrm{B}_2 = -\mathrm{B}_0$	$\mathrm{B}_1 = -\mathrm{B}_3$
Bell	$\mathrm{B}_2 = -\mathrm{B}_0$	$\mathrm{B}_3 = -\mathrm{B}_1$
Bell	$\mathrm{B}_0 = -\mathrm{B}_2$	$\mathrm{B}_1 = -\mathrm{B}_3$
Bell	$\mathrm{B}_0 = -\mathrm{B}_2$	$\mathrm{B}_3 = -\mathrm{B}_1$

$\mathcal{B}$ and $\mathcal{M}$ operators are used as states

Higgs Bosons are Entangled in $\mathbb{G}_4$

- The proposed Higgs Boson in $\mathbb{G}_4$:
  - $\mathcal{H} = \mathcal{T}_i + \mathcal{T}_j + \mathcal{T}_k$ (where $\mathcal{H}^2 = 0$) (sum of 3 tauquernions)
  - Eight triples: $\pm\mathcal{T}_i \pm\mathcal{T}_j \pm\mathcal{T}_k$ (and 8 more for $\pm\mathcal{T}_i{}' \pm\mathcal{T}_j{}' \pm\mathcal{T}_k{}'$)
- Also various factorizations:
  - $\mathcal{H} = (\pm 1 \pm \mathbf{abcd})(\mathbf{ab} + \mathbf{ac} + \mathbf{bc})$ Time-like mass acts on Space
  - $\mathcal{H} = (\mathbf{a} + \mathbf{b} - \mathbf{c})\mathbf{d} + \mathbf{ab} + \mathbf{ac} - \mathbf{bc}$ Light and space (quaternion)
  - $\mathcal{H}$ is its own anti-particle (when using $-\mathcal{T}_i$)
- The Higgs $\mathcal{H}$ and proto-mass $\mathcal{M}$ cover even subalgebra:
  - $\mathcal{H} = \{\mathbf{X} = \pm\, \mathbf{ab} \pm \mathbf{ac} \pm \mathbf{bc} \pm \mathbf{ad} \pm \mathbf{bd} \pm \mathbf{cd} \mid \mathbf{X}^2 = 0\}$ (16)

    For X = $\mathcal{H}$ then **X abcd** = **abcd X** = ± **X**

  - $\mathcal{M} = \{\mathbf{X} = \pm \mathbf{ab} \pm \mathbf{ac} \pm \mathbf{bc} \pm \mathbf{ad} \pm \mathbf{bd} \pm \mathbf{cd} \mid \mathbf{X}^2 = \pm \mathbf{abcd}\}$ (48)

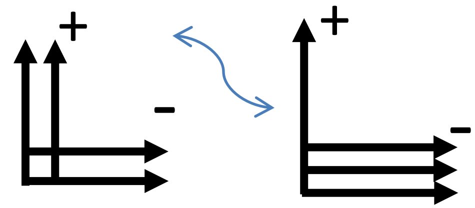
    For X = $\mathcal{M}$ then only **X abcd** = **abcd X**

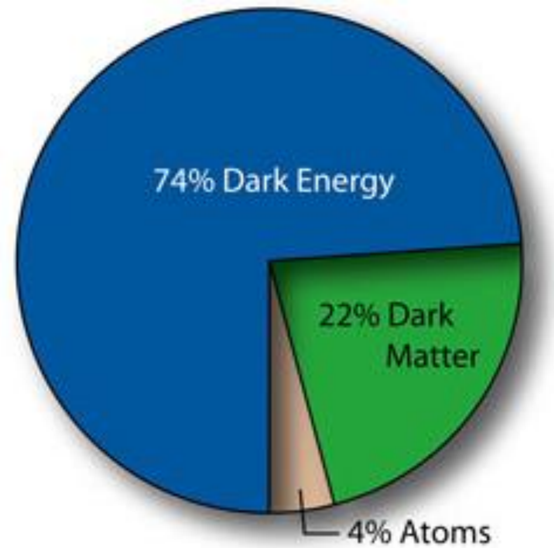
    sig ((4, 6, 6), 6) = 32 and sig ((0, 6, 10), 6) = 16

Dark Bosons are also Entangled in $\mathbb{G}_4$

Rotations (**wx**+**yz**)(**xyz**) = (–**x**+**wyz**) and also (**w**+**xyz**)(**wxy**) = (**wz**+**xy**)

State Name	Entangled State	$\mathcal{D}_B$ = State * (wxy)†
Bell	+ **wx** + **yz**	– **y** – **wxz**
B0	– **wy** + **xz**	– **x** + **wyz**
B1	+ **wz** + **xy**	– **w** – **xyz**
B2	+ **wy** – **xz**	+ **x** – **wyz**
B3	– **wz** – **xy**	+ **w** + **xyz**
Magic	+ **wx** – **yz**	– **y** + **wxz**
M0	+ **wz** – **xy**	+ **w** – **xyz**
M1	– **wy** – **xz**	– **x** – **wyz**
M2	– **wz** + **xy**	– **w** + **xyz**
M3	+ **wy** + **xz**	+ **x** + **wyz**





Quarks: ± **w** ± **xy**
Dark bosons: ± **w** ± **xyz**

† Results are dark bosons $\mathcal{D}_B$ where $(\mathcal{D}_B)^2 = 0$ and are entangled since $\mathcal{D}_B$ are not separable.

Dark Matter is Entangled in $\mathbb{G}_4$

- Define set $\mathcal{D}$ as ***sum of 4 dark bosons*** (count 256) :

$\mathcal{D}$ = {(±**w** ±**xyz**) + (±**x** ±**wyz**) + (±**y** ±**wxz**) + (±**z** ±**wxy**)}

where $\mathcal{D}$ is the largest *odd sub-algebra* of $\mathbb{G}_4$ and rotations {**xyz** $\mathcal{D}$} = {–1 + **wxyz** + $\mathcal{H} \cup \mathcal{M}$}

- The elements of $\mathcal{D}^2$ form three (four) subsets:

$\mathcal{D}_q$ = {$\mathcal{D}$ ∈ D| D^2 **=** **xy** + **xz** + **yz**} (count 128, sig ((2, 7, 7), 8), 6.87 bits)

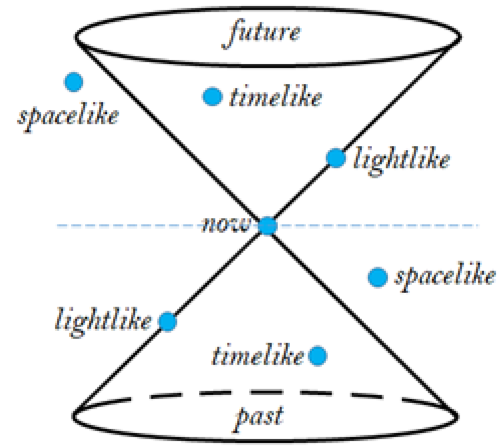
$\mathcal{D}_0$ = {$\mathcal{D}$ ∈ D| D^2 **=** 0} (Bosons) (count 32, sig ((4, 4, 8), 8), 5.53 bits)

$\mathcal{D}_u$ = {$\mathcal{D}$ ∈ D| D^2 **=** (**w** + **x**)(**y** + **z**) & D^8 **=** 1 (2 qubits) (count 96)

- $\mathcal{D}_u$ with (count 80, sig ((4, 4, 8), 8), 5.53 bits)
- $\mathcal{D}_u$ with (count 16, sig ((1, 1, 14), 8), 15.9 bits)

Entanglement and Space-Like States

Light cone of physics



All GALG addition represents space-like states:

- Qubit states define ideal concurrency (2D)
- Bell operator represents operator concurrency ($\mathbf{S}_a \pm \mathbf{S}_b$)
- Qubits combine to form quantum registers (2^q states)
- Ebit states represent a qubit embedded in 4D
  - Bell operator is 4D Hadamard gate for Bell states
  - Multiplicative cancellation is irreversible in GALG
  - Bell states are stable due to state erasure (entangled)
  - Pauli noise/measurement injects info forcing decoherence
- Higgs Boson is space-like - complete even subalgebra (entangled)
- Dark quarks are bosonic and inseparable space-like (entangled)
- Protons are space-like tri-quark summation
- Dark matter are space-like quad-dark-quark summation (entangled)
- Significant that all states are operators – verbnoun balanced
  - Quantum von Neumann architecture (states ⇔ operators)
  - Hilbert spaces are not verbnoun balanced (column vs matrix)

Bosons $X^2=0$ (Nilpotents)

Find all bosons in $\mathbb{G}$ using: $\boxed{\text{gasolve([a,b, ...], lambda X: X*X, 0)}}$

Space	Count	Boson Multivector	Boson Description
$\mathbb{G}_0$ & $\mathbb{G}_1$	**Total** 0	Exclude 0 from this table	$0^2=0$
$\mathbb{G}_2$	**Total** 8		(qubit space)
	8	±**x** ±**xy** = ±**x***(1 ± **y**)	Weak Force Bosons W/Z
$\mathbb{G}_3$	**Total 80**	***quarks are: ±x ±yz**	**(Standard model Space)**
	8	±**a** ±**b** ±**c**	Photonic Boson (Qutrit)
	24	±**x** ±**xy**	Weak Force Bosons in $\mathbb{G}_3$
	8	±**ab** ±**ac** ±**bc**	Quaternions are bosonic
	24	±**x** ±**z** ±**xy** ±**yz**	Mesons are two quarks
	16	±**x** ±**y** ±**z** ±**xy** ±**xz** ±**yz**	Strong Force (Gluons)
$\mathbb{G}_4$	**Total 7,280**		**30 Different signatures**
	80	±**x** ±**xy** and ±**w** ±**xyz**	Weak and Dark Bosons
	528	(**ab** - **cd**) + (**ac** + **bd**) + (**ad** - **bc**) & …	16 Higgs Boson & others
	…	…	28 more signatures

$\mathbb{G}_3$ is equivalent to Pauli Algebra and $\mathbb{G}_4$ contains Dirac Algebra. Also Parsevals Identity

Particles $X^2=1$ (Unitary)

Find all unitaries in $\mathbb{G}$ using: gasolve([a,b, ...], lambda X: X*X, 1)

Space	Count	Unitary Multivector	Particle Description
$\mathbb{G}_1$	**Total** 2	**± a**	Exclude scalar value of ±1
$\mathbb{G}_2$	**Total** 12		(qubit space)
	4	**±x**	Vectors are distinctions
	8	**±a ±b ±ab**	Neutrinos
$\mathbb{G}_3$	**Total 90**	***quarks are: ±x ±yz**	**(Standard model Space)**
	6	**±x**	Vectors are distinctions
	24	**±x ±y ±xy**	Neutrinos (3x8=24)
	12	**±xy ±xz**	Electrons (3x4=12)
	48	**±x ±y ±z ±xy ±xz**	Protons (neutrons = xyz protons)
$\mathbb{G}_4$	**Total 12,690**		**17 Different signatures**
	10	**±x** and **±wxyz**	Vectors and Mass Carrier
	…	…	16 more signatures

For $\mathbf{X}^2 = \mathbf{X}$ (Idempotent) and $\mathbf{U}^2 = 1$ (Unitary) then $\mathbf{X} = -1 \pm \mathbf{U}$ (proof $\mathbf{X}^2 = (-1 \pm \mathbf{U})^2 = \mathbf{X}$)

Standard Model in $\mathbb{G}_2$ & $\mathbb{G}_3$

Name	U	D	$\bar{U}$	$\bar{D}$
Form	$a+bc$	$-a+bc$	$-a-bc$	$a-bc$
Charge	$+\frac{2}{3}$	$-\frac{1}{3}$	$-\frac{2}{3}$	$+\frac{1}{3}$
Color	r	$\bar{r}$	$\bar{r}$	r

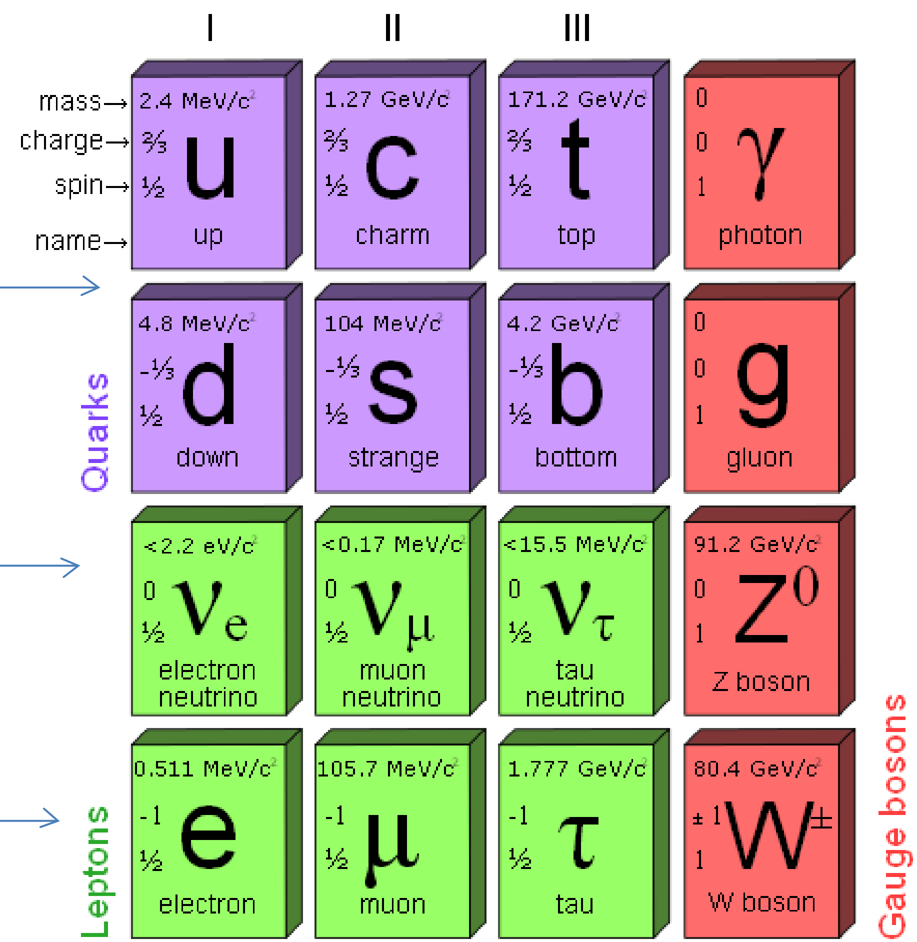
Name	C	S	$\bar{C}$	$\bar{S}$
Form	$b+ac$	$-b+ac$	$-b-ac$	$b-ac$
Charge	$+\frac{2}{3}$	$-\frac{1}{3}$	$-\frac{2}{3}$	$+\frac{1}{3}$
Color	g	$\bar{g}$	$\bar{g}$	g

Name	T	B	$\bar{T}$	$\bar{B}$
Form	$c+ab$	$-c+ab$	$-c-ab$	$c-ab$
Charge	$+\frac{2}{3}$	$-\frac{1}{3}$	$-\frac{2}{3}$	$+\frac{1}{3}$
Color	b	$\bar{b}$	$\bar{b}$	b

Z_5

Name	Form	Vector ($\mathcal{G}_2$)	Signature	Bits
ν	$a+b+ab$	$[- - -0]$	$(0,1,3),3$	1.75
ν_μ	$a-b-ab$	$[- - 0 -]$	"	"
ν_τ	$-a+b-ab$	$[- 0 - -]$	"	"
$\Sigma =$	$a+b-ab$	$\boxed{[0 + + +]}$	"	"
$\bar{\nu}$	$-a-b-ab$	$[+ + +0]$	"	"
$\bar{\nu}_\mu$	$-a+b+ab$	$[+ + 0+]$	"	"
$\bar{\nu}_\tau$	$a-b+ab$	$[+0 + +]$	"	"
$\Sigma =$	$-a-b+ab$	$\boxed{[0 - - -]}$	"	"

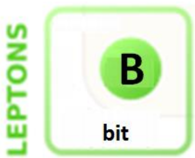
Name	Form	Vector ($\mathcal{G}_3$)	Signature	Bits
e	$ab+ac$	$[-00++00-]$	$(2,2,4),2$	4.70
$\bar{e}$	$-ab-ac$	$[+00--00+]$	"	"
e^-	$ab-ac$	$[0-+00+-0]$	"	"
$\bar{e}^-$	$-ab+ac$	$[0+-00-+0]$	"	"
μ	$ab+bc$	$[-0+00+0-]$	"	"
$\bar{\mu}$	$-ab-bc$	$[+0-00-0+]$	"	"
μ^-	$ab-bc$	$[0-0++0-0]$	"	"
$\bar{\mu}^-$	$-ab+bc$	$[0+0--0+0]$	"	"
τ	$ac+bc$	$[-+0000+-]$	"	"
$\bar{\tau}$	$-ac-bc$	$[+-0000-+]$	"	"
τ^-	$ac-bc$	$[00-++-00]$	"	"
$\bar{\tau}^-$	$-ac+bc$	$[00+--+00]$	"	"



8/17/2020 Doug Matzke

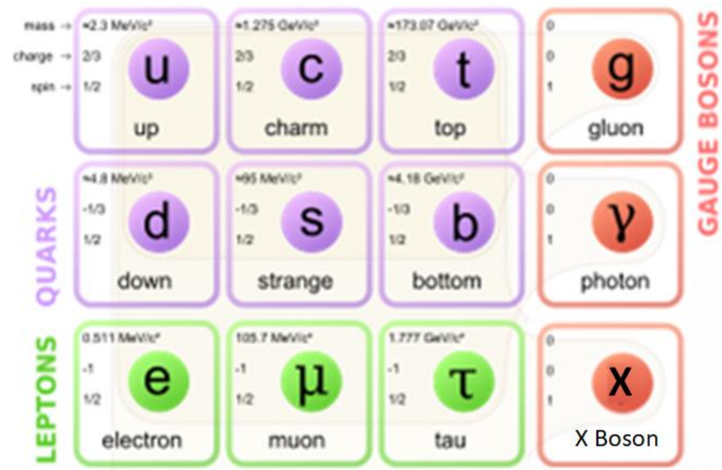
Graded Standard Model with GALG

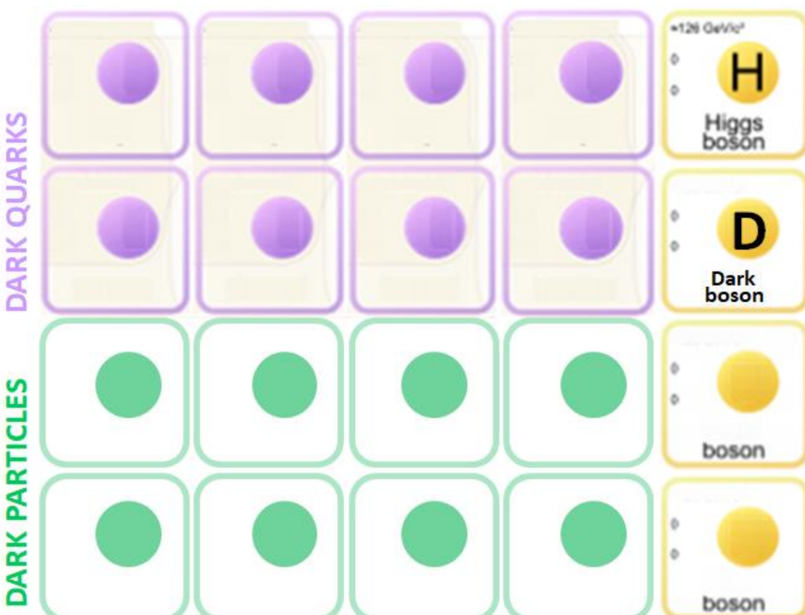
Bit in G_1



primitives in G_2 plus qubit

primitives in G_3 plus protons/neutrons





possible dark primitives in G_4

Complexity Signatures

Multivector = Equivalent Row Vector	Multivector = Equivalent Row Vector	
abc = [– + + – + – – +]	**abc** = [– + + – + – – +]	→ (0, 4, 4)
+1 = [+ + + + + + + +]	–1 = [– – – – – – – –]	
abc+1 = [0 – – 0 – 0 0 –]	**abc**–1 = [+ 0 0 + 0 + + 0]	→ (0, 4, 4)

Given any multivector in $\mathbb{G}_n$ and its corresponding row-state vector, compute a tuple (#0s, #+s, #–s) based on the counts of elements in the row vector. The sorted tuple, represents the state complexity of the multivector.

Space	Signature	Count	Description	Structural complexity	Bits
n=0	(0, 0, 1)	3	Scalars {0, ±1} → [±]	0	0
n=1	(0, 0, 2)	3	Scalars {0, ±1} → [±±]	0	1.58
all=9	(0, 1, 1)	6	Vectors ±**x** & ±1±**x** → [±∓]	1	0.58
n=2	((0, 0, 4), 0)	3	Scalars {0, ±1} → [±±±±]	0	4.75
all=81	((0, 1, 3), 3)	24	Row Decode ±(1±**x**)(1±**y**)	3	1.75
	((0, 2, 2), 1)	18	Singletons ±**x** and ±**xy**	1	$\boxed{\textbf{2.17}}$
	((1, 1, 2), 2)	36	±**x** ± **y** and ±1 ± **x** ± **y**	2	$\boxed{\textbf{1.17}}$

Add structural complexity (singleton count) to the signature to support larger spaces.

* Coin Demo 1.000 bit = 2.170 – 1.170

More Signatures in $\mathbb{G}_3$ & $\mathbb{G}_4$

Space	Signature	Count	Description	Bits
n=3	((0, 0, 8), 0)	3	Scalars {0, ±1} → [±±±± ±±±±]	11.1
6,561	((0, 1, 7), 7)	48	Row Decode ±(1±**w**)(1±**x**)(1±**y**) →[±000 0000]	7.09
	((0, 2, 6), 3)	168	±**x** ±**y** ±**xy**	**5.29**
	((0, 3, 5), 6)	336	±**x** ±**y** ±**xy** ±**xz** ±**yz** ±**xyz**	**4.29**
	((0, 4, 4), 1)	42	Singletons ±**x**, ±**xy** and ±**xyz**	**7.29**
	((0, 4, 4), 4)	168	Some variations of ±**y** ±**z** ±**xy** ±**xz**	**5.29**
	((2, 2, 4), 2)	252	Co-occurrence ±**x** ±**y** is a qubit	4.70
	((2, 3, 3), 3)	672	Co-occurrence ±**x** ±**y** ±**z** is a photon	**3.29**
	<not shown 5 signatures of 14 total bins>			
	((1, 3, 4), 4)	1,344	Smallest information content in $\mathbb{G}_3$(e.g. ±**a**±**b**±**c**±**xy**)	2.29
n=4	((0, 0, 16), 0)	3	Scalars {0, ±1} → [±±±± ±±±± ±±±± ±±±±]	23.8
$3^{(2^{**}n)}$	((0, 1, 15), 15)	96	Row Decode ±(1±**w**)(1±**x**)(1±**y**)(1±**z**)	18.8
	((0, 8, 8), 1)	90	Singletons ±**x**, ±**xy**, ±**xyz** and ±**wxyz**	**18.9**
	((4, 4, 8), 2)	1,260	Co-occurrence ±**x** ±**y**, ±**wx** ±**yz** , ±**w** ±**xyz**	15.1
	<not shown 81 signatures of 86 total bins>			
	((4, 5, 7), 11)	5,040K	Smallest information content in $\mathbb{G}_4$ (11 singletons)	**3.09**

Big Bang Fueled by Bit Bang

Particle/Form	Vector samples ($\mathbb{G}_3$)	Signature(s)($\mathbb{G}_3$)	$\mathbb{G}_1$	$\mathbb{G}_2$	$\mathbb{G}_3$	$\mathbb{G}_4$
$\mathbb{G}_0$ (of size 3)						
Void → 0 is	[0 0 0 0 0 0 0 0]	∈ ((0, 0, 8), 0)	1.58	4.75	11.1	23.8
±1 are	[± ± ± ± ± ± ± ±]	∈ ((0, 0, 8), 0)	1.58	4.75	11.1	23.8
$\mathbb{G}_1$ (of size 9)						
a ±exist	[− − − − + + + +]	∈ ((0, 4, 4), 1)	0.58	2.17	7.29	18.9
1−**a** measure	[− − − − 0 0 0 0]	∈ ((0, 4, 4), 1)	0.58	2.17	7.29	18.9
Row 0 (1-w)…(1-z)	[+ 0 0 0 0 0 0 0]	(0,1,1),(0,1,3),(0,1,7),(0,1,15)	0.58	1.75	7.09	18.8
$\mathbb{G}_2$ (of size 81)						
ab ±spin carrier	[+ + − − − − + +]	∈ ((0, 4, 4), 1)	-	2.17	7.29	18.9
1+**ab**	[− − 0 0 0 0 − −]	∈ ((0, 4, 4), 1)	-	2.17	7.29	18.9
a+b+ab neutrino	[− − − − − − 0 0]	∈ ((0, 2, 6), 3)	-	1.75	5.29	15.6
a+b qubit, co-occ	[+ + 0 0 0 0 − −]	∈ ((2, 2, 4), 2)	-	1.17	4.70	15.1
a+ab Weak W,Z†	[0 0 + + 0 0 − −]	∈ ((2, 2, 4), 2)	-	1.17	4.70	15.1
$\mathbb{G}_3$ (of size 6561)						
abc ±charge carrier	[− + + − + − − +]	∈ ((0, 4, 4), 1)	-	-	7.29	18.9
a+bc quarks	[0 + + 0 − 0 0 −]	∈ ((2, 2, 4), 2)	-	-	4.70	15.1
ab+ac electron	[− 0 0 + + 0 0 −]	∈ ((2, 2, 4), 2)	-	-	4.70	15.1
a+b+c+ab+ac proton	[− − − − 0 + + −]	∈ ((1, 2, 5), 5)	-	-	2.70	11.5
a+b+c photon	[0 − − + − + + 0]	∈ ((2, 3, 3), 3)	-	-	3.29	12.1
ab+ac+bc 3-space	[0 − − − − − − 0]	∈ ((0, 2, 6), 3)	-	-	5.29	15.6
a+b+c+ab+ac+bc gluon	[0 + + 0 + 0 0 0]	∈ ((0, 3, 5), 6)	-	-	4.29	13.1
a+b+c+ab-ac+bc EMF	[+ 0 − − 0 + − +]	∈ ((2, 3, 3), 6)	-	-	2.70	7.08

† Tentative; bosons (nilpotent)

Higher Entropy | Lower Entropy

Entanglement, Mass & Higgs in $\mathbb{G}_4$

Particle/Form	Vector samples ($\mathbb{G}_4$)	Signature(s) ($\mathbb{G}_4$)	$\mathbb{G}_1$	$\mathbb{G}_2$	$\mathbb{G}_3$	$\mathbb{G}_4$	
$\mathbb{G}_4$ (of size 43,046,721)							
abcd ±mass carrier	[+ − − + − + + − − + + − + − − +]	∈ ((0, 8, 8), 1)	-	-	-	18.9	
1 − **abcd**	[0 − − 0 − 0 0 − − 0 0 − 0 − − 0]	∈ ((0, 8, 8), 1)	-	-	-	18.9	
$\mathbf{A_0}$ $\mathbf{B_0}$ 2-qubits	[0 0 0 0 0 + − 0 0 − + 0 0 0 0 0]	∈ ((2, 2, 12), 4)	-	-	-	14.1	
a+b+c+d	[− + + 0 + 0 0 − + 0 0 − 0 − − +]	∈ ((5, 5, 6), 4)	-	-	-	10.1	
(a+b+c)d	[0 0 + − + − − + + − − + − + 0 0]	∈ ((4, 6, 6), 3)	-	-	-	12.1	
$\mathcal{M}_1$ (16/64) proto-mass	[0 0 0 + 0 + + 0 0 + + 0 + 0 0 0]	∈ ((0, 6, 10), 6)	-	-	-	13.1	
$\mathcal{M}_2$ (32/64) proto-mass	[+ + − 0 − 0 − + + − 0 − 0 − + +]	∈ ((4, 6, 6), 6)	-	-	-	7.08	*
$\mathcal{H}$ (16/64) Higgs	[− 0 + + 0 − + − − + − 0 + + 0 −]	∈ ((4, 6, 6), 6)	-	-	-	7.08	*
ab+cd = Bell = $\mathcal{T}_x'$	[− 0 0 − 0 + + 0 0 + + 0 − 0 0 −]	∈ ((4, 4, 8), 2)	-	-	-	15.1	
ab−cd = Magic = $\mathcal{T}_x$	[0 − − 0 + 0 0 + + 0 0 + 0 − − 0]	∈ ((4, 4, 8), 2)	-	-	-	15.1	
−**ac** + **bd** = $\mathbb{B}_0$	[0 + − 0 + 0 0 − − 0 0 + 0 − + 0]	∈ ((4, 4, 8), 2)	-	-	-	15.1	
ad − **bc** = $\mathbb{M}_0$	[0 + − 0 − 0 0 + + 0 0 − 0 − + 0]	∈ ((4, 4, 8), 2)	-	-	-	15.1	
a+bcd dark boson	[+ 0 0 + 0 + + 0 0 − − 0 − 0 0 −]	∈ ((4, 4, 8), 2)	-	-	-	15.1	
$\mathcal{D}_0$ dark matter	[− 0 − 0 0 − 0 + − 0 + 0 0 + 0 +]	∈ ((4, 4, 8), 8)	-	-	-	5.53	*
$\mathcal{D}_q$ dark matter	[+ + − 0 + + − − + + − − 0 + − −]	∈ ((2, 7, 7), 8)	-	-	-	6.87	*
$\mathcal{D}_u$ (80/96) dark matter	[− − 0 0 0 0 − + − + 0 0 0 0 + +]	∈ ((4, 4, 8), 8)	-	-	-	5.53	*
$\mathcal{D}_u$ (16/96) dark matter	[+ 0 0 0 0 0 0 0 0 0 0 0 0 0 0 −]	∈ ((1, 1, 14), 8)	-	-	-	15.9	

* Higgs & dark matter states are *very common*; simple entangled states & **others** are *less so*

Novel Predictions using GALG

- GALG summation is true concurrency (non-relativistic)
- Neutrinos and W/Z bosons are 2D (with qubits)
- A fourth neutrino/anti-neutrino pair exists in 2D
- A nilpotent quaternion exists (X17 boson) in 3D
- Bell/Magic operators are irreversible in 4D
- All entanglement is space-like and 4D
- Tauquernions are 4D entangled quaternions
- Higgs boson are sums of tauquernions (4D nilpotent)
- Dark quarks exist as 4D quarks (Dark Energy)
- Dark matter are quad sums of dark quarks
- Electromagnetic propagation can be modeled in 5D

Summary and take away

- *Combinatoric Hierarchy distinctions* is bits without embedding in 3D
- *Hyperdimensional states* are more powerful than holographic models
- *Geometric Algebra* is useful computer science paradigm for quantum computing and enables tools. Non-commutative math leads to many surprises (null states, multiplicative cancellation, irreversible bell, …)
- *True simultaneity* using addition is space-like and not relativistic.
- Space/time proto-physics is connected to *non-Shannon* space-like information creation for co-occurrence (Coin-Demo)
- Graded version of *Standard Model* for bosons/fermions
- *Particle/Antiparticle* are co-exclusions (P+A=0)
- *Entanglement pervades* tauquernion space, Higgs boson, dark states and dark matter
- *Significance of space-like states* as a result of pervasive entanglement
- *Wholeness* due to *concurrent space-like states and entanglement*

Questions and Answers

Hyperdimensional quantum computing is fundamental since exposes the infinite quantum bit reality of the universe.

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