

*Space-Like Computations*  
*on*  
*Computing Machines*

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**Abstract:** Space-like computation - the complement to Turing's time-like computation - is inherently distributed, self-organizing, and capable of multi-level awareness [aka. consciousness]. ... Includes an Appendix with the essential source code.

The paradigm has the structure

$$U(1) \times SU(2) \times SU(3) \times SO(4),$$

using geometric (Clifford) algebra over  $Z_3 = \{0, 1, -1\}$ .

Extracted from the USPTO application of 2015.

The patent issued on May 26, 2020.

*Download this paper from [RootsOfUnity.org](http://RootsOfUnity.org)*

The invention targets the construction of logically distributed computational systems, and solves this widely researched but hitherto unsolved problem.

It implements the Universal Wave Function of quantum mechanics in computer code, based on the concept of the co-occurrence of arbitrary events.

A simple example (the Coin Demo) shows that co-occurring events contain *information that conventional computers cannot access*, limited to sequentiality by the theorems of Alan Turing.

This same approach offers inherent and logarithmically efficient self-organization [based on 'experience in the world'] and will at some modest complexity level exhibit undeniable awareness.

*There is NO numerical computation whatsoever*  
because the 'data' is synchronization patterns.  
And NO physics ... *it's pure combinatorics.*  
yet system semantics satisfy

$$U(1) \times SU(2) \times SU(3) \times SO(4)$$

Applications: *all* natural and built systems.

The actual run-time structure that produces all behavior is built entirely out of **synchronization** [wait/signal] **tokens** in the form of tuples in a shared global tuple space ... this is the "data".

Obvious immediate applications: Internet of Things (IoT) and funds transfer systems (no 'mining' necessary), but these are just the tip of the iceberg - the patent will be the foundation of all computing, and a lot more, in the coming decades.

**Awareness** is a complex adaptive self-preserving resonance.  
One 4-tier [later] is enough. **Consciousness** is awareness of awareness, and uses two 4-tiers. The frequencies & amplitudes in a tier's surround determine its particular properties.

## Geometric (Clifford) Algebra $G_n$

multi-dimensional

graded

“coordinate free”

vector algebra

multiplication =  $90^\circ$  rotation

non-commutative:  $ab = -ba$

Here: over  $\mathbb{Z}_3 = \{0, 1, 2\} = \{0, 1, -1\}$

Zero = **Void**      **$\{1, -1\}$  are opposites.**

$a, b, \dots, ab, \dots, abc, \dots, abcd, \dots$  are mutually  $\perp$

Parseval's Identity: The projection of an n-dimensional function F onto an n-dimensional vector space **is** the Fourier decomposition of F.

So we're in a phase space ... **wave world**.

The phases are phases of synchronization: *go/nogo*,  
ie. signal/wait.

The tuples in the code are tokens indicating this.

## There's No Place Like Space

**Quaternion triples** - representations of 3-space

$$XY = Z, \quad YZ = X, \quad ZX = Y,$$

$$XYZ = -ZYX$$

$$\text{SU}(2) \quad G_3 = \{a, b, c\}$$

$$\text{Classic 3d: } X = ab, \quad Y = bc, \quad Z = ca,$$

$$XYZ = abc = 3\text{d volume};$$

$$-abc(ab + bc + ca) = a + b + c = \textit{photon}$$

$$\text{SO}(4) \quad G_4 = \{a, b, c, d\}$$

*TauQuernions:*

$$X = ab - cd, \quad Y = ac + bd, \quad Z = bc - ad;$$

$$\text{“} - 1 \text{”} = 1 + abcd;$$

paired disjoint mutually orthogonal planes

$$\text{nilpotent Higgs boson } (X + Y + Z)^2 = 0$$

houses *3+1d relativistic spacetime*

$$\text{SU}(3) \quad G_5 = \{a, b, c, d, e\}$$

*TauQuinions:*

$$X = ab - cde, \quad Y = ac + bde, \quad Z = bc - ade$$

$$\text{“} - 1 \text{”} = 1 + abcde$$

paired disjoint mutually orthogonal plane+volume

houses *electro-magnetism*

## ***Building Hierarchy***

The boundary  $a, b, c, d, e, \dots$  is given, but

Where do  $ab, abc, abcd, abcde$  come from?

$a + b \xrightarrow{\delta} ab$        $ab$  is the 'atom' of *spin*

$\delta$  is the geometric version of integration  $\int$

Apply ***co-exclusion***:  $(a + \tilde{b})|(\tilde{a} + b) \Rightarrow ab$ .  
 $(a + b)|(\tilde{a} + \tilde{b}) \Rightarrow ab$

So “the hierarchy” is the that of the calculus.

$\delta$  is the source of emergent behavior.

$\partial$  is the opposite of  $\delta$ , defined as the eigen form:

$$\partial_Q(X + Y) = X' + Y'$$

So build another level of hierarchy:

$$\begin{array}{ll}
 c + ab \xrightarrow{\delta} abc & abc \text{ is the "atom" of charge} \\
 & lhs \text{ is a boundary } \partial \text{ of } abc \\
 a + b \xrightarrow{\delta} ab &
 \end{array}$$

And another:

$$\begin{array}{ll}
 ab + cd \xrightarrow{\delta} abcd & abcd = \text{"atom" of mass/space} \\
 & ab + cd \text{ is } \textit{irreversible}
 \end{array}$$

$$\begin{array}{l}
 c + ab \xrightarrow{\delta} abc \\
 a + b \xrightarrow{\delta} ab
 \end{array}$$

And another:

$$\begin{array}{ll}
 ab + cde \xrightarrow{\delta} abcde & ab + cde \text{ is } \textit{irreversible} \\
 ab + cd \xrightarrow{\delta} abcd & (\text{also } a + bcd \xrightarrow{\delta} abcd) \\
 c + ab \xrightarrow{\delta} abc \\
 a + b \xrightarrow{\delta} ab
 \end{array}$$

*Includes all singletons & 2-sums  $\binom{n}{i+j}$ ,  $n, i+j \leq 5$*   
*1, 2, 3, 4, 5,*  
*1+1, 1+2, 2+2, 1+3, 2+3, 3+3*

## *By the Way*

*TauQuernions and TauQuinions are also*  
*entanglement operators*

*eg.*

$$(a + b)(c + d) = ac + ad + bc + bc, \text{ **but**}$$

$$(ab + cd)(a + b)(c + d) = ac - bd$$

*The previously distinct  $(a + b)$  and  $(c + d)$*   
*become “non-separable” in  $ac - bd$ .*

Also, irreversible due to loss of phase information.



About the algebra's pseudo-scalars

$a$	$ab$	$abc$	$abcd$	$abcde, \dots$
$a^2$	$(ab)^2$	$(abc)^2$	$(abcd)^2$	$(abcde)^2 \dots$
+1	-1	-1	+1	+1 -1...

The + - - ++ - - indicates powers of  $i = \sqrt{-1}$  !

The semantics repeat in a 4-cycle.  
So the hierarchy consists of tiers of 4.

Like this:

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.	•		
.	•		
		$3 + 3 = 6 \pmod{4} = 2$	
		$2 + 3 = 5 \pmod{4} = 1$	4-tier
<hr/>			
		$2 + 2 = 4 \pmod{4} = 0$	map to 1 new
		$1 + 3 = 4 \pmod{4} = 0$	map to 1 Begin
		$1 + 2 = 3$	
		$1 + 1 = 2$	

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*So what do we have?*

4. SO(4) TauQuernions  $ab + cd \xrightarrow{\delta} abcd$  ‡
3. SU(3) TauQuinions  $ab + cde \xrightarrow{\delta} abcde$  ‡
2. SU(2) Quaternions  $c + ab \xrightarrow{\delta} abc$
1. U(1) Circle group  $a + b \xrightarrow{\delta} ab$

‡ Entanglement operators

–

Everything is geometric, ie. space-like!

4. mass & gravity (= love)
3. electricity
2. magnetism
1. existence

*Inherently factors boundary inputs* into these four categories of interaction.

Stackable tiers. Constructive. Discrete. Finite but Unbounded. Non-reductive. Non-deterministic. Non-material.

## *Hierarchy Dynamics*

Use inner auto-morphisms  $A^{-1}(X + Y)A = X' + Y'$

[Unpack this to get a Feynman diagram]

$A = \delta X$  for the bubble-up,

$X = \partial A$  on the trickle-down:

$$\begin{aligned}
 ba(a + b)ab &= -a - b \\
 cba(a + bc)abc &= a + bc \\
 dcba(ab + cd)abcd &= ab + cd \\
 dcba(a + bcd)abcd &= -a - bcd \\
 edcba(ab + cde)abcde &= ab + cde \\
 edcba(a + bcde)abcde &= a + bcde
 \end{aligned}$$

Try input  $(a + b) + (c + d)$  on the 1-2-4 hierarchy:

$$abcd = \delta(ab + cd) = \delta(\delta(a + b) + \delta(c + d))$$

$(a + b), (c + d)$  bubbles reach states  $ab, cd \Rightarrow$  write

$$(a + b)ab + (c + d)cd = (-a + b) + (-c + d)$$

whence

$$\delta(-a + b) + \delta(-c + d) = \delta(-ab - cd) = abcd$$

Reflect from top  $\Rightarrow$  bubbles become droplets:

$$dcba(-ab - cd)abcd = ba + dc$$

The two droplets hit their  $xy$ 's:

$$ba(-a + b) + dc(-c + d)$$

& then trickle further down, having now become

$$-a - b - c - d$$

which, being on the sensory boundary, are effector commands, ie.

$$a \rightarrow -a \quad b \rightarrow -b \quad c \rightarrow -c \quad d \rightarrow -d$$

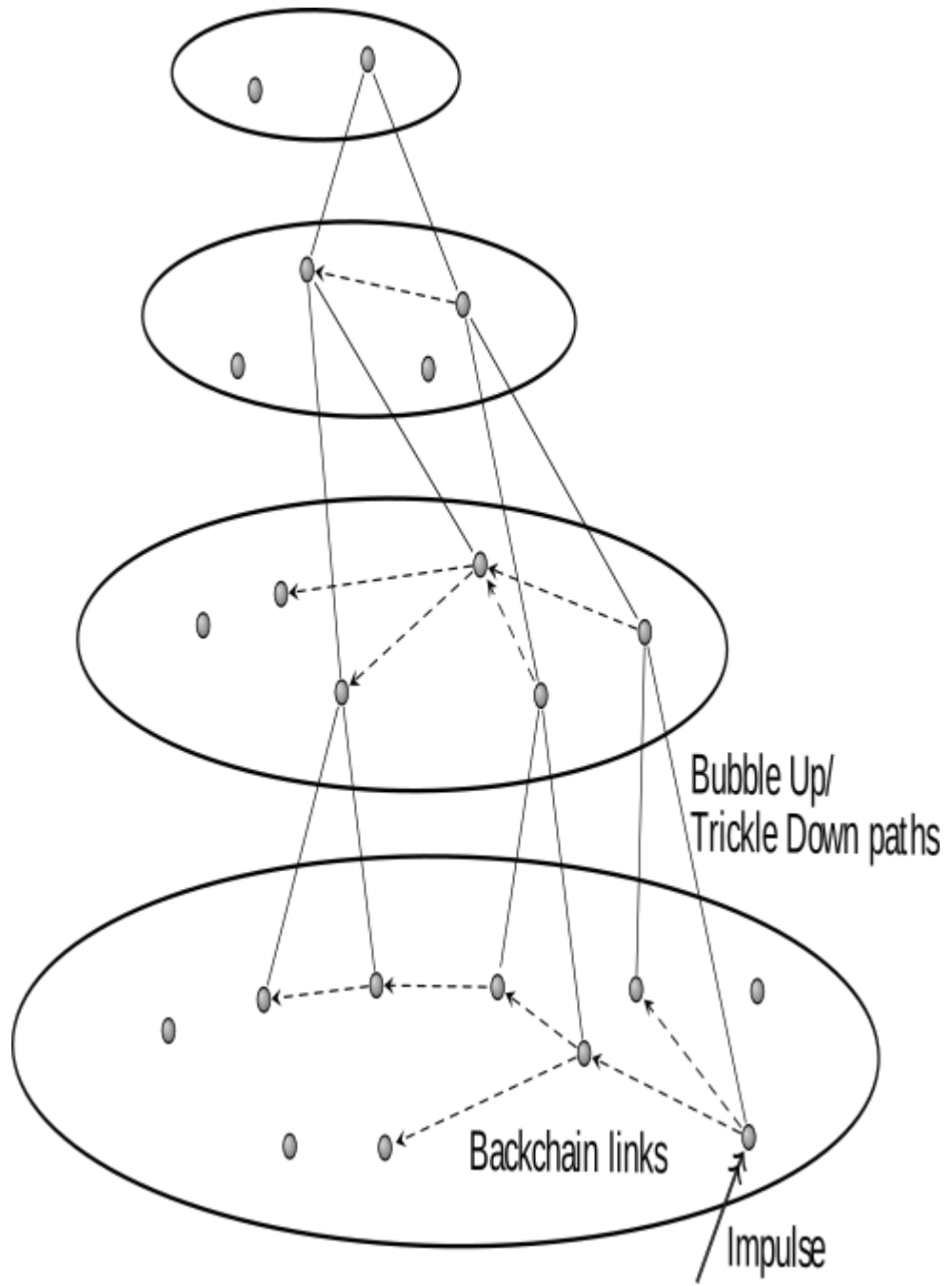
The change is complemented, the oscillation completed, and equilibrium maintained.

*This is a pure space-like computation.*

It reacts to its environment with utter immediacy - what *can* happen is what *does* happen ... and *only* that - in an uninterrupted, purely entropic and subjectively timeless Now.

The computation's deepest "purpose" is to maintain equilibrium with its surround, all the while growing (if possible) new structure based on its sensory experience.

*How Awareness Works*



## *Back-chaining*

*Suppose env:  $\tilde{z} \rightarrow z$  . Gotta undo  $\Rightarrow$  bubble to  $yz$ .*

*Suppose  $z$  is grounded, ie. has an able effector.*

*So,  $z \rightarrow \tilde{z}$  can happen cuz  $z \rightarrow \tilde{z}$  is grounded.*

*So  $yz \rightarrow \tilde{y}\tilde{z}$  can happen if also  $y \rightarrow \tilde{y}$  can happen.*

*But  $y \rightarrow \tilde{y}$  is ungrounded. So  $yz$  is ungrounded.*

*Maybe  $xy$  can do  $y \rightarrow \tilde{y}$  if  $x \rightarrow \tilde{x}$  can happen.*

*But  $x \rightarrow \tilde{x}$  is ungrounded. So  $xy$  is ungrounded.*

*Maybe  $wx$  can do  $x \rightarrow \tilde{x}$  if  $w \rightarrow \tilde{w}$  can happen.*

*Now suppose  $wx \rightarrow \tilde{w}\tilde{x}$  is grounded.*

*So the product  $(wx)(xy)(yz) = w(xx)(yy)z = wz$   
is what happens.*

*The backchain can be a tree, even a loop  
(controlled by the level above).*

*Note that the back-chaining sequence contains  
co-occurrences  $ab + bc$  at each stage.*

*The form  $ab + bc$  is that of a unitary electron ...  
 $(ab + bc)^2 = +1$ .*

*And level 2 is magnetism, so back-chaining here  
captures field lines & current flow.*

# *Let's look at the code!*

*See [RootsOfUnity.org](http://RootsOfUnity.org)*

*“Out of the Box: Self-organizing Awareness”*

*Thread Sensor* p.27

*Thread Effect* p.29

*Object Bubble Impulses Up* pp.32-33

*Thread 1: accept bubble from below*

*Thread 2: erect back-chain* .

*Thread 4: reflect downward at top* .

*Thread 3: accept trickle-down goal* .

*Thread Corm: build new 4-tier* pp.33-34.

*So in the end ...*

*Same  $2^{2^n}$  xor structure as the Combinatorial Hierarchy; 'distinction' = mutex.*

*The universe's structure is Descartes' dualism: space-like & time-like.*

*From our time-like pov, we resolve created-on-the-fly events into a dynamic 3+1d structure.*

*The physicists' error is to assume that this 3+1d is primary. It isn't.*

*Rather, the driver is the hyper-exponentially dimensional wave-function hierarchy.*

*Further, all change occurs via products with entangling quaternionic operators.*

*So all change is fundamentally space-like.*

*All things are space-like too: spin, charge, gravity (even matter) & love*

*Via hierarchical buildup, we are space-like too.*

*We are made of space  
and  
resonantly entangled  
with  
everything.*