

What's the Deep Reality beneath **Quantum Computing?** by Doug Matzke. Ph.D. www.QuantumDoug.com doug@quantumdoug.com Presented via Zoom at Austin IEEE CTS Jan 19, 2021

Abstract



Quantum computing and Quantum Physics contains important concepts about how the world is built. The fundamentals of the classical world is bits with its mutually exclusive 1/0 values. Quantum computing is based on qubits that are the superposition (or mixture) of two classical bits, and this property means that bits and probabilities are fundamental to physics. Typically these unique properties of superposition and entanglement are studied with complex mathematics, but they can be learned conceptually, which will be the basis of this gentle introduction. His 2002 Ph.D. used Geometric Algebra to represent quantum computing, which produced interesting predictions.

Once these concepts are understood that the universe is fundamentally probabilistic and informational then they will help understand quantum weirdness. He will also talk about the role of observation and quantum measurement, related to his new book <u>www.DeepRealityBook.com</u>. The take away from this talk is a better appreciation of the spectacular nature of how the universe is organized as hyper-dimensional collections of graded bits, qubits and ebits.

About Doug Matzke







• My moniker is Quantum Doug

- o IEEE Senior Life Member
- 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?
- EE Master's degree in 1980 at UT Austin
- 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)
- $\circ~$ Awarded \$1 million SBIR grants on topics:
 - Neural and quantum computing
- Deep Reality book coauthored with William A. Tiller
 - Source Science and bit-physics



Importance of Computational Scaling



- --- Nano enhances Moore's law
- --- Semiconductor limited Moore's law
- Dow Jones industrial average (1971–2012)

2010	2012	2013	2015	2016	2018
hp45		hp32		hp22	
45	35	32	25	22	18
54	42	38	30	27	21
45	35	32	25	22	18
25	20	18	14	13	10
18	14	13	10	9	7
	2010 hp45 45 54 45 25 18	2010 2012 hp45 35 54 42 45 35 25 20 18 14	2010 2012 2013 hp45 Mp32 45 32 45 35 32 38 45 35 32 38 45 35 32 38 45 35 32 38 45 35 32 38 45 35 32 38 45 35 32 38 45 35 32 38 18 14 13 38	2010 2012 2013 2015 hp45 hp32 1 45 35 32 25 54 42 38 30 45 35 32 25 54 42 38 30 45 35 32 25 25 20 18 14 18 14 13 10	2010 2012 2013 2015 2016 hp45 hp32 hp32 hp22 45 35 32 25 22 54 42 38 30 27 45 35 32 25 22 54 42 38 30 27 45 35 32 25 22 25 20 18 14 13 18 14 13 10 9

Quantum Computing from Physics







Information is Physical



Bits are part of physics, not just computer science

- > Rolf Landauer: Information is Physical (bit = $kT \ln 2$)
- Erasing of information effects thermodynamics
- Reversible computing is essential to QuComputing
- Bit is smallest increment to Black Hole (Planck area)
- John Wheeler: "It from Bit" (quantum matrix)
- Particle/Wave duality and Uncertainty Principle
- Classical universe emerges from quantum hyperdimensions





"Quantum Foam"



"Quantum Matrix"

Heisenberg Uncertainty Principle



The position and the velocity of an object cannot both be simultaneously measured exactly, even in theory. This duality is due to non-commutative properties and is similar to how Fourier series frequency vs time conjugate information. So quantum mechanical systems have intrinsic uncertainty.



Quantized Waves



 Quantum states are distributed probability waves
 Photons/particles are quantized *Wave-Particle Duality Waves/particles depending on measurement*
 Waves construct even Planck Scale spacetime
 Self Consistent over all paths (Feynman diagrams)



Quantum Tunneling



Particle position is also a probability amplitude
 Probability amplitude is non-zero thru barrier (p>0)
 Probability the particle escapes energy barrier
 Superposition of position at atom/molecular level
 Smaller wires will no longer contain electrons





Schrodinger's Cat



Thought experiment about extent of probabilities:
➢ Quantum Probabilities at the Macro Scale?
➢ Cat Dead and/or Alive due to quantum prob.



Qubit: two bits in Superposition



Superposition is a quantum property:

- Phase computing is source of all probabilities
- ➢All states are simultaneous/concurrently present

Classical bit states: Mutually Exclusive Quantum bit states: Orthogonal





Probabilities from Qubits



- > Bra-ket notation for matrices (Hilbert Spaces)
- \succ Coefficients c_x are complex probability amplitudes
- > Amplitudes squared c_{χ}^2 are probabilities
- > Unitarity: $c_0^2 + c_1^2 = 1$ (sum of probabilities is 1)
- Reversible phase based computing
- No-Cloning Theorem unknowable states



Superposition

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

$$state 0_{0} = |0\rangle = \begin{bmatrix} 1\\0 \end{bmatrix}$$
$$state 1_{0} = |1\rangle = \begin{bmatrix} 0\\1 \end{bmatrix}$$

Operators for a Qubit

90° $|1\rangle$

 $|0\rangle_{0^{\circ}}$

Reversible operations on a qubit Unitary Gate (no phase change) 180° \triangleright Phase Gate (rotate by some phase angle) $H|0\rangle \rightarrow \frac{|0\rangle+|1\rangle}{\sqrt{2}}$ \blacktriangleright Hadamard Gate (rotate by 45 degrees) \blacktriangleright Not Gate (rotate by 90 degrees) $X|0\rangle \rightarrow |1\rangle$ \blacktriangleright Invert Gate (rotate by 180 degrees)



Measurement on a Qubit

Irreversible operation on a qubit

- Measurement gives probabilistic result
- ➢ Probability is based on relative phase angle
- Collapse the wave function (Copenhagen Interpretation)
- Noise changes quantum states unexpectedly

Operators for 2 Qubits

Reversible operations on two qubits
➤Two or more qubits form a quantum register
➤Quantum register has 2^q states (tensor product)
➤CNOT: Controlled-NOT (conditional flip)
➤SWAP: Controlled-phase

Operators for 3 Qubits (Qutrit)

Universal Reversible operations on three qubits
➤ Gates don't erase information (Landauer's principle)
➤ Can be run forward/backward (billiard ball computing)
➤ Boolean complete since supports Boolean logic

Toffoli Gate CCNOT

NOT(x)=Toffoli'(1,1,x) AND(a,b)=Toffoli'(a,b,0) OR(a,b)=NOT(AND(NOT(a),NOT(b))

Fredkin Gate CSWAP

Visualizing hyperdimensions

Orthogonal dimensions

Cannot be embedded in three dimensions or 2D hologram!!

Points in hyperdimensions

1994 Peter Shor's algorithm

Shor's algorithm demonstrates quantum speedup:

- Uses all 2^q simultaneous states to solve problem (QFT)
- > Efficiently solves factoring, impossible by any classical computer
- Killer application for Quantum Computers
- Defined new complexity class: Quantum Polynomial time

Spurred the development of quantum computing, quantum encryption technology and other quantum algorithms.

Ebits: Entangled Qubits

Entanglement is a quantum property:

Multiple things (2 Qubits) acting as one Contains *inseparable* quantum states \blacktriangleright Non-locality due to >3 dimensions Einstein's "Spooky action at a distance"

EPR and Bell/Magic states/operators are well defined

Entangled photon pair $|\Psi\rangle_{12} = |\uparrow\rangle_1 |\uparrow\rangle_2 + |\leftrightarrow\rangle_1 |\leftrightarrow\rangle_2$

 $= |00\rangle \pm |11\rangle$

Entanglement is Space-like

Non-local connection due to 4 dimensional states

- Every ebit contains 4 private dimensions (beyond 3d+1t)
- Self consistency even though space-like states
- Ebits useful for secure communication Quantum Key Distribution
- My research shows space-time itself is entangled (tauquernions)
- My research shows dark-matter/energy are entangled

Quantum Supremacy

A universal quantum computer >50 Qubits will quickly solve problems no classical computer can solve!!

Killer app is Shor's algorithm.

D-Wave

IBM

Google

Microsoft

Intel

Quantum and Neural Computing

Both quantum and neural computing uses hyperdimensional math

Company	Qubits	Quantum Computing	AI Computing Technology
IBM	50 qubits	Longest Researcher - IBM Q	Deep Blue & IBM Watson
Google	72 qubits	D-Wave and Bristlecone chip	TensorFlow & AlphaGo Chip
Intel	49 qubits	Tangle-Lake chip	neuromorphic chip "Loihi"
Microsoft	unknown	Topological qubits (anyons)	FPGA computing and Augmented Reality
D-Wave	2000 qubits	Adiabatic Computing	Optimization algorithms
many		Computers & Communications	deep learning neural nets

Quantum States Simulate Universe

Classical world must emerge from quantum states and simulation is separate from simulator

DILBERT

BY SCOTT ADAMS

Quantum infrastructure is required to efficiently simulate a quantum system

Information from Concurrent Bits: Coin Demo: Act I

Setup:

Person stands with both hands behind back

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

Non-Shannon space-like information derives from simultaneity!

Non-metric Protospace and Prototime

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

Quantum Observer Effect

Double-slit experiment proves quantum wave behavior

Observer effect is a deep philosophical topic

#1 Global Consciousness Project

PEAR Lab – Roger Nelson

- Inspired by individual RNG results
- 70 host sites around the globe
- Monitoring RNGs over 15 years
- Global events change probabilities
- Coherent emotion causes change
- Over 500 events identified

Significance: unusual statistics are due to deeper physics foundation

#2 Mind "Observes" Quantum States

Important interaction with intent and quantum states

Double-slit by Dean Radin

- Closed & shielded doubleslit with photo detector
- Direct mental influence of quantum interference
- Worked remotely using online volunteers

Significance: no electromagnetic effects due to Faraday cage shielding

#3 Intention Host Device

Intention can be stored outside the brain and rebroadcast

William A. Tiller IHD

- Simple resonant device
- Program using Meditation for pH up or down
- IHD Can directly affect laboratory experiments
- Four kinds of lab effects
 - Inorganic
 - Organic
 - Living
 - Non-living

Significance: thoughts are not due to neural mechanisms

"This remarkable book is a fresh look at the connections between science and spirituality. Written in an easy-flowing conversational style, it dives deep into what authors Matzke and Tiller call 'Source Science."

—Dean Radin, PhD Chief Scientist, Institute of Noetic Sciences, and Distinguished Professor, California Institute of Integral Studies.

Why Source Science May Be the Key to Understanding Human Potential

DOUG MATZKE WILLIAM A. TILLER

Deep Reality Book

Hyperdimensional quantum bits are fundamental since exposes the infinite quantum bit reality of the universe for real intelligence.

"This remarkable book is a fresh look at the connections between science and spirituality. Written in an easy-flowing conversational style, it dives deep into what authors Matzke and Tiller call 'Source Science.' Fully grasping the implications of their expansive view of reality will make your head spin. *Deep Reality* is not for the faint of heart or those with rigid heads, but it is heartily recommended for everyone else." —Dean Radin, PhD Chief Scientist Institute of Noetic Sciences

Chief Scientist, Institute of Noetic Sciences, and Distinguished Professor, California Institute of Integral Studies.

Source Science Model

- 1. Information is Physical Rolf Landauer
 - Creation and deletion of information has effective energy
 - Connects information, entropy and black holes
 - "It from Bit" by John Wheeler
- 2. Universe is hyperdimensional Richard Feynman
 - Nature isn't classical dammit, it's quantum mechanical
 - Protophysics bits (GALG) can construct all of quantum physics
 - Each ebit has 4 private dimensions Spooky action
- 3. Mind is separate from the brain William Tiller
 - Mind is outside spacetime and exhibits non-local effects
 - Mental beings interacting with bio-bodysuit William Tiller
 - Rotes are quantum meaning structures Robert Monroe
 - Meaning is hyperdimensional and space-like Correlithms

Graded Spaces In Geometric Algebra

See operators for qubit and qutrit online in my PhD dissertation

TauQuernions: Entangled Quaternions in \mathbb{G}_4

> TauQuernions $(\mathcal{T}_{i}, \mathcal{T}_{j}, \mathcal{T}_{k} \& \text{ conjugate set } \mathcal{T}_{i}', \mathcal{T}_{j}', \mathcal{T}_{k}')$:

Entangled Quaternion isomorphs

•
$$M = T_i = ab - cd$$
, $T_j = ac + bd$ and $T_k = ad - bc$

•
$$\mathcal{B} = \mathcal{T}_i' = ab + cd$$
, $\mathcal{T}_j' = ac - bd$ 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)
- $(I^{-})^{2} = I^{+} = (-1 \pm abcd)$ (sparse +1: is idempotent)

 $B^2 + M^2 = -1$

 $B^4 + M^4 = +1$

>>> report4(1-abcd)																		
18.868 ((0, 8, 8), 1)	[Ø]		Ø	- 0	Ø	_	_	0(4 -	Ø	_	_	01	=	+	1	_	(a^b^c^d)
>>> report4(-1-abcd)																		
18.868 <<0, 8, 8>, 1>	[+	00	+	0+	+	Ø	9	+ ·	+ Ø	+	Ø	Ø	+]	=	—	1	—	(a^b^c^d)

*	$m{T}_{i}$	${oldsymbol{\mathcal{T}}_{i}}$	$oldsymbol{\mathcal{T}}_{k}$
$m{T}_{i}$	1 + abcd	–ad + bc	ac + bd
$m{T}_{ m i}$	ad – bc	1 + abcd	–ab + cd
$\overline{\boldsymbol{\mathcal{T}}}_{k}$	–ac – bd	ab – cd	1 + abcd

*	${\cal T}_{ m i}$	$\boldsymbol{\mathcal{T}}_{\mathrm{v}}$	$oldsymbol{\mathcal{T}}_{k}$
Γ _i	"-1"	$-{\cal T}_k$	${oldsymbol{\mathcal{T}}_{i}}$
<i>T</i> _i	$m{\mathcal{T}}_{k}$	"-1"	$-{\cal T}_{i}$
$oldsymbol{\mathcal{T}}_{k}$	- T _i	${oldsymbol{\mathcal{T}}_{i}}$	"-1"

${m T}_{ m i}$	\mathcal{T}_{i}	$oldsymbol{\mathcal{T}}_{k}$
Magic	$M_3 = -M_1$	$M_0 = -M_2$
Magic	$M_3 = -M_1$	$M_2 = -M_0$
Magic	$M_1 = -M_3$	$M_0 = -M_2$
Magic	$M_1 = -M_3$	$M_2 = -M_0$

${m T}_{ m i}^{\prime}$	Γ '	${oldsymbol{\mathcal{T}}_{k}}$,
Bell	$\mathbb{B}_2 = -\mathbb{B}_0$	$\mathbb{B}_1 = -\mathbb{B}_3$
Bell	$\mathbb{B}_2 = -\mathbb{B}_0$	$\mathbb{B}_3 = -\mathbb{B}_1$
Bell	$\mathbb{B}_0 = -\mathbb{B}_2$	$\mathbb{B}_1 = -\mathbb{B}_3$
Bell	$\mathbb{B}_0 = -\mathbb{B}_2$	$\mathbb{B}_3 = -\mathbb{B}_1$

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

Graded Standard Model with GALG

possible dark primitives in G₄

primitives in G₃ plus protons/neutrons

GALG Standard Model Predications:

- 1. Neutrino, Z/W bosons are 2D
- 2. Additional fourth Neutrino
- 3. Additional Boson (X17)
- 4. Bell States are 4D tauquernions
- 5. Bell Operator is irreversible
- 6. Higgs Boson is 4D
- 7. Dark matter/energy are 4D

Real Intelligence vs Artificial Intelligence

Humans represent real intelligence because:

- Demonstrate generalized learning
- Manage meaning even before language
- Massively parallel (even with slow neurons)
 - Quantum-like speedups
 - Most likely brain is an antenna
- Intention can directly affect quantum states
 - Double-slit experiment
 - Intention Host Device
- Humans exhibit non-local behaviors:
 - Space: Remote Viewing
 - Time: Presentience
- Space-like and wave-like mental states (source-like)
 - Meaning
 - Knowing
 - Awareness
 - Consciousness
 - Transcendent States

Conclusions: Quantum is fundamental

Following emerges from quantum information bits:

- Quantum probability amplitude waves
- Quantum superposition (qubits and probabilities)
- Quantum entanglement (ebits and "spooky action")
- ➢ All strange quantum physics principles
- Spacetime, zero point energy and quantum foam
- All particles (fermions=mass) and energy (bosons=massless)
- All energy/mass/space/time of classical/relativistic world
- > All sequential/parallel computing (time-like & light-like)
- All space-like quantum speedup
- Prediction human real intelligence are quantum states

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

Questions and Answers

Quantum computing is:

see <u>www.DeepRealityBook.com</u> and for more papers see <u>www.QuantumDoug.com</u>