World-Line String Bohm Quantum Potential, E8, and Consciousness

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Abstract

Penrose-Hameroff type Quantum Consciousness is described in terms of E8 Physics
(see viXra 1508.0157) and 26D String Theory with Strings seen as World-Lines
and Bohm Quantum Potential and Sarfatti Thought Decoherence. Tubulin Dimer
information content of Microtubules is seen to correspond to the Cl(16) Clifford Algebra
in which the E8 Lie Algebra is naturally contained. Creation-Annihilation Operators and
Algebraic Quantum Field Theory and AQFT Quantum Code for Bohm Quantum Theory
are also described.

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E8 Root Vectors and 26D String Theory

The Cl(16)-E8 AQFT inherits structure from the Cl(16)-E8 Local Lagrangian
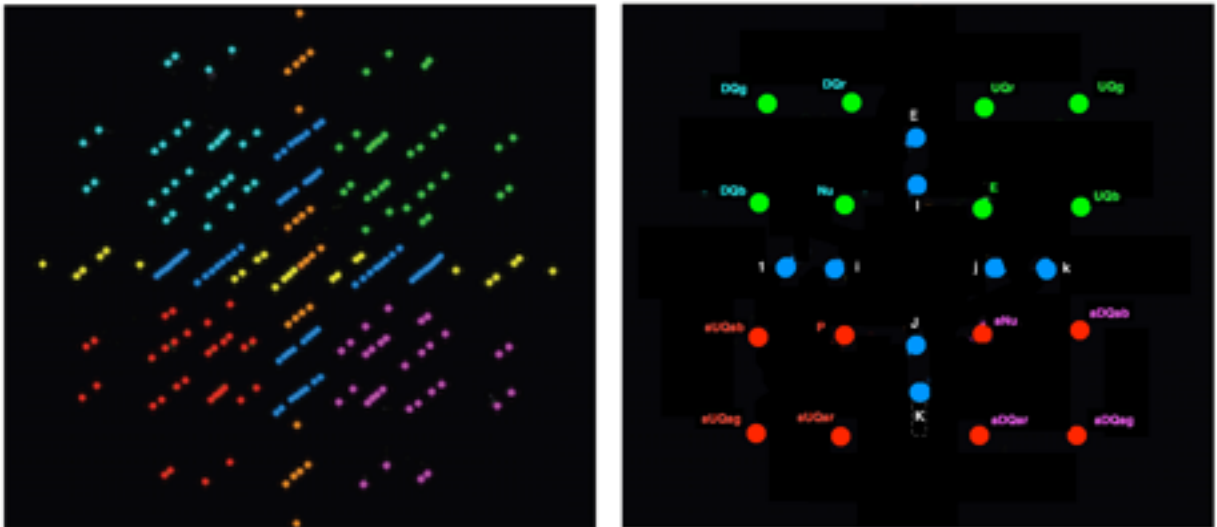
$$\int_{\text{8-dim SpaceTime}} \text{Gauge Gravity} + \text{Standard Model} + \text{Fermion Particle-AntiParticle}$$

.

whereby World-Lines of Particles are represented by Strings moving in a space
whose dimensionality includes   8v = 8-dim SpaceTime Dimensions +
+ 8s+ = 8 Fermion Particle Types + 8s- = 8 Fermion AntiParticle Types
combined in the traceless part J(3,O)o of the 3x3 Octonion Hermitian Jordan Algebra

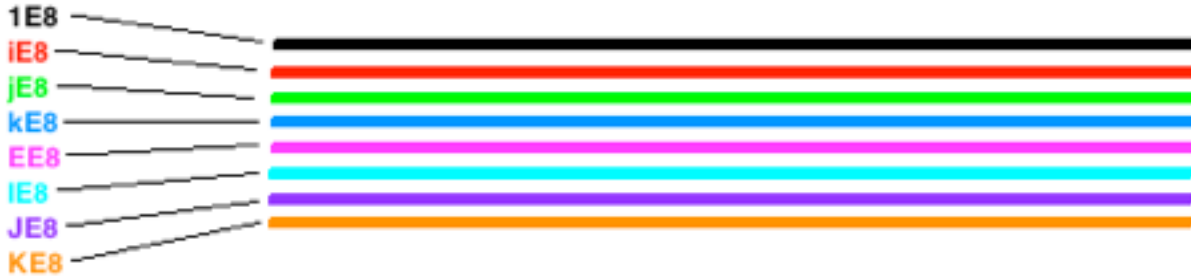|		
a	8s+	8v
8s+*	b	8s-
8v*	8s-*	-a-b

which has total dimension 8v + 8s+ + 8s- + 2 = 26 and is the space of a
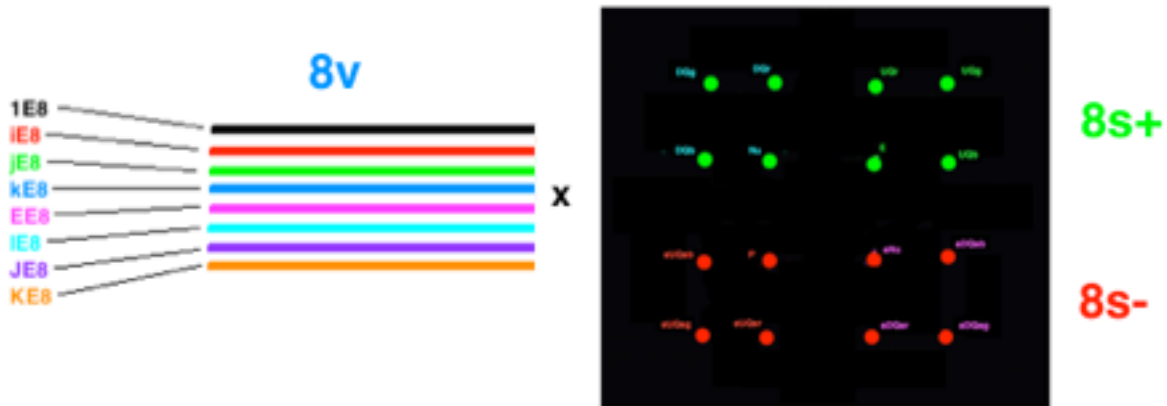26D String Theory with Strings seen as World-Lines.

24 = 8v + 8s+ + 8s- of the 26 dimensions of 26D String Theory correspond
to 24x8 = 192 of the 240 E8 Root Vectors by representing the 8v + 8s+ + 8s- as
superpositions of their respective 8 components

8v SpaceTime is represented by D8 branes. A D8 brane has
Planck-Scale Lattice Structure superpositions of 8 types of E8 Lattice
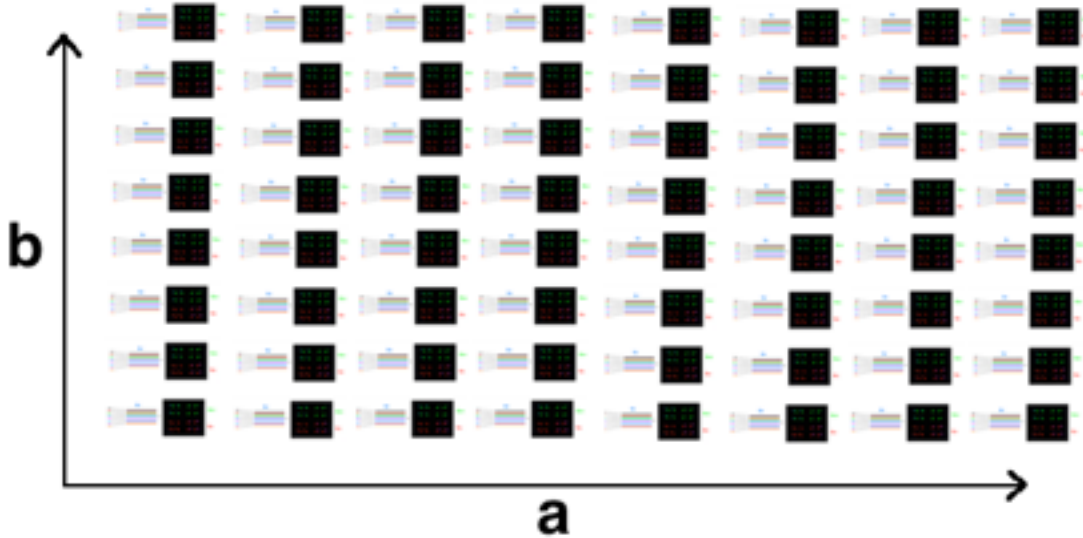denoted by 1E8, iE8, jE8, kE8, EE8, IE8, JE8, KE8

A single Snapshot of SpaceTime is represented by a D8 brane at each point of which
is placed Fermion Particles or AntiParticles represented by 8+8 = 16 orbifolded
dimensions of the 26 dimensions of 26D String Theory.

It is necessary to patch together SpaceTime Snapshots to form a Global Structure
describing a Many-Worlds Global Algebraic Quantum Field Theory (AQFT)
whose overall structure is described by Deutsch in "The Fabric of Reality" (Penguin 1997 pp. 276-283):
"… there is no fundamental demarcation between snapshots of other times and
snapshots of other universes ... Other times are just special cases of other universes ...
Suppose ... we toss a coin ... Each point in the diagram represents one snapshot
... in the multiverse there are far too many snapshots for clock readings alone to locate
a snapshot relative to the others. To do that, we need to consider the intricate detail of
which snapshots determine which others. …
in some regions of the multiverse, and in some places in space,
the snapshots of some physical objects do fall, for a period, into chains,
each of whose members determines all the others to a good approximation …".

The Many-Worlds Snapshots are structured as a 26-dim Lorentz Leech Lattice
of 26D String Theory parameterized by the a and b of J(3,O)o
as indicated in this 64-element subset of Snapshots

The 240 - 192 = 48 = 24+24 Root Vector Vertices of E8 that do not represent
the 8-dim D8 brane or the 8+8 = 16 dim of Orbifolds for Fermions
do represent the **Gauge Bosons (and their Ghosts) of E8 Physics**:

Gauge Bosons from 1E8, iE8, jE8, and kE8 parts of a D8 give U(2,2) Conformal Gravity
Gauge Bosons from EE8 part of a D8 give U(2) Electroweak Force
Gauge Bosons from IE8, JE8, and KE8 parts of a D8 give SU(3) Color Force

Each Deutsch chain of determination represents a World-Line of Particles / AntiParticles
corresponding to a String of 26D String Theory
such as the red line in this 64-element subset of Snapshots

26D String Theory is the Theory of Interactions of Strings = World-Lines.

Interactions of World-Lines can describe Quantum Theory
according to Andrew Gray (arXiv quant-ph/9712037):
"... probabilites are ... assigned to entire fine-grained histories ...
base[d] ... on the Feynman path integral formulation ...
The formulation is fully relativistic and applicable to multi-particle systems.
It ... makes the same experimental predictions as quantum field theory ...".
Green, Schwartz, and Witten say in their book "Superstring Theory" vol. 1 (Cambridge 1986)
"... For the ... closed ... bosonic string [**26D String Theory**] .... The first excited level ...
consists of ... the ground state ... tachyon ... and ... a scalar ... 'dilaton' ... and ...
SO(24) ... little group of a ...[26-dim]... massless particle ... and ...
a ... massless ... spin two state ...".

Closed string tachyons localized at orbifolds of fermions produce virtual clouds of
particles / antiparticles that dress fermions.

Dilatons are Goldstone bosons of spontaneously broken scale invariance that
(analagous to Higgs) go from mediating a long-range scalar gravity-type force
to the nonlocality of the Bohm-Sarfatti Quantum Potential.

The SO(24) little group is related to the Monster automorphism group that is
the symmetry of each cell of Planck-scale local lattice structure.

**The massless spin 2 state = Bohmion = Carrier of the Bohm Force
of the Bohm Quantum Potential.**

"... **Bohm's Quantum Potential can be viewed as an internal energy** of a quantum system ..." according to Dennis, de Gosson, and Hiley (arXiv 1412.5133) and
Peter R. Holland says in "The Quantum Theory of Motion" (Cambridge 1993): "... **the total force ... from the quantum potential ... does not ... fall off with distance** ...
because ... the quantum potential ... depends on the form of ...[the quantum state]... rather than ... its ... magnitude ...".

**Penrose-Hameroff-type Quantum Consciousness is due
to Resonant Quantum Potential Connections among Quantum State Forms**.
The Quantum State Form of a Conscious Brain is determined by
the configuration of a subset of its 10^18 to 10^19 Tubulin Dimers
with math description in terms of a large Real Clifford Algebra:

Resonance is discussed by Carver Mead in "Collective Electrodynamics" (MIT 2000):
"... we can build ... a resonator from ... electric dipole ... configuration[s] ...

[such as Tubulin Dimers]

Because there are charges at the two ends of the dipole, we can have a contribution to the electric coupling from the scalar potential ... as well [as] from the magnetic coupling ... from the vector potential ... electric dipole coupling is stronger than magnetic dipole coupling ... the coupling of ... two ... configurations ... is the same, whether retarded or advanced potentials are used. Any ... configuration ... couples to any other on its light cone, whether past or future. ... The total phase accumulation in a ... configuration ... is the sum of that due to its own current, and that due to currents in other ... configurations ... far away ...
The energy in a single resonator alternates between the kinetic energy of the electrons (inductance), and the potential energy of the electrons (capacitance). With the two resonators coupled, the energy shifts back and forth between the two resonators in such a way that the total energy is constant ... The conservation of energy holds despite an arbitrary separation between the resonators ... Instead of scaling linearly with the number of charges that take part in the motion, the momentum of a collective system scales as the square of the number of charges! ... The inertia of a collective system, however, is a manifestation of the interaction, and cannot be assigned to the elements separately. ... Thus, it is clear that collective quantum systems do not have a classical correspondence limit. ...".

For **the 10^18 Tubulin Dimers of the human brain**,
the resonant frequencies are the same and exchanges of energy among them
act to keep them **locked in a Quantum Protectorate collective coherent state**.

Philip W. Anderson in cond-mat/0007287 and cond-mat/007185 said:
"... Laughlin and Pines have introduced the term "Quantum protectorate" as a general descriptor of the fact that certain states of quantum many-body systems exhibit properties which are unaffected by imperfections, impurities and thermal fluctuations. They instance ... flux quantization in superconductors, equivalent to the Josephson frequency relation which again has mensuration accuracy and is independent of imperfections and scattering. ...
... the source of quantum protection is a collective state of the quantum field involved such that the individual particles are sufficiently tightly coupled that elementary excitations no longer involve a few particles but are collective excitations of the whole system, and therefore, macroscopic behavior is mostly determined by overall conservation laws ... **a "quantum protectorate" ...[is]... a state in which the many-body correlations are so strong that the dynamics can no longer be described in terms of individual particles, and therefore perturbations which scatter individual particles are not effective** ...".
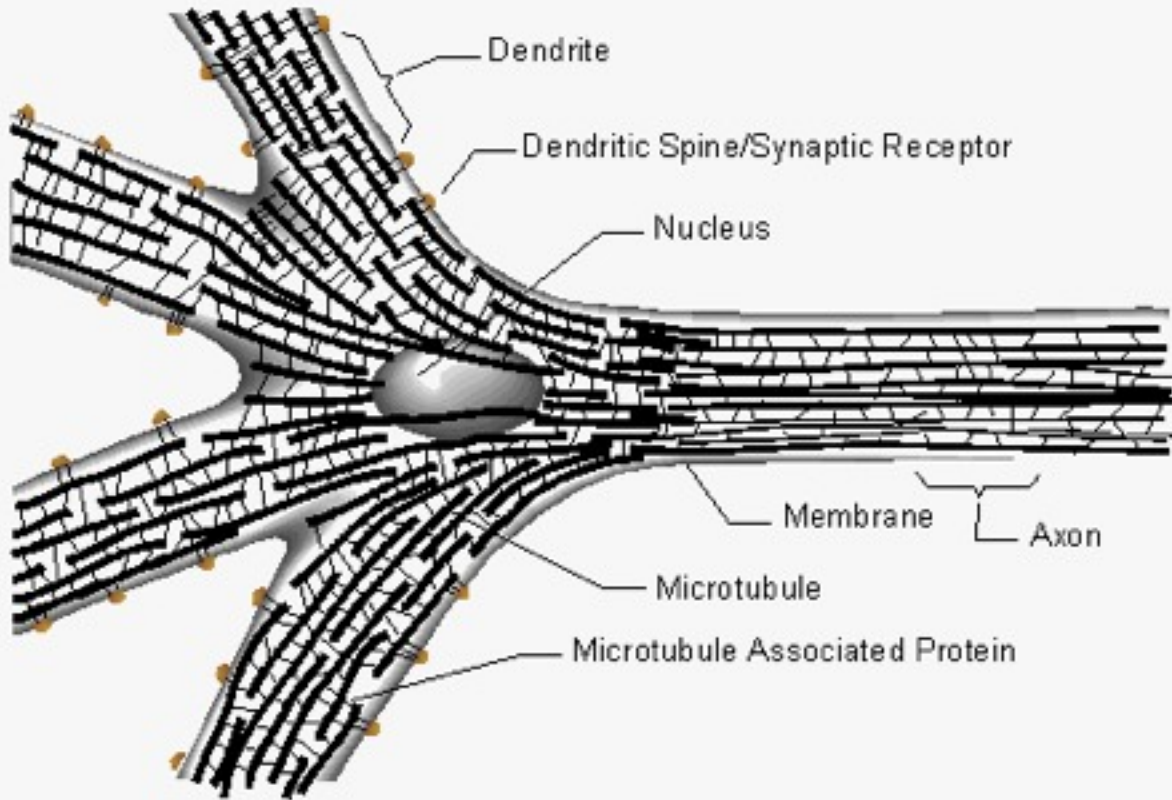Mershin, Sanabria, Miller, Nawarathna, Skoulakis, Mavromatos, Kolomenskii, Scheussler, Ludena, and Nanopoulos in physics/0505080 "Towards Experimental Tests of Quantum Effects in Cytoskeletal Proteins" said:

Classically, the various dimers can only be in the ...[   ]...
conformations. Each dimer is influenced by the neighboring dimers resulting in the possibility of a transition. This is the basis for classical information processing, which constitutes the picture of a (classical) cellular automaton.
If we assume ... that each dimer can find itself in a QM superposition of ...[those]... states, a quantum nature results. Tubulin can then be viewed as a typical two-state quantum mechanical system, where the dimers couple to conformational changes with 10^{-9} - 10^{-11} sec transitions, corresponding to an angular frequency
~ 10^{10} - 10^{12} Hz. In this approximation, the upper bound of this frequency range is assumed to represent (in order of magnitude) the characteristic frequency of the dimers, viewed as a two-state quantum-mechanical system ...[
    The Energy Gap of our Universe as superconductor condensate spacetime is from 3×10^{-18} Hz (radius of universe) to 3×10^{43} Hz (Planck length). Its RMS amplitude is 10^{13} Hz = 10 THz = energy of
    neutrino masses = critical temperature Tc of BSCCO superconducting crystal Josephson Junctions]...
large-scale quantum coherence ...[has been observed]... at temperatures within a factor of three of biological temperatures. MRI magnets contain hundreds of miles of superconducting wire and routinely carry a persistent current. There is no distance limit - the macroscopic wave function of the superfluid condensate of electron pairs, or Cooper pairs, in a sufficiently long cable could maintain its quantum phase coherence for many thousands of miles ... there is no limit to the total mass of the electrons participating in the superfluid state. The condensate is "protected" from thermal fluctuations by the BCS energy gap at the Fermi surface ... The term "quantum protectorate" ... describe[s] this and related many-body systems ...".
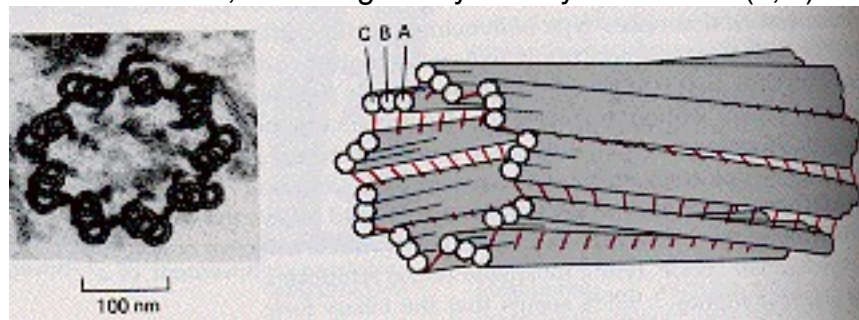
The Human Brain has about 10^11 Neuron cells, each about 1,000 nm in size.
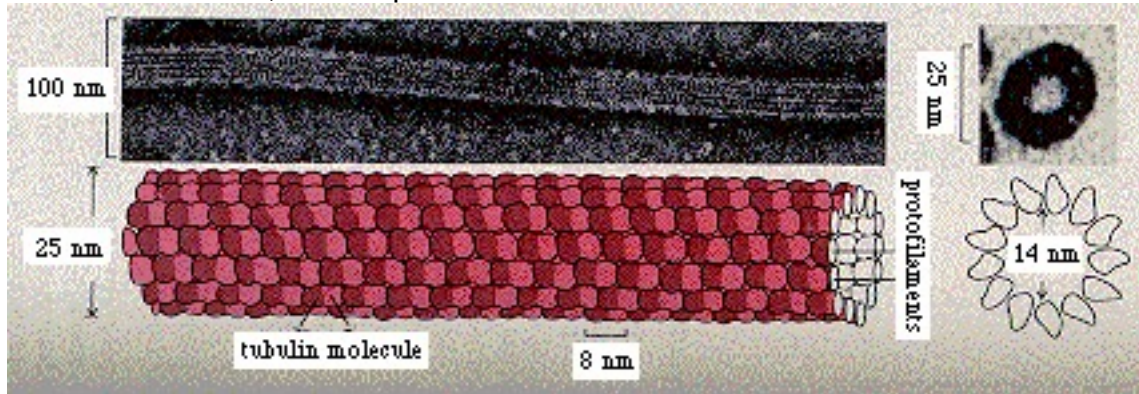The cytoskeleton of cells, including neurons of the brain, is made up of Microtubules

(image from "Orchestrated Objective Reduction of Quantum Coherence in Brain Microtubules:
The "Orch OR" Model for Consciousness" by Penrose and Hameroff)

The **Human Brain contains about 10^18 Microtubules** organized by the Centrosome.
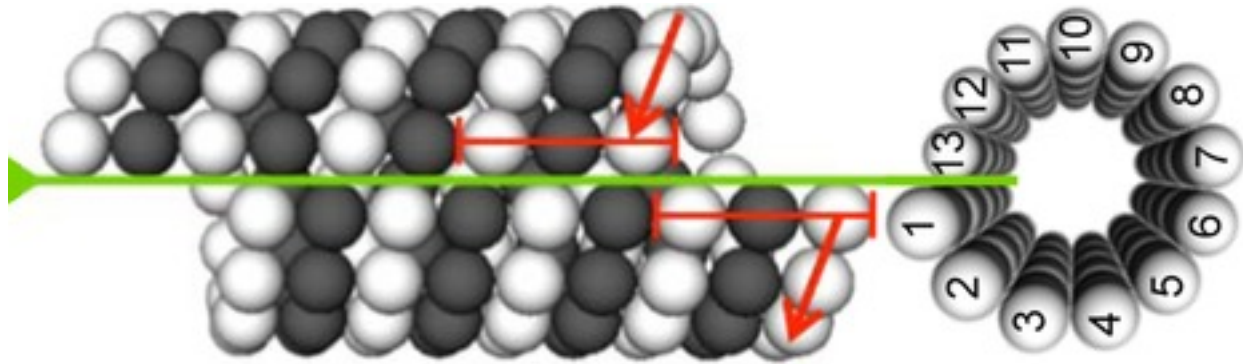Centrosomes contain a pair of Centrioles.

A Centriole is about 200 nm wide and 400 nm long. Its wall is made up
of 9 groups of 3 Microtubules, reflecting the symmetry of 27-dim J(3,O)

Each Microtubule is a hollow cylindrical tube with about 25 nm outside diameter
and 14 nm inside diameter, made up of 13 columns of Tubulin Dimers

(illustrations and information about cells, microtubules, and centrioles are from Molecular Biology of the
Cell, 2nd ed, by Alberts, Bray, Lewis, Raff, Roberts, and Watson (Garland 1989))

(image from Wikipedia on Microtubule)

Each Tubulin Dimer is about 8 nm x 4 nm x 4 nm, consists of two parts, alpha-tubulin
and beta-tubulin (each made up of about 450 Amino Acids, each containing roughly 20 Atoms)
A Microtubule 40 microns = 40,000 nm long contains 13 x 40,000 / 8 = 65,000 Dimers

(images adapted from nonlocal.com/hbar/microtubules.html by Rhett Savage)
The black dots indicate the position of the Conformation Electrons.
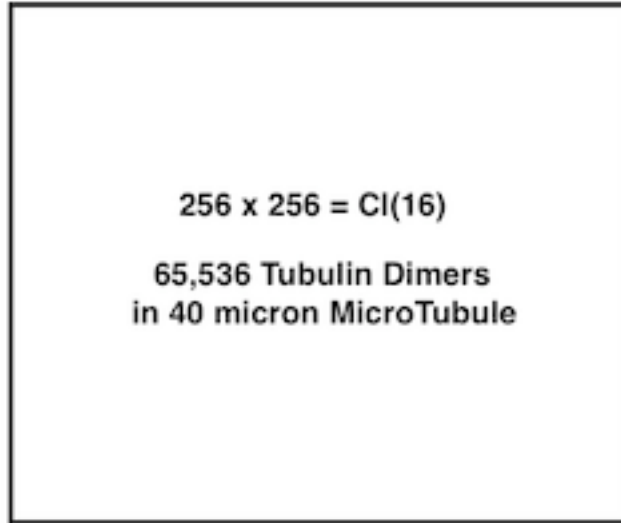There are two energetically distinct configurations for the Tubulin Dimers:
            Conformation Electrons Similarly Aligned (left image) - State 0
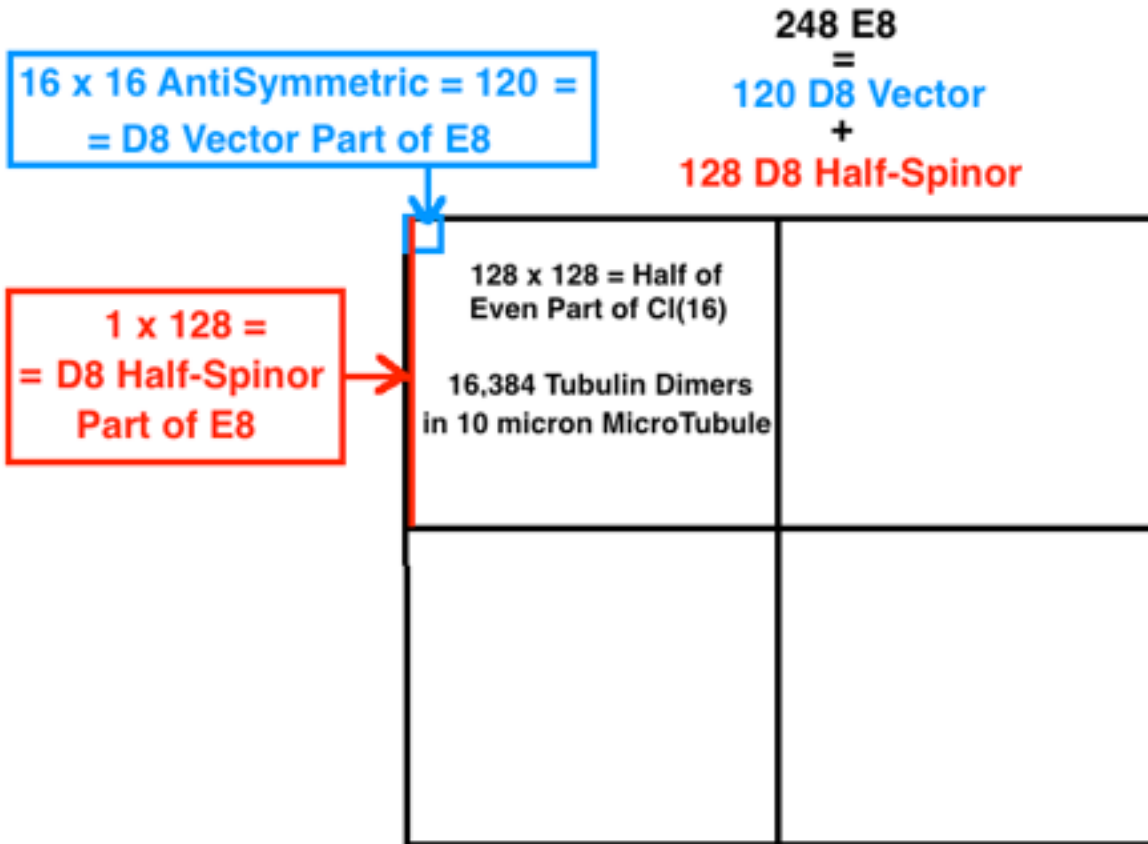   Conformation Electrons Maximally Separated (right image) - State 1

The two structures - State 0 ground state and State 1 higher energy state -
make Tubulin Dimers the basis for a Microtubule binary math / code system.

Microtubule binary math / code system corresponds to Clifford Algebras Cl(8) and Cl(8)xCl(8) = Cl(16) containing E8

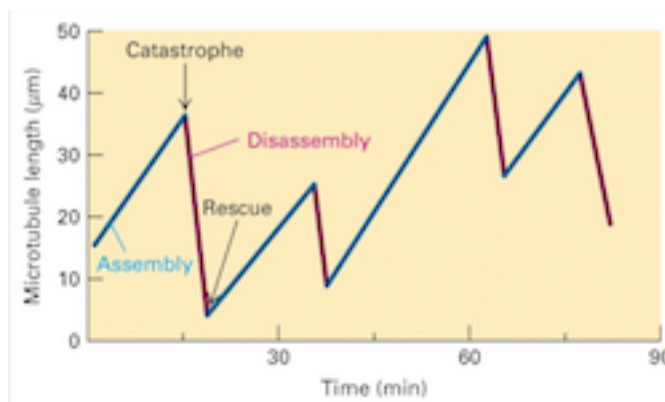256 x 256 = Cl(16)

65,536 Tubulin Dimers
in 40 micron MicroTubule

A 40 micron Microtubule contains Dimers representing the 65,536 elements of Cl(16) which contains the 248 elements of Lie Algebra E8 that defines E8 Physics Lagrangian.
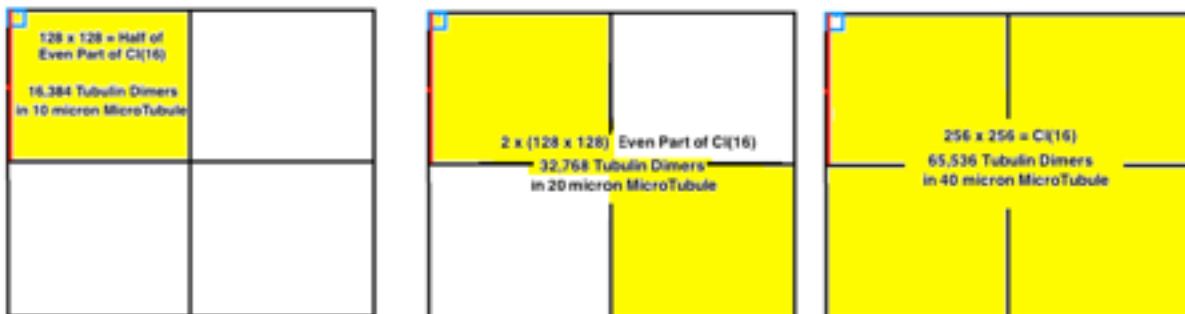
248 E8
=
120 D8 Vector
+
128 D8 Half-Spinor

16 x 16 AntiSymmetric = 120 =
= D8 Vector Part of E8

1 x 128 =
= D8 Half-Spinor
Part of E8

128 x 128 = Half of
Even Part of Cl(16)

16,384 Tubulin Dimers
in 10 micron MicroTubule

E8 lives in only half of the block diagonal Even Part half of Cl(16) so that
E8 of E8 Physics can be represented by the 16,384 Dimers of a 10 micron Microtubule.

According to 12biophys.blogspot.com Lecture 11 Microtubule structure is dynamic:
"... One end of the microtubule is composed of stable (GTP) monomers
while the rest of the tubule is made up of unstable (GDP) monomers.
The GTP end comprises a cap of stable monomers.
Random fluctuations either increase or decrease the size of the cap.
This results in 2 different dynamic states for the microtubule.
Growing: cap is present   Shrinking: cap is gone ...

...".
Microtubules spend most of their lives between 10 microns and 40 microns,
sizes that can represent E8 as half of the Even Part (half) of Cl(16) (10 microns)
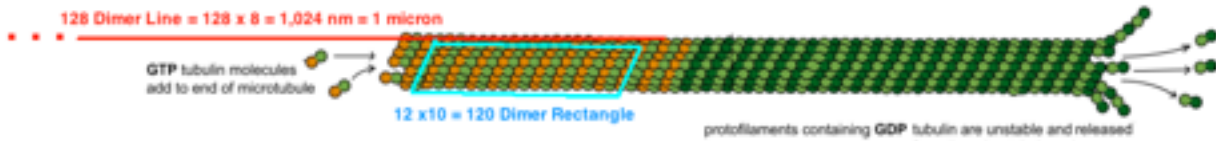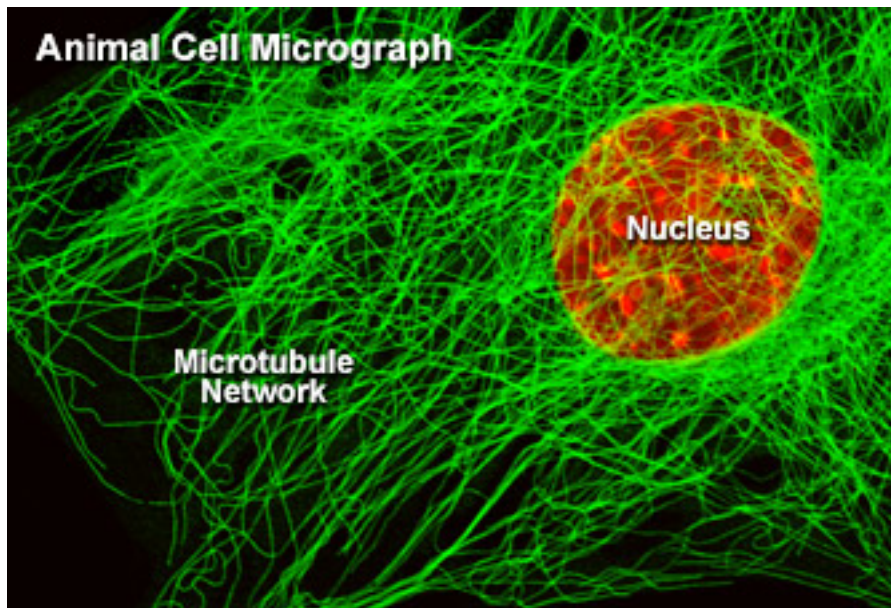

or as the Even Part (half) of Cl(16) (20 microns) or as full Cl(16) (40 microns).

In a given Microtubule

the 128 D8 Half-Spinor part ▬▬▬▬▬▬▬ is represented by a line of 128 Dimers in its stable GTP region
and

the 120 D8 Vector part ☐ by a 12 x 10 block of Dimers in its stable GTP region
(image adapted from 12biophys.blogspot.com Lecture 11)

The image immediately above does not show how thin is the Microtubule.
The following image (from micro.magnet.fsu.edu) shows overall Microtubule shape

How do the Microtubules communicate with each other ?

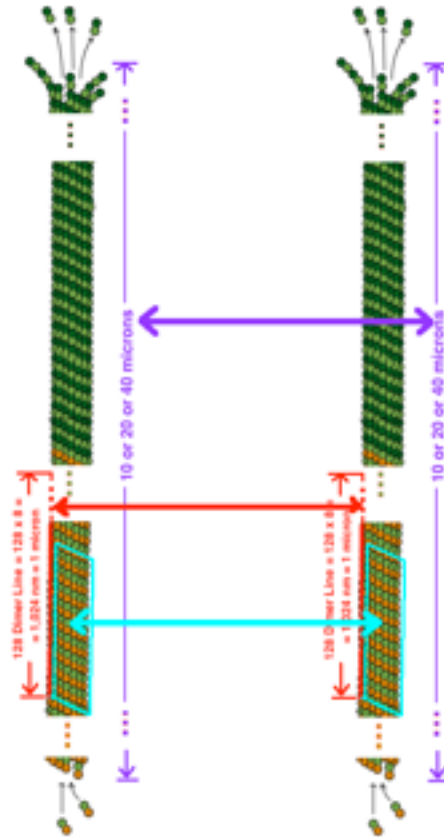Consider the Superposition of States State 0 and State 1 involving one Tubulin Dimer with Conformation Electron mass m and State1 / State 0 position separation a .

The Superposition Separation Energy Difference is the internal energy

$$E\_ssediff = G\, m^2 / a$$

that can be seen as either the **energy of 26D String Theory spin two gravitons** or the **Bohm Quantum Potential internal energy**, equivalently.

Communication between two Microtubules is by the Bohm Quantum Potential
between their respective corresponding Dimers (purple arrow)
with the correspondence being based on connection between respective E8 subsets,
the 128 D8 Half-Spinors (red arrow) and the 120 D8 BiVectors (cyan arrow)

How is information encoded in the Microtubules ?

Each Microtubule contains E8, allowing Microtubules to be corrrelated with each other.
The parts of the Microtubule beyond E8 are in Cl(16) for 40 micron Microtubules,
or the Even Subalgebra of Cl(16) for 20 micron Microtubules,
or half of the Even Subalgebra of Cl(16) for 10 micron Microtubules
so
since by 8-Periodicity of Real Clifford Algebras Cl(16) = Cl(8) x Cl(8)
and
since Cl(8) information is described by the Quantum Reed-Muller code [[256 , 0 , 24]]
the information content of Cl(16) and its Subalgebras **is described by the
Tensor Product Quantum Reed-Muller code [[256 , 0 , 24]] x [[256 , 0 , 24]]**

What about information in a large number of Microtubules ?

Since the information in one Microtubule is based on Cl(16)
and
since by 8-Periodicity Cl(16) x...(8N times tensor product)...x Cl(16) = Cl(16 N)
information of a large number of Microtubules is described by
  Tensor Products of [[256 , 0 , 24]] x [[256 , 0 , 24]] Quantum Reed-Muller codes

How does all this give rise to Penrose-Hameroff Quantum Consciousness ?

Consider the Superposition of States State 0 and State 1 involving one Tubulin Dimer
with Conformation Electron mass m and State1 / State 0 position separation a .
The Superposition Separation Energy Difference is the internal energy
$$E\_ssediff = G \, m^2 / a$$
that can be seen as either the **energy of 26D String Theory spin two gravitons**
or the **Bohm Quantum Potential internal energy**, equivalently.

For a given Tubulin Dimer a = 1 nanometer = 10^{-7} cm so that
   T = h / E_electron = (Compton / Schwarzschild) (a / c) = 10^{26} sec = 10^{19} years

Now consider the case of N Tubulin Dimers in Coherent Superposition
connected by the Bohm Quantum Potential Force that does not fall off with distance.

Jack Sarfatti defines coherence length L by $L^3 = N \, a^3$ so that
the Superposition Energy E_N of N superposed Conformation Electrons is

$$E\_N = G \, M^2 / L = N^{5/3} \, E\_ssediff$$

The decoherence time for the system of N Tubulin Electrons is

$$T\_N = h / E\_N = h / N^{5/3} \, E\_ssediff = N^{-5/3} \, 10^{26} \text{ sec}$$

So we have the following rough approximate Decoherence Times T_N

Number of Involved Tubulin Dimers	Time T_N	
10^{18}	10^{-5} sec	
10^{16}	25 x 10^{-3} sec	- 40 Hz - 7500 km wavelength - - high Schumann resonance
1.5 x 10^{15}	0.5 sec	- Radin/Bierman stimulus-experience time - - Bohmion traverse time for Hamiltonian Circuit of Tubulin Dimers separated 100 nm from neighbor

The Creation-Annihilation Operator structure of the Bohm Quantum Potential of 26D String Theory is given by the

Maximal Contraction of E8 = semidirect product A7 x h92
where h92 = 92+1+92 = 185-dim Heisenberg algebra and A7 = 63-dim SL(8)

The Maximal E8 Contraction A7 x h92 can be written as a 5-Graded Lie Algebra
28 + 64 + (SL(8,R) + 1) + 64 + 28
Central Even Grade 0 = SL(8,R) + 1

The 1 is a scalar and SL(8,R) = Spin(8) + Traceless Symmetric 8x8 Matrices,
so SL(8,R) represents a local 8-dim SpaceTime in Polar Coordinates.
Odd Grades -1 and +1 = 64 + 64
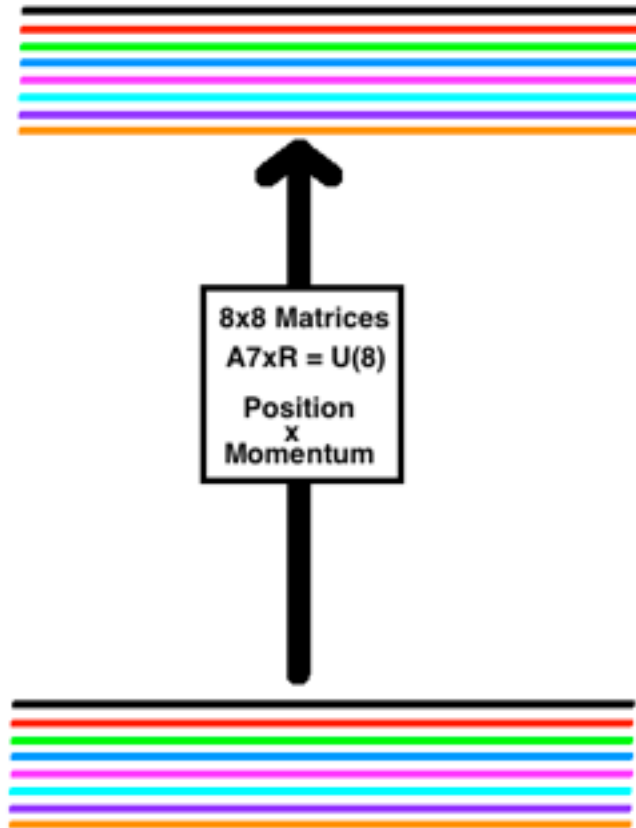
Each = 64 = 8x8 = Creation/Annihilation Operators for 8 components of 8 Fundamental Fermions.
Even Grades -2 and +2 = 28 + 28

Each = Creation/Annihilation Operators for 28 Gauge Bosons of Gravity + Standard Model.

The 8x8 matrices linking one D8 to the next D8 of a World-Line String
give A7xR = U(8) representing Position x Momentum

The Algebraic Quantum Field Theory (AQFT) structure of the Bohm Quantum Potential of 26D String Theory is given by the Cl(16)-E8 Local Lagrangian

$$\int \quad \text{Gauge Gravity} \quad + \text{Standard Model} + \quad \text{Fermion Particle-AntiParticle}$$

8-dim SpaceTime   .

living in Cl(16) and by 8-Periodicity of Real Clifford Algebras,
as the Completion of the Union of all Tensor Products of the form

Cl(16) x ...(N times tensor product)... x Cl(16) = Cl(16N)

For N = 2^8 = 256 the copies of Cl(16) are on the 256 vertices of the 8-dim HyperCube

For N = 2^16 = 65,536 = 4^8 the copies of Cl(16) fill in the 8-dim HyperCube
as described by William Gilbert's web page: "... **The n-bit reflected binary Gray code
will describe a path on the edges of an n-dimensional cube that can be used as
the initial stage of a Hilbert curve that will fill an n-dimensional cube**. ...".

The vertices of the Hilbert curve are at the centers of the 2^8 sub-8-HyperCubes whose
edge lengths are 1/2 of the edge lengths of the original 8-dim HyperCube
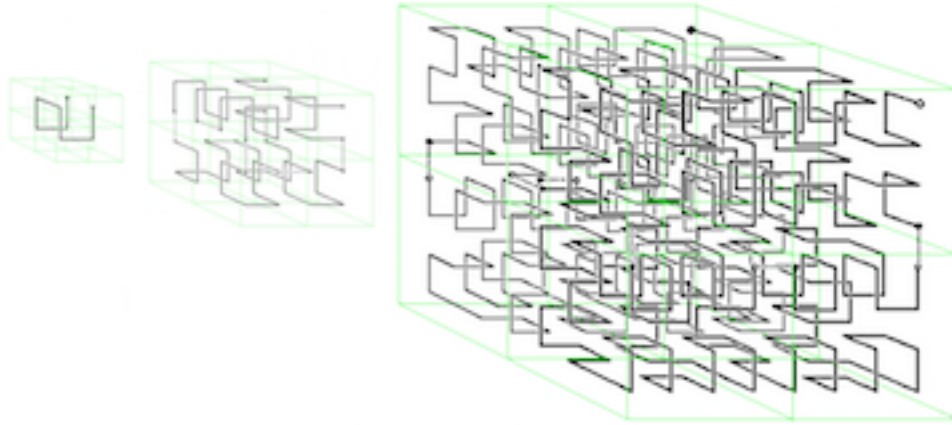
As N grows, the copies of Cl(16) continue to fill the 8-dim HyperCube of E8 SpaceTime
using higher Hilbert curve stages from the 8-bit reflected binary Gray code
subdividing the initial 8-dim HyperCube into more and more sub-HyperCubes.

If edges of sub-HyperCubes, equal to the distance between adjacent copies of Cl(16),
remain constantly at the Planck Length, then the
   full 8-dim HyperCube of our Universe expands as N grows to 2^16 and beyond
   similarly to the way shown by this 3-HyperCube example for N = 2^3, 4^3, 8^3
                     from Wiliam Gilbert's web page:

**The Union of all Cl(16) tensor products is
the Union of all subdivided 8-HyperCubes
and
their Completion is a huge superposition of 8-HyperCube Continuous Volumes
which Completion belongs to the Third Grothendieck Universe**.

AQFT Quantum Code

Cerf and Adami in quantum-ph/9512022 describe virtual qubit-anti-qubit pairs
(they call them ebit-anti-ebitpairs) that are related to negative conditional entropies for
quantum entangled systems and are similar to fermion particle-antiparticle pairs.
Therefore quantum information processes can be described by
particle-antiparticle diagrams much like particle physics diagrams and
**the Algebraic Quantum Field Theory of the E8 - Cl(16) = Cl(8)xCl(8) Physics Model
should be equivalent to a Quantum Code Information System.**

Quantum Reed-Muller code [[256 , 0 , 24]]
corresponds to
Real Clifford Algebra Cl(8)

Tensor Product Quantum Reed-Muller code [[256 , 0 , 24]] x [[256 , 0 , 24]]
corresponds to
Real Clifford Algebra Cl(8) x Cl(8) = Cl(16) containing E8

Completion of the Union of All Tensor Products of [[256 , 0 , 24]] x [[256 , 0 , 24]]
corresponds to
**AQFT (Algebraic Quantum Field Theory) hyperfinite von Neumann factor algebra
that is Completion of the Union of All Tensor Products of Cl(16)**