[Note - After this paper was accepted by arXiv in February 2004, it was removed by moderators.]

Penrose-Hameroff Quantum Tubulin Electrons, Chiao Gravity Antennas, and Mead Resonance

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Abstract:

Penrose and Hameroff have proposed that consciousness in the human brain may be based on gravitational interactions and quantum superposition states of electrons in tubulin cages in microtubules.

Chiao has proposed experimental construction of a gravity antenna that might be analogous to tubulin caged electrons.

Tegmark has criticized Penrose-Hameroff quantum consciousness, based on thermal decoherence of any such quantum superposition states.

This paper briefly describes some experimental results and theoretical ideas that indicate to me that Tegmark's criticism may be invalid.

Such theoretical ideas include Mead's quantum physics of resonance.

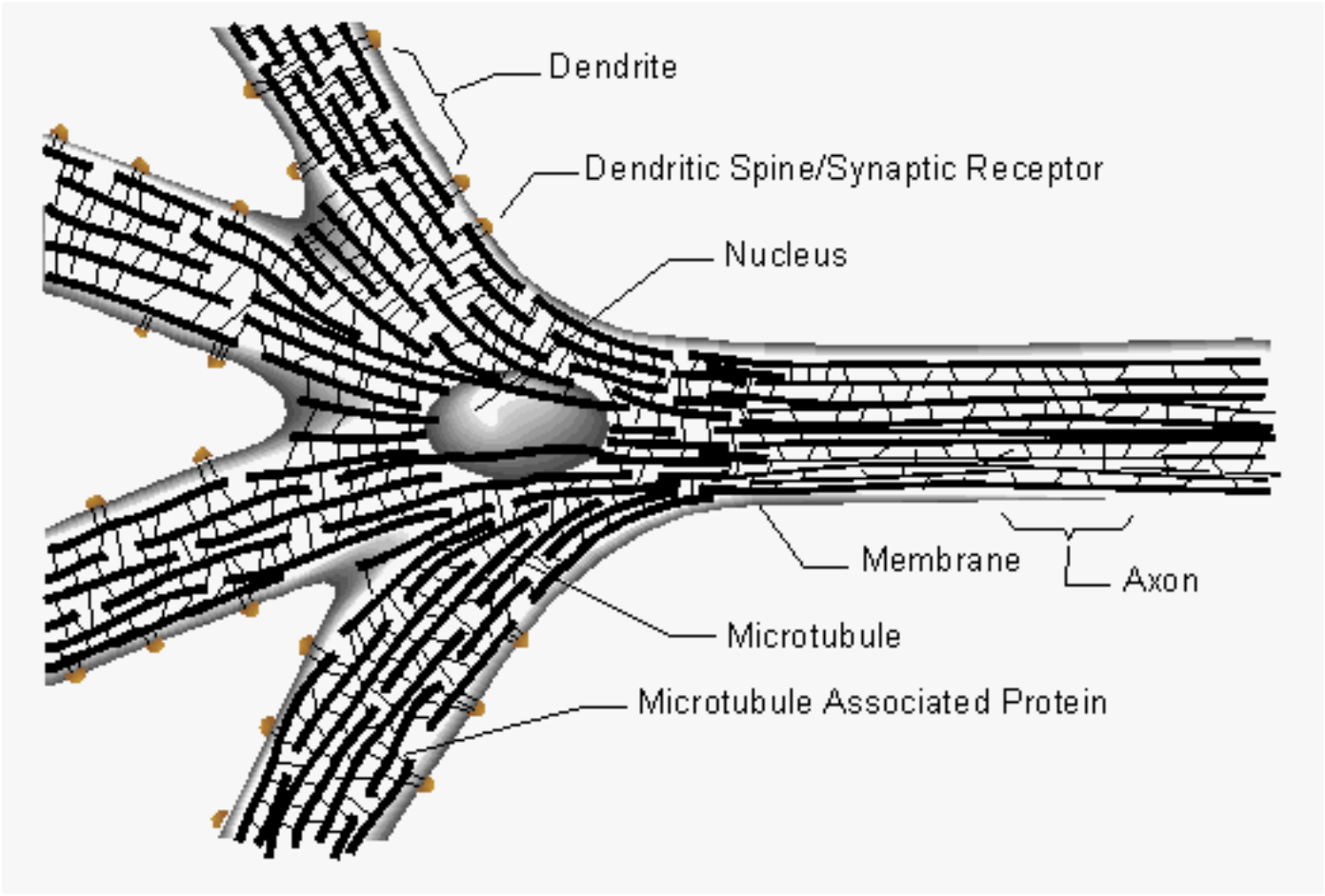
This paper closes with brief summaries of

- relevant experiments of Grinberg-Zylberbaum,
- the quantum cosmology of Paula Zizzi, and
- 26-dimensional closed unoriented bosonic string theory interpreted as a many-worlds quantum theory in which strings correspond to world lines, with massless spin-2 gravitons in 26-dimensions corresponding to gravitational interaction among tubulin electrons in states with Penrose-Hameroff superposition separation.

Penrose-Hameroff Quantum Consciousness

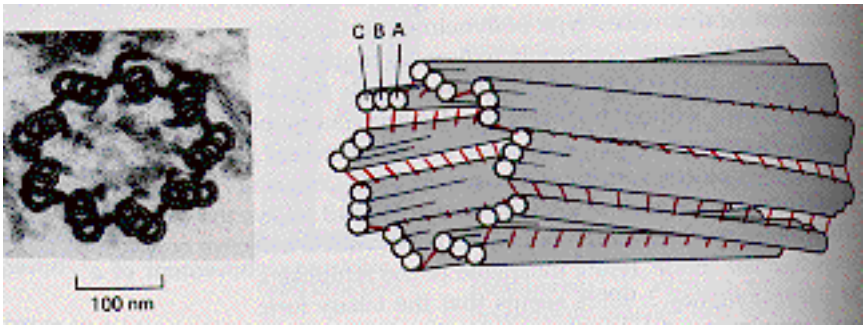
Roger Penrose and Stuart Hameroff propose that Consciousness involves a Planck scale Decoherence of Quantum Superpositions that they call Orch OR in their paper entitled Orchestrated Objective Reduction

of Quantum Coherence in Brain Microtubules: The "Orch OR" Model for Consciousness. Figure 1



is a "Schematic of central region of neuron (distal axon and dendrites not shown) showing parallel arrayed microtubules interconnected by MAPs [Microtubule Associated Proteins]. Microtubules in axons are lengthy and continuous, whereas in dendrites they are interrupted and of mixed polarity. Linking proteins connect microtubules to membrane proteins including receptors on dendritic spines.".

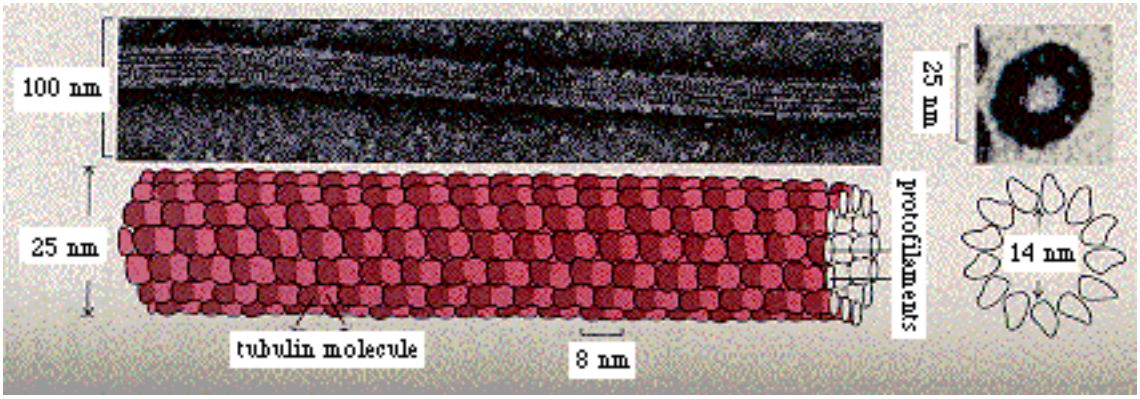
The Centrosome, in most animal cells, acts as a Microtubule Organizing Center. Most Centrosomes contain a pair of Centrioles arrranged at right angles to each other in an L-shaped configuration. A Centriole



is about 200 nm wide and 400 nm long. Its wall is made up of 9 groups of 3 microtubles. You can regard

the A microtubule of a triplet as being a complete microtubule, with the B and C microtubules being incomplete microtubules fused to A and B respectively. Each triplet is tilted in toward the central axis at an angle of about 45 degrees.

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.



(The two preceding illustrations are from Molecular Biology of the Cell, 2nd ed, by Alberts, Bray, Lewis, Raff, Roberts, and Watson (Garland 1989))

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 of which contains roughly 20 Atoms), and can exist in (at least) 2 different geometrical configurations, or conformations, involving the position of a single Electron.

Call this Electron the Conformation Electron, because in a single Tubulin Dimer its the position at the junction of the alpha-tubulin and the beta-tubulin determines the 2 different conformations of the Tubulin, which correspond to 2 different states of the dimer's electric polarization.

There are 10^7 Tubulin Dimers per neuron, with 10% of them, or 10^6, estimated to be involved in the consciousness process, and the remainder doing other things needed to keep the cell alive.

The human brain contains about 10^11 neurons.

Therefore, the human brain contains about 10^18 tubulins, about 10^17 of which are involved in the consciousness process.

The Tubulins in a Microtubule can represent Information, and act as Cellular Automata to process it.

Roger Penrose says, in Shadows of the Mind (Oxford 1994), page 344, "... We can now consider the gravitational self-energy of that mass distribution which is the difference between the mass distributions of the two states that are to be considered in quantum linear superposition. The reciprocal of this self-energy gives ... the reduction timescale ...".

This is the decoherence time T = h / E.

For a given Particle, Stuart Hameroff describes this as a particle being separated from itself, saying that the Superposition Separation a is "... the separation/displacement of a mass separated from its superposed self. ... The picture is spacetime geometry separating from itself, and re-anealing after time T. ...".

If the Superposition consists of States involving one Particle of Mass m, but with Superposition Separation a, then the Superposition Separation Energy Difference is the gravitational energy

$$E = G m^2 / a$$

In the Osaka paper (Hameroff, S.R. (1997) Quantum computing in microtubules: an intra-neural correlate of consciousness? Cognitive Studies: Bulletin of the Japanese Cognitive Science Society 4(3):67-92.)), Hameroff says that Penrose describes Superposition Separation as "... shearing off into separate, multiple spacetime universes as described in the Everett "multi&endash;worlds" view of quantum theory. ...".

The superposition energy E_N of N Tubulin Electrons and the corresponding decoherence time T_N can be calculated from the equations E = G m^2 / a and T = h / E.

Therefore for a single Electron (ignoring for simplicity some factors like 2 and pi, etc.):

$$T = h / (G m^2 / a) = (h / m c) (c^2 / G m) (a / c) =$$

$$= (\text{Compton} / \text{Schwarzschild}) (a / c)$$

where

2 G m / c^2 = Schwarzschild Radius of a classical black hole of mass m and

h / m c = Compton Radius of an elementary particle of mass m.

The calculation for a single Electron will be used as the basis for a superpositon of N Electrons over the 10-cm scale human brain. If the single Tubulin Electron with mass m_e has a Superposition Displacement a that is of the order of 10^(-7) cm, or one nanometer, then, since Compton = 10^(-11) cm and Schwarzschild = 10^(-55) cm and the speed of light c = 3 x 10^10 cm/sec, and since E_electron = G (m_e)^2 / a, we have

for a single Electron and ordinary gravity

$$T_{electron} = h / E_{electron} =$$

$$= (\text{Compton} / \text{Schwarzschild}) (a / c) = 10^{26} \text{ sec} = 10^{19} \text{ years.}$$

Now consider the case of N Tubulin Electrons in Coherent Superposition, in which ordinary gravity is realistic.

As Jack Sarfatti says, "Since all the [Tubulin] Electrons are nonlocally connected into a coherent whole we do not want to treat them as fluctuating statistically independent of each other ... .", and Stuart Hameroff agrees, saying "True. That's why we consider them coherently linked or entangled.". Jack Sarfatti defines the Superposition Energy E_N of N superposed Tubulin Electrons in N Tubulins as

$$E_N = G M^2 / L$$

where L is the mesoscopic quantum phase coherence length for the collective mode of N Tubulin Electrons of total mass M = N m with each electron having mass m and with L = a N^(1/3) where a is the separation of individual electrons and the cube root of N is the linear scale of of the whole collection of N Tubulin Electrons in the N Tubulins.

As Jack Sarfatti says (here I have substituted some of my numerical values for his): "... Note the volume ... is the sum of the volumes of all [10^17 Tubulins involved in the process of consciousness] even though they are separated in physical space from each other over the whole cortex of volume 10^3 cc - they are like one super-particle entangled in configuration space of [about 3 x 10^17 dimensions]! That is, this sentient post-quantum computing "enchanted web" is [10^17 little Tubulin nanoboxes] ... . Each box has a little arrow in Hilbert space and all the arrows are phase-locked over a time of order [0.5 milliseconds]. The actual physical distance between the boxes is irrelevant to this Einstein-Podolsky-Rosen network that is one coherent conscious system. The mesoscopic quantum coherence length L is what you would get if you lined up all these nanoboxes in a row - ... It is really not a metrical property in ordinary space. ...".

Therefore, we have:

$$E_N = N^2 G m^2 / a N^{(1/3)} =$$

$$= N^{(5/3)} G m^2 / a =$$

$$= N^{(5/3)} E_{electron}$$

To get the decoherence time for the system of N Tubulin Electrons, recall that (approximately) T_electron = h / E_electron = (Compton / Schwarzschild) (a / c) = 10^26 sec = 10^19 years, so that

$$T_N = h / E_N = h / N^{(5/3)} E_{electron} =$$

$$= N^{(-5/3)} T_{electron} =$$

$$= N^{(-5/3)} 10^{26} \text{ sec}$$

and

$$N = (10^{26} / (T_N))^{(3/5)} =$$

$$= 4 \times 10^{15} / (T_N)^{(3/5)}$$

From the above formulas get the following rough approximate Decoherence Tim T_N for various Numbers of Tubulin Dimers or Neurons, if 10% of the Tubulins in each Neuron are involved in the process of consciousness:

Time T_N	Number of Tubulins	Number of Neurons
10^(-43) sec (Planck)	2.5 x 10^41	
5 x 10^(-4) sec (2 kHz)	10^17	10^11
10^26 sec = 3 x 10^18 years	1	

The 10^17 tubulin Electron (10^11 Neuron) line of the table corresponds to the number of neurons in the human brain.

Here is a rough outline of what happens during the 0.5 milliseconds of a single conscious thought involving 10^17 Tubulin Electrons:

- Each Tubulin Site Electron sits within its tubulin cage in one of its 2 Quantum States. Each Tubulin Site Electron has one of 2^1 = 2 States, so it contains one qbit of information, representable by the 2^1 = 2-dimensional Cl(1) Clifford Algebra that is isomorphic to the Complex Numbers. The total of N = 10^17 Tubulin Site Electrons are connected and brought into a coherent Superposition of States, which, as was suggested by Robert Neil Boyd, is representable

by the 2^N = 2^(10^17)) dimensional Cl(10^17) Clifford Algebra. Cl(10^17) can be represented as the tensor product of about (10^17) / 8 = about 10^16 factors, each being 256-dimensional Cl(8). Further information about that Clifford Algebra structure, and related information theoretical and particle physics structures and models, can be found in material at http://www.innerx.net/personal/tsmith/TShome.html.

- Many of the Quantum States of the Superposition are Closed Timelike Loops, some of which intersect with others. If each Closed Timelike Loop represents an Abstract Idea, then the Intersections among the Closed Timelike Loops represent Interactive Abstract Thought operating on the set of Abstract Ideas.
- During the time of Superposition, new Abstract Thoughts can be derived from the original ones by reorganizing the corresponding Closed Timelike Loops and their Intersections.
- Conscious Thought formation ends when the Decoherence/Collapse time T_N is reached and Decoherence/Collapse occurs. Then, a single Abstract Idea is chosen from the entire Set of States in the Superposition. This is the Execution Process, which involves choosing one Abstract Idea and rejecting/executing the other Ideas of the Superposition.
- The chosen State from the Superposition determines the Positions of all the Gap Junction Electrons of the Quantum Tunnelling connections between Neurons.
- The Positions of the Gap Junction Electrons determine the Conformations of the Micrtubules that are adjacent to the Gap Junctions.
- The Conformations of those Microtubles determine, through MAP connections, the Conformations of other Microtubules in the same Neuron.
- The Conformation of a Microtubule determines the State of its Tubulins.
- The State of a Tubulin determines the State of its Tubulin Site Electron, thus completing the process.

Chaio Gravity Antennas

During that 0.5 milliseconds of the process of a single conscious thought, the 10^17 Tubulin Electrons are linked in a coherent state by gravity.

For such a gravity linkage to take place, two things are necessary:

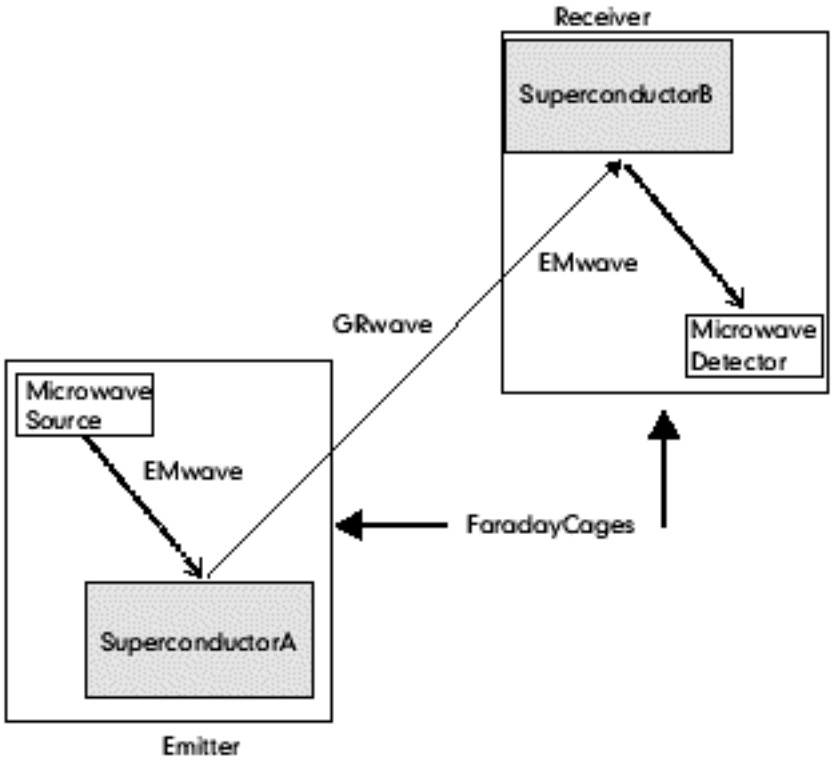
- There must be a gravitational connection among all 10^17 Tubulin Electrons; and
- There superposition must be stable with respect to decoherence during to the 0.5 millisecond duration of the single conscious thought.

First, does there exist a realistic mechanism of gravitational connection between all pairs of the 10^17 Tubulin Electrons?

A positive result in an experiment proposed by Raymond Chiao and described in gr-qc/0204012 [which is an "... abbreviated writeup of ...[his]... March 23, 2002 Wheeler Symposium lecture, and book chapter for Wheeler Festschrift ..." which book chapter is at gr-qc/0208024 and, in its final version, at gr-qc/0303100] might provide an affirmative answer. In that paper,

Chiao says:

"... Superconductors will be considered as macroscopic quantum gravitational antennas and transducers, which can directly convert upon reflection a beam of quadrupolar electromagnetic radiation into gravitational radiation, and vice versa, and thus serve as practical laboratory sources and receivers of microwave and other radio-frequency gravitational waves. ... a superconductor can by itself be a direct transducer from electromagnetic to gravitational radiation upon reflection of the wave from a vacuum superconductor interface, with a surprisingly good conversion efficiency. By reciprocity, this conversion process can be reversed, so that gravitational radiation can also be converted upon reflection into electromagnetic radiation from the same interface, with equal efficiency. ... under certain circumstances involving "natural impedance matching" between quadrupolar EM and GR plane waves upon a mirror-like reflection at the planar surface of extreme type II, dissipationless superconductors, the efficiency of such superconductors used as simultaneous transducers and antennas for gravitational radiation, might in fact become of the order of unity, so that a gravitational analog of Hertz's experiment might then become possible. ... These developments suggest the possibility of a simple, Hertz-like experiment, in which the emission and the reception of gravitational radiation at microwave frequencies can be implemented by means of a pair of superconductors used as transducers. ... The schematic of this experiment is ...



... we did not detect any observable signal inside the second Faraday cage, down to a limit of more than 70 dB below the microwave power source of around 10 dBm at 12 GHz. ... Note, however, that since the transition temperature of YBCO is 90 K, there may have been a substantial ohmic dissipation of the microwaves due to the remaining normal

> electrons at our operating temperature of 77 K, so that the EM wave was absorbed before it could reach the impedance-matching depth at z0. It may therefore be necessary to cool the superconductor down very low temperatures before the normal electron component freezes out sufficiently to achieve such impedance matching. [see gr-qc/0304026] ... An improved Hertz-like experiment using extreme type II superconductors with extremely low losses, perhaps at millikelvin temperatures, is a much more difficult, but worthwhile, experiment to perform. Such an improved experiment, if successful, would allow us to communicate through the Earth and its oceans, which, like all classical matter, are transparent to GR waves. ... I would especially like to thank my father-in-law, the late Yi-Fan Chiao, for his financial and moral support of this work. This work was partly supported also by the ONR. ...".

Further, in gr-qc/0303089, Walter J. Fitelson and Raymond Chiao say:

> "... Measurements of the tunneling time are briefly reviewed. ... using ... a photon-pair emission light source ... The arrival time of the tunneled photon was measured with respect to that of its twin, which had traversed a distance equal to the tunnel barrier thickness, but in the vacuum, by means of the difference in the two "click" times of two Geiger counters. ... when a photon succeeded in tunneling (which is rare), it arrived earlier than its twin which had traversed the vacuum ... as if the tunneling photons had traversed the tunnel barrier superluminally. The effective group velocity of the tunneling single-photon wavepacket was measured to be 1.7 +/- 0.2 times the vacuum speed of light. ...
>
> ... Next, time and matter in general relativity and quantum mechanics is examined. In particular, the question arises: How does gravitational radiation interact with a coherent quantum many-body system (a "quantum fluid")? ...
>
> ... the ground state of a superconductor, which possesses spontaneous symmetry breaking, and therefore off-diagonal long-range order, is very similar to that of the physical vacuum, which is believed also to possess spontanous symmetry breaking through the Higgs mechanism. In this sense, therefore, the vacuum is "superconducting." The question thus arises: How does such a broken-symmetry ground, or "vacuum," state interact with a dynamically changing spacetime, such as that associated with a GR wave? More generally: How do we embed quantum fields in dynamically curved spacetimes? ... Due to its gyroscopic nature, the spin vector of an electron undergoes parallel transport during the passage of a GR wave. The spin of the electron is constrained to lie inside the space-like submanifold of curved spacetime. ... the spin of the electron must be purely a space-like vector with no time-like component. This imposes an important constraint on the motion of the electron's spin, such that whenever the space-like submanifold of spacetime is disturbed by the passage of a gravitational wave, the spin must remain at all times perpendicular to the local time axis. If the spin vector is constrained to follow a conical trajectory during the passage of the gravitational wave, the electron picks up a Berry phase

proportional to the solid angle subtended by this conical trajectory after one period of the GR wave. In a manner similar to the persistent currents induced by the Berry phase in systems with off-diagonal long-range order. ... such a Berry phase induces an electrical current in the quantum Hall fluid, which is in a macroscopically coherent ground state. ... This current generates an EM wave. Thus a GR wave can be converted into an EM wave. By reciprocity, the time-reversed process of the conversion from an EM wave to a GR wave must also be possible. ... The question immediately arises: EM radiation is fundamentally a spin 1(photon) field, but GR radiation is fundamentally a spin 2 (graviton) field. How is it possible to convert one kind of radiation into the other, and not violate the conservation of angular momentum? The answer: The EM wave converts to the GR wave through a medium. Here specifically, the medium of conversion consists of a strong DC magnetic field applied to a system of electrons. This system possesses an axis of symmetry pointing along the magnetic field direction, and therefore transforms like a spin 1 object. When coupled to a spin 1 (circularly polarized) EM radiation field, the total system can in principle produce a spin 2 (circularly polarized) GR radiation field, by the addition of angular momentum. ... In the case of superconductors, Cooper pairs of electrons possess a macroscopic phase coherence, which can lead to an Aharonov-Bohm-type interference absent in the ionic lattice. Similarly, in the quantum Hall fluid, the electrons will also possess macroscopic phase coherence, ... which can lead to Berry-phase-type interference absent in the lattice. Furthermore, there exist ferromagnetic superfluids with intrinsic spin, ... in which an ionic lattice is completely absent,such in superfluid helium 3. In such ferromagnetic quantum fluids, there exists no ionic lattice ... Thus there may be more than one kind of quantum fluid which can serve as a transducer between EM and GR waves. ... However, it remains an open question as to how strong this interconversion process is between EM and GR radiation. ...

... There exist other situations in which a minimal-coupling rule similar to the one above, arises for scalar quantum fields in curved spacetime. ... Quantum mechanically, there may exist due to the macroscopic quantum phase coherence of the superconductor, collective, many-body enhancements of the above classical conversion efficiency. Most importantly, ...[see Speliotopoulos and Chiao, gr-qc/0302045]... there must exist enhancements due to the fact that the intensive coupling constant sqrt(G) of the Feynman graviton-matter vertex should be replaced by the extensive coupling constant sqrt(G) L, in order to account correctly for the tidal nature of GR waves. ...[L is]... a new characteristic length scale L corresponding to the typical size of the distance ... separating the test particle from the observer ... For example, L can be the typical size of the detection apparatus ... or of the transverse Gaussian wave packet size of the gravitational radiation ...

... How then do we account for the lack of any observable quantum transducer conversion in our experiment? There are several possible reasons, the most important ones probably having to do with the material properties of the YBCO medium. One such possible reason is the earlier observations of unexplained residual microwave and far-infrared losses (of the order of 10^(-5) ohms per square at 10 GHz) in YBCO and other high Tc

> superconductors,which are independent of temperature and have a frequency-squared dependence, ... which may be due to the fact that YBCO is a D-wave superconductor. ... In D-wave superconductors, there exists a four-fold symmetry of nodal lines along which the BCS gap vanishes, ... where the microwave attenuation may become large. Thus D-wave superconductors are quite unlike the classic, low-temperature S-wave superconductors with respect to their microwave losses. Since one of conditions for a good coupling of a quantum antenna and transducer to the GR wave sector is extremely low dissipative losses, the choice of YBCO as the material medium for the Hertz-type experiment may not have been a good one. ..".

Note that :

> if the negative result of the preliminary experiment were due to failure of the superconductor impedance-matching mechanism for converting EM waves to gravity waves [see gr-qc/0304026];
>
> then the negative result would not indicate failure of the gravity antenna concept, which is the important concept with respect to the Quantum Tubulin Electron model of Quanum Consciousness.

Note also that the Faraday cages of Chiao's schematic correspond to the Tubulin Cages of the Tubulin Electrons in the Quantum Tubulin Electron model of Quantum Consciousness, and that if Chiao's gravity antenna can receive gravity signals by graviton links, then Tubulin Electrons in their cages should be able to receive gravity signals establishing graviton links, as needed for the Penrose-Hameroff model of Quantum Tubulin Electron Quantum Consciousness.

Decoherence, Mead Resonance and Quantum Protectorates

Second, is the superposition state of Tubulin Electrons stable with respect to decoherence during to the 0.5 millisecond duration of the single conscious thought?

Max Tegmark, in quant-ph/9907009, says:

> "... Penrose has ... suggested that the dynamics of such excitations can make a microtubule act like a quantum computer, and that microtubules are the site of of human consciousness ... This idea has been further elaborated ... with the conclusion that quantum superpositions of coherent excitations can persist for as long as a second before being destroyed by decoherence ... This was hailed as a success for the model, the interpretation being that the quantum gravity effect on microtubules was identified with the human though process on this same timescale. This decoherence rate T = 1 s was computed assuming that quantum gravity is the main decoherence source. Since this quantum gravity model is somewhat

> controversial ... and its effect has been found to be more than 20 orders of magnitude weaker than other decoherence sources in some cases ... We will now ... evaluate ... decoherence sources for the microtubule case as well, to see whether they are in fact dominant ... we will ignore collisions between polarized tubulin dimers and nearby water molecules, since it has been argued that these may be in some sense ordered and part of the quantum system ... Let us instead apply ... the decoherence timescale
>
> T = (a^3 sqrt(m k t)) / N g q^2 | r' - r |
>
> caused by a single ion a distance a away. ...[where k is Boltzmann's constant and g = 1 4 pi e0 is the Coulomb constant, m is ion mass, N is number of ions, q is ion charge, and t is temperature]... with N = Q / qe = 10^3. The distance to the nearest ion will generally be less than ...[about] ... 26 nm ... Superpositions spanning many tubuline dimers ... therefore decohere on a timescale ...[about]... 10^(-13) s. due to the nearest ion alone. This is quite a conservative estimate, since the other ... 10^3 ions that are merely a small fraction further away will also contribute to the decoherence rate ... ... We neglected screening effects because the decoherence rates were dominated by the particles closest to the system, i.e., the very same particles that are responsible for screening the charge from more distant ones. ... We find that the decoherence timescales ...[about 10^(-13)]... seconds are typically much shorter than the relevant dynamical timescales ...[about 0.001 to 0.1 seconds]... both for regular neuron firing and for kink-like polarization excitations in microtubules. This conclusion disagrees with suggestions by Penrose and others that the brain acts as a quantum computer, and that quantum coherence is related to consciousness in a fundamental way. ...".

I disagree with Tegmark, on both experimental and theoretical grounds. I think that Tegmark has ignored significant phenomena related to maintaining coherence during the 0.5 millisecond duration of a single conscious thought involving 10^17 Tubulin Electrons.

On the experimental side, there are some results that indicate that coherence is maintained much longer than would be expected from analyses such as Tegmark's. For example:

- On page 20 of the 17 July 1999 issue of the New Scientist is an article by Charles Seife (a New Scientist Reporter) that says in part: "... last April [1998], Isaac Chuang of IBM in San Jose, California, and Neil Gershenfeld the Massachusetts Institute of Technology created a quantum computer ... in a forthcoming issue of Physical Review Letters, Carlton Caves ... say they are unsure why quantum computation worked. Gershenfeld and Chuang used magnetic fields to manipulate atoms in liquid chloroform. But the problem, says Caves, is that the choloroform atoms were not in "entangled" states. ... because the chloroform was at room temperature, the atoms could not have been entangled ... The thermal motion of the atoms would have mixed up their quantum states and ruined any entanglement. ... So why did the chloroform comuter work at

all? Caves's colleague John Smolin, a physicist at IBM in New York, suspects Chuang's chloroform has simulated a quantum computer, though he doesn't know how. Or maybe the experiment hints there are other ways of doing quantum computation that we don't yet understand. ...".

- A 6 July 2001 New Scientist article by Willis Knight says: "... Molecular transistors that run on single electrons now work at room temperature. Dutch scientists achieved the feat by buckling carbon nanotubes with an atomic force microscope. ... By buckling a metallic carbon nanotube, they formed a small area from which a single electron cannot escape at room temperature unless a current is applied via an electrode. ... pushing a single electron through the transistor caused it to exhibit quantum coherence. This means that the electron maintains some of the quantum state it obtained whilst inside the transistor when it leaves. The effect is not found within normal electronics. ...".
- According to Apoorva Patel in his paper Quantum Algorithms and the Genetic Code, quant-ph/0002037: "... Enzymes are the objects which catalyse biochemical reactions. They are large complicated molecules, much larger than the reactants they help, made of several peptide chains. Their shapes play an important part in catalysis, and often they completely surround the reaction region. They do not bind to either the reactants or the products ... for example, enzymes can suck out the solvent molecules from in between the reactants ... It is proposed that enzymes play a crucial role in maintaining quantum coherence ... Enzymes provide a shielded environment where quantum coherence of the reactants is maintained. ... For instance, diamagnetic electrons do an extraordinarily good job of shielding the nuclear spins from the environment ... the coherence time observed in NMR is O(10) sec, much longer than the thermal environment relaxation time (hbar / kT = O(10^(-14)) sec) and the molecular collision time (O(10^(-11)) sec), and still neighbouring nuclear spins couple through the electron cloud. ... Enzymes are able to create superposed states of chemically distinct molecules. ... Enzymes are known to do cut-and-paste jobs ... (e.g. ... methylation, replacing H by CH3, which converts U to T). Given such transition matrix elements, quantum mechanics automatically produces a superposition state as the lowest energy equilibrium state. ... Delocalisation of electrons and protons over distances of the order of a few angstroms greatly helps in molecular bond formation. It is important to note that these distances are much bigger than the Compton wavelengths of the particles, yet delocalisation is common and maintains quantum coherence. ...".
- According to an article by Bennett Davis in the 23 Feb 2002 edition of The New Scientist: "... In the early 1990s, Guenter Albrecht-Buehler ... at Northwestern ... discovered that some cells can detect and respond to light from others. ... cells ... were using light to signal their orientation. If so, they must have some kind of eye. ... centrioles fill the bill. These cylindrical structures have slanted "blades" which ... Albrecht-Buehler ... believes act as simple blinds. ... microtubules ... could act as optical fibres ... feeding light towards the centrioles from the cell's wall. ... why should cells want to detect light? ... they are talking to each other ... Cells in embryos might signal with photons so that they know how and where they fit into the developing body. ... Albrecht-Buehler ... wants to learn their language. ... In the 1980s Fritz-Albert Popp, then a lecturer at the University of Marburg in Germany, ... who now heads the International Institute of Biophysics in Neuss, Germany, ...[and]... runs a company called Biophotonen that offers its expertise in reading

photon emissions to gauge the freshness and purity of food ... became interested in the optical behaviour of cells. In a series of experiments Popp found that two cells separated by an opaque barrier release biophotons in uncoordinated patterns. Remove the barrier and the cells soon begin releasing photons in synchrony. ...".

- Acccording to cond-mat/0007185 and cond-mat/0007287 by Philip W. Anderson: "... **The most striking fact about the high-Tc cuprates is that in none of the relevant regions of the phase diagram is there any evidence of the usual effects of phonon or impurity scattering.** This is strong evidence that **these states are in a "quantum protectorate" ... 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**. ...".

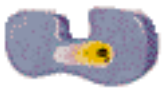
On the theoretical side, there are also some reasons that I disagree with Tegmark. For example:

- Hagan, Hameroff, and Tuszynski, in Physical Review E, Volume 65, 061901, published 10 June 2002, say: "... Tegmark's commentary is not aimed at an existing model in the literature but rather at a hybrid that replaces the superposed protein conformations of the orch. OR theory with a soliton in superposition along the microtubule ... recalculation after correcting for differences between the model on which Tegmark bases his calculations and the orch. OR model (superposition separation, charge vs dipole, dielectric constant) lengthens the decoherence time to 10^(-5) &endash;10^(-4) s ...".
- Mershin, Nanopoulos, and Skoulakis, in quant-ph/0007088, say: "... treat the tubulin molecule as the fundamental computation unit (qubit) in a quantum-computational net work that consists of microtubules (MTs), networks of MTs and ultimately entire neurons and neural networks. ...". They say "... **it has been shown [by D. L. Koruga, D. L. Ann. NY Acad. Sci. 466, 953-955 (1986)] that the particular geometrical arrangement (packing) of the tubulin protofilaments obeys an error-correcting mathematical code known as the K2(13, 2^6, 5) code** ... the existence of a quantum-error correcting code is needed to protect the delicate coherent qubits from decoherence. This has been the major problem of quantum computers until the works of Shor and Steane have independently shown that such a code can be implemented ... We conjecture that the K-code apparent in the packing of the tubulin dimers and protofilaments is partially responsible for keeping coherence among the tubulin dimers. By simulating the brain as a quantum computer it seems we are capable of obtaining a more accurate picture than if we simulate the brain as a classical, digital computer. ...".
- Raymond Chiao in gr-qc/0204012 says: "... quantum entanglement gives rise to EPR correlations at long distance scales within the superconductor. The electrons in a superconductor in its ground BCS state are not only macroscopically entangled, but due to the existence of the BCS gap which separates the BCS ground state energetically from all excited states, they are also protectively entangled, in the sense that this entangled state is protected by the presence of the BCS gap from decoherence arising from the thermal environment, provided that the system temperature is kept

well below the BCS transition temperature. The resulting large quantum rigidity is in contrast to the tiny rigidity of classical matter, such as that of the normal metals used in Weber bars, in their response to gravitational radiation. ...".

- **Mead Resonance:** Resonance among 10^17 Tubulin Electrons of a single conscious thought may be important in achieving and maintaining coherent superposition states among them. Carver Mead, in his book Collective Electrodynamics (MIT 2000), discusses resonance coupling with electromagnetic photons. If Raymond Chiao's gravity antenna idea is correct, then the same resonance phenomena should be applicable for gravity gravitons as for electromagnetic photons. Carver Mead says: "... In our investigation of radiative coupling, we use a superconducting resonator as a model system. ... we can build such a resonator from a superconducting loop and a capacitor ... the coupling of ... two loops is the same, whether retarded or advanced potentials are used. Any loop couples to any other on its light cone, whether past or future. ... The total phase accumulation in a loop is the sum of that due to its own current, and that due to currents in other loops far away. ... normal modes correspond to stationary states of the system. Once the system is oscillating in one of these modes, it will continue to do so forever. To understand energy transfer between the resonators, we can use mixtures of normal modes. ... Any energy leaving one resonator is tranferred to some other resonator, somewhere in the universe. 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 arbitraty separation between the resonators; it is a direct result of the symmetry of the advanced and retarded potentials. There is no energy "in transit" between them. ... the universe contains a truly enormous number of resonators ... [For the 10^17 Tubulin Electrons of a single conscious thought, the resonant frequencies are the same and exchanges of energy among them act to keep them locked in a collective coherent state.] ... How does a single resonator behave in an inhomogeneous universe full of other matter? In the real universe [outside the collective coherent set of tubulin electrons], no two resonators have identical resonant frequencies for long; however, it is a common occurrence that two frequencies will cross, and that energy will be exchanged between the resonators during the crossing. From the point of view of collective electrodynamics, this exchange of energy is the microscopic origin of the thermodynamic behavior of the universe as we observe it. ... In a random universe, any particular phase is equally likely for any given crossing. A particular resonator is therefore equally likely to receive either an increment or a decrement due to a given crossing. ... In a random universe [unlike the collective coherent set of tubulin electrons], there is no first-order effect in which energy flows from the high-amplitude resonator to the low-amplitude resonator; there is, however, a second-order effect in which energy flows, on the average, from the high-amplitude resonator to the low-amplitude resonator. The rate of energy flow is proportional to the difference in energies, and to the inverse square of the distance. ...

  ... The coupling between two loops considered ...[above]... is called magnetic dipole coupling. It is characterized by its proportionality to the second derivative of the current with respect to time. ... A much stronger coupling can be obtained between two straight sections of wire ... We can

imagine a resonator configuration for which this type of coupling is realizable: Two parallel capacitor plates [corresponding to the two holes in a tubulin  where the tubulin electron can be stable located] of capacitance C are connected by a straight section of superconducting wire of inductance L between their centers. Such a configuration ... is called an electric dipole. 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 by the square of the ratio of the wavelenght to the size of the element. ... For example, an atom half a nanometer in diameter radiates visible light of 500 nanometer wavelength. In this case, electric dipole coupling is a million times stronger than magnetic dipole coupling. ... we have treated the electron as a wave, continuous in space, carrying a continuous charge density with it. ... Arriving at the correct results required taking into account the interaction of the electron with itself, exactly as we have done in the case of the superconducting loop. The electron wave function depends on the potential; the potential depends of the charge density that is determined by the wave function. Thus, we have an inherently non-linear problem ... The nonlinearity ... poses some computational issues, but no conceptual issues. ... the nonlinear theory gives the correct energy levels for the hydrogen atom ... It is by now a common experimental fact that an atom, if sufficiently isolated from the rest of the universe, can stay in an excited state for an arbitrarily long period. ... The mechanism for initiating an atomic transition is not present in the isolated atom; it is the direct result of coupling with the rest of the universe. ... The electron wave function ... is particularly sensitive to coupling with other electrons; it is coupled either to far-away matter in the universe or to other electrons in a resonant cavity or other local structure. In the initial parts of this monograph, we were able to ignore coupling to far-away matter because we used a collective structure in which there are 10^23 electrons, arranged in such a way that the collective properties intrinsic to the structure scaled as the square of the number of electrons. ... we ...[made]... a connection between the classical concept of force and the quantum nature of matter through the concept of momentum. ... We would expect the total momentum P of the collective electron system [in a superconducting loop of wire] to be the momentum per charge times the number of charges in the loop. If there are n charges per unit length of wire ... P = n q L I ... I = n q v ... and ... P = L (nq)^2 v . The momentum is proportional to the velocity, as it should be. It is also proportional to the size of the loop, as reflected by the inductance L. ... 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! ... In an arrangement where charges are constrained to move in concert, each charge produces phase accumulation, not only for itself but for all the other charges as well. So the inertia of each charge increases linearly with the number of charges moving in concert. The inertia of the ensemble of coupled charges must therefore increase as the square of the number of charges. ...

[To see how Carver Mead's resonance might be applied to the Penrose-Hameroff tubulin electron model of consciousness, consider the maximal case of N tubulin electrons with N = 10^18, each electron having thermal energy E = kT, where k = 10^(-23) Joules Kelvin^(-1) and T = 300 Kelvin, so that Total Thermal

Energy = N^2 kT = 10^(36-23) x 300 = 3 x 10^15 Joules. (Due to the nonlinear square-scaling, it would take less if the collapse took place gradually, a few electrons at a time.) Note that decoherence by external thermal energy, with square-scaling, is different from the self-decoherence of the superposition state, based on the energy-time uncertainty principle Energy x Time = h, by which a conscious thought quantum state decoheres to form a completed thought. If N tubulin electrons are in a collective superpostion state of conscious thought, then the total energy needed to decohere them by external thermal energy (decoherence due to the heat of the brain) is much greater than the classical kinetic heat energy in the brain, so that Quantum Consciousness in the brain is stable against thermal decoherence due to the heat of the brain.]

> ... an N-turn closely coupled coil has an inductance L = N^2 Lo. Once again, we see the collective interaction scaling as the square of the number of interacting charges. ... When two classical massive bodies ... are bolted together, the inertia of the resuting composite body is simply the sum of the two individual inertias. 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. ... It is instructive to work out the magnitude of the electron inertia in a concrete case. A small superconducting magnet has 10^4 turns of NbTi wire approximately 0.1 mm in diameter. The magent is 7 cm long, and just under 5 cm in diameter, and produces a peak field of 7 tesla at a currrent of 40 amperes. The magnet weighs 0.5 kilograms, and has a measured inductance of approximately 0.5 henry. There are of the order of 10^28 electrons per cubic meter in the wire, or 10^20 electrons per meter length of wire, corresponding to approximately 10 coulombs of electronic charge per meter of wire. At 40 amperes, these electrons move at a velcoity v = 4 m / sec. the total length l of wire is about 10^3 meters, so the total electronic charge in the magnet is about 10^4 coulombs. Using these values, A = PHI / l = L I / l = 0.02 V sec / meter. The electromagnetic momentum p of an electron is just this vector potential multiplied by the electronic charge; from this, we can infer an electromagnetic mass m for each electron: q A = 3.2 x 10^(-21) coulomb V sec / meter = m v m = 10^(-21) kg For comparison, the mass of a free electron is approximately 10^(-30) kg, and the rest mass of a proton is a factor 1800 larger than that of an electron. The electromagnetic mass of an electron in our magnet is thus a factor of 10^9 larger than the rest mass of a free electron. ...[The electromagnetic mass of all the electrons in the magnet is 10^20 electrons / meter x 10^3 meters x 10^(-21) kg / electron = 100 kg]... The total inertia of the electron system in the magnet is much larger than the actual mass of all the atoms making up the magnet [0.5 kg]. ...".

[The above material from Carver Mead is directly applicable to the superposition state of tubulin electrons [[and is related to the idea of a **Quantum Protectorate**]]. The following material shows how the same viewpoint applies to understanding quantum state transitions.]

> ... We have developed a detailed description of the energy-transfer process between macroscopic quantum resonators ... We are now in a position to understand the radiative transfer between two identical atomic systems. ... The two atoms act like two small dipole

resonators, and energy is radiatively transferred ... Once the coupled mixed state starts to develop, it becomes self-reinforcing. ... This self-reinforcing behavior gives the transition its initial exponential character. Once the transition is fully under way, the two states are nearly equally represented in the superposition, and the coupled system closely resembles the coupled resonators ... Once the transition has run its course, each atom settles into its final eigenstate. ...

... there are quantum jumps, but they are not discontinuities. They may look discontinuous because of the nonlinear, self-reinforcing nature of a quantum transition; but at the fundamental level, everything can be followed in a smooth and continuous way .... to arrive at this picture, we had to give up the one-way direction of time, and allow coupling to everything on the light cone ... the Green's function for collective systems is totally free of singularities, and cannot, by its very nature, generate infinities ... There is no action of an elementary charge [which is fundamentally an amplitude to transmit or absorb energy by radiative transfer] upon itself ...".

- [[According to cond-mat/0007287 and cond-mat/0007185 by Philip W. Anderson: "... 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 the quantum Hall effect, which can be measured to 10^(-9) accuracy on samples with mean free paths comparable to the electron wavelength, and flux quantization in superconductors, equivalent to the Josephson frequency relation which again has mensuration accuracy and is independent of imperfections and scattering. An even simpler example is the rigidity and dimensional stability of crystalline solids evinced by the STM. ... **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 perturbations which scatter individual particles are not effective**. ... The purpose of this paper is, first, to present the overwhelming experimental evidence that **the metallic states of the high Tc cuprate superconductors are a quantum protectorate**; and second, to propose that this particular collective state involves the phenomenon of charge-spin separation, and to give indications as to why such a state should act like a quantum protectorate. ... Spin-charge separation is a very natural phenomenon in interacting Fermi systems from a symmetry point of view ... The Fermi liquid has an additional symmetry which is not contained in the underlying Hamiltonian, in that the two quasiparticles of opposite spins are exactly degenerate and have the same velocity at all points of the Fermi surface. This is symmetry SO(4) for the conserved currents at each Fermi surface point since we have 4 degenerate real Majorana Fermions. But the interaction terms do not have full SO(4) symmetry, since they change sign for improper rotations, so the true symmetry of the interacting Hamiltonian is SO4 / Z2 = SU2 x SU2, i.e., charge times spin. A finite kinetic energy supplies a field along the " direction of the charge SU(2) and reduces it to U(1), the conventional gauge symmetry of charged particles. ...". Also, according to cond-mat/0301077 by M.Ya. Amusia, A.Z. Msezane, and V.R. Shaginyan: "... the

fermion condensation ... can be compared to the Bose-Einstein condensation. ... the appearance of ... fermion condensate (FC) ... is a quantum phase transition ... that separates the regions of normal and strongly correlated liquids. Beyond the fermion condensation point the quasiparticle system is divided into two subsystems, one containing normal quasiparticles, the other being occupied by fermion condensate localized at the Fermi level. ... fermion systems with ... fermion condensate (FC) ... have features of a "quantum protectorate" ... This behavior ... takes place in both three dimensional and two dimensional strongly correlated systems ... The only difference between 2D electron systems and 3D ones is that in the latter ... fermion condensation quantum phase transition (FCQPT) ... occurs at densities which are well below those corresponding to 2D systems. For bulk 3He, FCQPT cannot probably take place since it is absorbed by the first order solidification ... an infinitely extended system composed of Fermi particles, or atoms, interacting by an artificially constructed potential with the desirable scattering length a ... may be viewed as trapped Fermi gases ... We conclude that FCQPT can be observed in traps by measuring the density of states at the Fermi level ... It seems quite probable that the neutron-neutron scattering length (a = 20 fm) is sufficiently large to be the dominant parameter and to permit the neutron matter to have an equilibrium energy, density, and the singular point ... at which the compressibility vanishes. Therefore, we can expect that FCQPT takes place in a low density neutron matter leading to stabilization of the matter by lowering its ground state energy. ... fermion condensate (FC) ... "quantum protectorate" ... behavior ... demonstrates the possibility to control the essence of strongly correlated electron liquids by weak magnetic fields. ... We have demonstrated that strongly correlated many-electron systems with FC, which exhibit strong deviations from the Landau Fermi liquid behavior, can be driven into the Landau Fermi liquid by applying a small magnetic field B at low temperatures. A re-entrance into the strongly correlated regime is observed if the magnetic field B decreases to zero, while the effective mass M* diverges as M* proportional to 1 / sqrt(B). The regime is restored at some temperature T* proportional to sqrt(B). This behavior is of a general form and takes place **in both three dimensional and two dimensional strongly correlated systems**, and **demonstrates the possibility to control the essence of strongly correlated electron liquids by weak magnetic fields**. ...".]]

I close this paper with brief summaries of relevant experiments of Grinberg-Zylberbaum, the quantum cosmology of Paula Zizzi, and 26-dimensional closed unoriented bosonic string theory interpreted as a many-worlds quantum theory in which strings correspond to world lines, with massless spin-2 gravitons in 26-dimensions corresponding to gravitational interaction among tubulin electrons in states with Penrose-Hameroff superposition separation.

- The whereabouts of Grinberg-Zylberbaum (as far as I know) is unknown, and he may even be deceased.
- Paola Zizzi was scheduled to describe her work at Quantum Mind 2003 - Consciousness, Quantum

Physics and the Brain,March 15-19, 2003, University of Arizona, Tucson, Arizona.

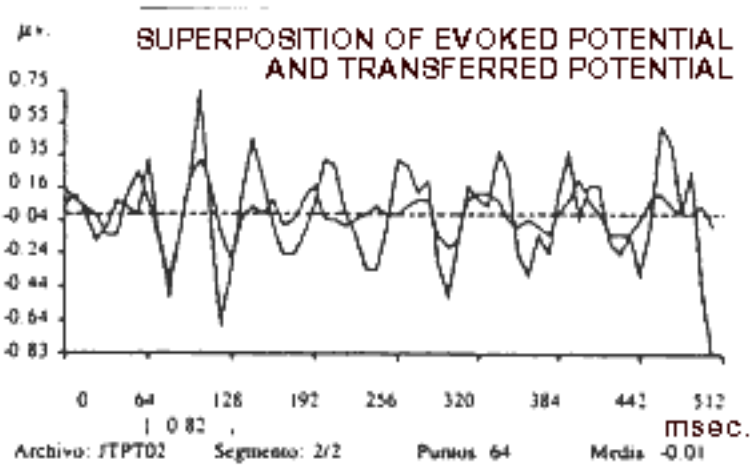
Some of her recent papers are: The Early Universe as a Quantum Growing Network, Ultimate Internets, and Spacetime at the Planck Scale: The Quantum Computer View.

- The interpretation of 26-dimensional closed unoriented bosonic string theory interpreted as a many-worlds quantum theory in which strings correspond to world lines is based on my D4-D5-E6-E7-E8 VoDou Physics Model.

Grinberg-Zylberbaum Experiments

Some interesting experimental results relevant to Chiao gravity antennas and to Mead resonant coupling were obtained by neurophysiologist Grinberg-Zylberbaum. According a 1997 Science Within Consciousness web article by Henry Swift:

> "... The experiment conducted by neurophysiologist Grinberg-Zylberbaum ... The Einstein-Podolsky-Rosen Paradox in the Brain; The Transferred Potential, Physics Essays 7,(4), 1994. ... demonstrate[s] the existence of a macroscopic quantum system in the human brain through the demonstration of ... non-local correlation between brains ... In this experiment two subjects ... meditated together for twenty minutes. A total of seven pairs of subjects of both sexes, with ages from 20-44 years participated in the study. After meditation and while maintaining their "direct communication" (without speech), they were placed in semi-silent, electro-magnetically shielded chambers separated by 45 feet. ... Both subjects were connected to EEG instruments and 100 random flashes of light were presented to subject A, while both remained reclined with semi-closed eyes. Subject B was not told when the light was flashed for subject A, and control correlation checks were also made at random times with no light flashes. The results indicated that, "after a meditative interaction between two people who were instructed to maintain direct communication (i.e. to feel each other's presence even at a distance), in about one out of four cases when one of the subjects was stimulated in such a way that his/her brain responded clearly (with a distinct evoked potential), the brain of the nonstimulated subject also reacted and showed a transferred potential of a similar morphology....



... The striking similarity of the transferred and evoked potentials and the total absence of transferred potentials in the control experiments leave no room for doubt about the existence of an unusual phenomenon, namely, propagation of influence without local signals. ... It is also extremely significant that the occurrence of transferred potential is always associated with the participants' feeling that their interaction is successfully completed (in contrast to the lack of transferred potential, when there is no such feeling). The interaction that correlates the subjects under study is entirely an interaction via non-local consciousness. ... none of the subjects B ever reported realizing any type of conscious experience related to the appearance of the transferred potential ...". According to a 1996 DynaPsych article by Ervin Laszlo: "... A particularly poignant example was furnished by a young couple, deeply in love. Their EEG patterns remained closely synchronized throughout the experiment, testifying to their report of feeling a deep oneness. ... In a limited way, Grinberg-Zylberbaum could also replicate his results. When a subject exhibited the transferred potentials in one experiment, he or she usually exhibited them in subsequent experiments as well. ...".

What has Grinberg-Zylberbaum done since 1994? That is unknown. According to an article by Sam Quinones, in the July/August 1997 New Age Journal, as shown on a Sustained Action web page:

"... In 1977 Grinberg returned to Mexico City ... A deeply spiritual man, Grinberg had moved from houses where he felt bad energy, believed he once had flown, and kept a meditation room lined with books and pictures of gurus. A semi-observant Jew, he sought out great thinkers on the Kabbalah. ... at UNAM ... he ... met the person who, he wrote later, would influence him more than any other: Barbara Guerrero, a former cabaret singer and lottery ticket seller who had fought with Pancho Villa as a young girl. Doña Pachita, as Guerrero was known, was a curandera. ... Pachita could go into a trance state during which the spirit of Cuauhtémoc, the nephew of the great Aztec ruler Moctezuma, occupied her consciousness. ... Grinberg ... believed that experience and perception were created as a result of this interaction, and that the curative powers of shamans and *curanderas* like Pachita came from their ability to gain access to the informational matrix and change it,

thereby affecting reality. ... Grinberg designed an experiment . . . using two people instead of one. Both subjects, with electrodes attached to their skulls, were put in a dark room and told to try to achieve a sort of meditative union. After twenty minutes, one was sent to a separate room. The remaining person was stimulated with a series of light flashes or sounds while his or her brain waves were measured. The brain waves of the isolated person were also measured. In 1987 Grinberg recorded for the first time a simultaneous reaction to the stimuli on the part of the isolated, non-stimulated person, a phenomenon he called 'transferred potential.' Over the years, with increasingly sophisticated equipment, he documented transferred potential 25 percent of the time, he wrote. It was a remarkable finding, totally contrary to the tenets of mainstream science. Grinberg believed it supported his theory of a neuronal field connecting all human minds. ... In 1991, Grinberg, his wife, and Tony Karam visited Castaneda at the latter's invitation in Los Angeles. There, Karam says, Castaneda proposed that Grinberg leave his UNAM lab to live in his community. Grinberg declined. Their relationship disintegrated during a trip Castaneda took to Mexico City two years later. Grinberg's friends and family remember him frequently calling Castaneda an egomaniac, more interested in power than truth. They also recall that Tere [Grinberg's wife] remained enamored with Castaneda and his group. ... For Jacobo Grinberg Zylberbaum, 1994 was a pretty good year. ... At his laboratory in the psychology department of the National Autonomous University of Mexico (UNAM) in Mexico City, he recorded the brain waves of a shaman, Don Rodolfo from Veracruz, in a trance state. ... Grinberg's book on his seminal influence, Barbara Guerrero, the blind witch doctor known as Dona Pachita, was finally about to be published in English. ... Then in December, Grinberg missed some appointments with students. Two days before his long-awaited trip to Nepal on December 14, he failed to attend his own birthday party. ... When Grinberg did not return from Nepal as planned, still no one thought much of it. ... But the weeks became months. Calls were made ... Nothing. No record of Grinberg or his wife ... Tere ... even leaving Mexico. ... In the two-and-a-half years since he disappeared, no trace of him, dead or alive, has been found. All that remain are his books, his theories ... The theory for which Grinberg came to be known reflected his personality. Relying on physics and his experiences with witch doctors, or *curanderos*--a bit of Einstein, a bit of Dona Pachita--its essential message was warm and hopeful: All humankind is interconnected. ...".

Zizzi Quantum Cosmology

In gr-qc/0007006, Paola Zizzi says, (with some editing by me denoted by [ ]):

"... the vacuum-dominated early inflationary universe ... is a superposed quantum state of qubits. ... the early universe had a conscious experience at the end of inflation, when the superposed quantum state of ... [10^18 = N quantum qubits] ... underwent Objective Reduction. The striking point is that this value of [N] equals the number of superposed

tubulins-qubits in our brain ... [in the inflationary phase of our universe] ... the quantum register grows with time. In fact, at each time step ... [Tn = (n+1) Tplanck (where Tplanck = 5.3 x 10^(-44) sec)] ... a Planckian black hole, (the n=1 qubit state 1 which acts as a creation operator , supplies the quantum register with extra qubits. ... At time Tn = (n+1) Tplanck the quantum gravity register will consist of (n+1)^2 qubits. [Let N = (n+1)^2] ... By the quantum holographic principle, we associate N qubits to the nth de Sitter horizon ... remember that |1> = Had|0> where Had is the Hadamard gate ... the state ... [of N qubits] ... can be expressed as ... [|N> = (Had|0>)^N] ... As the time evolution is discrete, the quantum gravity register resembles more a quantum cellular automata than a quantum computer. Moreover, the quantum gravity register has the peculiarity to grow at each time step (it is self-producing). If we adopt an atemporal picture, then the early inflationary universe can be interpreted as an ensemble of quantum gravity registers in parallel ... which reminds us of the many-worlds interpretation. ... The superposed state of quantum gravity registers represents the early inflationary universe which is a closed system. Obviously then, the superposed quantum state cannot undergo environmental decoherence. However, we know that at the end of the inflationary epoch, the universe reheated by getting energy from the vacuum, and started to be radiation-dominated becoming a Friedmann universe. This phase transition should correspond to decoherence of the superposed quantum state. The only possible reduction model in this case is self-reduction ... during inflation, gravitational entropy and quantum entropy are mostly equivalent ... Moreover ... The value of the cosmological constant now is ... /\N = 10^(-56) cm^(-2) ... in agreement with inflationary theories. If decoherence of N qubits occurred now, at Tnow = 10^60 Tplanck (that is, n = 10^60, N = 10^120) there would be a maximum gravitational entropy ... [maximum entropy Smax = N ln2 = 10^120] ... In fact, the actual entropy is about ... [entropy now Snow = 10^101] ... [Therefore] decoherence should have occurred for ... [Ndecoh = 10^(120-101) = 10^19 = 2^64] ... which corresponds to ... [n = 9 and to] ... the decoherence time ... [Tdecoh = 10^9 Tplanck = 10(-34) sec] ...".

Is there a fundamental reason that the number of qubits at which our inflationary universe experiences self-decoherence is Ndecoh = 10^19 = 2^64 ?

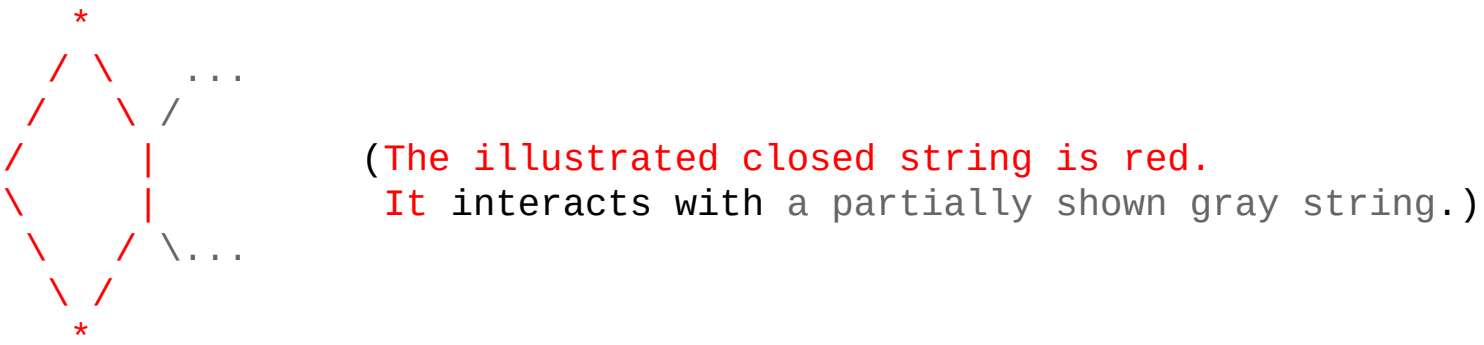
From the point of view of the D4-D5-E6-E7-E8 Vodou Physics model, the fundamental structure is the 2^8 = 256-dimensional Cl(8) Clifford algebra, which can be described by 2^8 qubits. Our inflationary universe decoheres when it has Ndecoh = 2^64 qubits. What is special about 2^64 qubits ? 2^64 qubits corresponds to the Clifford algebra Cl(64) = Cl(8x8). By the periodicity-8 theorem of real Clifford algebras that Cl(K8) = Cl(8) x ... tensor product K times ... x Cl(8), we have: Cl(64) = Cl(8x8) = Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) Therefore, Cl(64) is the first (lowest dimension) Clifford algebra at which we can reflexively identify each component Cl(8) with a vector in the Cl(8) vector space. This reflexive identification/reduction causes decoherence. In my opinion, it is the reason that our universe decoheres at N = 2^64 = 10^19, so that inflation ends at age 10^(-34) sec.

Note that Ndecoh = 2^64 = 10^19 qubits is just an order of magnitude larger than the number of tubulins

Ntub = 10^18 of the human brain. In my opinion, conscious thought is due to superposition states of those 10^18 tubulins. Since a brain with Ndecoh = 10^19 tubulins would undergo self-decoherence and would therefore not be able to maintain the superposition necessary for thought, it seems that the human brain is about as big as an individual brain can be.

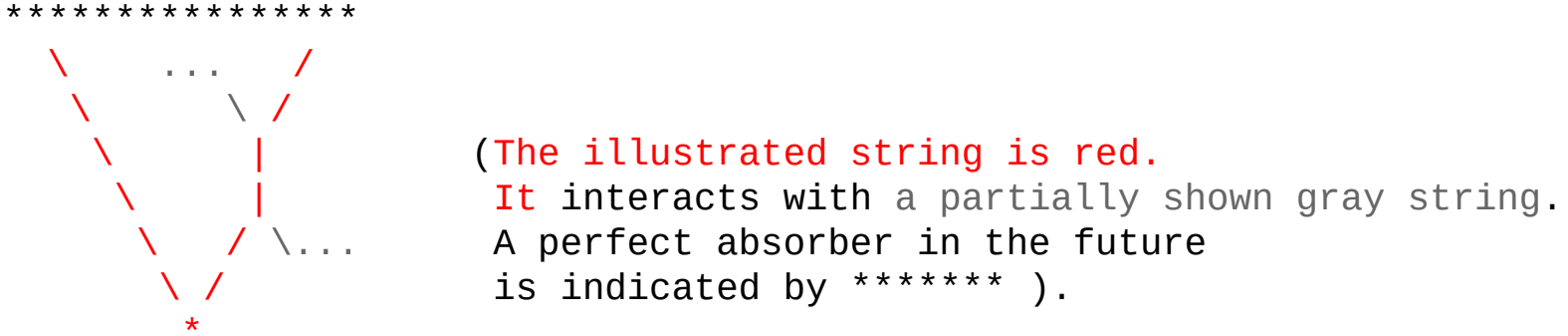
26-dimensional closed unoriented bosonic string theory interpreted as a Many-Worlds Quantum Theory in which strings correspond to World Lines, with massless spin-2 Gravitons in 26-dimensions corresponding to gravitational interaction among Tubulin Electrons in states with Penrose-Hameroff Superposition Separation

[[In the D4-D5-E6-E7-E8 VoDou Physics model, **closed strings represent the world-lines of fermion particle-antiparticle pairs** (the pair of fermions acting as a boson so that the entire string is bosonic) **from the time of their creation to their eventual mutual annihilation**,



perhaps with lots of interactions with lots of other particles/antiparticles of other world-lines in the meantime, so that part of each string might represent a photon or other particle of any type formed by interaction of one of the particle/antiparticle pair.

Note that since our Universe began with a Big Bang, all its particles originate from pair creation since then. For pairs that do not appear to reconnect for mutual annihilation within the volume of 26-dimensional spacetime being considered in working with the String Theory,



> the string is closed by considering the 26-dimensional spacetime to be a compactified 25+1 dimensional Minkowski spacetime due to considering the Universe to "... be a perfect absorber in the future ...[as in]... the Wheeler-Feynman ... absorber theory of radiation ..." described by Narlikar in his book Introduction to Cosmology (Cambridge 1997) (Section 8.8.1) and related to the Collective Electrodynamics of Carver Mead. For most of the matter in our Galactic Cluster, such an absorber could be a Black Hole of the Black Hole Era. Such a compactification is also similar to the conformally compactified 3+1 dimensional Minkowski spacetime M# used by Penrose and Rindler in their book Spinors and Space-Time, Volume 2 (Cambridge 1986) (particularly Chapter 9).]]

Roger Penrose says, in Shadows of the Mind (Oxford 1994), page 344,

> "... We can now consider the gravitational self-energy of that mass distribution which is the difference between the mass distributions of the two states that are to be considered in quantum linear superposition. The reciprocal of this self-energy gives ... the reduction timescale ...".

This is the decoherence time T = h / E.

For a given Particle, Stuart Hameroff describes this as a particle being separated from itself, saying that

> the Superposition Separation a is "... the separation/displacement of a mass separated from its superposed self. ... The picture is spacetime geometry separating from itself, and re-anealing after time T. ...".

If the Superposition consists of States involving one Particle of Mass m, but with Superposition Separation a, then the Superposition Separation Energy Difference is the gravitational energy

E = G m^2 / a

In the Osaka paper, Hameroff says that Penrose describes Superposition Separation as "... shearing off into separate, multiple spacetime universes as described in the Everett "multi&endash;worlds" view of quantum theory. ...".

If 26-dimensional closed unoriented bosonic string theory is interpreted as a Many-Worlds Quantum Theory in which strings correspond to World Lines

(see my paper at http://arXiv.org/abs/physics/0102042)

then massless spin-2 Gravitons in 26 dimensions correspond to gravitational interaction among States

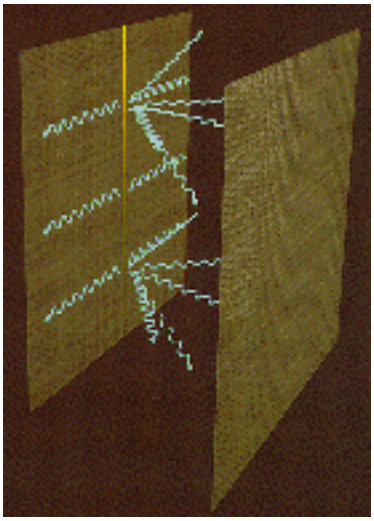
with Penrose-Hameroff Superposition Separation.

Such massless spin-2 Gravitons in 26 dimensions are described by Joseph Polchinski in his books String Theory vols. I and II(Cambridge 1998) where he says:

> "... [In] the simplest case of 26 flat dimensions ... the closed bosonic string ... theory has the maximal 26-dimensional Poincare invariance ... [and] ... is the unique theory with this symmetry ... It is possible to have a consistent theory with only closed strings ... with Guv representing the graviton ...", as to which Green, Schwartz, and Witten, in their book Superstring Theory, vol. 1, p. 181 (Cambridge 1986) say "... the long-wavelength limit of the interactions of the massless modes of the bosonic closed string ... [which] ... can be put in the form
>
> INTEGRAL d^26 x sqrt(g) R
>
> ...[of 26-dimensional general relativistic Einstein Gravitation]...".

A nice description of how such Gravitons propagate in the 26 dimensions is given by Stephen Hawking in his book The Universe in a Nutshell (Bantam 2001). To see how Hawking's description of gravity in 26 dimensions might be applied to the Penrose-Hameroff tubulin electron model of consciousness, first assume the validity of the interpretation of 26-dimensional bosonic string theory as a Many-Worlds Quantum Theory in which strings correspond to World Lines. However, Hawking speaks of branes rather than individual particle world lines. From the viewpoint of this paper, such branes should be regarded as 4-dimensional physical spacetime neighborhoods of individual particles. Timelike parts of such branes should be described in terms of 27-dimensional M-theory, and spacelike parts of such branes should be described in terms of 28-dimensional F-theory (for more about such M-theory and F-theory, see my paper at http://arXiv.org/abs/physics/0102042). In his book, Hawking says:

> "... Large extra dimensions ... would imply that we live in a brane world, a four-dimensional surface or brane in a higher-dimensional spacetime. Matter and nongravitational forces would be confined to the brane. ... On the other hand, gravity ... would permeate the whole bulk of the higher-dimensional spacetime ... because gravity would spread out in the extra dimensions, it ... would fall off faster with distance than it would in four dimensions. ... If this more rapid falloff of the gravitational force extended to astronomical distances, we would have noticed its effect ... However, this would not happen if the extra dimensions ended on another brane not far away from the brane on which we live. ...

 ...

[Note that in the Penrose-Hameroff model the superposition separation of two individual states in the superposition states of a single tubulin electron is of the order of a nanometer.]

> ... A second brane near our brane would prevent gravity from spreading far into the extra dimensions and would mean that at distances greater than the brane separation, gravity would fall off at the rate one would expect for four dimensions. ...
>
> ... On the other hand, for distances less than the separation of the branes, gravity would vary more rapidly. The very small gravitational force between heavy objects has been measured accurately in the lab but the experiments so far would not have detected the effects of branes separated by less than a few millimeters. ...".

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