Is the Human Brain Quantum Mechanical ?

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Abstract
Research published by Dubois, on a computational derivation of quantum relativist electromagnetic systems, and by Rowlands, on the discovery of a self-organized universal process of universal rewrite productions for computer hardware to interpret, taken together with new evidence, all support the contention that the information-processing architecture of the human brain is indeed quantum mechanical. In particular, the evidence of Scully et al taken together with that of Schempp, presented over several years, shows how the usual objection to quantum coherence, that the brain is a thermodynamic hot machine, can be and are overcome, as is indeed would appear to be the case for the photosynthetic harvesting of photons by chlorophyll.
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1 Introduction

Work published by Dubois[1] on the computational derivation of quantum relativist electromagnetic systems with forward-backward space-time shifts, and by Rowlands on the discovery of a self-organized universal process of universal rewrite productions ('NUCRS') for computer hardware to interpret (and given in full detail in the 2007 World Scientific book *Zero to Infinity*)[2] taken together with new evidence appearing in the leading journals *Science*[3] and *Nature*[6], all support the contention that the information-processing architecture of the human brain is indeed quantum mechanical. In particular, the evidence of Scully et al[3] taken together with that of Schempp[7] shows how the usual objection to quantum coherence, that the brain is a thermodynamic hot machine, can be and are overcome, as is indeed would appear to be the case for the photosynthetic harvesting of photons by chlorophyll[6].

The objective of this paper is to show how NUCRS research and that of Scully et al. provide quantum physical dynamic and thermodynamic solutions which can account for crucial properties of actual human brains, i.e. firstly, their ability to process exponentially complex data in real time necessary to their survival, including 3D geometric dynamic imagery in parallel with the semantic natural language reading and writing of symbols; and that it account for, secondly, geometric detail and mechanisms of their architecture; where in particular these solutions, thirdly, could account for human creativity; consciousness; the mind and the self (as physically distinct from the neural brain and human cellular being, respectively) in terms of entirely novel emergent quantum properties of matter that may never have existed before cosmologically; and fourthly, explain how it is possible for the human brain / being to have the self-

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organised capability to understand the cosmos from which it is emergent, including the means by which this semantic understanding can be expressed in terms of a grammatical computational universal rewrite language of meaningful symbols, i.e. be thought, written down, read and communicated to other human beings and where the concepts/physics of anti-commutativity/fermion and commutativity/boson are found to be fundamental to the computational self organization.

The hypothesis that the human brain is quantum physical signal processing system as proposed by Sir John Eccles who asked whether 'mental events cause neural events analogously to the probability fields of the quantum mechanics',[8] has support from his research into the neurophysiology of the brain and in particular the human synapse where there is a probabilistic release of a single synaptic vesicle containing some 10^4 of various neurotransmitter molecules from the hexagonal synaptic vesticular grid so as to provide the synaptic action / current density across the synaptic junction on neural axon firing. It is also in full concordance with the mathematical explanation provided by Rowlands' universal computational rewrite as an understanding of quantum physics.[2] The nilpotent Dirac theory which emerges from this rewrite structure leads in a most natural way to the usual expressions s^t and $c^d = c(s^x, s^y, s^z)$ known as the 'probability' current and density respectively of the quantum wave, so as to define the total number of particles which will on average pass through a surface element in unit time. So, having satisfied Eccles' hypothesis that the brain might indeed be a probabilistic computational machine, we can go forward with some confidence to evaluate other possibilities, of which the earliest is that of da Vinci, which is remarkably in agreement with the computational rewrite approach to the quantum physical signal processing operation of the human body and brain.

Da Vinci mooted that the relative proportions of the human body contained in the unit disk were those of the golden number G. But computationally the unit disk with metric $i^2 + 1 = 0$, is an equation for chaos, character G, fractal dimension 2, which has the desired quantum logic $i = \sqrt{(\text{NOT} = -1 = \text{False})}$; i also describes Feynman's computer constructor universal primitive, the unit wire & ensures signals in the plane (x, y) are a Fourier duality pair. It is possible, therefore, that the human body and brain may indeed have a quantum mechanical explanation, and particularly since the human genome is to known to specify both, where evidentially the genetic code itself is computer constructor universal in the Von Neumann sense.[9] This conclusion might be considered as confirmed by the work of Kaschube et al, reported in *Science*[4,5] where three distantly related mammals are shown to share a self organized visual cortex brain architecture characterised by density π, for from the Euler identity $\exp i(\theta = \pi) = -1$, i as a parameter, has characters π, -1 and exponential constant e. The unit disk has infinitely many unit vectors (each of unique relative phase θ) all of which are roots of the metric, which from $\exp i(\theta = \pi / 2) = i$ are all orthogonal and so specify the Hilbert space in which all the solutions / roots of the quantum formalism are known to lie. These Hilbert space unit vectors satisfy Wittgenstein's (1975) semantic language principle that 'there is only one proposition to each fact θ that answers to it, and the sense of the proposition cannot be expressed except by repeating it'.[10] Its unitary (U) symmetries are the well known behaviours $U(1)$, $SU(2)$ and $SU(3)$ of Standard Model Elementary particle

physics and the $SU(4)$ and $SU(5)$ of Einstein's General Relativity and its extension in the Klein-Kaluza theory *respectively*. Examples of the $U(1)$ unit wire are the chemical bond, the neural axon and 1-dimensional Fourier transform action.

Further substantiation is to be found in Chapters 19 and 20 of Rowlands' 2007 World Scientific book Zero *to Infinity*,[2] in the authors' AAAI 2007 Spring conference paper 'How Intelligence Evolved?'[3] and. in particular, in Diaz and Rowlands' 'D:The infinite Square Roots of -1'[11] among a series of other CASYS publications by the British Computer Society's Cybernetics Machines Group, supplemented by recent evidence from papers published in the leading journals *Science* and *Nature*, by Scully et al[3] and Collini et al.[6] Of course, it is reasonable to ask about the ambient body temperature quantum computation essential to the functioning of living systems like the human brain, and how the brain's visual cortex can be self-organized in such a way that it can function as a single inseparable heat bath of energy and matter. It is proposed that such recent publications now supply the answer that they can, giving necessary support to Eccles' hypothesis that 'the neurophysiology of the amazing working of the human synapse demands a quantum mechanical explanation?'

2 The New Evidence

Collini et al[6] conclude that ambient body temperature quantum computation is proven with respect to the marine algae photosynthetic harvesting of photons by chlorophyll. This allows us to postulate that it is ubiquitous to all plant life, and to all animal life too – for if the magnesium atom in chlorophyll is replaced by an iron atom, the result is a molecule like haemoglobin that harvests our oxygen. Thus, although science cannot currently perform qubit computation of any significant complexity in the laboratory, nature would appear to do so all the time in all living systems and subsystems, and unlike digital computation to be capable of solving natural problems of exponential complexity in real time, as the universal nilpotent computational rewrite system (NUCRS) mechanism of Rowlands' book makes clear is the case.[2] The metric $i^2 + 1 = 0$ ensures that quantum computation is confined to wave behaviour where $\cos^2\theta + \sin^2\theta = 1$ for any phase θ, so that normalization, together with Fourier encoding / decoding transform action is always possible. In fact, as the working of Magnetic Resonance Imaging (MRI) shows, see Figure 1, Heisenberg uncertainty is the very mechanism by which quantum computation of the desired MRI imagery takes place, and not a thermodynamic obstacle to it, as is usually thought to be the case.

In another significant development, as published by Scully et al (*Science*, 2003),[3] the Carnot Engine that idealizes the workings of the Second Law of Thermodynamics can be replaced by a Quantum Carnot Engine which describes the law's extended functioning in a single ambient temperature heat bath, where an ensemble of matter of quantum coherence phase θ leads to the quantum emergence of new states of matter called a 'phaseonium'. These provide a very general confirmation of what we seek, for, if the human body departs even by a small amount from the ambient temperature of 37 degrees, it loses consciousness or becomes ill and can die.

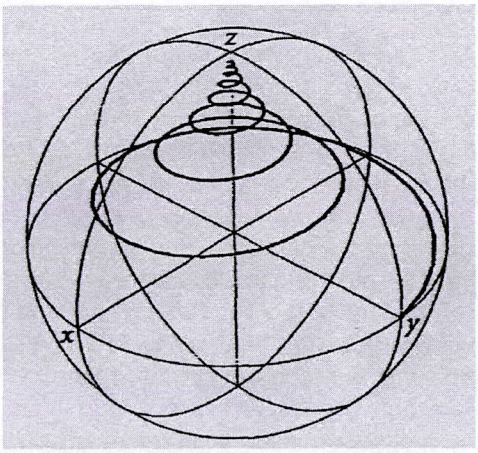

Figure 1 Holochoric compression

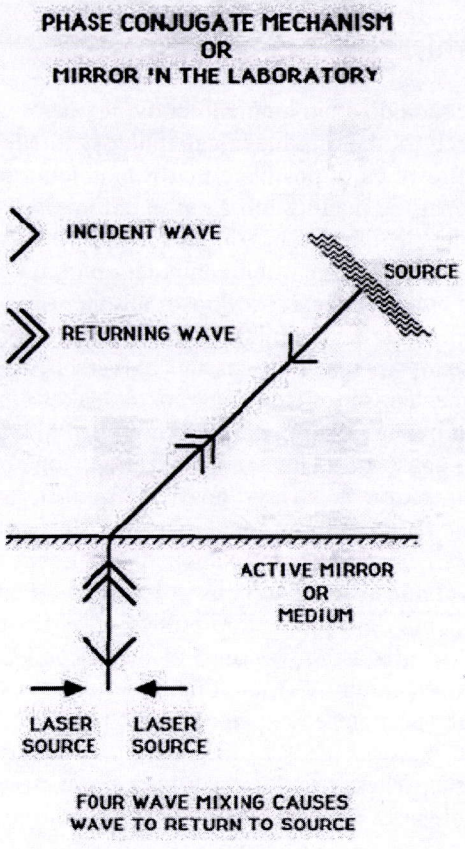

Figure 2 Half-phase conjugation

It can therefore be postulated that dying implies a loss of quantum coherence / entanglement (*qc* / *e*) and a subsequent breakdown of the body's 3D chemical structural complexity in the form of its chemical bonding, and that *qc* / *e* is central, too, to the workings of the body's self organized immune system and mechanisms of self repair. Equally, such entanglement is, by implication, essential to the emergence of each entirely new human being, so that when DNA enters, say, a stem cell in the appropriate way, it acts as ' a quantum thermodynamic program' for the spontaneous self-organized emergence of the being / organism in question, by a process of spontaneous phase conjugate adaptive resonance, see figure 2.

3 The Evidence at the Time of the BCSCMsG's 1986 Foundation

The evidence at the time of the foundation of the British Computer Society's Cybernetics Machines Group in 1986 was basically 3-fold. The publication of Deutsch's Royal Society paper of 1985[13] on universal quantum computation, Albert's conclusion that quantum and digital automata were radically different,[14] and Sir John Eccles' Royal Society paper of 1986 in which he put forward his quantum structure of the brain hypothesis,[8] based on:

1) Ramon y Cajal's 1911 hypothesis that brain neurons act seemingly linearly independently, and

2) the astonishingly complicated structure and workings of the mammalian neural synapse, i.e. the probabilistic exocytosis of a single synaptic vesicle (contents 10^4 molecules of neurotransmitter, one of many inside the synaptic bulb) via the hexagonal vesicular grid of attachment sites to provide the synaptic gain across the synaptic junction.

Briefly, therefore, Eccles hypothesized that if the nature of the workings of the synapse were quantum mechanical (QM) then the whole brain would be too. And a QM explanation is that the synapse (insulated in a bulb of very high dielectric constant) functions as a quantum Carnot engine where the vesicles are the ensemble of matter from which a new property, i.e. a neuro-transmitter, emerges to provide a synaptic gain / weighting via the *SU*(6) hexagonal vesicular grid.

4 The Proposed Self Organised Quantum Mechanical Working of the Human Brain / Mind and Senses

This begins with the observation that when any form of illumination is incident upon a 3D object, the 3D geometric dynamic object image is spontaneously encoded in the incident illumination. No human intervention or observer is needed or required to produce this image, which takes place by changes in the amplitude and phase of the wave front – a fact easily substantiated by holography. We can think of holographic encoding as the addition of a reference wave to the above object image carrying beam to produce a 2D wave interference pattern / hologram and the 3D image decoding as the subtraction of the reference wave, so as to reveal the 3D image, originally encoded (Figure 2).

Let us point out that similar holographic effects in automata were simulated by Dubois[21] with hyperincursive methods for generating fractals in automata relating to diffusion and wave equations.

It would be illogical, in fact, for the senses to throw away the phase information and try to recovery the 3D image from a pattern of bits which may then require additional encyclopedic knowledge of the world. For such knowledge is directly encodable as an element in an associative memory and filter bank of holograms for subsequent use, by simply combining the 3D object image-bearing illumination incident to the eye with a reference wave that the rods or cones of the eye supply. These then act on behalf of the brain as the secondary sources of a 3D dynamic image wave front, where, it is known, this front is reconstituted as the actual 3D dynamic image itself on the surface of the visual cortex. For, as nondegenerate quantum holography shows, there are sharp frequency, $\nu = \nu'$, $\nu \neq 0$, adaptive resonant coupling conditions with a very narrow spectral window, where $< \psi \otimes \varphi >< \psi' \otimes \varphi' > \neq 0$ such that $\psi \otimes \varphi$ and $\psi' \otimes \varphi'$ (in which and $\otimes$ stands for tensor multiplication) are holographic interference patterns / holograms (in the filter bank memory), which are 0 when $\nu \neq \nu'$ (Schempp, 1993)[7]

3D holographic image reconstruction allows information in the form of θ arriving at the senses to be used / viewed immediately as a whole in the form of a single 3D wave front passed, see Figure 3, as a hologram directly to the brain (based on a unique spectral / reference wave frequency, the brain supplies) for use as memory and as filters; so that the human brain can start with an empty slate.

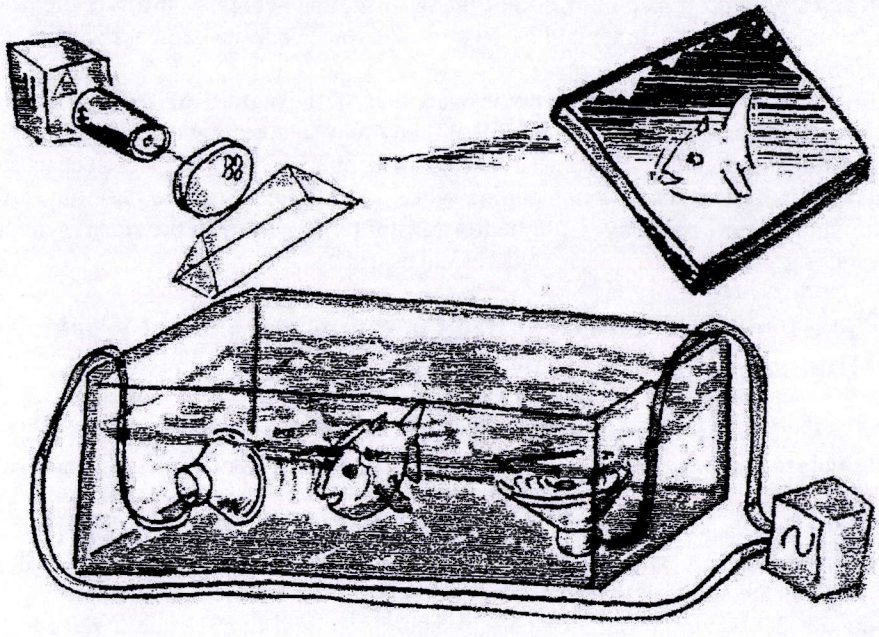

Figure 3 Holochoric transduction

Furthermore, it tells us that the human senses and sensory apparatus do not process information in the form of words / symbols / bits but as object images of 3D geometric dynamic structure using quantum holography in the form of sensory quantum holograms, which the brain stores hierarchically in the form of a 3D associative memory and filter bank, and where the NUCRS tells us that 'bits' are in separate use to encode semantic language signals in the form of an alphabet with a universal grammar. This leads to the conclusion[15,16] that the brain needs to be composed of two distinct (linked) brain hemispheres, as is evidentially the case.

5 Conclusion – What Further Evidence does this Construction of the Brain Provide ?

It may be, therefore, as in the two hemispheres, that the human brain as a whole is of a totally dual construction, with a neural / glia (neuron / glia cell → 'electron / ion') dual geometry[17,18] as the form of a self-organized brain / mind equipped with emergent symbolic / alphabetic semantic language capabilities, where the laws of natural language have the NUCRS universal grammar / alphabet, and the brain / mind is the control centre of each self-organized individual human body / self → controlling nerve fibre / microtubule dual, respectively.[19,20]

There is therefore an actual physical emergent human self and an actual physical emergent human mind as part of each self-organized human body and self-organized human brain, so as to result in our evident 3D sensory self awareness, and which endows human semantic intelligence via dual brain / mind interaction, i.e. thought, giving us the evident capability to describe and understand the Universe from which as a species we are emergent and inseparable, because the brain / mind, body / self and the Universe, all possess the same self -similar universal self-organization.[16] The precise architecture of the human brain will remain a controversial subject for some years to come, but we believe that several separate pieces of evidence point to the kind of structure and organization we have suggested, and that further evidence, as it is uncovered, will tend to support the idea that the human brain has quantum mechanical or *quantum mechanical-like* features on a scale beyond the atomic or molecular level where everything is clearly quantum mechanical.

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