

BEYOND THE STALEMATE: CONSCIOUS MIND-BODY - QUANTUM MECHANICS - FREE WILL - POSSIBLE PANPSYCHISM - POSSIBLE INTERPRETATION OF QUANTUM ENIGMA

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ABSTRACT: I wish to discuss a large, interwoven set of topics pointed at in the title above. Much of what I say is highly speculative, some is testable, some is, at present, surely not. It is, I hope, useful, to set these ideas forth for our consideration. What I shall say assumes quantum measurement is real, and that Bohm's interpretation of Quantum Mechanics is not true.

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KEYWORDS: mind-body; acausal consequences, poised realm, free will theorem; quantum enigma; consciousness.

INTRODUCTION

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THE CAUSAL CLOSURE OF CLASSICAL PHYSICS IS THE SOURCE OF THE STALEMATE.

We all know Newton, his three laws of motion, universal gravitation, and invention of differential and integral calculus. Given seven billiard balls rolling on a billiard table, we might ask Newton what will happen to the balls. “Write down the initial conditions of position and momenta of the balls, the boundary conditions of the edges of the table, and the forces between the balls, and the balls and the edge of the table using my three laws of motion in differential equation form. Then, to find out what will happen to the balls in the future (or past, my laws are time reversible), integrate my differential equations to obtain the trajectories of the balls (for all time in the absence of friction)”. But, I note, integration is deduction of the consequences of Newton’s differential equations for the trajectories of the balls, and deduction is “entailment”. “All men are mortal. Socrates is a man, therefore Socrates is a mortal.” is a syllogism whose conclusion is logically entailed by the truth, if so, of the premises. So too the trajectories are entailed by integration of Newtons differential equation.

But this entailment sets up the Stalemate. If the brain is a classical physics system, then the present state of the classical physics brain is entirely sufficient to determine the next state of the brain. But then, there is **NOTHING** for mind to do, and **NO WAY** for mind to do it! It would be like asking mind to alter the trajectories of the balls on the billiard table.

Thus, if mind somehow is present in a classical physics setting, it can have **NO** consequences at all for the classical physics world. At best, the mind can be merely epiphenomenal. (We might wonder if mind exists and is merely epiphenomenal, and if mind with brain evolved, what selective advantage could it have had?).

The culprit is the causal closure of classical physics with, as Aristotle said, no Prime mover. The Stalemate arises because we want mind to act causally on brain, but it cannot because all the classical physics causes are already in the laws of the billiard ball classical physics neuronal system and attendant classical physics further variables including classical physics noise.

QUANTUM MECHANICS PROVIDES TWO WAYS TO BREAK THE CAUSAL CLOSURE OF CLASSICAL PHYSICS AND HAVE ACAUSAL CONSEQUENCES FOR THE “CLASSICAL” BRAIN.

I begin with a familiar outline of Quantum Mechanics, with the caveat that I am not a physicist. 1) We all know the two slit experiment and the resulting interference pattern of spots on the developed film emulsion beyond the two open slits. 2) We know the Schrodinger linear wave equation, often set equal typically to a classical potential V . The equation has no energy term, so what is “waving” cannot be matter or energy. No one knows what is “waving”. I will propose below that what are waving are “possibilities”, (1), or, with Heisenberg, Potentialities,(2). 3) We know the Born rule: square the amplitude of each wave, say spin up or spin down, in superposition, and that is the probability that upon measurement that outcome will be found. We know there are 16 interpretations of Quantum Mechanics, in which measurement is real in some and not others. As noted above I assume measurement is real. 4) Finally we all know the astonishing confirmation of Non-locality for entangled quantum variables.

RES POTENTIA AND RES EXTENSA, LINKED, HENCE UNITED, BY MEASUREMENT.

I may be proposing a 17th interpretation of quantum mechanics, rather similar in some aspects to Heisenberg’s Potenia,(2), but on different grounds. I begin with Feynman’s formulation of quantum mechanics as a sum over all possible simultaneous histories,(3). This is accepted as an equivalent formulation of quantum mechanics by most physicists. On this formulation, one must say that a SINGLE photon on its way through the two slits to the film emulsion simultaneously does and does NOT pass through the left slit. But this statement breaks Aristotle’s Law of the Excluded Middle, where “A and Not A” is a contradiction. Thus, on Feynman’s formulation, quantum coherent behavior does NOT obey the law of the excluded middle. After quantum measurement, the result does obey the law of the excluded middle. For example, the electron, upon measurement, is found to be either spin up, or spin down, not both simultaneously. So measurement, if real, does take Quantum Mechanics from something that does not obey the law of the excluded middle to something that does obey the law of the excluded middle.

Philosopher C. S. Pierce noted that Actuals and Probables DO obey the law of the Excluded Middle, but Possibles do not. Thus, “The photon possibly did and possibly did not simultaneously go through the left slit” is NOT a contradiction.

I now wish to propose a new dualism, but not a substance dualism: Res potentia - ontologically real Possibles that do not obey the Law of the Excluded Middle, and Res extensa - ontologically real Actuals that do obey the Law of the Excluded Middle,

linked by measurement, (1). Because Possibles are not a substance, consistent with the fact that the Schrodinger equation has no energy term, this dualism is not a substance dualism. “Possibles” are not far from Heisenberg’s “Potentia”,(2), indeed may be identical. If so, what is waving in the Schrodinger equation are possibilities.

I note next that if we accept Res potentia and Res extensa united by measurement, there can be no deductive mechanism for measurement. The “X is possible” of Res potentia does not deductively entail the “X is actual” of Res extensa. Physicists like equations. Here the logic is very simple, but correct. This is an hypothesis easily disproved were we to discover a deductive mechanism for measurement, not found since 1927, but a valid test of the Res potentia hypothesis only assuming measurement is real.

RES POTENTIA AND NON-LOCALITY

We have a hard time thinking about non-locality. I like the following: Possibilities are not located in space and time. This provides one way to think about non-locality in which measurement, located in space and time, of one of two entangled electrons as spin up, instantaneously implies the second is located in space and time, and is spin down. If Res potentia is not in space and time, entanglement can “spread” instantaneously, but “spread” is wrongly thought of as located in space and time. Here measurements create Actuals that do obey the law of the excluded middle, so, I want to hope, must be located in space and time, or spacetime, the latter only if quantum mechanics can ever be formulated with respect to General Relativity.

THE “POISED REALM” HOVERING REVERSIBLY BETWEEN QUANTUM AND “CLASSICAL” WORLDS.

Gabor Vattay, Samuli Niiranen and I have recently proposed, or perhaps discovered, a new “Poised Realm”, (4,5), in which the total system can hover reversibly between quantum coherent and “classical” worlds, with the known debates about what the classical world may be. The Poised Realm is captured by an X Y coordinate system. At the origin on the Y axis, the system is quantum coherent. As the system moves up the Y axis, the system undergoes increasing decoherence as an open quantum system losing phase information to the environment and approaches “classicality” infinitely closely for all practical purposes, FAPP, (6). (I note that the decoherence program no longer seems to think it can account for quantum measurement, again if measurement is real, (7). What is new on the Y axis, is that REcoherence can occur and move the system back down the Y axis from “Classical” FAPP to quantum coherent. The possibility of recoherence is assured by a theorem by Peter Shor, (7), now in use for quantum error correction in decohering qubits with the input of “information”. More

recently, quantum biology at body temperature is firmly established in the long lived quantum coherence of light harvesting molecules. Even more recently, experimental evidence supports recoherence induced by phonons in the light harvesting complex that induce recoherence in the electron involved, (8). The Y axis seems real in theory and practice.

The X axis is: Order, Criticality and Chaos, going out from the origin. In classical physics, this arises as a set of Hamiltonians are tuned from a conservative oscillation like a pendulum, where neighboring orbits are parallel and the Lyapunov exponent is thus 0, to a critical point out the X axis where the Lyapunov exponent undergoes a second order phase transition to become slightly positive at Criticality, then more positive in the Chaotic parts of the X axis. In the quantum coherent world, criticality corresponds to the metal - insulator transition between extended and localized wave functions. The X axis is also real. Vattay and colleagues, (9), have now measured the absorption spectra of hundreds of different organic molecules. From each molecule one constructs a histogram of the number of small energy intervals between absorption bands, and larger and larger energy intervals. The ordered regime corresponds to a well known exponential decay, from many short intervals to a few long intervals. The Chaotic regime is a unimodal distribution. The critical regime is a unimodal distribution whose single peak is shifted toward shorter wavelengths than the chaotic regime, (5). Almost half the molecules examined are ordered, and, astonishingly, almost half are critical, a single point on the X axis. A few are chaotic. So the X axis is real. Why half are critical is a new mystery. Thus, the X axis is real. Since both the X and Y axis are real, the Poised Realm is real.

New physics arises in the Poised Realm, in part because decoherence is dissipative, so the Schrodinger equation does not propagate time reversibly and unitarily, but temporal behavior can be followed using Density Matrix methods. Experimental evidence for new physics includes the fact that in coherent systems, jumps between quantum states are Poisson distributed in time, yielding the familiar exponential half life. In the presence of decoherence, the jumps are no longer Poisson in time, confirmed experimentally, and sometimes called the AntiZeno Effect,(10). The full portent of the Poised Realm may be very large. I will propose below that it plays a major role in the Mind - Body problem.

TWO WAYS THE POISED REALM ALLOWS ACAUSAL CONSEQUENCES FOR THE "CLASSICAL WORLD".

First, if we accept decoherence to classicality FAPP, then decoherence is entirely an acausal loss of phase information from the open quantum system to the universe. So a quantum "mind" can have acausal consequences for the classical "meat" of the brain,

breaking the Stalemate of the Causal Closure of Classical Physics. But by recoherence, the total system, quantum, poised realm and “classical” can have repeated acausal consequences for the “classical meat of the brain”. Here I take “mind” to include quantum coherence, measurement, and the Poised Realm. We will see below that a quantum description does not yet suffice to get us to “consciousness” or experiential terms.

The second way that the above system can have acausal consequences for the “classical” meat of the brain is quantum measurement which can acausally restore coherence in a decohering quantum variable, or, again if measurement is real, alter the classical world by leaving a record, as the spot in the two slit experiment does.

In short a Mind - Body system that is quantum coherent, Poised Realm, and “classical”, can escape the Stalemate. Mind can, in principle, be real in the world and effect its becoming, and not merely epiphenomenal. This alone suggests taking any such ideas and considering them. We have been frozen with the Stalemate for 350 years.

However, the discussion above is void of experiential terms such as consciousness, qualia, and responsible free will, topics I take up below.

BEGINNING IMPLICATIONS FOR NEUROBIOLOGY.

With Penrose,(11), and Stapp,(12), but for overlapping reasons, I want to propose that conscious experience, qualia, is associated with quantum measurement. I do so in part based on the fine discussion of the Quantum Enigma, (12), discussed with hesitation below. The first important issue is that, even in the two slit experiment, we never consciously experience the quantum coherent state, rather we SEE the results of measurement, Yes, the spot is HERE on the film. This suggests that conscious experience is not associated with quantum coherence itself, but with a “yes” outcome to quantum measurement.

This hypothesis is experimentally testable genetically, (1). Fruit flies, and other animals, can be anesthetized by ether. Take a wild type population of fruit flies, and over generations, select a “mutant” subpopulation that can be anesthetized by shorter and lower doses of ether, perhaps until none is needed. Sequence the DNA of the selected “mutant” and wild type populations of flies, detect mutant genes, hence proteins, if they exist, in the selected population, and test if those proteins fail to carry out some quantum measurement that the wild type proteins do “in vivo”. I do not know how to pick out what quantum measurements might be relevant, but clearly this is a start of an experimental test.

CONNECTIONS TO NEUROBIOLOGY.

The anatomical location of such “mutant” proteins can be established. Suppose the relevant proteins were located in synapses and part of the post cleft neurotransmitter protein receptor complex. Then one can imagine that quantum behaviors altering the receptor protein(s) could affect adjacent dendritic transmembrane potentials, the subsequent potentials transmitted to neural cell bodies and summing, or not, at the axon hillock to trigger action potentials propagating down the axons. In principle, this would be a start of tying quantum behavior to all of classical neurobiology. But the proposal that conscious experience is associated with measurement “turns the brain on its head”. The business end of the mind brain system related to qualia are the relevant quantum variables in the brain. However, I need only claim that measurement is a necessary, not sufficient condition for consciousness. Recent experiments with stimuli that can shift from “conscious of” to “not conscious of”, suggest that higher brain areas are also necessary for “conscious of”.

ENTANGLEMENT AND THE BINDING PROBLEM

In the Astonishing Hypothesis, Francis Crick describes the binding problem, (14j). We are to suppose that a yellow triangle and blue square are being observed. If “yellow”, “blue”, “triangle” and “square” are processed in anatomically disconnected areas of the brain, a claim I will accept, then how do “yellow” and “triangle” become bound into the experience of “yellow triangle” and how do “blue” and “square” become bound into the experience of “blue square”. One solution is a 40 Hertz oscillations in the brain and if “yellow” and “triangle” occur at one phase of the oscillation and “blue” and “square” at a different phase, then binding occurs to yield “yellow triangle” and “blue square”. This might work. My problem is that we seem to bind indefinitely many, here visual, qualities or features and fitting them all into “discriminably” different phases of the oscillation seems problematic, but conceivable.

I want to try entanglement to solve the binding problem, (1). There is now weak evidence for entanglement of a number of quantum variables, including photons, in cells and the brain, (15). Suppose that some set of N quantum variables in the brain can become entangled and are in anatomically disconnected areas of the brain. Then it is known that upon measurement, their outcomes are correlated and more correlated as the number of entangled variables increases. Thus the qualia upon measurement may be highly correlated into a new “whole”. This could mediate “binding” in anatomically disconnected areas of the brain in ways that also respect neuroanatomical connectivity.

The binding problem is a subset of the Unity of Consciousness issue, for example, the experienced perceived whole visual field. We might suppose that this unity of

consciousness is mediated by entanglement and co-measurement and an enormously rich evolved neural system. Such proposed entanglement is, in principle, testable. Three further issues arise, for we experience a “unity of consciousness”. 1) But with shifting attention we seem to experience different unities of consciousness. Then we might imagine that the shifting attention and resulting shifting unity of consciousness reflects in part different subsets of quantum variables becoming entangled and measured to yield shifting patterns of conscious experience, presumably tied to known neural processes related to attention. 2) Entanglement solves the “combination” problem of W. James, who considered atoms of consciousness, but then noted that combinations of consciousness atoms seemed to yield new “wholes”. He noted that a house made of bricks, from the viewpoint of the bricks is just a bunch of bricks, not a new “whole”, but only a new “whole”, say a house, to an outside observer. But there is no outside “observer”. James never solved the combination problem. But with entanglement, the N entangled variables are no longer independent at all, so can give rise to an experience which is a new whole, perhaps solving the combination problem. The new whole may also solve the famous Frame Problem of computer science. 3) In order for entanglement to work and to shift, there must be means to entangle different “desired” sets of quantum variables. I give one conceivable mechanism: decoherence broadens absorption bands, recoherence narrows them. Thus imaging entangling a “desired” set of decoherent quantum variables in a wavelength about 300K, the temperature of the brain so able to transverse the brain, but chosen so that wavelength will be absorbed only in the broadened absorption region of decoherent quantum variables. Then by decoherence and recoherence, which variables become entangled can be altered.

POSSIBLE DIRECT TESTS OF QUANTUM MIND

If mind is partially quantum coherent or also Poised Realm, then by entanglement and non-locality, both telepathy and telekinesis are possible. Weak evidence and somewhat improved evidence supports both, (16, 17). Indeed, there are reports of many computers around the world, generating random numbers both with classical random number generators, and by quantum randomness, tested for “erratic” behavior when major public events happen, such as the death of Nelson Mandela. It is claimed that the resulting deviations are statistically significant. I cannot attest to this, but this kind of experiment has the strong virtue that the outcomes, if statistically significant outputs of computers, are objective data. By contrast, claimed telepathic experiences are harder to verify. Such telekinesis experiments are quite cheap. If confirmed, the obvious explanation is non-locality, hence a quantum role in the mind-body system. It

seems very worth pursuing such experiments, for the causal closure of classical physics can only yield an epiphenomenal mind, while a quantum mind can have consequences for the “classical” body and world, so be a mind beyond merely epiphenomenal. Decoherence may render such phenomena evanescent, a topic perhaps to be examined.

THE STRONG FREE WILL THEOREM AND THE SUBJECTIVE POLE

Nothing in the above discussion involves “experience” in any way. I have at best afforded a way to achieve a “mind body” system in which quantum and Poised Realm mind really can alter the “classical” world by acausal consequences for brain, so mind need not be merely epiphenomenal. That is a lot, if true.

Since Descartes’s *Res cogitans*, in his substance dualism with *Res extensa*, failed and *Res extensa* and Newton won with nothing for mind to do and no way for mind to do it given the triumph of classical physics and its causal closure, the subjective pole of experience has been distanced by the “hard sciences”.

But a recent theorem by Conway and Kochen, a mathematician and a physicist, The Strong Free Will Theorem, (18), offers its own hope. The theorem states that if the physicist has free will in setting up the Stern Gerlach apparatus to prepare an electron to be measured as spin up or spin down, rather than preparing it to be measured as spin left or spin right then: 1) Nothing in the past of the universe determines the outcome of measurement. 2) There can be no mechanism for measurement (independently supported by *Res potentia* and *Res extensa* linked by real measurement. 3) Then the stunning: The electron free will **DECIDES** to be spin up or spin down! This is the only theorem I know in physics that uses an experiential term, “Decides”, but it depends upon measurement being real.

Assume for the moment the theorem holds. Then there is a further mystery. If 1000 electrons are identically prepared and independent, to be spin up with 50% probability and spin down with 50% probability and all independent electrons are measured, in fact, about 50% will be spin up and 50% will be spin down. But if the electrons are independent and each has “free will” and “decides”, how can it turn out that in fact 50% wind up spin up and 50% wind up spin down? The easiest thought is that each electron has a “preference” to choose with 50% spin up and choose with 50% spin down. If so, “decides” comes with “preferences” and hence a “will” that is “responsible”.

But the Strong Free Will Theorem is circular. It assumes the physicist has free will then proves the electron does. But why should we assume the physicist has free will? I now want to try to break this circularity.

Here are the two standard “responsible free will” issues. If classical physics holds we have no free will at all. If we try to use quantum indeterminism, it is merely random. So a random quantum event occurs in my brain, I kill the little old lady, but I am not “responsible”, the quantum event was random. So even if measurement is real, and ontologically indeterminate, so underlies a “free will”, that will cannot be responsible.

The situation is not helped if we consider 50 independently prepared electrons, all say 50% spin up and 50% spin down, and measure them all. We will get an INDEPENDENT set of 50 random up/down outcomes. So again, the set as a whole, whose outcomes are random and independent, cannot yield an ontological basis, not yet experiential, for a responsible free will.

Now consider N entangled particles, say electrons, again spin up and spin down. It is a standard theorem of Quantum Mechanics for entangled particles that measurement of the first particle, whatever the outcome, up or down, typically CHANGES the probabilities for the outcome of the next measured electron. This arises because the first measurement alters the density matrices used to propagate the Schrodinger equation for the remaining $N - 1$ electrons. Thus, each successive measurement of the next among the N entangled particles, alters, by the Born rule, the probabilities of the next measurement. So the set of N measurement outcomes are NOT independent. Indeed this non-independence is now one new approach to quantum computing, (19).

I now argue that this non-independence provides an ontological basis, not yet experiential basis, for a responsible free will. First, note that in a limiting case, the amplitudes could be altered such that the probabilities for spin up or spin down went all the way to 100% or 0%. But then the outcome of measurements would be “determinate” and even if unentailed, hence though free, we would have no free will “choice” any more than in entailed classical physics. Thus, in general, let the probabilities change, but typically remain less than 100% or 0%. These probabilities constitute what I want to call “enabling constraints” on the deciding electron to “decide responsibly” within the constraints set by the Born rule. In general, I claim that all human free will actions occur in the context of enabling constraints that create a “relevant set of possible actions”. Unconstrained “free will” makes no sense for acting humans. We, at least sometimes, act for reasons, purposes, and intentions, given by context and capacities that constitute, in part, the enabling constraints. Thus, and this claim is essential: I claim that non-independence of measurements for entangled particles allows an ontological basis for a responsible free will for the physicist.

If the above is correct, and measurement is real, we must take the Strong Free Will Theorem seriously, and electrons do “decide” and to fit the fact that 100 identically prepared electrons yield outcomes upon measurement that fit the Born rule, seem to require “preferences” hence “responsible” decisions. But if so, we have the start in this Theorem, of an experiential pole. In measurements, electrons “decide”, perhaps “responsibly”. It does not follow that in “deciding” the electrons are “conscious” of deciding. I am going to propose that electrons ARE conscious in deciding ie upon measurement. Of course, unlike the case of anesthetizing fruit flies to see if their conscious experience is associated with quantum measurement, I have no idea how to test if electrons “decide”. It is at least logically possible that this “deciding” could be “anesthetized”, altering the Born rule outcomes, but who has any idea how to do this at present? Nor can I imagine how to test if electrons are “conscious” at measurement e.g by somehow “anesthetizing” them. Despite the incapacity to now test these conclusions, I will assume that electrons do decide and are conscious of their decision at measurement, again if measurement is real. Of course these postulate a form of panpsychism - measurement anywhere in the universe is always associated with a doing, ie deciding, and with conscious experience. On this ground, consciousness is not an emergent property of biological evolution, but like mass and momentum, used by evolution for further reasons I mention next. But a possible further virtue of the assumption that electrons are conscious and decide responsibly at measurement is that it may just provide a solution to the Quantum Enigma, discussed below, bearing on human responsible free will and consciousness, in a way that could unify free will and consciousness from quantum variables like electrons to us.

HUMAN KNOWING BEYOND PROPOSITIONS AND THE LAW OF THE EXCLUDED MIDDLE

In an article, “No entailing laws, but enablement in the evolution of the biosphere” by Giuseppe Long, Mael Montevil, Stuart Kauffman, (20), we hope we prove that we cannot prestate the ever changing phase space of biological functionalities in evolution. As a consequence, we can write and integrate no entailing laws of motion for the becoming of the biosphere, a major negative result if correct. The result states that evolution is not even mathematizable. If so no final theory can entail the becoming of the entire universe of which the biosphere is a part. More we show that we cannot in general, prestate the relevant biological functionalities that arise during evolution in what we call an “adjacent possible”. For example swim bladders unprestably evolved from the lungs of lung fish, (21). Given feathers, flight based on feathers was in the Adjacent Possible of the evolution of the biosphere. In general, we do not know ahead of time the possibilities in the Adjacent Possible in biological or in, e.g. technological,

economic, or scientific evolution. If we do not know what CAN happen, we cannot reason about it. Sufficient reason fails us. Yet we make our way, not knowing what can happen. How?

How? Language evolved from metaphoric language to propositional language. We all use metaphors to orient and act in the world. Art is metaphoric. Now, critically, metaphors are neither true nor false! This may well echo quantum coherent behavior being neither true nor false, ie not following Aristotle's law of the excluded middle. There is evidence that human concept usage has quantum, not classical logic, (22). Further, note that it seems clear that no pre-stated set of true/false propositions can exhaust the meaning of a metaphor.

Now consider the invention of propositional, true false, language. With it comes the possibility of logic and syllogism. "All men are mortal. Socrates is a man. Therefore Socrates is a mortal". From propositions comes also the later emergence of classical physics, where all is logically entailed. Propositional language is thus enabling, compared to metaphors, it enables logic, but at the price of categorizing the world in arbitrary ways.

But if we must live forward in time and often cannot know what can happen, we cannot reason about it with true false propositions, so again how do we do it? One way is with metaphors which are neither true nor false, and cannot be exhausted by any pre-stated set of true false propositions. Wittgenstein's irreducible "language games" hint in the same direction,(23). We live our lives, as he argued, in part by these irreducible language games. But more broadly and deeply is to ask: What is intuition? Is it merely savvy imagination eg of new combinations of the old, a horse with a human head? I think not. We intuit new "wholes", much as W. James worried about new wholes in combinations of his "atoms of consciousness", and and we find "new uses of tools" all the time. My own intuition, is that intuition may be a direct awareness or participation in the Possible, Heisenberg's Potentia(2), my Res potentia, (1), thus, perhaps even without Res potentia, participation in the quantum coherent aspects of our mind-body system. Because we are not conscious of quantum coherence, I will suggest that unconscious mind may be quantum coherent, hence, I hope, 'Potentia' that are ontologically real. If so, intuition arises from the unconscious mind, and only by measurement can the intuition then become conscious, perhaps a new "unity of consciousness whole" via entanglement and measurement, an hypothesis that may be testable someday, if not already in part, (17). Intuition is, then, irrational, neither true nor false. As we will see below, we are almost forced to the suggestion that an unconscious quantum coherent mind carries "information" by aspects of quantum mechanics in the quantum enigma itself, to which I now turn, with my own skepticism and trepidation.

THE QUANTUM ENIGMA.

No one has solved this enigma. I try, not a physicist, below. It is of very deep importance in its own right and also because it seems to depend both upon responsible free will - at least by the physicist choosing the experiment to do - and consciousness in measurement. Thus central issues of mind-body arise here too, free will and consciousness. My hope is to find a possible unifying role for consciousness and responsible free will from electrons and fermions at measurement up to a responsible free will and non-epiphenomenal consciousness in humans. We cannot yet test if electrons really “decide”, but have the hopefully decircularized Strong Free Will theorem to rest on, with the further hypothesis that the electron is conscious at measurement, now untestable.

I BUILD ON THE EXAMPLES IN THE QUANTUM ENIGMA (13).

One electron is prepared as a superposition in two boxes. If we are free willed, and thus counterfactual statements can be real, we can choose to do either to an experiment to look in a box to see if the electron is there, yes or no, or instead, counterfactually, we can choose to do an experiment that allows us to “infer” that the electron is in a superposition in two boxes. We, free willed, choose the question, Nature answers. If our consciousness plays a role in measurement, we and nature jointly “create reality”. We do not experience this interference, we infer it. But if instead we had chosen to “look” in box 1, and we had consciously seen the electron then the electron IS in box 1. Also IF we look in first box and electron is NOT in first box where we look, it IS in the other box, ie finding electron NOT in first box “collapses the wave function” so it IS in second box, despite fact we did not look in second box. Thus, if we have free will, our choice of experiment, and here, our conscious observation of the electron, together with nature’s answer, “creates” reality. Because we only “see” the electron if in box 1, our conscious experience seems to be associated with a Yes measurement answer where the wave function “collapses. We are not conscious of the superposition.

The Enigma requires a responsible free willed choice by the physicist of what experiment to do, and could have chosen otherwise, thus a choice of what question to ask of nature. Free will requires the present could have been different. Free will requires the truth of counterfactuals sometimes. Heisenberg’s Potentia and my Res potentia seem to allow this. So may ontologically indeterminate outcomes of real quantum measurement, without invoking Potentia or Res potentia. The hopefully decircularized Strong Free Will Theorem, gives an ontological, not yet experiential, basis for the physicist’s free will, and thus demonstrates that electrons “DECIDE” to be spin up, but could have decided to be spin down, so the outcome could have been

different. To fit the fact that independently prepared quantum variables with, say, the same 50% probability of up and of down, when measured yield, on average 50% up and 50% down, but they are independent, a reasonable assumption is that the electrons each decide with a preference, 50% up 50% down, hence decide “responsibly”. Hopefully if electrons have experiential responsible free will, so can we humans. On these grounds, the Enigma is real at least in that the physicist CAN choose, and can have chosen otherwise, which experiment to do, hence can play a role in creating reality. But the choice of experiment does alter the answer nature gives, so the entire enigma is “real” if free will is real.

Desidera for a solution to the Enigma:

1. What is/are the roles of consciousness in the enigma?
2. If we are conscious, and add to the strong free will theorem the hypothesis that the electron deciding is aware, conscious, of its decision in measurement, can we find logically consistent possible roles from quantum variables to us for consciousness and responsible free willed doings in answering the Enigma?
3. We do not know what classical world “is”, on the 17 interpretations of QM, now including Res potentia, (1). I want to TRY to use the quantum Zeno effect to obtain, hopefully testably, a “classical enough world” in my try at the Enigma.
4. The quantum Zeno effect, well known, (24), can be induced by repeated measurements of a system “collapsed” to a single quantum state by prior measurement, rapidly enough to trap it in the same state as it slowly, quadratically in time, “flowers” new possibilities. Decoherence, thought of as a measurement by the environment, also induces the Zeno effect,(6, 24).. The Zeno effect stops or slows the propagations of the Schrodinger waves.
5. It cannot be the case that the Quantum Zeno effect stops the evolution of the Schrodinger equation always and everywhere. QED works and radioactive decay has a exponential half life, due to Poisson in time quantum transitions.
6. Below I discuss quantum variables capable of multiple states which can be co-trapped by cross measurement and induction of the Zeno effect. I believe all I really need is co-trapping by cross measurement that can induce the Zeno effect.
7. I want to stress the real distinction between quantum measurements which do not and which do create stable structures, stable to different extents. In QED, the world consisting only of electrons and photons absorbed and emitted by electrons, NO STABLE structures emerge.

8. I will say with many physicists that measurements include an electron absorbing or emitting a photon. Then QED measurements themselves creates no stable structures. Why?
9. But a single photon hitting the silver halide screen in the two slit experiment creates, after development, a stable spot that remains in place for years. So quantum measurement, i.e. the spot, can create a stable structure, called a "record". Thus, there are degrees of stability between QED and spot. Why?
10. Consider a single electron emitting a photon and let that emission be a "responsible doing" and let the single electron consciously "observe itself" emitting the photon, so measuring the emission, so the emission, measured, is an Actual, and obeys the law of the excluded middle. But in this case, there is only one electron and one photon emission, then the electron drops to a different energy level. Thus, there is no rapidly repeated re-emission of the photon from the original excitation state, hence re-measurement, to induce the quantum Zeno effect by an isolated electron. Thus QED continues as formulated as the Schrodinger coherent behavior propagates unitarily. This suggests that there may be something about the density of electron and photons which may interact that can induce the Zeno effect, by some kind of co-measurement, rather as decoherence argues when the environment observes and "measures" the open quantum system(6, 24).
11. I want now to ask how: 1) the density of electrons and photons, or more generally, fermions and bosons they exchange, may affect the onset and degree of a Zeno effect whether by a broad environment, as in decoherence, or with many fewer variables co-measuring one another by electrons/ fermions exchanging photons/bosons, with presumed doings and conscious co-measurements.
12. Consider a thought experiment. Two electrons are very close. Electron 1 is in energy level A, electron 2 is at lower energy B. Electron 1 "decides" to emit a photon of energy A - B, and measures itself in doing so. Electron 1 drops to energy level B. The photon is absorbed by electron 2, which then jumps to energy level A. But electron 2 also, a short time after electron 1 measured itself, hence rapidly, remeasures electron 1, in nearby energy level B. This measurement of electron 1 now in energy state B, Zeno slows the flowering of new waves in electron 1. Now let the two electrons play ping pong, each emitting and the other absorbing a photon of energy A - B. Each time, the measured electron measures itself on "deciding and jumping to the alternative energy state, and a short time later the new energy state of that electron is

remeasured by the other electron, hence “rapidly”, to induce to some extent the Zeno slowing. This thought experiment seems to be the two electron one photon limit of decoherence in general with observation and measurement by the “environment”. The two electrons and one photon co-trap one another to some extent by the Zeno effect.

13. Such co-trapping is testable in completely reflective cavities, where the cavity boundary conditions insure that the electrons have a finite set of states, that reflect electrons and photons. Consider altering the density of electrons, capable of only two, for now, states, and photons. As the density increases, is co-trapping and slowing of the expected Poisson in time jumps between up and down seen and does the slowing increase with density?
14. More generally, such electrons can be in a large number of energy states. In a reflective cavity reflecting electrons and photons, with electrons all prepared, half each in one of two nearby mid-energy states, can co-trapping be observed as above? More, since the electrons have many energy states above and below the two initial mid-energy states, does escape from co-trapping from the two initial energy levels to nearby or other levels occur more slowly than expected, e.g Poisson in time and on the Fermi rule?
15. If the quantum variables are not co-trapped into a relatively few states among many, the quantum Zeno effect cannot have set in. The system stays quantum coherent as in QED with Poisson in time jumps between energy levels. If so, the co-trapping hypothesis is false.
16. The above experiments, if successful, would be consistent, rather like decoherence, with co-observation and a Zeno effect slowing the Schrodinger propagations.
17. Decoherence can approach the classical world arbitrarily, but does not explain measurement itself,(6,25). Both decoherence and the above, perhaps a variant of decoherence, use measurement. There are roles above for responsible free will “deciding” and conscious observing measurement by the quantum variables themselves in approaching the classical world.
18. Nothing above is a stable “structure”, nor is the degree of stability of structures from QED to the spot on the screen clear. Molecules are stable structures in the “spot” in the two slit experiment. There is an enormous body of work on chemical bonds, valence bond theory, atomic structures, Pauli’s exclusion principle, all known. I do not here discuss this vast topic, but ask if co-trapping can be observed in molecules. The co-trapping noted above may be consistent with new testable consequences, in molecules. Such a test might be to prepare

a molecule in a state where half the electrons and protons were in one mid-energy state and the other half in another nearby mid-energy state, then observe if they remain in those two states longer than the Poisson time expectation, hence might be Zeno co-trapped. If the answer is “yes”, then Zeno co-trapping is real and may add to the “classicality” of single molecules up to even more “classicality” in a huge lump of coal, also a single molecule which in addition provides a decoherent observing environment for its protons and electrons and nucleons as well as rotational and vibrational molecular modes.

19. Can “measurement” be by the apparatus without human consciousness? Yes if coal can measure and record. In von Neumann’s, (26), epistemic cut, this places the cut at the macroscopic apparatus, which the lump of coal may be as well. Then the moon exists, as Einstein hoped. On the above ideas, the apparatus can measure and record without human consciousness.
20. von Neumann’s, (26), ultimate “far end” of the epistemic cut is the conscious human observer. A role for the conscious observer is also in Rosenblum and Kuttner’s Quantum Enigma, (13), where WE humans observe the electron in Box 1. But we typically observe the electron in box 1 by a macroscopic measuring device, not by eyesight alone. If we use an apparatus to measure, thus it remains moot if the device itself measures or our consciousness is required. I note that perhaps eyesight alone may suffice: A few photons suffice for a threshold visual response, so the sufficiency of human consciousness in measurement can perhaps be tested, if it is not already established. Smell is now thought to be quantum and may provide a direct test of a conscious versus anesthetized human role in measurement. These might be direct experiments showing human consciousness is sufficient for measurement, if measurement is real. A sometimes sufficiency of human consciousness in measurement is necessary for the full Quantum Enigma as stated to be real. We humans free willed choose the experiment, nature answers and we conscious humans observe and measure via our consciousness so jointly co-create reality. More if we could cleanly demonstrate that human consciousness can be sufficient for measurement, that fact would suggest, but not prove, that electrons exchanging photons ARE conscious to achieve measurement and co-trapping. By the above discussion of co-trapping and the Zeno effect, if confirmed, the lump of coal can measure and keep a record as well. But if we were to show that human consciousness can be sufficient for measurement, we would need to invent another independent mechanism beyond consciousness

by electrons exchanging photons for measurement. In short, if the above, where testable, were confirmed for co-trapping, and human consciousness can be sufficient for measurement, these are real grounds to suppose electrons are conscious in measurement, hence in co-measurement and Zeno co-trapping.

21. What might a role for a conscious human, or other, observer be in measurement? It might be to collapse the total measured system into a single state that then evolves into a small subset of states which then can remain co-trapped by a Zeno effect making and keeping the observed system “more classical” after human transient conscious observation. If the co-trapping experiment above were confirmed this would be supportive of co-trapping, but not yet of a direct role for human consciousness in inducing such co-trapping.
22. The above is still not sufficient. We need to deal with the set of complementary Heisenberg aspects of classical world, such as position/momentum, time/energy etc. But decoherence and “einselection” has been shown to yield a preferred momentum/position basis, (27).
23. Finally, the Poised Realm seems real, new physics abides in the Poised Realm where the Schrodinger equation does not propagate time reversibly because decoherence is a dissipative term, and both decoherence and recoherence can occur. If the Poised Realm proves real, all the above needs to be rethought.

CONCLUSIONS

I have tried to show that we can only have an epiphenomenal mind if we base mind on classical physics. This is due to the causal closure of classical physics. Quantum mechanics and the Poised Realm afford two ways, decoherence and recoherence, and measurement, by which a “quantum mind” can have acausal consequences for “classical” brain and body. The Poised Realm is almost surely real and suggests an entirely new form of “computing system” a Trans Turing System which is quantum, Poised Realm and “classical”. This takes us beyond the Turing machine, a finite state, finite time subset of classical physics, (1). Thus mind can be beyond the Stalemate and more than epiphenomenal, my main point. We are not aware of quantum superpositions but of the “yes” outcomes of measurement. I have suggested on these grounds that conscious experience is associated, testably, with measurements by molecules in the brain, whose post measurement behaviors, say in synapses, affect nearby transmembrane potentials in dendrites, hence axon firings, and then standard neurobiology; and that the shifting attention in our unity of consciousness in anatomically disconnected areas may be obtained via shifting patterns of entanglement among different sets of quantum variables, each set addressed, for example, by widened absorption bands in decoherent quantum variables. Shifting patterns of

decoherence and recoherence among quantum variables then is one way that different sets of quantum variables can be entangled. The entanglement possibility can hopefully be tied to known data from neurobiology on attention. Measurement of entangled variables is ever more highly correlated as the number of variables entangled increases, and could yield shifting Unities of Consciousness experienced as new wholes due to entanglement. None of the discussion of quantum mechanics alone leads to experiential terms. I have based my approaches to conscious experience and doing on the Strong Free Will theorem, and sought to remove its circularity by the non-independence of measurements of entangled quantum degrees of freedom. If this is successful, it establishes only an “ontological” basis, not yet experiential basis, for the free will of the physicist in posing the question to Nature, If this is accepted, then we must take the Strong Free Will Theorem seriously, and in Nature’s answer, the electrons “decide”. But to fit the Born rule for independently prepared, say electrons, we have to suppose that each electron has a free will “preference” to fit the Born probabilities, hence plausibly “decide responsibly”. I then try, with high skepticism, to explore use of the Quantum Zeno effect among fermions such as electrons and protons which “decide” and “are conscious” so measure one another by photon/boson exchange, to obtain a testable view of a classical enough world where a sufficient density of, say electrons and photons can carry out co-measurement that co-traps variables in a subset, perhaps shifting, of their possible energy states, by the Zeno effect and this slows or stops the propagation of the Schrodinger equation in the sense that the co-trapped system remains in a subset of its states. These ideas may be a variant of the well known Decoherence theory. Interest in the Quantum Enigma, a vast topic, is for its own sake, and because it requires responsible free will in which the physicist could have chosen the other experiment, hence a role for counterfactual claims, and probably sometimes a role for human conscious observations as Bohr argued.

While obviously highly speculative, some aspects of these ideas are testable. We are led to the possibility of panpsychism, a conscious and “responsibly deciding” universe by quantum variables upon measurement, and a “knowing” quantum coherent state which is not conscious. Perhaps this all is a version of Wheeler’s Participatory Universe Observing Itself,(28).

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