An Unexpectedly Specific Theory of Consciousness

Terry Bollinger
2023-04-26.16:30 EDT Wed [2023-04-27.16:15, added Kuhn scale discussion, pages 5-7]
https://youtu.be/IhS6ecYZFdQ&lc=UgyLwwBgdrl2k-5EMl94AaABAg.9ooGRr0pIny9ozNovsT9rc

A Comment on the Sabine Hossenfelder YouTube post:
Quantum Computers Could Solve These Problems (Apr 22, 2023)
https://youtu.be/IhS6ecYZFdQ?t=5m33s

@mikewiest5135 on 2023-04-22 Sat

I wonder if the quantum neural network model of eye-tracking a moving target in Behera *et al.* 2005 [1] would be an example along the lines you envision [in your 2023-04-22 reply to my comment on why qubits are a terrible approach to quantum computing] [2]? It is not a conventional algorithm in terms of qubits, but it appears to outperform the classical Kalman filter … dramatically.

@TerryBollinger on 2023-04-22 Sat

@mikewiest5135 thanks, that sounds intriguing! I'll look at the paper and post a comment reasonably soon.

@mikewiest5135 on 2023-04-22 Sat

@TerryBollinger Cool! It's pretty short!

Mike Wiest, thanks. I found the 2005 Behera-Kar-Elitzur paper exceptionally interesting.

The Behera-Kar-Elitzur idea that surprised and interested me most was their hypothesis of a strong correlation between eye saccades and non-linear soliton Schrödinger wave models, with the wave models superposed on and correlated to the data states of conventional neural lattice models. Saccades have always fascinated me. In a recent research program review, I suggested to one research group that saccades might be a visual version of auditory stochastic amplification, in which a small amount of noise to quiet recording increases the audibility of extremely faint sounds.

That made me wonder whether stochastic amplification in auditory neural networks might also have a Schrödinger soliton representation with attractive modeling properties. Instead of fixed locations, auditory solitons might represent recognition of notes or other short, identifiable sound units. A hierarchy of such solitons might form a flexible recognition map up to and beyond words, including abstract concepts. I suspect such a model should be capable of rapid reconfiguration, which might provide a quantum analog to some close-to-chaos models of how quickly human perceptions can change based on new data (the "snap of a twig behind you in a dark forest" effect). And yes, that amounts to a hierarchical quantum-soliton model of cognitive modeling. Interesting.

Another related finding — which I've had no luck tracking down so far — was a new set of research results that correlated compact neural wave patterns to the recognition of objects. Unfortunately, I didn't take enough notes and could not find the group or recall even if it was fMRI or direct probe data, though I think it was the latter. I'll keep looking. That was a fascinating set of results relevant to this soliton modeling idea. My recollection, again fuzzy, is that they were either solitons or compact wave packets.

The Behera-Kar-Elitzur paper is frank in its summary to admitting there is no physical theory for their hypothesis of correlated conventional neural lattices and soliton quantum waves. However, they quote Penrose's decades-old and controversial microtubule approach to quantum mechanics in brains. Rather than rehash ideas that haven't resulted in testable predictions, I think it's better to frame this issue as a challenge. Given that quantum solitons produce compact models with testable correlations to extremely well-known phenomena (saccades), are there any plausible paths in quantum mechanics by which such wave phenomena might arise in warm, chaotic neural networks?

To my genuine surprise at taking up my challenge, using photon (versus qubit) analogies does suggest one surprisingly straightforward path for how Behera-Kar-Elitzur solitons might arise and interact within warm neural networks, which is to replace photons with quasiparticles that quantize the well-known and entirely classical data transfers known to exist between neurons. As long as neural lattice remains highly transparent to such quasiparticles, the same subtle violations of classical space and time constraints seen in single-photon lensing experiments *must* occur for each such quasiparticle.

These violations, which occur for *any* particle or quasiparticle that traverses a transparent medium in a wave-like fashion, are subtle because it is effortless for xyzt-wired brains to translate them into hidden-variable (Bohm) interpretations in which the photons become point-like particles traversing absolute xyzt paths hidden by quantum uncertainty. However, quantum ghost imaging [3][4][5] in warm photon systems shows that such point-first interpretations of photons are not helpful very for explaining how reality works. As [5] notes with simplicity, "A single photon is a kind of non-classic light."

Ghost imaging uses complicated and energetic processes to create correlated (entangled) pairs of photon waves. However, I would suggest a more general, less particle-focused perspective: Every localized detection of a single photon or quasiparticle interacting with a transparent or reflective object becomes entangled with that object. For example, a mirror at a 45° angle diverts the path of a single photon by 90°. However, since a photon contains momentum, the only way this can happen is for the reflected photon to deposit momentum on the mirror as a whole, as with solar sails. This process sounds simple and deterministic until one considers that the photon may have many such paths, none of which become historical and thus irreversible until the photon is detected. Until that happens, the details of how the photon deposits its momentum within some reflective or transparently refractive medium remain in a quantum state, including the entire reflective or refractive system. The momentum deposited after detection is minuscule but fully conserved and thus quite real. It becomes noticeable if, as in the case of solar sails, many photons follow the same path.

What the Behera-Kar-Elitzur (BKE) quantum soliton model suggests is intriguing: If a quantum soliton representing the location of an unmoving object collapses, it produces two effects. The first effect is the quantized deposition of the *energy* of the quasiparticle somewhere within the neural region where the soliton resided. The second effect is a broader, region-wide deposition of excruciatingly tiny quantities of momentum related to the final path of the quasiparticle. This deposition of momentum, while amazingly small, does *not* follow the usual rules of space and time but those of entanglement.

I wonder: Could particular neural dendrites, particularly the exceptionally lengthy ones, possibly do more than convey purely classical energy signals? Might they also serve as literal antennas for accumulating and then acting upon the tiny flashes of momentum that occur whenever a BKE soliton collapses? If so, one possibility is that they might help stabilize or even reconstruct the quantum soliton, making it persistent in a way impossible in simpler media. I suspect that such a reconstruction process might also explain how the quantum waves display negative dispersion, that is, how the neural structure encourages them to appear as consolidated, non-dispersive solitons that persist for more extended periods. Unlike conventional quantum waves, these actively consolidated waves would never separate from the medium in which they exist.

I must now bring up an essential deep-physics contrarian view (that would be me) on this bizarre-sounding idea that a warm, random brain might *actively maintain and manipulate* a quantum wave function. Here's the point: *Quantum wave function manipulation is the most fundamental feature of classical reality*. It's *not* some rare item that only occurs under extreme conditions, and that alone makes it more amenable to coexisting with non-extreme systems such as human brains.

When I say "most fundamental," I'm not kidding. Here's the problem: *moderated* wave collapse — by which I mean dramatic but finite-lower-end *rescaling* [6] of the wave function, as opposed to the physically impossible, ultra-classical, full-point collapses of Bohr and Copenhagen ("particle *or* wave") that no lab experiments demonstrate — is the foundation of solid matter physics, since every form of binding is also a momentum exchange in which two entities, e.g., two bonded hydrogen atoms, *observe* each other through that exchange of momentum. We don't notice this because many convenient equations model the observation process as "potentials," which, in turn, are classical physics in disguise. There are no smooth potentials in quantum physics, only sufficiently plentiful low-energy momentum exchanges to give the illusion of smoothness.

When it comes to the relationship between cosmic spacetime and quantum mechanics, we have it all nicely backward: Quantum mechanics doesn't "damage" the perfection of infinitely smooth space and time locations by inserting randomness in the locations of purely point-like particles. Instead, it *approximates* the creation of such indefinitely precise locations by creating finer levels of what we think of as space and time.

(A tangent here, but worth mentioning: Cosmologists need to note that condensed matter physicists have *better* and *more accurate* equations for creating spacetime because they have enough local matter fueling their approximations and create especially precise instantiations of space and time. The implication is that most cosmologists need to talk more to the condensed matter folks and less with other cosmologists. As we think of them, space and time don't even *exist* without mutual observation via binding forces that asymptotically approach the smooth and nearly continuous limits we think of as spacetime. Without condensed matter, you fall into the much weirder distance-squared infrastructure that links causal cosmic events. Also, while speaking of a distance-squared cosmos, there's a reason why Pythagorean squared distances pop up in fundamental physics. The reason goes back to how solid-state matter creates the local coordinate systems we call "frames." All the math theorems that assume infinitely smoothness and infinite differentiability beyond the finite edges of such frames are overgeneralizations of the nicely smooth illusions that ferocious levels of wave function collapse within large chunks of condensed matter provide us.)

Back on the topic of brain physics, the point is this: Dropping the non-physical Copenhagen insistence on "only" perfect particles or "only" perfect waves is a necessary first step if we ever want to understand a lot of currently messy physics in more detail. One such possibility that I find intriguing is high-temperature superconductivity, which may require recognition that there exist ways to create and manipulate bosonic wave functions that the points-first Copenhagen extremum model *cannot* express.

But after reading this paper, I'm now (versus just days ago before reading this paper) seeing consciousness physics as probably an even better case of physics in need of more realistic non-point models of how quantum observation and collapse work. As of this week, I suspect that consciousness is the most sophisticated example of biology implementing large-scale quantum wave function creation and manipulation. That means we can probably learn a lot of new and compelling modeling math by studying it in more detail and a new way of seeing physics, which avoids the needless limiting effects of the Copenhagen-inspired model of treating quantum waves and particles as either-or entities. Here's an example: I would not be surprised if developing a predictive, well-quantified quantum model of consciousness also provides insights into the quantum wave structures underlying high-temperature superconductors. The high-temperature superconductors might even *be* negative-dispersion soliton quantum waves. If this analogy is correct, then the way the brain uses such waves is far more structured and complex than anything folks are getting by accident by mixing and processing complex recipes of inorganic ingredients.

While not fully in xyzt spacetime in terms of their dynamic behaviors, their stabilization by the neural lattice solitons by the neural lattice means they are accessible to traditional scientific experimentation. For example, the usual admonition that human brains can only hold a handful of concepts simultaneously would become a measure of how many top-level BKE solitons the average human neural lattice can maintain in parallel. Short-term memory becomes a hierarchy of BKE solitons — and, arguably, so would consciousness itself. The bits and pieces of such an "active matrix" quantum soliton structure would be familiar entities such as energy and momentum, but the solitons themselves would *not* be entirely classical. From a philosophical perspective, it's an intriguing mix of mundane physics and quantum phenomena that reach, at least a bit, beyond standard concepts of space and time.

The idea that an "Aha!" moment represents the formation of a specific quantum soliton linked with the neural lattice and thus detectable via fMRI or other neural activity detection methods is deeply intriguing.

In Robert Lawrence Kuhn's must-read nine-level taxonomy of most-to-least reductionist consciousness interpretations [7], neural-supported BKE solitons fall solidly into Level 4, *Quantum* Consciousness. However, that ranking is a bit deceptive since I've assumed quantum-emergent spacetime as a given throughout this analysis. By quantum-emergent, I mean a universe in which the mathematical *concept* of three orthogonal dimensions, plus time, does not exist until interactions in a broader model of quantum mechanics cause them to emerge, and even then, only as an asymptotic approximation that applies only within the local observer frame of reference. This model has no universal spacetime, though there *are* universal concepts of separation between events that the local frame reinterprets as local xyzt coordinates. In this broadened definition of the importance of quantum mechanics, saying that consciousness falls on Level 4, Quantum Consciousness, of the Kuhn Consciousness (KC) scale also takes on a significantly broader meaning.

The current KC scale — an update is likely in 2023 — has these levels (arrows are mine):

1. *Physicalism or Materialism*
2. *Epiphenomenalism* ↑ Increasing restriction
3. *Non-reductive Physicalism*
4. ***Quantum Consciousness***
5. *Qualia Force*
6. *Qualia Space*
7. *Panpsychism* ↓ Upward composition
8. *Dualism*
9. *Consciousness as Ultimate Reality*

What changes under a quantum-emerging spacetime interpretation of the KC scale is that Level 4 becomes the balancing point between two effects: *Downward restriction* of quantum possibilities to enable the level of complexity and irreversible dynamics that we think of as the physical universe; and *upward composition* of the lower levels of quantum and physical behaviors to create new emergent behaviors. Notably, the upward quantum composition process has access to *both* the restricted Levels 1 to 3 and the far less constrained Levels 5 to 9. Levels 1 to 3 are givens; Levels 5 to 9 are potentials.

In this restriction-composition interpretation of consciousness, Level 1 *Physicalism or Materialism* is no longer a definition of consciousness but a powerful constraint on the range of options available to any given consciousness. It is the ashes-to-ashes and dust-to-dust constraint, the recognition that breaking out of these levels of quantum reality settings — the universal settings of particle physics, for example, as well as the more fragmented and less universal local settings for space and time — are not available options for a consciousness whose existence *depends* on neural lattices. At the same time, the nature of the imposed limits of Levels 1 to 3 softens since point-like materialism fades into an overly optimistic mathematical fantasy in a quantum-emergent universe.

In the upward or composition direction, KC Levels 5 to 9 become opportunities for Level 4 soliton quantum waves as they interact and compose. Typical concepts of xyzt spacetime do not limit these options. They necessarily extend beyond that framework due to the inherent reliance of the material world on quantum settings that violate ordinary concepts of space and time. For example, every time two particles, primarily electrons, create volume via Pauli exclusion, they can recognize their need to exclude each other only by accessing a singular quantum (Matryoshka) definition encompassing the *entire* physical universe. In that sense, even ordinary volume and the ability of a table to support objects are events whose physics reaches beyond all local definitions of space and time.

Particle physics, however, is an example of a Matryoshka extremum. The fundamental particles are all worst-case scenarios in which the scale distance between the *definition* of the particle and the *instantiation* of local xyz copies of it reaches a maximum. Thus the Matryoshka electron encompasses the entirety of what we think of as spacetime, yet at the other end of the duality, it becomes a mind-numbing number of electron wave packets that typically reside at atomic scales of a tenth of a nanometer.

Not all Matryoshka relations need to be that extreme, and that is where defining the limits of individual consciousness grows blurry. An incredibly mundane-sounding way of explaining the problem is this: Linear momentum is always absolutely conserved yet has *no* lower limit on how finely one can divide it up. That does not sound very interesting until you realize that at the quantum level, linear momentum is *the* quantity that rescales and coordinates quantum wave functions at *every* sale of existence. Linear momentum is one of the two primary substrates — mass being the other — for implementing what, at classical scales, we call information. This conserved linear momentum is *everywhere*, and many forms spread outward at the speed of light.

We approximate this complex spread using thermodynamics, but thermodynamics doesn't work well for describing the quantum aspects of this enormous soup and spectrum of ancient and new information in which we exist. As you read these words, for example, you receive a tiny quantity of information that originated with me. However, that also means you received a tiny bit of linear momentum from me. That kind of transfer is possible since creating action-reaction linear momentum pairs is an incredibly cheap operation in our universe [8]. However, it also means my information has *rescaled*, for lack of a better word, some aspect of your quantum consciousness. You experience such events, ideally, in terms of "understanding" the meaning I sent.

But if the BKE soliton model is experimentally valid, what does your "understanding" mean at the physics level? It means that some minimal information-form linear momentum connected two quantum waves *without* collapsing either wave. That's possible in the BKE model since it presumes that the neural structures on both sides are working very hard and spending substantial energy to prevent such collapses.

So the question becomes this: If two physically distant quantum solitons can exchange even a tiny amount of linear momentum through conventional communications, are they still isolated at the quantum level? Or, as in the more mundane case of classical aperture synthesis radio telescopes, do they retain a level of actual connection? If so, that connection is at least partially outside the local-only xyzt frames of the two participants. The possibility of stable and stably linked remote quantum wave functions becomes at least a point to consider. It becomes at least a possibility that the shared "aha!" moments that teammates sometimes share after exchanging data could, in cases where their BKE structures are already similar, include a quantum component of both sides forming a similar *quantum-linked* soliton that then informs their classical neural lattice of the idea.

Issues such as the impact of minute momentum exchanges between *stable* BKE quantum solitons are why it is not easy to make precise assessments of the higher levels of the KC scale. The universe is full of linear momentum exchanges representing far less extreme examples of Matryoshka dualities than particle physics, in which some pattern has broad but not universal distribution. Two researchers sharing a Eureka moment might be an example of a small-scale Matryoshka duality — a quantum effect enabled by purely conventional information exchanges but sped along by a reinforcing quantum effect.

KC Level 5, *Qualia Force*, is a possible example. Here's a startling possibility: Might the effects many folks call "qualia" be instances of a single large, but not universal, quantum soliton definitions, for example, of the sensation "red"? The implication would be that the red qualia are a Matryoshka duality whose singular, large-scale definition is limited to, perhaps, life on earth but whose small end can exist in any organism that finds this particular BKE soliton useful for faster processing of sensory data.

In short, far from terminating at KC Level 4, quantum consciousness might be the critical *enabler* for constructing and sharing a practical "library" of outside-of-spacetime BKE soliton designs that help organisms process sensory data more effectively.

Finally, if BKE solitons do exist, they would definitively answer several interesting and long-term philosophical questions, such as these three:

Are computers conscious?

The answer would be a solid and emphatic *no*. By design, computers push quantum wave functions as far away as possible.

Is it possible to build a sentient machine with emotions and consciousness?

The answer to this would be an emphatic *yes*. We have no clue how to manipulate quantum reality at that level of precision at this time, but that would change in time.

Might consciousness extend beyond the bounds of individual brains?

This question remains remarkably tricky despite the clear connection between highly structured neural lattices and any potential BKE solitons.

That's because we don't have a realistic mathematical model (yet) of how the underlying distance-squared concept of separation works at various scales, from particles up through cosmic voids. But it does say that all of these levels are somehow connected. Those connections are not easily analyzed using classically inspired (and thus domain-limited) point-like maths. Thomas Hertog's recent book [9] on Hawking's final theory of time takes the rare but essential step of recognizing photons that fields are observers. From that, he intriguingly derives a timeless perspective in which the most widely shared and fundamental bits and pieces of the universe, such as electrons, are reflections of entities that sound suspiciously similar to a universe-spanning stabilized quantum soliton wave functions that "somehow" create correspondingly small images of themselves across space and time.

In my quick review of Hertog's book [10], I coined the Matryoshka duality, a reference to the nested dolls. This duality pairs a well-defined set of quantum numbers and properties (e.g., the electron archetype) that is vast and singular in the sense of existing outside of space and time and thus applying across *all* of space and time, yet simultaneously exists at the tiniest scales in the form of incredibly numerous images — Robert Lawrence Kuhn kindly provided me with an estimate of $\approx 10^{81}$ xyz images in the case of the electron — that differ only in their location in xyzt space. The duality is like a see-saw in which the longest planks give the most extreme dualities, with the entire universe nestled like shells within the dualities that define particle physics. However, shorter planks give dualities that exist only over smaller regions, corresponding to wave functions that managed to stabilize at levels large enough to cover large regions of spacetime without being fully universal. What these would become experimentally is unclear, though the idea that some might be related to dark matter distributions comes to mind as an exciting possibility. Perhaps dark matter isn't particulate but simply an example of wave functions that aren't as adamant about collapsing as we anticipate from point-first models.

Interestingly, BKE solitons would likely be part of this dualities hierarchy since they also represent large-yet-fairly-stable quantum wave functions, possibly at *either* end of such dualities. That makes my head hurt, so I'll leave it for some other time. But it does mean that the existence of such hard-physics phenomena as absolutely identical electrons across space and time makes it risky to assume the universe's internal structure, including whatever physics gives rise to consciousness and awareness, can be teased apart so neatly as any purely reductionist assessment would seem to suggest.

The initial PDF notes I made while reviewing the BKE paper — all predating the description above — are provided below in order of when I made them (not page order). The final note is the most important since it addresses how and whether quantum soliton might coexist and work with biological neural lattices.

T. Bollinger notes on *Quantum Brain: A Recurrent Quantum Neural Network Model to Describe Eye Tracking of Moving Targets*, by L. Behera, I. Kar, and A. C. Elitzur:

"[Our] paper is silent about the exact biological connection between classical and quantum brain since it is unclear to us." [2023-04-24.17:26:15, p. 6, highlighted only]

"Another obvious question is that of decoherence." [17:26:31, p. 6, highlighted only]

"The stochastic filtering of a dc signal using RQNN is 1000 times more accurate than a Kalman filter." [17:27:27, p. 5, highlighted only]

"The idea behind the proposed quantum computing model is as follows. As an individual observes a moving target, the uncertain spatial position of the moving target triggers a

wave packet within the quantum brain. [We hypothesize that the] quantum brain is … this wave packet [that] turns out to be a collective response of a classical neural lattice." [17:28:19, p. 3, highlighted only]

"The other very interesting observation is that the movements of the wave packets while tracking a fixed target are not continuous but discrete." [17:29:18, p. 1, highlighted only]

"According to current research, microtubules, the basic components of the neural cytoskeleton, are very likely to possess quantum mechanical properties due to their size and structure." [17:38:48, p. 1, comment below]

'Very likely' vastly overstates the situation. Penrose's microtubule has been around for decades but still lacks any widely accepted formulation using standard xyzt-first quantum theory. The microtubules are too large, too complex, and too hot to give rise to a coherent state in the first place. Another issue is the lack, to the best of my knowledge, of any proposed mechanism for transferring data between electrical and chemical neural activity and these low-energy, slow-changing structural proteins.

"FIG. 1: Quantum Brain - A Theoretical Model" [19:32:03, p. 2, comment below]

What Figure 1 does, in a nutshell, is link together data from thousands of *classical* neuron activities created by the same stimulation into a *single* quantum wave function, more specifically, a quantum wave whose wave interacts with its surroundings to create negative dispersion, which in turn gives a persistent, non-dispersing wave — a soliton.

This figure makes two assumptions about neural biology and physics, which are:

(1) *Parallel neural activities in a warm neural matrix* can *be quantum-linked.*

The first implication of such a statement is that, in terms of lens-like quantum computing, coherently initiated parallel neural activities retain sufficient coherency to constitute a single wave. There is a biological precedent for this since, in chlorophyll complexes, parallel exciton pathways ensure nearly perfect lens-like photon energy transfers for photosynthesis. Chlorophyll complexes thus provide a potential higher-energy bio model for this type of fiber-based lensing.

Optical fibers with graduated lengths accomplish this type of lensing since they amount to path samples from a single solid lens. The same kind of sampling-of-a-lens coherency applies synthetics aperture radioisotopes in which time-stamped phases of radio signals from multiple radio telescopes provide exquisite resolutions using fiber-like "samples" of vastly larger waves.

In all these cases, the common origin of the parallel paths makes the lens-like integration at the end possible. Postulating that neural paths maintain sufficient coherency to do something similar thus is a pretty reasonable hypothesis.

However — and this is a *big* "however" — this is a *classical* wave analysis so far. Saying that some same-origin, phase-retaining neural paths retain enough coherency to recover their origin via a Fourier transform is *not* the same as saying those paths are quantum-linked. It also does not instantly say that they are *not* quantum-linked. In all of the electromagnetic radiation cases I just mentioned, the pathways *do* remain linked at a quantum level.

The reason that sounds wrong is that folks are accustomed to thinking of photons as actual particles that necessarily travel down one or another fiber. That *can* be true if each fiber explicitly detects the photon and thus destroys its quantum behavior. However, somewhat non-intuitively, that generally does not happen to photons passing through good-quality optical fibers.

The test to tell the difference between classical, per-fiber waves and still-quantum multi-fiber waves is this: For whatever type of energy transmitted, does the lens-like behavior persist when only *one* quantum of energy passes through the network?

This idea of single-quantum coherency testing of any network is a multi-path variant of Feynman's discussion of electrons going through two slits [11]. The principle remains the same in all such cases: If a quantum can pass through the network, leaving *no* information signature that distinguishes one path from another, then *all* quanta passing through the networks remain quantum. That's counter to the usual intuition that bright sources of light, such as lasers traveling multiple paths, are no longer quantum simply *because* they are bright. In the case of bright lights, it instead becomes harder to pull out the relationships of *individual* photons to the overall network.

So what does all of this mean for common-origin waves in parallel neural paths?

It means this: If there exists a quasiparticle — an excitation with small but real energy — that is (a) quantizable and (b) capable of navigating the neural lattice *without* leaving any persistent traces of its passage, then the overall set of excitations remains quantum *even at high power and at room temperature*.

That sounds a bit radical, yet it's standard quantum mechanics. Quasiparticles don't become classical and localized just because there are lots of them. They become classical only if they get irreversibly *detected* along one of those paths.

If such quasiparticles exist, their wave-like behaviors over large networks are outside the usual bounds of xyzt spacetime. The reason is that detecting their final destinations removes all other detection possibilities, thus the possibility of depositing small but measurable linear momentum at those other locations. No local xyzt framework can capture that kind of entangled behavior. Interestingly, it was Einstein's introduction of just this issue that Einstein at the 1927 Solvay meeting that, in time, ended up getting him more-or-less excommunicated from the quantum community he helped found [12].

The historical label for this relocation of a quasiparticle, which occurs partially outside local xyzt constraints, is "wave collapse." The problem with that phrase is that it *assumes* the observer's spacetime to be fundamental. However, special relativity 101 says that's never the case. No matter how mathematically traditional it is to represent a Schrödinger wave using xyzt coordinates, all such representations perform poorly at capturing the extreme observer-independent symmetries of actual Schrödinger waves. Such waves always *originate* from a single xyzt frame, but as they evolve, they become less tied to that set of local-only xyzt constraints. We call the results of that creeping independence "entanglement," but that word fails badly to capture the depth of the problem. Besides energy and other conservation laws, old quantum wave functions don't *care* much about the local-only xyzt framework from which they originated — and the older they get, the less they care. Their world has become more one of unified space and time — distance-squared metrics — that don't generate historical information and so don't need to abide by our annoyingly local-only causality constraints.

Getting back to the proposed quantum waves of this paper, what all of this boils down to is that if you want room-temperature quantum wave functions in a neural lattice, what you need most is a type of quasiparticle for which the neural lattice is *transparent*. I mean that word in the most literal sense, such as glass being transparent to photons. The quasiparticles must pass through a large, likely fibrous neural structure *without* leaving information signatures in any branch except the final destination. That, incidentally, is the same statement as saying the brain must be "transparent" to these quasiparticles. While transparency seems mundane to us due to the many examples we see around us, it is, in fact, one of the more astonishing words in all of quantum mechanics.

Do these quasiparticles exist? I have no idea. If they do, they *must* be a quantized version of the signals that neural researchers always observe. If they exist, that connection makes it easy to name them: *synaptons* for quantized synaptic signals and *actons* for the smallest possible quantized increases in action potentials.

Offhandedly, I don't see any easy way that microtubules would have any connection to this. The requirements are quantization of *known* signal mechanisms plus transparency. That, no kidding, is about it. The trick is whether synaptons and actons exist. That question should be reasonably accessible to experimentation, though more subtlety than using only high-energy, and thus hyper-classical, single, and multiple photon detection methods is needed, except at the start and end.

(2) The neural lattice must have negative dispersion *for the soliton quasiparticles.*

Negative dispersion is the quirky form of refraction that makes wave solitons possible. If you accept the premises of this paper, the addition of negative dispersal to already-transparent neural lattices might well turn out to be *the* difference between low-level sensory processes and the more complex and (quite literally) colorful forms of perception that we associate with consciousness and intuition. Indeed, this paper provides a quite fascinating and persuasive argument that even neural outcomes as mundane as saccades may be nothing more than reflections of how such solitons interact with reality to maintain an efficient internal model of that reality. That's intriguing!

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