

Good and Evil at the Planck Scale

Jill Niemark's *Nexus* interview with Stuart Hameroff

Q: You're an anesthesiologist who's exploring the frontiers of consciousness research. What are the links between the two?

A: In medical school I became interested in consciousness, and thought I'd go into a specialty like neurology or psychiatry, but in 1975 the Chairman of Anesthesiology at the University of Arizona - a renaissance man named Burnell Brown - suggested that to understand consciousness I should study how anesthesia works. It's a tangible physical process acting on an otherwise unmeasurable phenomenon, and the mechanism was, and still is, largely unknown. Anesthesia is tricky and subtle. The right amount of anesthesia erases consciousness while other brain functions continue. The gas anesthetics are the most interesting because they actually work by very weak, physical, quantum-mechanical interactions. They don't utilize chemical or ionic bonds of any kind, they're not polar molecules, they don't bind to receptors. They can be inert. They're very soluble in lipid environments, so for many years it was assumed that since neural membranes are mostly lipids, gas anesthetics worked by getting into the membranes and impairing their function. But in the 1980's it was realized that anesthetics work directly on proteins which account for the dynamic actions of membranes. Within proteins are specific tiny pockets that are lipid-like and it turned out that anesthetic gas molecules got sucked into these little pockets. Once there the anesthetic molecules didn't form chemical bonds like other drugs, but bound only by very weak quantum forces known as van der Waals forces. One or two anesthetic molecules per protein were enough to do the trick. The question is, why would such very, very weak quantum mechanical forces in such tiny regions of certain proteins have such profound effects? The answer is that proteins normally dance back and forth between different forms and shapes to perform their functions. What controls the normal functions of individual proteins are quantum mechanical forces in these pockets, and what choreographs them all together is quantum coherence. Anesthetics inhibit normally occurring quantum mechanical forces in those pockets within proteins, and so those quantum forces must be important for consciousness itself.

Q: You speculate that there has to be a certain biological complexity in order to actually give rise to genuine consciousness. If I recall, you suggest that consciousness probably arises once we get to the evolutionary complexity of a nematode. That sounds like emergence to me, although your view of emergence is richer and more complex than a simple brain-as-neuronal-network paradigm.

A: The standard answer to how we get consciousness is definitely emergence, that from sufficiently complex computation consciousness emerges. The idea that a critical level of complexity in a hierarchal system gives rise to new novel properties is true, for example wetness

out of water, and hurricanes out of dust and gas molecules. Emergence is a real phenomenon. But there's no equation or prediction for how many neurons interacting in such a way will produce consciousness. Just saying consciousness emerges from complexity is like waving a magic wand and pulling a rabbit out of a hat. Emergence may be part of the story but I think consciousness must be related to something irreducible, or fundamental.

Q: You've suggested that consciousness arises when the quantum wave function collapses in structures in the brain's neurons called microtubules. Are you saying that collapse is an emergent phenomenon?

A: That depends on what type of collapse, or reduction, you're talking about, and few people agree on this. If you have a quantum wave function – a quantum superposition of multiple possibilities for example – which interacts with environment it is said to decohere, a type of collapse. But if a quantum system avoids environmental decoherence, then what? Roger Penrose's idea is that it will eventually reach a specific, objective threshold for collapse, or reduction, thus objective reduction, or OR. This self-collapse or objective reduction is predicted by an equation, actually the Heisenberg uncertainty principle, so it's an emergent property at a predicted level. You have an equation that predicts how and when objective reduction occurs. Roger and I believe OR in microtubules produces a conscious event, and that a sequence of these events is our stream of consciousness. From the indeterminacy principle we can predict, for example, how many microtubules and how many neurons would be involved in conscious events which occur on a time scale matching physiological events known to occur in the brain.

Q: I've come to think of myself as an aspectist, in the tradition of Spinoza. He believed that mind and body were just two aspects of an underlying, absolute reality. How would you classify yourself?

A: I'm a panprotopsychoist—whatever gives rise to consciousness is implicit and inherent and exists everywhere in the universe. It's an irreducible, fundamental feature of the universe like spin or charge. One philosopher who took such a view was Whitehead. He said the precursor of conscious experience is everywhere in the universe, and also that the universe is a process, made up of events rather than things. He viewed consciousness as a sequence of events, occasions of experience, occurring in a wider field of protoconscious experience. Whitehead's occasions of experience are compatible with and perhaps even equivalent to quantum state reductions, for example Roger Penrose's OR events. Here we finally have a connection between philosophy and science. But what's the wider field of protoconscious experience? Roger's OR is based on the idea that quantum superpositions are separations at the most basic level of the universe at the Planck scale. So you ask yourself, what is this basic level? What is the universe made of? Even mass is not fundamental according to Einstein, and atoms are mostly empty space as is most of the universe. So what is the universe made of? This argument has been going on since the Greeks. Is there a background fabric, or just an empty void? In the last few decades there's been a lot of intense work trying to understand the background pattern of the universe. It turns out that

as we go down in scale, well below the size of atoms, things are smooth and featureless until we get to the apparent basement level of the universe known as the Planck scale, some 25 orders of magnitude smaller than atoms. At the Planck scale things get coarse and irregular, with a vast amount of information and energy. How can we describe it? String theory has tried, but others for example Lee Smolin argues for spin networks, based on Roger Penrose's original idea that at this level everything is spin. The universe is made of spiderwebs of spin. I'm oversimplifying it, but the number of possible shapes and edges and spins for each Planck volume, or pixel of reality, is huge, and the number of pixels for example in the volume of our brains is incredibly vast. So the amount of information at the Planck scale is absolutely mind-boggling, and its also nonlocal – that is distributed something like a hologram.

Q: So how do you tie this into panpsychism?

A: Everything – matter, energy - comes from curvatures and other properties originating at the Planck scale. If consciousness has some protoconscious precursor which is fundamental or irreducible it must originate as some sort of pattern at the same basic level of the universe. Philosophers call the raw components of conscious experience qualia. I'm suggesting that qualia are specific patterns or properties at the Planck scale. Why not? They have to exist in some form. If there's something fundamental and irreducible about consciousness or its precursors, as Spinoza and Whitehead said, then they have to exist somewhere.

Q: But you usually don't translate from that level to this one we're living in. There isn't a direct correlation.

A: Ah but there is. That's the beauty of Roger's objective reduction. It's a bridge between the Planck scale and our everyday world, described by one simple equation – the uncertainty principle. Our brains, and our microtubules, make the connection. If our conscious experience is a compilation of fundamental qualia, then we're like a painter with a palette. All the individual colors are on the palette, and the artist takes a little of this, a little of that, and gets a Mona Lisa. So the colors are like the patterns of fundamental spacetime geometry from which our brain processes select particular sets for each conscious moment. And if qualia are fundamental and exist at the Planck scale, then why not Platonic values like truth and beauty, good and evil.

Q: But you can already explain things like ethics, for instance, with Darwinian evolution. You don't need this explanation.

A: Ideas about beauty may change, for various cultural reasons. But I think mathematical truth is constant. But in any case, as Smolin points out even the Planck scale structure of spin networks has a dynamic evolution. So, for instance, though aesthetic values a thousand years ago are different than today, there is still something called mathematical truth.

Q: Then you're a Platonist!

A: I've become one. It makes sense to me.

Q: What about near death experiences? You've said you may have an explanation for them that has to do with the quantum effects in the microtubules.

A: If consciousness is the result of quantum processes in microtubules connecting to processes at the Planck scale, then even if the brain stops working the quantum information could persist and remain coherent for a while because of quantum entanglement. It's possible that the soul could be a particular coherent pattern in fundamental spacetime geometry at the Planck scale. I'd like to think that, anyway. It's sort of reassuring.

Q: How has all this theorizing affected your life?

A: It's enhanced my spiritual nature. I rejected organized religion a long time ago. I like the idea that spirituality and God and consciousness could be part of the universe in a scientific way. I'm not saying we've explained these concepts because the more we learn the more awesome it is. It's very humbling to peel off one layer and find out how much more we don't know. Just consider the vastness at the Planck scale. If you take the sum total of this nonlocal, interconnected information and the idea of Platonic values embedded at the Planck scale, that's pretty consistent with the idea of an omniscient, omnipresent, beneficent being.

Q: So is evil at the Planck scale?

A: Either evil is implicit at the Planck scale along with good, or evil people are wired differently biologically for whatever reason and are influenced in an aberrant way.

Q: You've got a conference coming up this spring that discusses quantum mind.

A: Yes, its called "Quantum Mind 2003: Consciousness, quantum physics and the brain" and it will be held in Tucson March 15-19. Consciousness has played a role in quantum mechanics all the way back to the question of the observer effect. Quantum computing is coming along very rapidly and will bring these ideas to the forefront soon. Information about the conference is at www.consciousness.arizona.edu/quantum-mind2