

# Discovery of quantum vibrations in 'microtubules' corroborates theory of consciousness

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A review and update of a controversial 20-year-old theory of consciousness published in *Physics of Life Reviews* claims that consciousness derives from deeper level, finer scale activities inside brain neurons. The recent discovery of quantum vibrations in "microtubules" inside brain neurons corroborates this theory, according to review authors Stuart Hameroff and Sir Roger Penrose. They suggest that EEG rhythms (brain waves) also derive from deeper level microtubule vibrations, and that from a practical standpoint, treating brain microtubule vibrations could benefit a host of mental, neurological, and cognitive conditions.

The theory, called "orchestrated objective reduction" ('Orch OR'), was first put forward in the mid-1990s by eminent mathematical physicist Sir Roger Penrose, FRS, Mathematical Institute and Wadham College, University of Oxford, and prominent anesthesiologist Stuart Hameroff, MD, Anesthesiology, Psychology and Center for Consciousness Studies, The University of Arizona, Tucson. They suggested that quantum vibrational computations in [microtubules](#) were "orchestrated" ("Orch") by synaptic inputs and memory stored in microtubules, and terminated by Penrose "objective reduction" ('OR'), hence "Orch OR." Microtubules are major components of the cell structural skeleton.

Orch OR was harshly criticized from its inception, as the [brain](#) was considered too "warm, wet, and noisy" for seemingly delicate quantum

processes. However, evidence has now shown warm quantum coherence in plant photosynthesis, bird brain navigation, our sense of smell, and brain microtubules. The recent discovery of warm temperature quantum vibrations in microtubules inside [brain neurons](#) by the research group led by Anirban Bandyopadhyay, PhD, at the National Institute of Material Sciences in Tsukuba, Japan (and now at MIT), corroborates the pair's theory and suggests that EEG rhythms also derive from deeper level microtubule vibrations. In addition, work from the laboratory of Roderick G. Eckenhoff, MD, at the University of Pennsylvania, suggests that anesthesia, which selectively erases [consciousness](#) while sparing non-conscious brain activities, acts via microtubules in brain neurons.

"The origin of consciousness reflects our place in the universe, the nature of our existence. Did consciousness evolve from complex computations among brain neurons, as most scientists assert? Or has consciousness, in some sense, been here all along, as spiritual approaches maintain?" ask Hameroff and Penrose in the current review. "This opens a potential Pandora's Box, but our theory accommodates both these views, suggesting consciousness derives from quantum vibrations in microtubules, protein polymers inside brain neurons, which both govern neuronal and synaptic function, and connect brain processes to self-organizing processes in the fine scale, 'proto-conscious' quantum structure of reality."

After 20 years of skeptical criticism, "the evidence now clearly supports Orch OR," continue Hameroff and Penrose. "Our new paper updates the evidence, clarifies Orch OR quantum bits, or "qubits," as helical pathways in microtubule lattices, rebuts critics, and reviews 20 testable predictions of Orch OR published in 1998 – of these, six are confirmed and none refuted."

An important new facet of the theory is introduced. Microtubule quantum vibrations (e.g. in megahertz) appear to interfere and produce

much slower EEG "beat frequencies." Despite a century of clinical use, the underlying origins of EEG rhythms have remained a mystery. Clinical trials of brief brain stimulation aimed at microtubule resonances with megahertz mechanical vibrations using transcranial ultrasound have shown reported improvements in mood, and may prove useful against Alzheimer's disease and brain injury in the future.

Lead author Stuart Hameroff concludes, "Orch OR is the most rigorous, comprehensive and successfully-tested theory of consciousness ever put forth. From a practical standpoint, treating brain microtubule vibrations could benefit a host of mental, neurological, and cognitive conditions."

The review is accompanied by eight commentaries from outside authorities, including an Australian group of Orch OR arch-skeptics. To all, Hameroff and Penrose respond robustly.

Penrose, Hameroff and Bandyopadhyay will explore their theories during a session on "Microtubules and the Big Consciousness Debate" at the Brainstorm Sessions, a public three-day event at the Brakke Grond in Amsterdam, the Netherlands, January 16-18, 2014. They will engage skeptics in a debate on the nature of consciousness, and Bandyopadhyay and his team will couple microtubule vibrations from active neurons to play Indian musical instruments. "Consciousness depends on anharmonic vibrations of microtubules inside neurons, similar to certain kinds of Indian music, but unlike Western music which is harmonic," Hameroff explains.

**More information:** "Consciousness in the universe: A review of the 'Orch OR' theory," by Stuart Hameroff, MD, and Roger Penrose, FRS. [dx.doi.org/10.1016/j.pprev.2013.08.002](http://dx.doi.org/10.1016/j.pprev.2013.08.002)

Commentaries on the review are:

"Reply to criticism of the 'Orch OR qubit'—'Orchestrated objective reduction' is scientifically justified," by Stuart Hameroff, MD, and Roger Penrose, FRS; [dx.doi.org/10.1016/j.pprev.2013.11.00](https://doi.org/10.1016/j.pprev.2013.11.00)

"Reply to seven commentaries on "Consciousness in the universe: Review of the 'Orch OR' theory," by Stuart Hameroff, MD, and Roger Penrose, FRS. [dx.doi.org/10.1016/j.pprev.2013.08.002](https://doi.org/10.1016/j.pprev.2013.08.002)

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