

# Explaining the Brain Function with Quantum Effects



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## 1. Quantum brain as a new approach

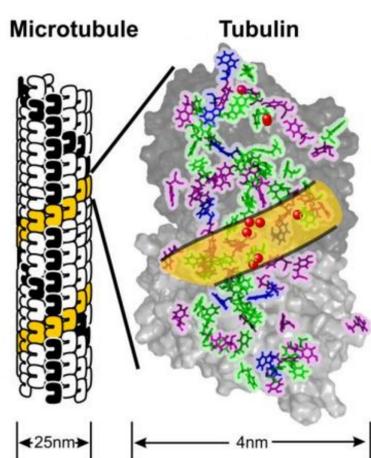
The problem of how the brain works and produces consciousness, remains one of the greatest challenges in the science world. Classical physics explains this by linking synapses of different neurons. Although this approach is widely accepted, it alone is unable to explain some phenomena, such as consciousness in single-celled organisms like *paramecium*. With the advent of quantum mechanics, the quantum approach to the brain gave rise to new theories that one of the most important of which is the theory of 'orchestrated objective reduction' ('Orch OR'). According to this theory, quantum phenomena such as entanglement and superposition may play an important role in describing brain function and explaining consciousness.

## 2. Orchestrated objective reduction model

The Orch OR model is the result of the collaboration of theoretical physicists (Roger Penrose) and anesthesiologist (Stuart Hameroff). Penrose argued from Goedel's theorem that conscious understanding required some feature outside the brain's classical computational system, or any classical computer, then Hameroff came up with the idea in a study of anesthesia and neurons. he had concluded that microtubules could organize, or "orchestrate" information at a very fine scale in biology to act as each cell's nervous system or "on-board computer." he suggested to Roger that microtubules may be the quantum computer he needed to organize, or orchestrate OR events in the brain.

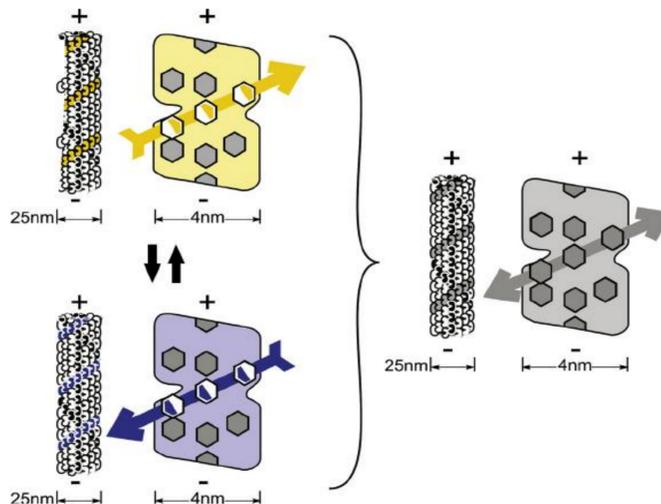
## 3. Quantum channels in microtubules

'Quantum mobility' in microtubules has been proposed to mediate consciousness. Through molecular modeling it has shown: a) non-polar, hydrophobic quantum mobility pathways ('quantum channels') of tryptophan rings in tubulin, b) binding of anesthetic gas molecules in these channels, c) capabilities for  $\pi$ -electron resonant energy transfer, or exciton hopping, among tryptophan aromatic rings in quantum channels, similar to photosynthesis protein quantum coherence.



## 4. Microtubules as biological quantum computers

Microtubules inside brain neurons would function as biological quantum computers that qubit has evolved to polarity orientations of collective electron cloud dipole (or spin) states within tubulins. These dipoles are proposed to couple to those in neighboring tubulins along helical pathways in microtubule lattices and exchanging information with neural- and network-level activities like membrane potentials and synaptic plasticity.



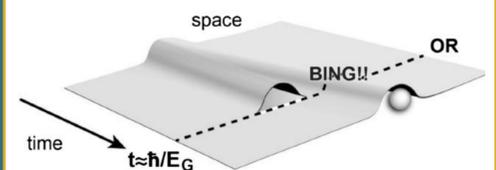
## 5. Objective reduction cause consciousness

The basis of the Orch OR theory is the occurrence of the process of collapse (reduction) of the quantum wave function in neurons. This event is related to the quantum coherence states in tubulin proteins. According to this theory, consciousness arises when a system is adequately organized (here in the tubulin proteins in microtubules) and is able to maintain (isolate) its quantum coherence among its constituents. This system can automatically undergo an orchestrated reduction of the wave function which results in a system (microtubule assemblies in neurons) producing successive reducing waves and eventually creating a cascade of consciousness.

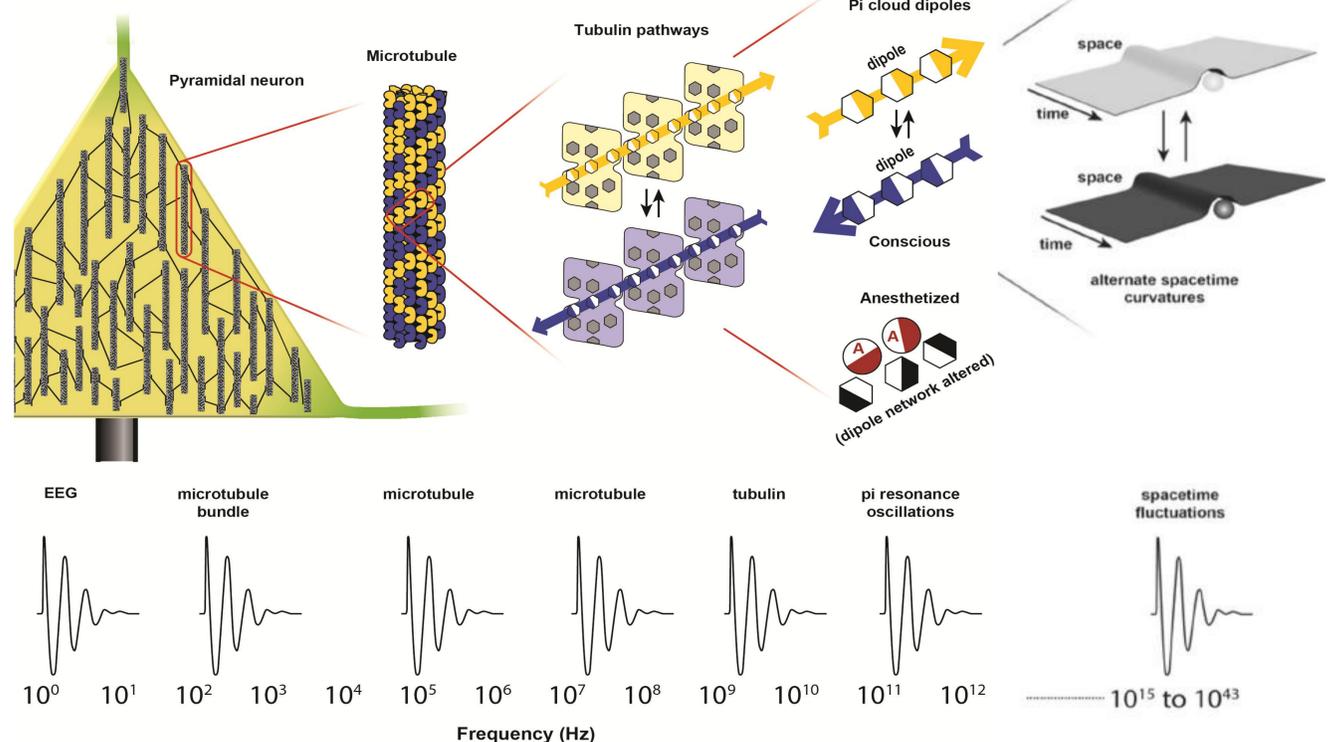
## 6. Particle superposition as alternate curvatures in spacetime geometry

Penrose began by addressing the nature of superposition through Einstein's general relativity in which mass is equivalent to curvature in spacetime geometry, previously considered for large masses. He applied the same principle to quantum particles, considering them as tiny curvatures in spacetime geometry.

### Objective Reduction (OR)



Quantum superposition of a particle in two locations in a 2-dimensional spacetime sheet reaches threshold for Penrose OR at time  $t = h/EG$  at which OR occurs with a moment of (proto-)conscious experience (BING). Collapse causes (or is equivalent to) consciousness. Quantum state reduction occurs due to an objective threshold (objective reduction). An external conscious observer is not necessary, and "multiple worlds" is avoided.



In the Orch OR picture, the brain is organized as a multiscale, fractal-like structural and dynamical hierarchy extending from slower, larger brain-wide networks to smaller, faster quantum vibrations in microtubules inside neurons. Orch OR can occur at any of these frequencies, or resonant combinations, like music can change scale. The hierarchy can extend to even faster, smaller scales in spacetime geometry.

## Conclusion

In our interaction with the outside world, our quantum brain is capable of reproducing equivalent geometry of spacetime by means of 'orchestrated objective reduction' in microtubules and thus 'perception' takes place.

## References

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