Technical Endnotes: How is the quantum state maintained within microtubules?

The Orch OR theory of consciousness proposes that meaningful quantum effects are possible within the "warm, wet and noisy" environment of the brain (conditions which are normally known to cause disruptive decoherence of the quantum state), due to the molecular and atomic structure of the MT's tubulin proteins[4]. The following overview is how quantum states can be sustained within the inherently chaotic environment of the cell:

MT's tubulin proteins are made of non-polar organic carbon rings which assemble together in a helical structure, allowing for protection from surrounding water (oil and water don't mix) and other particles. Their aromatic molecular structure creates polarizable pi-orbital electron clouds, a feature which allows neighboring tubulin proteins to oscillate their electron clouds together as dipoles, due to van der Waals London Dispersion forces - which themselves require quantum mechanics to explain.

This creates a quantum state of coherence between these oscillatory electron clouds; thermal heat has a "pumping" effect on these oscillations, which energetically help maintain the state rather than decohere it - a process originally proposed by the physicist Herbert Frohlich.

As an explanatory mechanism for the interaction between microtubules and anesthesia molecules, Hameroff proposes that anesthetic interaction occurs due to the non-polar anesthesia molecules oscillating through the same London Dispersion forces within tubulin that are responsible for creating the state of quantum coherence[4,16]. After initially becoming coherent with them, they are then "dispersed" due to differences of polarizability between the anesthetic molecules and the tubulin, thus disrupting the quantum state and also consciousness.