

Departments of Physics Colloquium

Coherent Energy Transfer in Microtubule Tryptophan Lattices Coupled to a Noisy Environment

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Friday, September 25, 2015

1:30 – 2:30 PM

Venue: OE 134, MMC



Abstract: Past arguments have stated that biological systems are far too “warm, wet and noisy” to support quantum phenomena mainly due to thermal effects disrupting quantum coherence. However recent experimental results and theoretical analyses have shown that thermal energy may assist, rather than disrupt, quantum coherence, especially in the “dry” hydrophobic interiors of biomolecules. Most prominently, research points to the necessary involvement of quantum coherence and entanglement between uniquely arranged chromophores in light harvesting photosynthetic complexes. Similarly, the protein tubulin, which composes microtubule cytoskeletal filaments, displays a distinct architecture of chromophoric tryptophan amino acids. The arrangement and dipolar properties of these aromatics are comparable to those found in photosynthetic light harvesting complexes suggesting that tubulin may support coherent energy transfer. Tubulin aggregated into the lattice structure of microtubules may thus support quantum coherence, potentially conveying biological signals essential to cellular processes. Here we present evidence of coherent excitation between chromophoric tryptophan amino acids in tubulin via dipole interactions while coupled to a thermal environment. Arguments for the conditions favoring such a quantum mechanism of signal propagation along a microtubule are also provided. Overall, we find that it is feasible that such an arrangement of tryptophan amino acids in tubulin could effectively transfer energy along the microtubule length via a combination of coherent tunneling and incoherent relaxation/excitation.

Biography: Travis Craddock, Ph.D. is an assistant professor of Psychology, Computer Science and Medicine at Nova Southeastern University’s Institute for Neuro-Immune Medicine. Here he serves as Associate Director of the Clinical Systems Biology Group. Where his current research involves applying systems biology and biophysics methods towards the purpose of identifying novel treatments for complex chronic illness involving neuroinflammation.

He received his BSc. in co-op physics from the University of Guelph and went on to finish a M.Sc. and Ph.D. in the field of biophysics at the University of Alberta under the supervision of Jack Tuszynski, Ph.D. His graduate research activities focused on subneural biomolecular information processing, and nanoscale neuroscience descriptions of memory, cognition and cognitive dysfunction in neurodegenerative disorders such as Alzheimer’s disease. His postdoctoral work was conducted under the supervision of Gordon Broderick, Ph.D., in the Broderick Laboratory for Clinical Systems Biology in the Department of Medicine, at the University of Alberta. Here his work focused on using a theory driven systems biology approach to investigate neuroendocrine-immune interaction dynamics in neuroinflammation and its relation complex diseases such as Gulf War Illness, and chronic fatigue syndrome.

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