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Quantum Coherence and Entanglement in Photosythesis

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Abstract:

The initial, light-harvesting step of photosynthesis is known to be exceptionally efficient, transporting absorbed light energy as electronic excitation to the reaction center with near unity efficiency within a few picoseconds. Experiments have revealed that this process shows surprisingly long-lived electronic coherences, prompting speculation that light-harvesting complexes might be robust, evolved quantum processors that operate effectively in a highly decohering environment. I shall present and discuss theoretical studies of the quantum dynamics of a prototypical photosynthetic light harvesting complex, the Fenna-Matthews-Olson (FMO) complex, that analyze the nature and extent of two characteristic features of quantum processors, namely quantum speedup and quantum entanglement, in these biological systems. I shall also address the question of whether such quantum coherence carries a biological advantage.