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Testing quantum speedups in exciton transport through a photosynthetic complex using quantum stochastic walks

Photosynthesis is a highly efficient process, nearly 100 percent of the red photons falling on the surface of leaves reach the reaction center and get transformed into energy. Quantum coherence has been speculated to play a significant role in this very efficient transport process which involves photons transforming to excitons and then traveling to the reaction center. Studies on photosynthetic complexes focus mainly on the Fenna-Matthews-Olson complex obtained from green-sulfur bacteria. However, there has been a debate regarding whether quantum coherence results in any speedup of the exciton transport process. To address this we model exciton transport in FMO using a quantum stochastic walk(QSW) with either pure dephasing or with both dephasing and incoherence. We find that the QSW model with pure dephasing leads to a substantial quantum speedup as compared to a QSW model which includes both dephasing and incoherence.

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