Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Limits of quantum speedup in photosynthetic light harvesting[1]
STEPHAN HOYER, Department of Physics, University of California, Berkeley, MOHAN SAROVAR, BIRGITTA WHALEY, Department of Chemistry, University of California, Berkeley — It has been suggested that excitation transport in photosynthetic light harvesting complexes features speedups analogous to those found in quantum algorithms. Here we compare dynamics in these systems to quantum walks to elucidate the limits of such quantum speedups. For the Fenna-Matthews-Olson (FMO) complex of green sulfur bacteria, we show that while there is indeed speedup at short times, this is short lived (70 fs) despite longer lived (ps) quantum coherence. Remarkably, this time scale is independent of the details of the decoherence model. More generally, we show that the distinguishing features of light-harvesting complexes limit quantum speedup and cause even diffusive transport to be slowed. These results suggest that quantum coherent effects in biological systems are optimized for efficiency and robustness rather than for achieving the more elusive goal of quantum speedup.

[1]This work was supported by DARPA under Award No. N66001-09-1-2026.

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Date submitted: 19 Nov 2009 Electronic form version 1.4