Abstract Submitted
for the DAMOP15 Meeting of
The American Physical Society

The assistance of molecular vibrations on coherent energy transfer in photosynthesis from the view of quantum heat engine ZHEDONG ZHANG, JIN WANG, SUNY Stony Brook — Recently the quantum nature in the energy transport in solar cell and light-harvesting complexes have attracted much attention, by being triggered by the experimental observations. We model the light-harvesting complex (i.e., PEB_{50} dimer) as a quantum heat engine and study the effect of the undamped intra-molecule vibrational modes on the coherent energy transfer and quantum transport. Possibly this system can be artificially simulated by atom-cavity setup. We find that the exciton-vibration interaction has non-trivial contribution to the promotion of quantum yield as well as transport properties of the quantum heat engine at steady state, by enhancing the quantum coherence quantified by entanglement entropy. The perfect quantum yield over 90% has been obtained, assisted by exciton-vibration coupling. We attribute these improvements to the renormalization of the electronic couplings effectively induced by exciton-vibration interaction and the subsequent delocalization of excitons. Finally we demonstrate that the thermal relaxation and dephasing can help the excitation energy transfer in PEB_{50} dimer.

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Date submitted: 29 Jan 2015 Electronic form version 1.4