Abstract Submitted
for the DAMOP15 Meeting of
The American Physical Society

Adiabatic Quantum Search in Open Systems DOMINIK WILD, SARANG GOPALAKRISHNAN, MICHAEL KNAP, Harvard University, NORMAN YAO, UC Berkeley, MIKHAIL LUKIN, Harvard University — We explore the dynamics of an adiabatic quantum search algorithm in an open system in order to identify potential speed-up or slow-down due to the coupling to the environment. We show that even for a very general environment, Grover's scaling of the computation time with the size of the search space remains optimal. In the presence of a bosonic environment, we observe a dynamic phase transition from underdamped to overdamped evolution of the system as a function of the noise spectral density. The phase transition is further reflected by a change of the thermalization rate. For underdamped evolution, the thermalization rate obeys the optimal, quantum-enhanced scaling with the size of the search space, whereas the scaling is classical in the overdamped regime. We provide a physical interpretation of the phase transition in terms of a renormalized tunneling rate and hence show that quantum speed-up is only attainable in the underdamped phase.

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Date submitted: 29 Jan 2015 Electronic form version 1.4