Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

Emergent effective spin models in ion-trap-based quantum simulators[1] CHENG-CHING JOSEPH WANG, Georgetown University, UMD AND JQI COLLABORATION — We show how effective spin models emerge from the interaction of laser light with the ions in a linear Paul trap. It has been shown that quantum Ising models can be studied by adiabatic state evolution in a transverse magnetic field which is ramped from large to small values. The standard proof involves and adiabatic elimination of the phonons in the Lamb-Dicke regime. We discuss here that such an elimination can be problematic due to the inherent entanglement between the spins and the phonons. If the magnetic field is ramped sufficiently fast, one can show that all quantum state probabilities measured along the Ising field axis are independent of the phonons. But if the field is ramped more slowly, then the phonons and spins become entangled. Nevertheless, the main effects are to change the spin entanglement of the quantum states rather than the probabilities of the different states in the wavefunction. We present numerical evidence to illustrate these points.

[1]This work was supported under ARO grant number W911NF0710576 with funds from the DARPA OLE Program.

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Date submitted: 17 Nov 2010 Electronic form version 1.4