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Phonon effects on analog quantum simulation with ultracold ions in a linear Paul trap C.-C. JOSEPH WANG, JAMES FREERICKS, Georgetown University — Linear Paul traps have been used to simulate the transverse field Ising model with long-range spin couplings. Here, we study the effects of phonon creation on the spin state probability and spin entanglement. The effective spin models are created by applying a spin-dependent force with a laser that couples the spin state to the phonons of the ion crystal. Adiabatically removing the phonons creates an action described by a static spin Hamiltonian plus additional quantum time-dependent phases. In appropriate limits, the system is described predominantly by the static spin Hamiltonian. Here, we solve for the evolution of the coupled spin-phonon system exactly using exact diagonalization and examine the effect of phonon creation during the simulation on the probabilities of different spin states and on their entanglement. In particular, we examine phonon effects on the possibility for seeing the kink transition when the laser is detuned between the two phonon modes that lie below the COM mode.

C.-C. Joseph Wang
Georgetown University

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