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Phonons do not harm some ion-trap quantum simulators C.-C. JOSEPH WANG, JAMES FREERICKS, Georgetown University — Ion-trap quantum simulators can be used to simulate simple spin Hamiltonians. In this talk, we focus on applying driving laser fields in the transverse direction, detuned from phonon resonances and in the Lamb-Dicke limit. The interaction of the light with the hyperfine states of the ion can cause the system to feel a spin-dependent force, which, in turn, results in an effective spin-spin coupling of the system, one of the simplest spin Hamiltonians to simulate is the transverse field Ising model. For this Hamiltonian, one can show, via an explicit factorization of the evolution operator for the spin and the phonon degrees of freedom, that the phonons completely decouple from the problem and do not affect the time-dependent dynamics of the spins, even if one moves near resonance with a normal mode of the ion chain. This implies that one need not worry about any decoherence effects arising from the phonons, and it implies that the spin Hamiltonian simulation is less susceptible to noise than previously thought. We also discuss how general these results are when one considers other spin Hamiltonians or when one goes beyond the Lamb-Dicke limit.

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