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Role of spin-motion entanglement in quantum trapped ion simulators[1] ARGHAVAN SAFAVI-NAINI, MICHAEL WALL, JILA, NIST, Univ of Colorado - Boulder, ASIER PIÑEIRO-ORIOLI, ITP, Universität Heidelberg, ANA MARIA REY, JILA, NIST, Univ of Colorado - Boulder — Arrays of trapped ions realize quantum simulators of long-range spin models by coupling the ion spin to the phonon modes of the Coulomb crystal. In addition to spin-spin interactions, the spin-motion coupling may also lead to significant spin-motion entanglement, which degrades the fidelity of the quantum simulator. Here, we present results from two numerical approaches which allow us to simulate the full spin-phonon dynamics for tens to hundreds of ions. The first approach is numerically exact and uses a recently developed variant of the t-DMRG method, while the second approach is is based on the Truncated Wigner Approximation [1,2]. We first benchmark the two methods by studying the dynamics of the spin-phonon model in the absence of a transverse field, where as previously shown, spin-motion entanglement introduces oscillations to various observables, such as spin-spin correlations and spin squeezing [3]. We then present results for the analytically intractable case of a large transverse magnetic field, where we find a more drastic effect of spin-motion entanglement is more drastic.

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