

Abstract Submitted  
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**Phonon mediated quantum spin simulator made from a two-dimensional Wigner crystal in Penning traps**<sup>1</sup> JOSEPH WANG, Theoretical Division, Los Alamos National Lab, ADAM KEITH, University of Colorado at Boulder, J. K. FREERICKS, Georgetown University — Motivated by recent advances in quantum simulations in a Penning trap, we give a theoretical description for the use of two-dimensional cold ions in a rotating trap as a quantum emulator. The collective axial phonon modes and planar modes are studied in detail, including all effects of the rotating frame. We show the character of the phonon modes and spectrum, which is crucial for engineering exotic spin interactions. In the presence of laser-ion coupling with these coherent phonon excitations, we show theoretically how the spin-spin Hamiltonian can be generated. Specifically, we notice certain parameter regimes in which the level of frustration between spins can be engineered by the coupling to the planar modes. This may be relevant to the quantum simulation of spin-glass physics or other disordered problems.

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