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Trapping Ions in an optical lattice for quantum simulation MATT GRAU, CHRISTOPH FISCHER, OLIVER WIPFLI, JONATHAN HOME, ETH Zurich — Quantum many-body spin Hamiltonians are important tools for describing condensed matter systems, but many such Hamiltonians are difficult to simulate on classical computers. Quantum simulation offers an avenue for overcoming these limitations.Arrays of trapped ions are an attractive platform for quantum simulation due to the high level of control combined with the intrinsic long-range Coulomb interaction that can be used to engineer tunable spin-spin couplings. However, varying lattice geometry is challenging with current trapping techniques. We are developing a new apparatus to trap arrays of ions in optical lattices for the purpose of quantum simulation. This should allow trapping two and three-dimensional crystals with a designed geometry. I will present results of simulations of equilibrium positions and normal modes of such a system, which indicate that in a first design arrays of around 40 ions could be trapped with ion-ion distances of under 10 microns, and also with low residual heating rates due to off-resonant scattering and laser fluctuations. By using Magnesium ions, we expect to be able to cool and image the ions while trapped in a deep optical lattice formed by a high finesse optical cavity. Experimental progress towards these goals will be described.

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