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Quantum Simulations with Trapped Ions DANA BERKELAND, DAVID LIZON, GREGORY OGIN, ROBERT SCARLETT, Los Alamos National Laboratory — A quantum simulator is necessary for solving many-body quantum problems that would be intractable using a classical computer, even with advanced numerical techniques. Quantum simulators can solve only a limited set of problems, but building one would represent an important milestone in the road to universal quantum computation. We are using an array of strontium ions confined in a linear rf trap to build a multi-body quantum simulator. In our experiment, each ion simulates a single spin system, while Coulomb and optical forces simulate spin-spin interactions and magnetic fields. This system can simulate the most basic models of condensed matter physics: the Ising model and the XYZ Heisenberg model. We are building more complex ion traps that will let us work with many more ions, and with two-dimensional arrays of ions. Ultimately, these systems will show us how to perform complex simulations in two dimensions, investigate new ordered states of matter, and further develop technology for a universal quantum computer.

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