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Quantum Simulators, Spin Systems, and Trapped Ions W. LYBARGER, Los Alamos National Lab / UCLA, D. BERKELAND, M. BOSHIER, J. CHIAVERINI, D. DALVIT, D. LIZON, W.R. SCARLETT, R. SOMMA, K. VANT, Los Alamos National Lab, M. BLAIN, B. JOKIEL, C. TIGGES, Sandia National Lab — Many quantum spin systems cannot be efficiently simulated on classical computers as they require exponentially large resources. Yet many such systems can be simulated efficiently with quantum simulators (QS) that do not require universal control like quantum computers. Following the work of Porras and Cirac [Phys. Rev. Lett. 92, 207901-1 (2004)] we discuss current theoretical and experimental efforts at Los Alamos to implement a QS for Ising-like and Heisenberg-like models with trapped ion qubit "spins". The states of the QS systems follow nearly the same equations of motion as the systems of interest and, unlike with real materials, the experimenter has the advantage of direct access to and control over the spins. We will discuss proof-of-principle investigations of two ion simulations in a single-well trap, in which we use state-selective optical forces to induce ion-ion interactions. Also we will describe collaborative work with Sandia NL on microfabricated multi-zone traps, suitable for quantum computation, that we will use for more advanced simulations.

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