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Quantum Simulation: Classical Algorithms Versus Analog Simulators[1] JONATHAN MOUSSA, Sandia National Labs — An emerging near-term application for quantum devices is the use of physical qubits without error correction to directly implement many-body Hamiltonians of interest. Such analog quantum simulators may be easier to control and measure than other physical realizations of a Hamiltonian. They have the potential to overcome fundamental limitations of approximate classical algorithms for simulating quantum systems, particularly their real-time dynamics. We compare the behavior of noisy analog quantum simulators operating under several different noise models with several standard classical algorithms including matrix product states. Also, we assess the performance of a new classical algorithm based on approximate state reconstruction through entropy maximization constrained by known expectation values. These tests are based on a finite Heisenberg spin chain both with and without a localizing random field and initialized to either equilibrium, near-equilibrium, or non-equilibrium states. This work was supported by the Laboratory Directed Research and Development program at Sandia National Laboratories.

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