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Efficiency of classical simulations for open-system dynamics of Ising models using quantum trajectories ANUPAM MITRA, AKIMASA MIYAKE, IVAN DEUTSCH, University of New Mexico — Quantum simulation of non-equilibrium dynamics in many-body systems is seen to be a near-term goal for Noisy Intermediate Scale Quantum (NISQ) devices. While closed quantum system unitary dynamics can become intractable due to rapid growth of entanglement, in NISQ devices, noise and decoherence will limit this growth. As such, we expect that there exist levels of noise and dissipation for which we can classically simulate the observed dynamics efficiently. We study this in the context of Ising spin chains in 1D. We employ a matrix product state representation and use the quantum trajectory method to solve the master equation. For sufficient decoherence and noise, we study how a truncation of the bond dimension of the tensors leads to an efficient simulation that is a good approximation to the exact dynamics. We find that the complexity of the state representation decreases for larger decoherence rates, while the complexity of the state representation is preserved for smaller decoherence rates, compared to the energy scales of the Hamiltonians. Finally, we study physical implementations of our models based on neutral atoms and superconducting qubit NISQ devices.

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