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Many-body quench dynamics in trapped-ion quantum simulators[1]

LEI FENG, WEN LIN TAN, ARINJOY DE, HARVEY B. KAPLAN, KATE COLLINS, PATRICK BECKER, ANTONIS KYPRIANIDIS, WILLIAM MORONG, JQI, University of Maryland, GUIDO PAGANO, Rice University, CHRISTOPHER MONROE, JQI, University of Maryland — Trapped-ion quantum simulators are pristine platforms to study out-of-equilibrium many-body systems. We engineer such a simulator embedded with tunable long-range spin-spin interaction using qubits encoded in the hyperfine clock state of $^{171}Yb^{+}$ atomic ions. With precise laser control, long coherence times, and individual single-shot readout capability, we explore the out-of-equilibrium dynamics after a quantum quench in a transverse Ising Hamiltonian. We first investigate the domain-wall confinement effect on the spin dynamics after the sudden quench. We observe that the spreading of correlations is confined since low-energy excitations are bounded to meson-like quasiparticles. We further study how a weakly nonintegrable many-body system thermalizes after a quantum quench by looking at the temporal fluctuations of the spins [1]. Such fluctuations are exponentially suppressed by increasing the system size as a result of many-body dephasing. We also introduce EIT cooling to simultaneously cool many motional modes of a long chain of ions across a large bandwidth, which is particularly useful for low-frequency modes. [1] H. B. Kaplan, et al., arXiv: 2001.02477 (2020).

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