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Prethermalization and Many-body localization (MBL) in trapped ion spins.[1] J. ZHANG, J. SMITH, A. LEE, P. W. HESS, B. NEYENHUIS, JQI, Univ. of Maryland and NIST, P. RICHERME, Dept. of Physics, Indiana University, Bloomington., P. HAUKE, M. HEYL, Institute for Theoretical Physics, University of Innsbruck, Austria, D. A. HUSE, Physics Department, Princeton University, Princeton, NJ, USA, Z.X. GONG, A. GORSHKOV, C. MONROE, JQI, Univ. of Maryland and NIST — We present experimental investigations of quantum thermalization and equilibration dynamics in a precisely controlled, interacting, 171Yb+ spin chain, with up to 25 ions. We quench the trapped ion spins in a quantum many-body Hamiltonian with single-atom addressing techniques and measure the long-term dynamics with single-site resolution. With a long-range XY model spin Hamiltonian, we observe emergence of an exotic prethermal phase in the quench dynamics. This non-trivial prethermal phase arise from an inhomogeneous effective potential landscape, due to a combination of the long-range interactions and the open boundary condition. We also observe the absence of spin transport due to many-body localization (MBL) in the transverse-field Ising model with programmable disorder[1]. We measure the Hamming distance and verify the growth of entanglement through the Quantum Fisher Information (QFI) entanglement witness, consistent with expectations for the MBL state. [1] J. Smith et, al. arXiv: 1512.06172(2015).

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