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Thermalization near integrability in a dipolar quantum Newton's cradle WIL KAO, YIJUN TANG, KUAN-YU LI, SANGWON SEO, Stanford University, KRISHNANAND MALLAYYA, MARCOS RIGOL, Pennsylvania State University, SARANG GOPALAKRISHNAN, CUNY College of Staten Island, BENJAMIN LEV, Stanford University — Isolated quantum many-body systems with integrable dynamics do not thermalize starting from generic initial states. As one perturbs such systems away from integrability, thermalization sets in, but the nature of the crossover from integrable to thermalizing behavior remains unclear. We investigate this problem by studying the dynamics of the momentum distribution in a dipolar quantum Newton's cradle consisting of highly magnetic dysprosium atoms – the first one-dimensional Bose gas with strong, tuneable magnetic dipole-dipole interactions. We provide the first experimental evidence that thermalization close to integrability exhibits a fast dephasing followed by near-exponential thermalization, and the measured thermalization rate is consistent with a parameter-free theoretical estimate. By providing tunability between regimes of integrable and nonintegrable dynamics, our work sheds light on the temporal structure by which isolated quantum many-body systems approach thermalization.

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