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Observation of a dimensional crossover from 1D to 3D gases[1]

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A 1D gas with δ-fn interactions is an integrable many-body system, which means, among other things, that it does not thermalize after it is prepared out of equilibrium. We recently demonstrated this experimentally using a quantum Newton's cradle, an array of out-of-equilibrium 1D Bose gases. When we reduce the depth of the 2D optical lattice that makes the 1D systems, the mapping onto an integrable system is compromised. We see the atoms begin to thermalize, at a rate that depends exponentially on the lattice depth, with no apparent threshold. How energy is shared among dimensions after the system reaches equilibrium also depends on the lattice depth, and varies continuously from all the energy being in one dimension to equipartition of energy among dimensions. We will also describe other experimental handles on integrability. This work was performed with Toshiya Kinoshita and Trevor Wenger.

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