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Microscopy of many-body localization in one dimension JOYCE KWAN, MATTHEW RISPOLI, ROBERT SCHITTKO, SOOSHIN KIM, ALEXANDER LUKIN, JULIAN LEONARD, MARKUS GREINER, Harvard University —
An interacting quantum system that is subject to disorder may cease to thermalize due to localization of its constituents, thereby marking the breakdown of thermodynamics. We realize such a many-body-localized system in a disordered Bose-Hubbard chain and present studies of its microscopic properties. At strong disorder, we observe that the particles become localized, suppressing transport and preventing the thermalization of subsystems. We measure the development of non-local quantum correlations, whose evolution is consistent with a logarithmic growth of entanglement entropy [1]. At intermediate disorder, we find that the system exhibits critical properties, such as sub-diffusive transport and system-size dependent thermalization. We provide evidence that these dynamics are driven by a network-like structure, which persists in multi-point correlations of high order, and thereby identify the many-body nature of the critical regime [2]. Finally, we study the influence of a thermal bath on many-body localization by connecting the system to a disorder-free region.
[1] A. Lukin et al., arXiv: 1805.09819 [2] M. Rispoli et al., arXiv: 1812.06959

Julian Leonard
Harvard University

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