

Many-body localization and quantum ergodicity in disordered long-range Ising models

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<http://arxiv.org/pdf/1410.1491v3.pdf> [2]

Ergodicity in quantum many-body systems is - despite its fundamental importance - still an open problem. Many-body localization provides a general framework for quantum ergodicity, and may therefore offer important insights. However, the characterization of many-body localization through simple observables is a difficult task. In this article, we introduce a measure for distances in Hilbert space for spin-1/2 systems that can be interpreted as a generalization of the Anderson localization length to the many-body Hilbert space. We show that this many-body localization length is equivalent to a simple local observable in real space, which can be measured in experiments of superconducting qubits, polar molecules, Rydberg atoms, and trapped ions. Using the many-body localization length and a necessary criterion for ergodicity that it provides, we study many-body localization and quantum ergodicity in power-law-interacting Ising models subject to disorder in the transverse field. Based on the nonequilibrium dynamical renormalization group, numerically exact diagonalization, and an analysis of the statistics of resonances we find a many-body localized phase at infinite temperature for small power-law exponents. Within the applicability of these methods, we find no indications of a delocalization transition.

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- [12. SIMULATIONS](#) [4]
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