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Local ergotropy dynamically witnesses many-body localized phases

Anderson localization (AL) and Many-Body localization (MBL) are dynamical phenomena in which the quantum system fails to dynamically achieve the thermodynamical equilibrium. It is known in literature that, for a quantum spin chain bipartite into two halves, entanglement entropy trend over time serves as characterization for the different phases, that is AL, MBL, and ergodic one. Previous works have shown the possibility of distinguishing the phases via thermodynamic quantities that relied on global observables. This process needs an energy price to switch-off the interactions between the subsystem and the rest, which acts as an environment. The aim of the research is to demonstrate that local ergotropy, the maximum extractable work via local unitary operations on a small subsystem, is also a dynamical signature for localization phenomena without turning off any Hamiltonian coupling. In particular, the one-dimensional disordered XXZ Heisenberg model is analysed via extended numerical simulations. Taking two two spins as subsystem, it is showed that local ergotropy time behaviour clearly varies distinguishing MBL and ergodic phases. One of the fundamental consequences of our results is that an experimenter can have access to a quantum thermodynamical marker for dynamical phenomena, such as localization ones, without the need local observables, like the entanglement entropy, but only via local measures of extracted work

Theme

Theme 1. Energy advantage and cost of quantum technology

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