Prethermalisation and thermalisation in long-range quantum spin systems

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Recent studies of isolated quantum systems have led to an improved understanding of conditions necessary and/or sufficient for thermalisation to occur (see [1] and references therein). Less is known about the time scales on which thermalisation takes place. Here, analytic results on the relevant time scales are reported for long-range interacting Ising systems on one-, two-, and three-dimensional lattices [2]. The results have applications to experiments on ultrcold polar molecules, and the are presently used for refined benchmarking of trapped-ion quantum simulators.

Different to the exponential relaxation of expectation values known from the nearest-neighbour Ising chain, we find stretched or compressed exponential decay in time towards the corresponding equilibrium values. For sufficiently long-ranged interactions, a wide separation of time scales occurs, leading to pronounced prethermalisation plateaus of correlation functions prior to their relaxation to equilibrium. We discuss the implications of these findings for trapped-ion quantum simulation [4].

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