Effective theories in quantum dynamics: the Kibble-Zurek mechanism

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Slow quenches of the magnetic field across the paramagnetic-ferromagnetic phase transition of spin systems produce heat. In systems with short-range interactions the heat exhibits universal power-law scaling as a function of the quench rate, known as Kibble-Zurek scaling. However, the conventional scaling for the surface energy of topological defects is disrupted in long-range systems due to the influence of nonlocal effects. To investigate this, we focus on the strong long-range quantum Ising model as a concrete example. By constructing an exactly solvable low-energy theory we make an analytic prediction for the "scaling" of the heat arising after a quasi-static drive, showing perfect agreement with numerical observations obtained by exact diagolanization.