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Constrained dynamics in the 2D quantum Ising model

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The quantum Ising model on a square lattice exhibits an emergent dynamical constraint: in the ordered phase, the dynamics approximately conserve the total length of the domain walls. We numerically investigate the dynamics in the crossover from the constrained to the diffusive regime on lattices of up to 16×16 spins. The dynamical constraint, and the subsequent fragmentation of the Hilbert space lead to anomalously long thermalization times. Within the prethermal regime, we find confined elementary excitations, slow growth of entanglement, and suppression of the light-cone correlation spread. We probe the dynamics of interfaces through sudden quenches of product states with domains of opposite magnetization. This allows us to identify and understand dominant microscopic processes; resonant edge modes which originate at the corners and freely propagate along flat interfaces. Given that it occurs in a very general setup, the discussed phenomena plays an important role in various fields of research, from the physics of confinement, quantum coarsening and roughening transitions, to the nucleation of false vacuum bubbles.

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