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Dynamical relaxation behaviors of a critical quench

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We study the universal dynamical relaxation behaviors of a quantum XY chain following a quench, paying special attention to the case in which the initial state is a critical ground state, or the postquenched Hamiltonian is at a critical point of equilibrium quantum phase transition, or both of them are critical. In such a “critical quench,” we find very interesting real-time dynamical scaling behaviors and we find crossover phenomena between them.For a quench from a noncritical point to a critical point, we find that, compared to the noncritical quench,the universal power-law scaling behavior does not change; however, there may be a crossover between theexponential decaying behavior and the power-law scaling. For a quench from a critical point to a noncritical point, the power-law scaling behaviors $t^{-3/2}$ and $t^{-3/4}$ in the noncritical quenches may be changed to t^{-1} and $t^{-1/2}$, respectively. If the prequenched Hamiltonian is set to be a point that is close to but not exactly at a critical point, we find interesting crossover phenomena between different power-law scaling behaviors. We also study the quench from the vicinity of a multicritical point, we find crossover behaviors that are induced by a different mechanism, and we find another crossover exponent. All the results are related to the gap-closing properties of the energy spectrum of the critical points.

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