Phenomenology of first order dark state phase transitions

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Abstract

Non-equilibrium dynamics featuring a fluctuationless (dark) state recently gained a lot of attraction since their implementation in the context of driven-open quantum systems represents a viable possibility to engineer unique, pure states. We consider driven many-body spin systems in the vicinity of a discontinuous jump from a dark steady state to a fluctuating steady state as a function of the driving strength. The very existence of a dark state configuration in these systems guarantees the genuine nonequilibrium character of the phase transition. We analyze the relevant long wavelength fluctuations driving this transition by means of the functional renormalization group and benchmark our results with Langevin simulations. This allows us to identify similarities and clear differences to common, equilibrium phase transitions, and to establish the phenomenology for a first order dark state phase transition.

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