Quantum phase transition with dissipative frustration

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We study the quantum phase transition of the one-dimensional phase model in the presence of dissipative frustration, provided by an interaction of the system with the environment through two noncommuting operators. Such a model can be realized in Josephson junction chains with shunt resistances and resistances between the chain and the ground. Using a self-consistent harmonic approximation, we determine the phase diagram at zero temperature which exhibits a quantum phase transition between an ordered phase, corresponding to the superconducting state, and a disordered phase, corresponding to the insulating state with localized superconducting charge. Interestingly, we find that the critical line separating the two phases has a nonmonotonic behavior as a function of the dissipative coupling strength. This result is a consequence of the frustration between (i) one dissipative coupling that quenches the quantum phase fluctuations favoring the ordered phase and (ii) one that quenches the quantum momentum (charge) fluctuations leading to a vanishing phase coherence. Moreover, within the self-consistent harmonic approximation, we analyze the dissipation induced crossover between a first and second order phase transition, showing that quantum frustration increases the range in which the phase transition is second order. The nonmonotonic behavior is reflected also in the purity of the system that quantifies the degree of correlation between the system and the environment, and in the logarithmic negativity as an entanglement measure that encodes the internal quantum correlations in the chain.

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