Decoherence and quantum quench: the relationship with excited state quantum phase transitions

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In this contribution I analyze how and why the phenomena of quantum decoherence [1] and quantum quench [2] are strongly affected by the presence of an excited state quantum phase transition (ESQPT) in the system under study. In the case of quantum decoherence I consider a single qubit that interacts with a two-level boson system with a critical internal dynamics. This phenomenon can be easily studied using either the Lipkin or the Interacting Boson Model, as well as with other more complex two-level systems. In the case of quantum quench I consider models describing a single-mode bosonic field coupled to a collections of atoms, *e.g.* a $SU(1,1)$ model, the Jaynes-Cummings, and the Dicke model. All these models have been extensively used in quantum optics.

On one hand, I explore how the decoherence process is affected by the presence of a quantum phase transition in the environment [3]. I conclude that the dynamics of the qubit changes dramatically when the environment experiences an ESQPT. On the other hand, I show that the presence of a ESQPT in a quantum optics model affects the quantum relaxation processes following an abrupt quench in the control parameter [4].

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