An approach to environmental effects on quantum spin systems

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In the framework of quantum spin Hamiltonians, describing the exchange interaction between neighboring spins lying on a lattice, the coupling with the underlying lattice is introduced. This gives rise to environmental effects which are experimentally unavoidable and arise from the modifications of the density matrix due to heat transfer between spin excitations and phonon degrees of freedom. By means of the Caldeira-Leggett scheme [2,3] it is possible to evaluate such effects through the analysis of the associated influence action, obtained after tracing-out the lattice degrees of freedom, so that the corresponding path integral can be evaluated within the pure-quantum self-consistent harmonic approximation (PQSCHA) [3]. As the main spin-lattice coupling mechanism consists in the dependence of the exchange parameter upon the distance of vibrating ions, the influence action turns out to be quartic and requires a generalization of the PQSCHA. Extended phase diagrams accounting for the environmental interaction can thus be derived.

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