Nonequilibrium correlations in open quantum dynamics

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We study the memory effects and nonequilibrium correlations in open quantum systems, which was initiated recently in papers [1,2]. The nonequilibrium statistical operator method [3] was used to derive the non-Markovian master equation for an open quantum system, taking into account memory effects and the evolution of an additional "relevant" variable—the mean interaction energy of the composite system (the open quantum system plus its environment). This approach allows one to describe systematically the long-living nonequilibrium correlations associated with the total energy conservation. However, the price paid for this possibility is the need to solve the system of coupled evolution equations for the statistical operator of the open system and the additional nonequilibrium state parameters.

Our main concern is the time behaviour of the so-called quasi-temperature, which is a parameter conjugated to the mean interaction energy [1]. We derive the evolution equation for the quasi-temperature which has the form of the generalized thermodynamic relation envolving the generalized heat capacity [2]. Its right-hand side is nothing but the derivative of the total kinetic energy of the composite system.

Using this approach, we derive the system of kinetic equations for the generelized coherence in the dephasing model (which is known to be an exactly solvable one [4]) up to the second order in interaction taking into account the dynamical correlations in the "q-bit+environment" system.

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