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Spin-boson description of the temporal behavior of the dynamical system with time-dependent coupling to the environment

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This work shows how a kinetic process is formed in a dynamic system that is in a non-stationary coupling with the environment. It is assumed that the environment has a large number of degrees of freedom and therefore transitions in a dynamic system do not change the state of the environment. However, due to the openness of a dynamic system, the environment is capable of modifying both the states of the system and its energy levels. We are considering a quantum dynamic system, where the exchange of energy between the system and the environment is carried out through vibrational quanta (phonons). Using the method of nonequilibrium statistical mechanics, kinetic equations are obtained that describe the time evolution of the density matrix of a dynamic system under conditions of strong (polaron) coupling with vibrational modes of both the environment and the system. The difference from a similar type of research is that the coupling between the electronic states of the system and its vibration states is assumed to be time-dependent. We proposed a unitary-transformation, which made it possible to take into account this non-stationary coupling directly in the operator responsible for transitions between states of the system. This opened up the possibility of using the perturbation method to derive the master equation for the probabilities of occupying system states. As an example of the application of non-stationary polaron transformation, the kinetics of establishing the probabilities of occupation of electronic states of an open TLS is considered.

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