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Non-Markovian finite-temperature two-time correlation functions of system operators of a quantum Brownian motion model PO-WEN CHEN, YU-AN TASI, HSI-SHENG GOAN, Department of Physics, National Taiwan University, NTU TEAM — We evaluate the non-Markovian two-time correlations (CF's) of system operators of a quantum Brownian motion (QBM) model in two different ways, one by the exactly solvable Heisenberg equation of motion through fluctuation-dissipation theorem and the other by the projection operator technique through the perturbative time-convolutionless non-Markovian effective master equation. In Markovian case, a famous procedure to compute two-time CF's of system operators in open quantum systems is the quantum regression theorem (QRT). However, the QRT is not valid or needs corrections in the non-Markoian domain even in the weak system-bath coupling regime. The calculated non-Markovian two-time CF's up to fourth order in system-environment coupling strength agree well with those obtained from exact evaluation in the weak and mediate coupling regime, which demonstrates the validity of our derived non-Markovian evolution equations. But, the exact analytical two-time CF's for an Ohmic bath presented in the literature are only for the initial time t2 being in the steady state (t2$\rightarrow \infty$), i.e. at equilibrium. Our evolution equations of the non-Markovian two-time CF's are, however, valid for any initial time t2 For a finite initial time t2, considerable difference in the non-Markovian CF's between the fourth-order system-bath coupling case and its second order counterparts can be observed. These results obtained using our derived non-Markovian evolution equations differ significantly from the Markovian case obtained using the QRT and from the non-Markovian case obtained directly using the QRT.

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