

Nonclassical energy-change distribution as a witness of non-Markovian quantum dynamics

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We address the problem of identifying non-Markovian quantum time evolutions of an open quantum system by only performing measurements of the system's energy. We demonstrate that violations of CP-divisibility are always witnessed by non-positive values of the energy-change Kirkwood-Dirac quasiprobability distribution associated with the system's Hamiltonian, evaluated at consecutive times. The link between non CP-divisibility and non-positivity of the system's energy-change distribution is stronger when the system-environment interactions are energy-preserving. The witness works whenever anomalous energy fluxes, due to non-Markovianity, are realized. Anomalous fluxes are also detected by the non-Markovianity measure built over the quantum mutual information between the states of the open system and of a quantum correlated reference.

[1] M. Pezzutto, A. Corr, G. De Chiara, S. Lorenzo, S. Gherardini, arxiv:2605.26818.

[2] S. Gherardini and G. De Chiara, PRX Quantum 5, 030201 (2024).