

# Simulating Open Quantum Systems with Hamiltonian Ensembles and the Nonclassicality of the Dynamics

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The incoherent dynamical properties of open quantum systems are generically attributed to an ongoing correlation between the system and its environment. Here, we propose a novel way to assess the nature of these system-environment correlations by examining the system dynamics alone. Our approach is based on the possibility or impossibility to simulate open-system dynamics with Hamiltonian ensembles. As we show, such (im)possibility to simulate is closely linked to the system-environment correlations. We thus define the nonclassicality of open-system dynamics in terms of the nonexistence of a Hamiltonian-ensemble simulation. This classifies any nonunital open-system dynamics as nonclassical. We give examples for open-system dynamics that are unital and classical, as well as unital and nonclassical.

[1] H.-B. Chen, C. Gneiting, P.-Y. Lo, Y.-n. Chen, and F. Nori, Phys. Rev. Lett. **120**, 030403 (2018).