Quantum transport and thermodynamics using the hierarchical equations of motion method

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The hierarchical equations of motion (HEOM) formalism is an accurate and efficient approach to simulate the dynamics of open quantum systems [1]. Formulated as a density matrix scheme, it generalizes perturbative quantum master equation methods by including higher-order contributions as well as non-Markovian memory and allows for the systematic convergence of the results. In this talk, applications of the HEOM method are discussed to quantum transport in nanostructures as well as to quantum thermodynamics. This includes the study of charge transport in driven quantum systems with electron-phonon interaction [2]. Furthermore, the principle of minimal dissipation is employed to investigate thermodynamic properties such as work, heat, and entropy production in open quantum systems [3]. In particular, the case of strong system-environment coupling is considered.

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[3] A. Colla and H.-P. Breuer, Phys. Rev. A 105, 052216 (2022).