MASTER EQUATION APPROACH TO TRANSIENT QUANTUM TRANSPORT IN NANOSTRUCTURES

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We present a non-equilibrium quantum transport theory for transient electron dynamics in nanodevices based on exact master equation derived with the path integral method in the fermion coherent-state representation. Applying the exact master equation to nanodevices, we also establish the connection of the reduced density matrix and the transient quantum transport current with the Keldysh nonequilibrium Green functions. The theory enables us to study transient quantum transport in nanostructures with back-reaction effects from the contacts, with non-Markovian dissipation and decoherence being fully taken into account. In applications, we utilize the theory to specific quantum transport systems, a variety of quantum decoherence and quantum transport phenomena involving the non-Markovian memory effect are investigated in both transient and stationary scenarios at arbitrary initial temperatures of the contacts.

[1] P. Y. Yang and W. M. Zhang, Front. Phys. 12(4), 127204 (2017).