

Real-time renormalization group studies of quantum impurity models

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We present the real-time renormalization group (RTRG) approach for a study of time dynamics in quantum impurity models as well of nonequilibrium electron transport through interacting quantum dots. The approach is based on the quantum kinetic equation in the Liouvillian formulation, and uses the Laplace variable as the flow parameter. By means of the RTRG method we analyze the nonequilibrium Kondo model at finite voltage and temperature, and calculate an approximate lineshape of the differential conductance in the whole crossover regime from weak to strong coupling. The results are shown to agree well with exact methods in equilibrium, Fermi-liquid theory, weak-coupling expansions, and recent experiments. In addition, we study relaxation and quench dynamics in the Kondo model as well as in the interacting resonant level and spin-boson models, and discuss universal and nonuniversal features of time evolution in these models.