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Real-Time Dynamics in Quantum Impurity Systems: A Time-dependent Numerical Renormalization Group Approach

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In contrast to equilibrium conditions, the understanding of real-time evolution of many-particle quantum systems is still at its infancy. A novel approach to time dependent non-equilibrium quantum impurity systems is presented. It is based on a combination of Feynman's concept of a reduced density matrix and Wilson's numerical renormalization group. As a first application, the two different time scales for spin- and charge-relaxation processes in ultra-small quantum dots are extracted and results for the ferromagnetic Kondo model are presented. The method is also applied to the Spin-Boson model. I will show the excellent agreement between the TD-NRG and the exact analytical result for the decoherence of a pure quantum state coupled to a subohmic Bosonic bath. I will discuss how dissipation and decoherence arises in our method.