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Functional renormalization group in nonequilbrium:
A new many-body method for the study of transport through quantum wires and quantum dots.

Functional renormalization group (fRG) methods are frequently used techniques to describe the low-energy physics of interacting many-body systems in equilibrium. Recently, fRG has been formulated in real-time, offering the possibility to describe nonequilibrium phenomena. It will be reviewed how fRG can be combined with real-time diagrammatic techniques either based on Liouville-operator methods or the Keldysh formalism. Various possibilities for the choice of the cutoff function are discussed and it is explained that real-time techniques can be combined with a frequency cutoff on the imaginary axis. This offers the possibility for a unified description of equilibrium and nonequilibrium problems. The techniques are applied to the description of transport through quantum dots in the Kondo regime and through quantum wires with Luttinger liquid behaviour. Furthermore it is discussed how the real-time evolution of the reduced density matrix of a strongly correlated quantum dot can be calculated. Two interesting physical phenomena will be adressed: (1) The influence of nonequilbrium induced relaxation and dephasing rates on the RG flow and the development of a systematic microscopic approach to implement these decay rates as cutoff parameters for generic quantum dot models. (2) The investigation of the influence of nonequilibrium distribution functions on power law exponents of the local density of states in Luttinger liquids containing impurities and tunneling barriers to the leads.