Interplay of strong correlation and dissipation in nonequilibrium lattice systems

Jong Han

SUNY at Buffalo, 239 Fronczak Hall, Buffalo, USA

Nonequilibrium in electron lattices driven by a uniform electric field is discussed. Contrary to quantum dot systems, dissipation mechanism and its interplay with many-body interaction are one of the central questions. In nonequilibrium lattice systems, the dissipation cannot be simply taken as an implicit medium of providing thermal steady-state, but should be explicitly included as a part of the time-evolution. We reformulate the nonequilibrium problem by a time-independent Coulomb gauge Hamiltonian. The scattering-state formalism is applied to a tight-binding lattice coupled to fermionic baths. We establish the exact solution to the model, and then incorporate the Hubbard interaction within the dynamical mean-field theory. We present the Dyson equation for inhomogeneous lattice and show that the implementation reproduces the linear response theory accurately. We discuss whether the DC conductivity is renormalized by Hubbard interaction. The linear response theory breaks down much earlier than expected, at the inter-site voltage drop much smaller than the quasi-particle bandwidth, in a stark contrast to the conventional wisdom in Kondo physics of quantum dot models. It is argued that the dominating physics in lattice nonequilibrium is not the field vs quasi-particle energy, but it is rather the Joule heat vs the quasi-particle energy. Furthermore, we show that the destruction of the quasi-particle states is immediately followed by a current saturation phenomenon, which has been observed in nano-device experiments.