Charge and spin transport in strongly correlated one-dimensional quantum systems driven far from equilibrium

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We study the charge conductivity in one-dimensional prototype models of interacting particles, such as the Hubbard and the t-V spinless fermion model, when coupled to some external baths injecting and extracting particles at the boundaries. We show that, if these systems are driven far from equilibrium, a negative differential conductivity regime can arise. The above electronic models can be mapped into Heisenberg-like spin ladders coupled to two magnetic baths, so that charge transport mechanisms are explained in terms of quantum spin transport. The negative differential conductivity is due to oppositely polarized ferromagnetic domains which arise at the edges of the chain, and therefore inhibit spin transport: we propose a qualitative understanding of the phenomenon by analyzing the localization of one-magnon excitations created at the borders of a ferromagnetic region. We also show that negative differential conductivity is stable against breaking of integrability. Numerical simulations of non-equilibrium time evolution have been performed by employing a Monte-Carlo wave function approach and a matrix product operator formalism.

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