Non-equilibrium Luttinger liquids

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We develop [1–3] the bosonization formalism for Luttinger liquids out of equilibrium. It allows us to build a theory of tunneling spectroscopy of interacting electrons in a non-equilibrium quantum wire coupled to reservoirs. The problem is modelled as a Luttinger liquid structure with spatially dependent interaction and with non-equilibrium (in general, different) energy distributions of left- and right-movers. The interaction leads to the renormalization of the tunneling density of states, as well as to the redistribution function of electrons over energies. The energy relaxation is controlled by the plasmon scattering on the boundary between regions with different interaction strength and affects the distribution function of electrons in the wire as well as of those emitted from the interacting regions into electrodes. We further calculate the dephasing which governs the smearing of zero-bias anomalies in the tunneling density of states.

Our general result for the non-equilibrium electron Green function is expressed in terms of functional determinants related (via an analytical continuation) to those arising in the problem of electron counting statistics. The result shows an intrinsic relation of the dephasing and energy redistribution physics in the Luttinger-liquid structures to "fractionalization" of electron-hole excitations (phase pulses) in the tunneling process and at boundaries with non-interacting leads.

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[1] D. B. Gutman, Yuval Gefen, and A. D. Mirlin, Phys. Rev. Lett. 101, 126802 (2008).
[2] D. B. Gutman, Yuval Gefen, and A. D. Mirlin, arXiv:0903.3333.
[3] D. B. Gutman, Yuval Gefen, and A. D. Mirlin, in preparation.