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Duality of Weak and Strong Scatterer in Luttinger Liquid Coupled to Massless Bosons[1] ALEXEY GALDA, Materials Science Division, Argonne National Laboratory, Argonne, IL, IGOR YURKEVICH, Nonlinearity and Complexity Research Group, Aston University, Birmingham, United Kingdom, OLEG YEVTUSHENKO, Ludwig Maximilians University, Arnold Sommerfeld Center and Center for Nano-Science, Munich, Germany, IGOR LERNER, School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom
— We study electronic transport in a Luttinger liquid (LL) with an embedded impurity, which is either a weak scatterer (WS) or a weak link (WL), when interacting electrons are coupled to one-dimensional massless bosons (e.g., acoustic phonons). The additional coupling competes with Coulomb interaction changing scaling exponents of various correlation functions. The impurity strength λ and the tunneling amplitude t in the WS and WL limits scale at low energies ε as: $\lambda(\varepsilon) \sim \lambda_0\, \varepsilon^{\Delta_{\rm ws}-1}$ and $t(\varepsilon) \sim t_0\, \varepsilon^{\Delta_{\rm wl}-1}$, correspondingly. We find that the duality relation between the scaling dimensions established for the standard LL, $\Delta_{\rm ws}\Delta_{\rm wl} = 1$, holds in the presence of the additional coupling for an arbitrary fixed strength of boson scattering from the impurity. As a result, at low temperatures the system remains either an ideal insulator or an ideal metal, regardless of the scattering strength. However, in the case when electron and boson scattering from the impurity are correlated, the system has a rich phase diagram that includes a metal-insulator transition at some intermediate values of the scattering.

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