MAR07-2006-005195

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

Dynamic Response of One-Dimensional Interacting Fermions[1]

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Evaluation of the dynamic structure factor $S(q,\omega)$ of interacting one-dimensional fermions with a nonlinear dispersion relation was posing an interesting problem, which could not be addressed within the Luttinger liquid theory. The recent solution [1] of the problem for spinless fermions uncovered new universal features of the structure factor, originating from the combined effects of the nonlinear dispersion and interactions. The sharp peak, characteristic for the Tomonaga-Luttinger model, broadens up; for a fixed wave vector q, the structure factor becomes finite at arbitrarily large frequency. The main spectral weight, however, is confined to a narrow frequency interval with the width of order $q^2/2m$; here mass m is determined by the curvature of the dispersion relation. At the lower boundary of this interval the structure factor exhibits power-law singularity with exponent depending on the interaction strength and on the wave vector. The origin of the newly found non-analytical behavior of the structure factor is related to the physics of the Fermi-edge singularity. The constructed theory provides a link between this phenomenon, well-known in the context of electron systems, and the anomalies in the response functions of other one-dimensional systems, as there are close similarities between the dynamic responses of fermions, quantum magnets, and interacting bosons.

[1] M. Pustilnik, M. Khodas, A. Kamenev, and L.I. Glazman, Phys. Rev. Lett. **96**, 196405 (2006)

[1] This work is supported by NSF grants DMR02-37296 and DMR-0405212