UNIVERSAL SPECTRAL FUNCTION OF 1D INTERACTING FERMIONS

L.I. Glazman and A. Imambekov

Yale University, New Haven, Connecticut, USA, 06520

One-dimensional quantum fluids are conventionally described within the Luttinger liquid paradigm: as the principal simplification, a generic spectrum of the constituent particles is replaced by a linear one. Here we demosntrate that the nonlinearity of the generic spectrum in fact introduces a new energy scale, $\sim p^2/(2m^*) \ll vp$, into the spectral function $A(p,\omega)$, and changes it near the edge $\omega \approx vp$ drastically. Spectral function $A(p,\omega)$ develops new power-law singularities at energies $\omega \approx \pm vp \pm p^2/(2m^*)$. Remarkably, the corresponding new exponents for short-ranged interactions depend only on the Luttinger liquid parameter K. We also find the universal crossover of $A(p,\omega)$ to the Luttinger liquid theory predictions valid at energies significantly exceeding $p^2/(2m^*)$ away from the edge. The theory developed in this article is applicable not only to fermionic, but also to 1D spin liquids and to bosonic systems. It can be probed in experiments on electron tunneling in nanostructires, magnetic neutron scattering, and in spectroscopy of cold atoms systems.