Single-particle excitations and hetero-pairing effects in an ultracold Fermi gas with mass imbalance

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We theoretically discuss single-particle excitations in an ultracold Fermi gas with mass imbalance. Using an extended $T$-matrix theory[1], which can correctly describe the BCS-BEC crossover physics in the presence of mass imbalance, we clarify how the mass difference affects single-particle properties of this system. Since the Fermi temperature of the light particle component is higher than that of the heavy particle component, for a given temperature, the momentum distribution $n_{pH}$ of the latter component naturally becomes broader than the former case ($n_{pL}$), as shown in Figs.1(a) and (b). As a result, for the light mass component, while the Pauli blocking suppresses particle-particle scatterings when $p \lesssim k_F$ (where $k_F$ is the Fermi momentum), the spectral weight is broadened by the scattering effect when $p \gtrsim k_F$ (Fig.1(c)). For the heavy particle component, on the other hand, since particles deep inside the Fermi level also contribute to scatterings, the spectral width in the low momentum region is found to be broader than that of light particles. In addition, the momentum dependence of the spectral width is weaker than that of the light mass component. (See Fig.1(d).) Since Cooper-pairings between different kinds of fermions have been recently discussed in various research fields, such as $^{40}$K-$^6$Li mixtures, exciton (polariton) condensates, as well as color superconductivity, our results would be useful in understanding these novel Fermi superfluids.