Self-consistent T-matrix approach to an interacting ultracold Fermi gas with mass imbalance

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We investigate the superfluid phase transition in the BCS-BEC crossover regime of an ultracold Fermi gas with mass imbalance. In our previous paper[1], within the framework of an extended T-matrix approximation (ETMA), we showed that the superfluid phase transition temperature $T_{\rm c}$ vanishes in the weak-coupling BCS regime, when the ratio of mass imbalance becomes large to some extent. In our presentation, extending ETMA to include higher order pairing fluctuations within a self-consistent T-matrix level[2], we clarify that $T_{\rm c}$ actually remains finite even in the highly mass-imbalanced case. The key to obtain this finite $T_{\rm c}$ is found to be a consistent treatment of $\mu_{\rm L}$ and $\mu_{\rm H}$ in the gap equation (where $\mu_{\rm L}$ and $\mu_{\rm H}$ are the chemical potentials of the light mass component and heavy mass component, respectively). Using this strong-coupling theory, we also determine the phase diagram of a Fermi gas in terms of temperature, interaction strength, and the ratio of mass imbalance. Since Fermi condensates with mass imbalance have been recently discussed in various systems, such as a ^{40}K-^{6}Li Fermi gas, exciton-polariton condensate, and color superconductivity, our results would be useful in understanding physical properties of these novel Fermi superfluids.

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2. R. Haussmann, Z. Phys. B **91**, 291 (1993).

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