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Quasiparticle Spectrum of Quantum Degenerate Fermi Gas in the Presence of Self-Consistent Magnetization Field

YANG Xiao-Xue[1] and WU Ying[1,2]

[1] Physics Department and State Key Laboratory for Laser Technique, Huazhong University of Science and Technology, Wuhan 430074, China
[2] Wuhan Institute of Physics and Mathematics, the Chinese Academy of Sciences, Wuhan 430071, China
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Abstract: In this paper, we develop a systematic and simple method to derive quasiparticle spectrum of the quantum degenerate Fermi gases within the framework of Hartree-Fock-Bogoliubov theory which turns a general nonlinear two-body interaction Hamiltonian into a bilinear Hamiltonian by introducing certain self-consistent mean fields. Applying the approach, we obtain the quasi-particle spectrum of the model describing the superfluid phase transition that arises when a Feshbach resonance pairing occurs in a dilute Fermi gas in the presence of the magnetization fields $m=U\Sigma_k \langle a_{k\downarrow}{}^{\dagger} a_{k\uparrow}\rangle$ and $m_k=U\Sigma_{k'} \langle a_{k'\downarrow}{}^{\dagger} a_{k'+2k\uparrow}\rangle$. When the gap parameter Δ is smaller than one or both of the magnetization fields, the spectrum manifests roton-type structure dramatically different from the spectrum in the absence of the magnetization fields.

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