Resonant Enhancement of the FFLO State in 3D by an Optical Potential

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In a spin-imbalanced Fermi gas, a competition exists between Cooper-pairing with zero momentum and with finite momentum. The former is the well-known BCS superfluid, while the latter gives rise to the Fulde-Ferrell-Larkin-Ovchinnikov state (FFLO state). This exotic state has hitherto eluded all experimental observation. In this contribution, we propose a new way to stabilize the FFLO state in a three-dimensional (3D) Fermi gas. Our description is based on the Feynman path-integral framework in which we start from the partition sum of an imbalanced Fermi gas. To allow for the formation of the FFLO state, a suitable form for the saddle point is chosen, in which the pairs have a finite center-of-mass momentum. Subsequently, we investigate the effect of imposing an optical potential, applied along one direction, on the 3D Fermi gas. By constructing the phase diagrams of the system, we show that the presence of the optical potential greatly enhances the stability region of the FFLO state, relative to the case of the 3D Fermi gas without optical potential. It is shown that the FFLO state can exist up to a higher level of spin imbalance if the wavelength of the optical potential becomes smaller. We propose that this concept can be used experimentally to resonantly enhance the stability region of the FFLO state[1].

[1]Jeroen P.A. Devreese, Sergei Klimin, and Jacques Tempere, Phys. Rev. A **83**, 013606 (2011).