Superconductivity in an almost localized Fermi liquid of quasiparticles with spin-dependent masses and effective field induced by electron correlations

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We consider first the Cooper-pair bound state and the condensed phase of an almost localized Fermi liquid (ALFL) composed of quasiparticles in a narrow-band with the spin-dependent masses (SDM) and an effective field, both induced by strong electronic correlations. Both of these novel characteristics are calculated in a self-consistent manner for each of the phases separately. We analyze the bound states as a function of Cooper-pair momentum $|Q|$ in applied magnetic field in the strongly Pauli limiting case (i.e. when the orbital effects of applied magnetic field are disregarded). The spin-direction dependence of the effective mass makes the quasiparticles comprising Cooper pair distinguishable in the quantum mechanical sense, while the condensed gas of pairs may still be regarded as composed of identical entities. The Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) condensed state of moving pairs is by far more robust in the applied field for the case with spin-dependent masses than in the situation with equal masses of quasiparticles. Relative stability of the Bardeen-Cooper-Schrieffer (BCS) vs. FFLO phase is analyzed in detail on temperature - applied field plane. We conclude that the spin-dependent masses may play an important role in stabilizing high-field low-temperature (HFLT) unconventional superconducting states (FFLO being an instance) in systems such as CeCoIn$_5$, organic metals and possibly others.