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 $|\mathbf{Q}|$ 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.