On the BCS-BEC crossover

in the Spin-Polarized Attractive Hubbard Model

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We study the evolution of superfluid properties from the weak coupling (BCS like) to the strong coupling limit of tightly bound local pairs (LP) with increasing attraction, at T=0, within the spin-polarized attractive Hubbard model. The analysis is carried out both for the case of a fixed chemical potential and a fixed number of particles. The broken symmetry Hartree approximation is used. For a d=2 square lattice we find no homogeneous polarized superfluid state for the strong attraction and obtain that for two-component Fermi system on a 2D lattice with population imbalance, the phase separation is energetically favorable for a fixed particle concentration, even on the LP (BEC) side. We also investigate the BCS-BEC crossover diagrams in the presence of a Zeeman magnetic field in 3D for a simple cubic lattice. As opposed to the d=2 case, for strong attraction and in the dilute limit, the homogeneous magnetized superconducting phase (MSC) and the tricritical point are found in the (h-μ) and (h-n) diagrams. The MSC phase is a specific superfluid state being a coherent mixture of LP's (hard-core Bosons) and excess of spin-up Fermions. We also analyze the influence of the Hartree term on the BCS-BEC crossover diagrams in magnetic field and show that the presence of such a term restricts the range of the occurrence of the MSC phase.