Stability of Superfluid Phases in the 2D Spin-Polarized Attractive Hubbard Model

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9.7 cm

We study the evolution from the weak coupling (BCS-like limit) to the strong coupling limit of tightly bound local pairs (LP's) with increasing attraction, in the presence of the Zeeman magnetic field (h) for $d = 2$, within the spin-polarized attractive Hubbard model. The broken symmetry Hartree approximation and strong coupling expansion are used. We also apply the Kosterlitz-Thouless (KT) scenario to determine the phase coherence temperatures. For spin independent hopping integrals ($t^{\uparrow} = t^{\downarrow}$), we find no stable homogeneous polarized superfluid (SC_M) state in the ground state for the strong attraction and obtain that for a two-component Fermi system on a 2D lattice with population imbalance, phase separation is favored for a fixed particle concentration, even on the LP (BEC) side. We also examine the influence of spin dependent hopping integrals (mass imbalance) on the stability of the SC_M phase. We find a topological quantum phase transition (Lifshitz type) from the unpolarized superfluid phase (SC_0) to SC_M and tricritical points in the ($h - |U|$) and ($t^{\uparrow}/t^{\downarrow} - |U|$) ground state phase diagrams. We also construct the finite temperature phase diagrams for both $t^{\uparrow} = t^{\downarrow}$ and $t^{\uparrow} \neq t^{\downarrow}$ and analyze the possibility of occurrence of a spin polarized KT superfluid.

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