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

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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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