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The interplay between superconductivity and magnetism in a model of magnetic superconductor with pair hopping

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We present studies of an effective model of magnetic superconductor with short coherence length. The tight binding Hamiltonian consists of (i) the effective on-site interaction U, (ii) the intersite magnetic exchange interactions (J^z, J^{xy}) between nearest-neighbors and (iii) the intersite charge exchange term I, determining the hopping of electron pairs between nearest-neighbor sites.

In the analysis of the phase diagrams and thermodynamic properties of this model we have adopted the variational approach, which treats the on-site interaction term exactly and the intersite interactions within the mean-field approximation. We have also obtained rigorous results for 1D-chain in the ground state. Moreover, at $T = 0$ some results derived within random phase approximation (and spin-wave approximation) for $d = 2$ and $d = 3$ lattices and within the low density expansions for $d = 3$ lattices have been presented.

One finds that the system considered can exhibit very interesting multicritical behaviors caused by the competition between magnetism and superconductivity. Our investigations of the general case (as a function of the electron concentration n and as a function of the chemical potential μ) show that, depending on the values of interaction parameters, the system can exhibit three homogeneous phases: superconducting (SS), (anti-)ferromagnetic (F) and nonordered (NO). The SS-F transition is always discontinuous (for fixed μ), what leads to phase separation on the phase diagrams as a function of n. The homogeneous mixed phase (with nonzero both magnetization and superconducting order parameters) never occurs on phase diagrams. On the contrary several types of phase separated states, such as SS/NO, F/NO and SS/F, are found to be stable in definite ranges of model parameters. Two tricritical lines, connected with a change of the order of transitions: SS-NO and F-NO, are obtained on the diagrams.

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