Properties of extended Hubbard models with anisotropic spin-exchange interaction

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The phase diagrams and electron orderings of the half-filled extended Hubbard models with anisotropic spin-exchange interactions ($J_\perp$, $J_\parallel$) are studied. The cases of ferromagnetic ($J_\alpha<0$) and antiferromagnetic ($J_\alpha>0$) exchange couplings are considered. The analysis of these $t - U - J_\parallel - J_\perp$ models is performed for d-dimensional hypercubic lattices including d=1 and $d=\infty$ by means of the (broken symmetry) HFA supplemented, for $d=\infty$, by the slave-boson mean-field method. Some rigorous results derived for the strong coupling regimes of the models for d=1 and $d=\infty$ are presented. The effects of phase fluctuations on the critical temperatures of the XY orderings for d=2 are also determined within the framework of the Kosterlitz-Thouless (K-T) scenario. The interplay between the on-site interaction U and the intersite exchange interactions can stabilize several new ordered phases, absent in the usual Hubbard model and in the models with U=0. In particular at half-filling and d=1, these phases for the $t - U - J_\parallel$ model ($J_\perp=0$) are: the site-located planar antiferromagnetic (AF_{XY}), the bond located CDW (bCDW) as well as two mixed phases (i) with site and bond located AF_{XY} (AF_{XY} +b AF_{XY}) and (ii) with bAF_{XY} and s-wave superconducivity (bAF_{XY}+SS), whereas for the $t - U - J_\perp$ model ($J_\parallel=0$): the bCDW, the uniaxial antiferromagnetic (AF_z) as well as the mixed phases (i) with bCDW+SS, (ii) with triplet and singlet superconductivity (TS+SS) and (iii) with TS+AF_z. For $d=\infty$ the corresponding diagrams are simpler and consist of the phases involving exclusively site located orderings.

The obtained phase diagrams for d=1 are in good agreement with recent results derived for limiting cases using the continuum-limit approach and the density-matrix renormalization group method.

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