Electron orderings and phase separations in a simple model of magnetic insulators

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A simple effective model for description of magnetically ordered insulators is studied. The tight binding Hamiltonian consists of the effective on-site interaction (U) and intersite magnetic exchange interactions (J^z, J^{xy}) between nearest-neighbors.

The phase diagrams and thermodynamic properties of this model have been determined within the variational approach, which treats the on-site interaction term exactly and the intersite interactions within the mean-field approximation.

We show that, depending on the values of interaction parameters and the electron concentration (n), the system can exhibit not only homogeneous phases: (anti-)ferromagnetic (F) and nonordered (NO), but also phase separated states (PS: F-NO). For a fixed n one finds the following phase transitions (both continuous and discontinuous ones) and sequences of transitions, which can occur with increasing temperature: F→NO, PS→NO, PS→F→NO, PS→F→PS→NO.

We also present some rigorous results concerning the ground state phase diagrams obtained for n=1 and as a function of the chemical potential μ and compare them with the results of the variational approach.