Magnetic and thermal properties of the Ising-Hubbard diamond chain

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The ground state and thermodynamic properties at low temperature of a spin-1/2 Ising-Hubbard diamond chain are studied. Ising-like spins occupy the nodal vertices on the line of the chain and mobile electrons are placed in the lateral interstitial vertices. The constants of Ising interaction on opposite sides of a diamond unit are supposed to be equal, but can be different on neighboring sides.

Using the decoration-iteration transformation and the transfer-matrix method, the exact calculation of temperature and external field dependencies of the free energy, entropy, specific heat, magnetization, and susceptibility is performed. The competition between the Hubbard repulsion and the hopping integral is examined for the ground state. It is shown that the Hubbard repulsion leads only to decreasing of antiferromagnetic correlations between mobile electrons caused by hopping processes. We also study the manifestation of this competition in the specific heat, magnetization, and susceptibility temperature dependencies and in the low-temperature magnetization processes.

In the large-value limit of the hopping integral and Hubbard repulsion (when the ratio of the squared hopping integral and the Hubbard repulsion is finite) the chain is shown to be equivalent to the Ising-Heisenberg diamond chain with the isotropic Heisenberg interaction between spins of localized electrons.