Thermodynamic features of the 1D dilute Ising model in the external magnetic field

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The dilute Ising model is one of the basic models in the theory of magnetic systems with quenched or annealed disorder [1]. Despite the absence of ordering at finite temperatures, one-dimensional spin systems exhibit a number of interesting phenomena such as magnetization plateaus, pseudophases, and pseudo-transitions. Previously, we considered the features of local distributions in our model [2]. In this work we show the behavior of the system in a magnetic field.

We use the $S = 1$ pseudospin formalism to describe our system. For a given lattice site, the states with the pseudospin projections $S_z = \pm 1$ correspond to the two magnetic states with the conventional spin projections $s_z = \pm 1/2$. The state with $S_z = 0$ corresponds to charged nonmagnetic state. The Hamiltonian of the system is

$$H = -J \sum_i S_{z,i} S_{z,i+1} + V \sum_i P_{0,i} P_{0,i+1} - h \sum_i S_{z,i} - \mu \sum_i P_{0,i}, \qquad (1)$$

where $S_{z,i}$ is a z-projection of the on-site pseudospin operator, $P_{0,i} = 1 - S_{z,i}^2$ is the projection operator on $S_z = 0$ state, J is the exchange constant, V is the intersite density-density interaction, h is the external magnetic field, μ is the chemical potential.

We use the transfer-matrix method applied to Hamiltonian (1) to explore the ground state and the evolution of our system with the temperature. We get the dependences of thermodynamic quantities on temperature and concentration of impurities, which allow us to calculate the entropy change in the applied magnetic field. We explore the ground state diagram of the system in the external magnetic field and the magnetic entropy change caused by the frustration in the ground state.

References:

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The reseach was supported by the Government of the Russian Federation, Programm 02.A03.21.0006 and by the Ministry of Education and Science of the Russian Federation, project No FEUZ-2020-0054.