MAGNETIC PROPERTIES OF A BILAYER SYSTEM WITH ANISOTROPIC HEISENBERG INTERACTION

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A magnetic bilayer system with spin $S = 1/2$, the coordination number $z = 5$ and anisotropic Heisenberg ferromagnetic interactions is studied by the cluster variational method in the pair approximation. The anisotropy parameter defined as $J^{x,y}/J^z$ ratio varies from zero value, which is characteristic for the pure Ising model, until unity - corresponding to the isotropic Heisenberg interactions. The complete and self-consistent thermodynamic description based on the Gibbs free-energy expression is given. All relevant thermodynamic properties such as spontaneous magnetization, pair correlation function (both quantum and classical), entropy, isothermal susceptibility and magnetic specific heat are calculated. The influence of anisotropy on all the thermal characteristics is discussed. In particular, the analytical expression for the phase transition temperature vs. anisotropy is obtained, and the numerical calculations are compared with those for $2D$ and $3D$ systems. It is shown how the Curie temperature increases when the anisotropy parameter decreases from unity to zero value. It is also found that the Gibbs energy at absolute zero temperature does not depend on the anisotropy parameter. However, for the isotropic Heisenberg interactions at $T = 0$ the residual entropy remains, which reduces the spontaneous magnetization. In such a case, the possibility of occurrence of quantum phase transition is predicted.

9.7 cm

13.4 cm

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