Linear Perturbation Renormalization Group method for Ising-like spin systems

J. Sznajd

Institute for Low Temperature and Structure Research, Polish Academy of Sciences, Wroclaw, Poland E–mail: sznajd@int.pan.wroc.pl

The linear perturbation group transformation (LPRG) is used to study the thermodynamics of the axial next-nearest-neighbor Ising model with four spin interactions (extended ANNNI) in a field. The LPRG for weakly interacting Ising chains is presented and examined in the systems of ferro- and antiferromagnetic chains in the longitudinal field. The method is used to study finite field para - ferrimagnetic phase transitions observed in layered uranium compunds, $UAs_{1-x}Se_x$, UPd_2Si_2 or UNi_2Si_2. The above-mentioned systems are made of ferromagnetic layers and the spins from the nearest-neighbor and next-nearest-neighbor layers are coupled by the antiferromagnetic interactions $J_1 < 0$ and $J_2 < 0$, respectively. Each of these systems ehibits a triple point in which two orderd pahses (ferrimagnetic and incomensurate) meet the paramagnetic one, and all undergo the high field phase transition from para- to ferrimagnetic $(+ + -)$ phase. However, if in $UAs_{1-x}Se_x$ the para-ferri phase transition is of the first order as expecetd from the symmetry reason, in UT_2Si_2 $(T = Pd, Ni)$ this transition seems to be a continuous one, at least in the vicinity of the multicritical point. Within the MFA the critical character of the finite field para - ferrimagnetic transition at least at one isolated point can be described by the ANNNI model supplemented by an additional e.g. four-spin interaction. However, in LPRG approximation for the ratio $\kappa = J_2/J_1$ around 0.5 there is a critical value of the field for which an isolated critical point exists also in the original ANNNI model. The temperature dependences of the specific heat for several values of the field and κ are presented. The positive four-spin interaction shifts the critical point towards higher field and changes the shape of the specific heat curve. In the latter case for the fields small enough the specific heat exhibits two-peak structure in the paramagnetic phase.