Phase Transitions in Antiferromagnetic Triangular Blume-Capel Model with Hard Core Exclusions

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Using Monte Carlo simulation we analyze phase transitions of three triangular Blume-Capel (BC) models with antiferromagnetic (AFM) interactions. First model is a standard BC model with AFM interactions between nearest neighbours (1NN). Two other models have AFM interactions between third nearest neighbors (3NN). One of them has hard core exclusions between the 1NN particles (3NN1 model) and the other - between 1NN and second-neighbour particles (3NN12 model). Finite-size scaling analysis reveals that in these models, as in the 1NN AFM BC model, the transition from paramagnetic to long-range order (LRO) AFM phase is either of the first-order or goes through intermediate phase which might be attributed to Berezinskii-Kosterlitz-Thouless (BKT) type. We show that properties of the low-temperature phase transition to the AFM phase of 1NN, 3NN1 and 3NN12 models are very similar in all interval of a normalized single-ion anisotropy parameter, δ, except the first order phase transitions region. Due to different entropy of the 3NN12 and 3NN1 models, their higher temperature behaviour is different from that of the 1NN model. Three phase transitions are observed for the 3NN12 model: (i) from paramagnetic phase to the phase with domains of the LRO AFM phase at T_c ; (ii) from this structure to diluted frustrated BKT- type phase at T_2 (high-temperature limit of the critical line of the BKT- type phase transitions) and (iii) from this frustrated phase to the AFM LRO phase at T_1 (low-temperature limit of this line). For the 3NN12 model $T_c > T_2 > T_1$ at $0 < \delta < 1.15$ (range I), $T_c = T_2 > T_1$ at $1.15 < \delta < 1.3$ (range II) and $T_c = T_2 = T_1$ at $1.3 < \delta < 1.5$ (range III). For 3NN1 model $T_c = T_2 > T_1$ at $0 < \delta < 1.2$ (range II) and $T_c = T_2 = T_1$ at $1.2 < \delta < 1.5$ (range III). In range III there is only first order phase transition. In range II the transition at $T_c = T_2$ is of the first order, too. In range I the transition at T_c is either a weak first-order or a second-order phase transition.