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Stable, Metastable and Unstable Solutions of a Spin-1 Ising System in the Presence of Magnetic Fields due to the Dipole and Quadrupole Moments

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Abstract

The spin-1 Ising model [1] with bilinear (J) and biquadratic (K) interactions is studied for magnetic fields H_S and H_Q representing dipole and quadrupole moments, respectively, by using the lowest approximation of the cluster variation method [2]. Thermal variations of stable, metastable and unstable solutions of the dipole and quadrupole moments as a function of the reduced temperature for various values of $\alpha = J/K$. H_S and H_Q are given and discussed in our previous paper [3], extensively. In this study, we have investigated the effect of H_S, H_Q and α on metastable and unstable solutions which are very important for many experimental and theoretical cases, such as metallic glasses, binary alloys, superfluids, superconductors, gels, lasers, magnetic systems, astrophysics, glasses and crystalline ceramics, etc. [4]. It is found that metastable and unstable solutions occur at high temperatures when α and H_Q are increased. On the other hand, if H_S is increased, metastable and unstable solutions can be obtained only at low temperatures. The temperature where the metastable and unstable solutions first exist (while the reduced temperature is decreasing) is called the quasicritical temperature, T_{qc}. We also determined that T_{qc} is linear function of α and slopes are small for small values of H_S and big values of H_Q. Finally, H_S and H_Q are plotted as a function of T_{qc} and it is found that T_{qc} is an exponential decaying function of H_S for constant values of α and H_Q; and T_{qc} is an exponential increasing function of H_Q for constant values of α and H_S.

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