Study of Second Order Phase Transition for a Mixed Spin Ferrimagnetic System Using Landau – Expansion

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ABSTRACT

In this research, magnetic phase transitions, in a molecular based magnet, have been studied using mean field method (MFM). It is worth to note, a mixed spin- (3,7/2) Blume-Capel ferrimagnetic model has been investigated. By applying Blume- Capel configuration (BCC) to a system has two sublattices with spin-3 and spin-7/2, the phase diagram of the ground-state for square and simple cubic lattices in the ($D_A/|J|$, $D_B/|J|$) has been constructed. Based on Bogoliubov inequality (BI) of the free energy, it has been induced the spin compensation phenomena. Characteristic critical points, i.e., many ferrimagnetic compensation temperatures of the model have been predicted as well. New results for a cubic lattice have been given that they stimulate an experimental work in the compounds $Gd_2O_2S:Ln^{3+}$ (Ln = Eu, Tb). On the other hand, it has been expanded the free energy function based on Landau theory, to evaluate the second order phase transition lines experiencing the proposed system.We have established the free energy as a function of sublattices magnetizations using the canonical partition function Z. The magnetic anisotropies, i.e., crystalfield have carefully been changed so that one can examine interesting phenomena such as compensation behaviors and characteristic types for the total and sublattices magnetizations as functions of the absolute temperatures. It has been found that the proposed system has many compensation temperatures when ($-2.999 \leq D / J \leq -2.55 _A$) with fixed values of $D / J = -2.0 _B$ و$D_B / J = -3.0$, for a simple cubic lattice (z=6). Besides, a series of behavior’s types has been obtained for both structural lattices, which are L-, M-, type and P-, R-, S-, W- type for simple cubic and square lattices, respectively It remains to mention that the occurrence of a compensation point is of great technological importance since at this point only a small driven field is required to change the sign of the resultant magnetization; this property is useful in reducing the area of the hysteresis loop.