CHAPTER IV

CONCLUSION

In recapitulation,we have been concerned with the spin glasses. Ever since Cannella and Mydosh (5) observed a cusp like peak in the a.c. susceptibility of the AuFe alloy at a well defined temperature T_g, known as the spin-glass freezing temperature, many attempts have been made to understand these and other similar system. The attempt which had a considerable influence in this respect was due to Edwards and Anderson(6). Their theory predicted a cusp in the susceptibility although the expect shape of the cusp is somewhat different from that observed experimentally.

Following Edwards and Anderson's work(6) David Sherrington and Scott Kirkpatrick (S.K.)(7) proposed an infinite-range model of spin-glass in which every spin is coupled with all others pairwise and the distribution of the exchange interaction is assumed to be Gaussian. They studied this model using replica method to obtained the various thermodynamic quantities. Unfortunately they get a negative entropy at zero temperature. Otherwise, their results were physically very appealing.

In order to remedy this unphysical result D.J. Thouless, P.W. Anderson and R.G. Palmer(TAP) (8) developed and mean-field theory for S.K. model. Making use of the Bethe approximation, they obtained a self-consistent equation. They solved it in two limiting tempera ture regime, i.e., in the vicinity of the critical temperature T_g and at very low temperatures. At T = 0 K they obtained a zero entropy in contrast to the negative value derived by Sherrington et al(7). Above the critical temperature the correct S.K. equations were regained.

Besides TAP's method, other mean field method which avoid the replica trick are the Bethe-Peierls-Weiss (BPW) method(11,14,16) and the self-consistent mean random field approximation(MRF)(12,13,14).

Klein et al (14) use a modified BPW method couple with the probability distribution of internal fields to compare the predictions of various mean field approximation with each other. They find that when the effective number of neighbors z approaches infinity all the magnetic properties arising from the BPW,MRF and S.K. method are identical.

In our work we studied phase transition in a prototype model of a spin glass. We first calculated the spin magnetization and the pair correlation function using the Hamiltonian for z + 1 spins in terms of the variables J_{oi} and H_i . When the probability distribution of interaction strengths P_2 (J_{ij}) is given, we determined the probability distribution P_1 (H_i) for the field strength. Knowing P_1 (H_i) and P_2 (J_{ij}) we have calculated the thermodynamic variables using the Bethe-Peierls-Weiss approximation.

The internal energy was obtained. The free energy was expressed in terms of the internal energy and a constant of integration $S°$. Thermodynamic quantities appropriate for the quenched system were obtained by first obtaining the appropriate quantity from this free energy for a given configuration and then averaging it over all configurations. We then obtained the two equations which determined the ratio between the interaction strength J_1 and the critical temperature T_g.

The transition to the spin glass phase in our prototype model occurs when non-zero values of the order parameter q are possible. So we will solve the two equations (Eq. 2.19 and Eq.2.19') for non-vanishing value of q.

Since the two equations are simultaneous trancendental equations we have solved them numerically. We used the Newton - Raphson method for solving simultaneous equations. The results are shown in Table 1 -20. From these results we get Fig. 21. showing $\frac{J_1}{k_B T_g}$ versus c for various value of nearest neighbor z and ratio between interaction strength A.

We have fitted the curves shown on Fig. 21. to a quadratic concentration dependence by the least square best fit method. For given concentration c the ratio $\frac{J_1}{k_B T_g}$ is obtained for various value of z and A

We have also obtained the curves showing $\frac{J_1}{k_B T_g}$ versus z for various value of c and A which shown in Fig.22.