CHAPTER - 5
SUMMARY AND CONCLUSION

5. 1: HIGH T_C CUPRATES SUPERCONDUCTORS

The effect of antiferromagnetic order parameter (ϕ) on Superconducting order parameter *(Δ)* in multilayer cuprate Superconductors has been Studied by using double time Green's function technique, and expressions for Δ and ϕ have been obtained. The expression for Δ is found to be dependent on the antiferromagnetic order parameter (ϕ) along with temperature (T). It has been found that at low temperatures superconducting order parameter decreases linearly with increasing antiferromagnetic order parameter. But at the temperature 32.5 k and 35 k, which is close to transition temperature (37 k), this linearity is violated and superconducting order first suddenly and then after gradually decreases with increase of antiferromagnetic order. This shows that at close to transition temperature the area of co-existence of antiferromagnetism and superconductivity decreases. Results also shows that magnetic order parameter (ϕ) increases with T_C when T_C is below 35 k and when T_C cross the 35 k, magnetic order start to decrease.

From these results it concludes that magnetic order (ϕ) can support superconductivity when T_C is below 35 k. Therefore for those compounds where T_C is upto 35 k, the Hamiltonian represented in equation (3.5) is the possible model for them. However if T_C is more than 35 k, like as Y – Cuprates or Bi – Cuprates, the Hamiltonian which we have taken is not suitable model. Further for cuprates having T_C below which 35 k, magnetic order may co-exist with superconductivity and could be helpful as ϕ increases with T_C.

The expression for $\phi_{l'l'}$ is found to be dependent on the exchange interaction of localized electrons *(J)* and exchange interaction of localized & conduction electrons *(τ)*.

Results show that when the exchange interaction between localized electrons (J) increases, T_C first sharply increases and then for higher values of J, T_C reaches at saturated value because the system is in a pair state characterized by the fact that all electrons are locally paired. This exchange interaction (J) helps to make cooper pairs of local spins with antiferromagnetic coupling at the same sites which help to increase transition temperature T_C and also helps to overcome coulomb repulsion between electrons.

So, from these results it can be conclude that the exchange interaction between localized electrons plays an important role for co-existence of magnetism and superconductivity at same temperature and hence the element having the large value of these interactions may help to increase the transition temperature (T_C).

5. 2: IRON PNICTIDE SUPERCONDUCTORS (OXYPNICTIDES):

The magnetic properties of LnOFeAs system has been studied using anisotropic Heisenberg model with three in-plane (J_1, J_2 & J_3) and one out-of-plane ($J_\perp$) exchange interactions. Starting with stripe configuration with two interpenetrating sublattices such that the spins are always oppositely aligned in two sublattices, the expression for sublattice magnetization and Néel Temperature (T_N) using Green's Function technique within random phase approximation (RPA) has been obtained. Using the expression for Néel Temperature, variation of T_N with $J_\perp$ and also the effect of $J_\perp$ on the sublattice magnetization has been studied. It is evident from the curve that as $J_\perp$ increases the sublattice magnetization also increases at all temperature $\leq T_N$. It is also seen from the curves that increase in $J_\perp$, increases T_N as well. This implies that $J_\perp$ increases T_N, helping to maintain the long range order and thus has an important role in magnetic dynamics of '1111' pnictides.

In conclusion it can say that this present anisotropic Heisenberg model (3.41) has been successful in obtaining Néel temperature for LnFeAsO system with realistic values of in-plane and out-of-plane exchange couplings. The estimated value of out-of-plane exchange coupling ($J_\perp$) in these compounds is 3 meV. Further the positive dependence of T_N on $J_\perp$ finds relevance in view of high T_N of 122 pnictides, which are bilayer compounds, and a new channel of interlayer interaction could possibly lead to enhancement of T_N as the case in cuprates. Although the interaction between Fe and As has been emphasized by J. Zhao et al. and T. Yildrim, but no theoretical and experimental values of $J_\perp$ are available. Experiments exploring the role of $J_\perp$ and its strength will be desirable to validate the predicted strength of Fe-As interaction.