Preface

The thesis contains a theoretical study on three important phenomena namely, Magnetic hyperthermia, Bose-Einstein condensation (BEC) of quasiparticles (magnons) and unconventional superconductivity. Magnetic hyperthermia refers to heating of magnetic particles with the application of external magnetic field which may be useful in hyperthermic oncology. The effect of a very high static magnetic field in a ferromagnetic system is investigated theoretically and found that it leads to a very small increase in temperature. However, the effect of a radio frequency (RF) magnetic field applied along with a static field leads to an appreciable increase in temperature. In the case of a radio frequency (RF) alternating magnetic field which is taken perpendicular to a static magnetic field, it is noted that the magnons of uniform mode get excited. The phenomenon is known as ferromagnetic resonance. In the case of a high applied RF magnetic field, one obtains a number of excited magnon modes which is different from the former case as discussed. It is also noted that the absorption of energy from RF field leads to an increase in temperature of the system.

It is observed that when an RF magnetic field taken parallel to the static one, magnons of frequency equal to the half of the frequency of the applied field are get excited. In this case, the temperature of a ferromagnetic substance also increases. The estimated rise in temperature agrees with that measured experimentally.

Recently Bose-Einstein condensation (BEC) of different quasiparticles has become an interesting topic of research as they have small effective mass and can be excited externally. In this direction magnons are particles that falls under the category. The condensation of these particles has been realized in thin film of ferromagnetic substance subjected to parallel pumping. Different aspects of this experimental observation are explored quantitatively through spin wave treatment. In the case of parallel pumping, the theoretical framework considered here is given by a formula connecting the time required for the formation of magnon BEC in a thin film of ferromagnetic material and the applied RF magnetic field. The estimated times required for the condensation with different applied fields are in good agreement with that of the experimental observed result. Using similar theoretical framework, the condition needed for the formation of BEC of magnons is also predicted in the case of perpendicular pumping.

Unconventional superconductivity remains an interesting topic of research for last three decades. It is known that, superconductivity and the ferromagnetism occur simultaneously in UGe_2, URhGe *etc.* substances. It may be pointed out here that the BCS theory fails to account the phenomenon on the basis of electron phonon interactions. On the other hand, superconductivity and antiferromagnetism also found to occur simultaneously in iron pnictide superconductor under external pressure or with doping. To understand the mechanism behind the formation cooper pair in the case of unconventional superconducting materials is under hot debate. In the thesis, the above problem is discussed by considering electron-magnon interaction with magnon as pairing glue. The critical temperature of superconductivity is computed here making use of the modified BCS equation proposed here.