Chapter 1

Introduction to high T_C superconductors: Order parameter symmetry

Discovered in 1986 by Bednorz and Muller [1] high temperature superconductors (HTSC) are one class of the strongly correlated electronic systems which in recent times have drawn a lot of attention from the condensed matter physicists. These highly anisotropic layered materials posses some of the very unusual properties both in the normal and superconducting states. During the last decade there have been many experimental and theoretical investigations to study and understand the properties of these systems [2]. Though a consensus has emerged over many complicated phenomena, there remain widely divergent views regarding the nature of both normal and superconducting states as well as the origin of the pairing mechanisms in this class of systems. High temperature superconductivity was first discovered in the system La-Ba-Cu-O (LBCO) followed by $YBa_2Cu_3O_{7-\delta}$ (YBCO), $Bi_2Sr_2CaCu_2O_{8-\delta}$ (BSCCO or Bi2212), $Tl_2Ba_2CaCu_2O_{8-\delta}$ (TBCCO or Tl-2212), etc., with increasing transition temperatures. The transition temperatures of these systems (>80K) are too high to be accounted by the BCS electron-phonon coupling mechanism. Although there is substantial evidence for electron pairing in the superconducting state, the underlying pairing mechanism is still an open problem to be answered. The cuprate superconductors also exhibit strong magnetic interactions in the form of antiferromagnetic spin correlations that are usually mutually exclusive with superconductivity. Almost every conceivable mechanism that could create a pairing interaction sufficiently strong to yield superconductivity at these elevated temperatures has been investigated, but still there has not been any universally accepted view on the nature of pairing mechanism yet.