MAR06-2005-003973

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Optical properties of Cuprates in the Normal and superconducting state.[1]

DIRK VAN DER MAREL, University of Geneva

For superconducting materials it is interesting and important to determine the kinetic energy of the conduction electrons, $<<H>>_T$, because its behavior as a function of temperature dependence, in particular at the superconducting phase transition, provides a direct and profound insight in the mechanisms by which the superconducting phase is stabilized. The intra-band optical spectral weight, W(T), is, apart from a minus sign, closely related to the kinetic energy[1]. With modern optical techniques it is possible to measure W(T) very accurately as a function of temperature. Over the past few years several teams have reported that by the superconducting phase transition affects the optical conductivity over an energy range of several electron Volts[2-8]. Some of these results were accurate enough to determine the effect of superconductivity on W(T). Here we present new optical data for a large number of underdoped and optimally doped samples of various compositions. In order to clearly distinguish the effect of the superconducting phase transition from other temperature dependencies, we use a dense sampling of temperatures (1 spectrum every Kelvin) over a broad range of temperatures and frequencies. All our data support that the change at Tc of W(T) parallel to the CuO2-planes is opposite to the trend expected from the BCS prediction. For strongly overdoped samples the observed behavior of W(T) in the normal state and in the superconducting state is qualitatively different compared to underdoped and optimally doped superconductors.

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[1]This work was supported by the Swiss National Science Foundation through the NCCR 'Materials with Novel Electronic Properties'