INTERPLAY OF EXTERNALLY DOPED AND THERMALY ACTIVATED HOLES IN LSCO AND ITS IMPACT ON THE PSEUDOGAP CROSSOVER

L.P. Gor'kov (FSU, NHMFL); G.B. Teitel'baum (E.K. Zavoiskii Institute for Technical Physics of the RAS, Kazan, Russia)

Introduction

Transition from the Mott insulated state into metallic and superconducting (SC) state is driven in cuprates by external doping. However, doping is *not* the thermodynamic path, and the actual number of carriers may be different from the doping level, x. It is assumed that initially doped holes go onto the oxygen sites, since the Cu(d^9)- and the oxygen levels are separated by a "charge transfer gap"(~1.2-1.5eV).With the increase of concentration, x, charges of dopant ions rearrange the overall energy balance, so that at x as small as x~0.03, recent ARPES experiments testify in favor of the bands formation. Amount of the Sr-doped holes and the effective number of carriers has been subject of intense research since early days of the High-T_c era, mainly by means of measuring the Hall coefficient, R_H , as a function of the dopants` concentration and the temperature.

Results and Conclusions

Until recently the reliable Hall effect data for LSCO were available mostly below the room temperature interval. There was no consensus in the interpretation of the concentration and the temperature dependence of the data.

For this Report we have analyzed a large number of recent data for $R_H(x, T)$ in LSCO that now cover the broad range of both concentrations and higher temperatures (up to 1000K). We arrived to the following conclusions:

I. The effective number of carriers from the Hall experiments, n_{Hall} , can be presented as the sum of the contributions due to the external doping and from thermally activated carriers:

$$n_{Hall}= n_0(x) + n_1(x)\exp(-D(x)/T) \qquad [1]$$

II. The activation energy, D(x), is the thermodynamic characteristic. The activated behavior must come about from some bound levels. It turned out that D(x) deduced from the Hall data, coincides with the distance to chemical potential for the so-called van Hove flat band, as measured by ARPES. We invoke the lattice involvement of in localizing states near (0,pi) patches. A characteristic energy scale of the lattice localization was estimated as~10meV.

III. The notorious pseudogap temperature, T*(x), follows from Eq.[1] just from comparison when the number of doped carriers and activated ones becomes approximately equal.

IV. It follows from Eq.[1] that number of holes on the Cu-sites is not preserved, and, hence, spins are moving around.

Acknowledgements

The work of L.P.G was supported by the NHMFL, that of G.R.T. through RFBR Grant N 04-02-17137.

References

[1] Gor'kov,L.P., *et al*., Phys. Rev. Lett. (to be published in the December issue, 2006).