MAGNETORESISTANCE AS A FUNCTION OF DOPING AND DISORDER IN PCCO

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Introduction

In hole doped cuprates, the overdoped region is believed to be metallic (Fermi liquid-like), whereas in the underdoped region, at low temperatures the resistivity increases with decreasing temperatures and may even be logarithmically diverging at T=0 [1].The normal state of the n-doped cuprates is also characterized by negative magnetoresistance(MR) at low temperatures. This behavior was interpreted in terms of e.g. weak localization [2] or Kondo effect [3]. Recently, we found evidence for a quantum phase transition at x=0.165±0.005 [4]. We also found that below x_c the upturn in resistivity appears at low temperatures. The purpose of this research is to find additional evidence for a quantum critical behavior in the MR and to try and tune through it by disordering an x=0.17 by means of proton irradiation and oxygen content variation.

Experimental

In plane resistivity of $Pr_{2-x}Ce_xCuO_4$ (PCCO) films as a function of magnetic field (up to 32.4T in the DC field facility) temperature (0.5K-20K) and angle with the *c* direction was measured for $0.11 \leq x \leq 0.19$. x=0.17 sample was measured also as a function of number of protons irradiated onto the sample and with various oxygen contents. To extract the spin MR, first, we measured the resistance as a function of H⊥ab up to 32.4T. We then rotate the film in a field of 32.4T with θ the angle between the field and the ab-planes. θ=0 corresponds to field applied parallel to the current (and the ab-planes); θ=90° is field perpendicular to the film. If only $H_\perp$ affects the MR, then the resistance at a field H_0 applied perpendicular to the film should be the same as when the maximal available field of 32.4T is applied at an angle $\theta_0=\arcsin(H_0/32.4T)$. We therefore transform the field sweep into an effective angle, θ, using $\theta=\arcsin(H/32.4T)$.

Results and Discussion

In the high doping regime (x≥0.16) the results of the field sweep and those from the rotation in field overlap.[5] This means that there is <u>only</u> a perpendicular MR component i.e. orbital MR. A strong parallel magnetic field effect, observed as the difference between the field sweep and the rotation in field for x<0.16. In fact, *the MR is almost isotropic in the x=0.13 - 0.15 samples*. Surprisingly, this suggests that most of the n-MR seen when H⊥ab is coming from an isotropic, spin effect. Orbital or 2D effects can thus be ruled out.

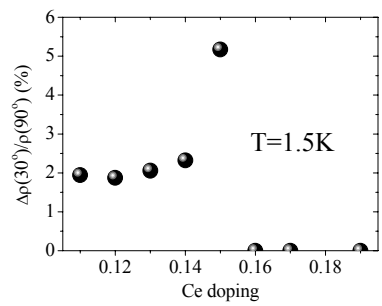

Fig.1 The spin MR as a function of Ce doping for PCCO (see text for details).

In fig.1 we plot the isotropic spin effect of 16.2T field [5]. The spin effect vanishes dramatically at x=0.16 at this temperature. This is consistent with the evidence for a quantum phase transition at x=0.165±0.005 that we have previously reported [4].

Similar measurements and analysis were done as a function of proton dose (fig. 2a) and oxygen content (fig. 2c), no spin MR was found for either system. However, a small upturn was induced by both irradiation and oxygenation and T_c was much reduced. We therefore believe that the irradiation/oxygenation (for x=0.17) induced upturn has different origin than the one observed in underdoped samples.

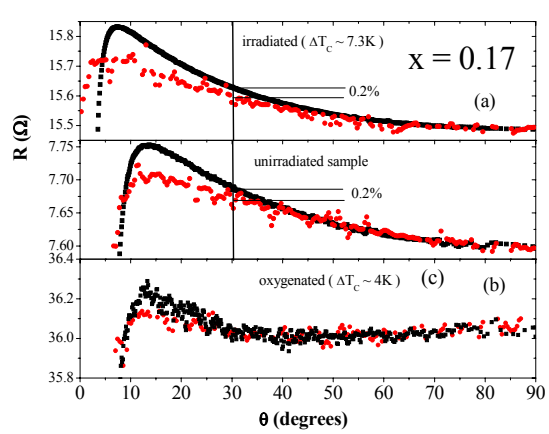

Fig. 2 Comparison between field sweep (black) and rotation in a 31 T field (red) for: (a) heavily irradiated, (b) untreated (c) oxygenated samples.

References

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