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Angular Magnetoresistance of the Reconstructed Fermi Surface in the Cuprates

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Introduction

In the cuprate high temperature superconductors, charge density wave (CDW) order has been found at temperatures below the superconducting critical temperature. Because of the proximity of the CDW to superconductivity, it is therefore of interest as the two phases may have an important relationship. In underdoped $HgBa_2CuO_{4+\delta}$ (Hg1201), the CDW reconstructs the Fermi surface near 25 K [1,2]. Determining precisely the shape of the reconstructed Fermi surface and its evolution with temperature would thus help to illuminate the nature of the CDW. This can be done by measuring the angular dependence of the c-axis magnetoresistance (MR) of the superconductor. The angular MR has already proved valuable in mapping the Fermi surface of YBCO [3] and $Tl_2Ba_2CuO_{6+\delta}$ [4], and should provide important information about the Hg1201 Fermi surface [5].

Experimental

The angular magnetoresistance of underdoped Hg1201 was measured at the NHMFL Pulsed Field Facility in 65-Tesla Multi-Shot magnets. Four-terminal transport measurements along the c-axis were completed on two underdoped samples. The magnetoresistance was obtained for many polar and azimuthal angles of the sample with respect to the magnetic field, using a rotator probe available at the facility.

Results and Discussion

In our samples of Hg1201, clear signatures of the angular dependence of the magnetoresistance were observed. A fourfold dependence on azimuthal angle ϕ was seen at in the samples beginning near 150 K and persisting to nearly 90 K. In addition, there is a marked dependence of the magnetoresistance on polar angle. Figure 1 shows the magnetoresistance in an underdoped sample of superconducting critical temperature T_c = 81 K as a function of magnetic field, at both polar angle $\theta = 0^o$ and $\theta = 48^o$ with respect to the applied magnetic field. The behavior of the magnetoresistance changes as a function of polar angle and temperature.

Conclusions

The angular dependence of the magnetoresistance data points towards a Fermi surface that evolves with temperature, possibly reflecting the evolution of the CDW with temperature. Fitting the magnetoresistance to various models will be necessary to extract the shape of the Fermi surface and determine the symmetries broken by the CDW.

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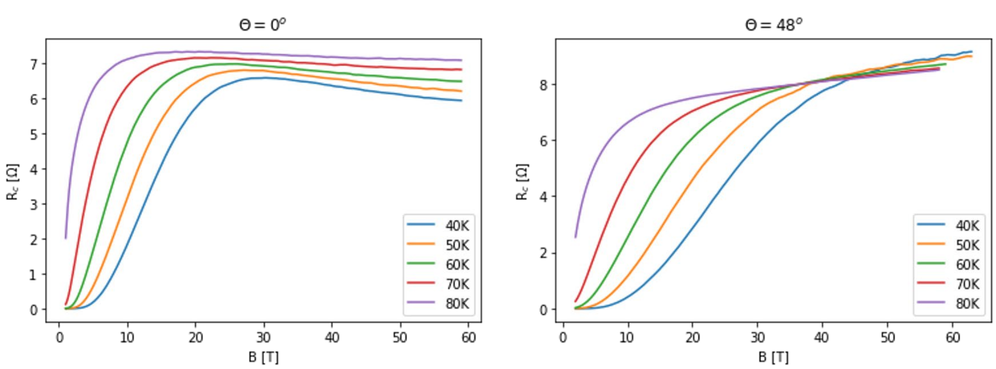

Fig.1 Comparison of the magnetoresistance from 40-80 K and different polar angles. The left panel depicts magnetoresistance of the sample at with the c-axis parallel to the magnetic field, and the right panel is the magnetoresistance with the c-axis rotated 48^o to the field.