LOW TEMPERATURE, HIGH FIELD TRANSPORT IN $Pr_{2-x}Ce_xCuO_{4\pm\delta}$

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Introduction

It has been suggested that the n-doped superconducting compound $Pr_{2-x}Ce_xCuO_{4-\delta}$ (PCCO) undergoes a quantum phase transition as a function of doping. A kink in the Hall coefficient, a change in the resistivity exponent, a dramatic increase in the coefficient, A, of a $\rho=\rho_0+AT^2$ fit, and the appearance of an upturn in the resistivity are found at the critical doping $x=0.165\pm0.005$.[1] Neutron scattering and muon spin rotation measurements suggest that the critical point is due to an antiferromagnetic to paramagnetic transition in the normal state.[2] In another view, the cuprates undergo a bose-insulator to superconductor transition (SIT).[3] Both the antiferromagnetic transition and the SIT have predicted behavior of the magnetoresistance (MR). Near an antiferromagnetic transition, a scaling behavior of the MR as a function of temperature, residual resistivity, and magnetic field was predicted by A. Rosch. [4]. A different scaling behavior is expected for the SIT [5].

We measured the MR, Hall effect, and resistivity of thin, epitaxial, c-axis oriented PCCO films as a function of doping, temperature, and magnetic field. Theoretical fits to the low temperature behavior of Hall, MR, and resistivity measurements are important in determining the ground state behavior as a function of doping (i.e. Fermi liquid behavior, marginal FL behavior, SIT, quantum phase transition, etc.).

Experimental

The transverse (R_{xx}) and longitudinal (R_{xy}) resistances were measured as a function of magnetic field, temperature ($T < 300$ mK), and cerium doping in PCCO. The magnetic field was applied parallel to the c-axis and transport was measured in the ab-plane. We performed these measurements using the dilution refrigerator/18 T superconducting magnet system (MK3 SCM1) in the Millikelvin Lab within the DC Field Facility at the NHMFL.

Results and Discussion

The temperature dependence of the normal state resistivity (in a 10 T field) displayed an unanticipated saturation below 300 mK, in all samples measured. As a result, measurements of the MR at various temperatures overlapped (within the noise of the measurement) and an analysis of SIT behavior was not possible in this temperature range.

Hall measurements down to 20 mK yielded a continued temperature dependence for underdoped samples and saturation for overdoped samples. Scatter and noise in the data, however, suggest further measurements are required. Signal-to-noise ratios could be improved by optimizing the sample geometry and possibly by an improved ac measurement technique.

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References

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