Kohler's Rule in the Cuprate Superconductor $Nd_{2-x}Ce_xCuO_{4+\delta}$

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Introduction

For a conventional Fermi-liquid system, the change in isothermal dc resistivity ($\delta\rho$) in an applied field (H) obeys a functional relation known as Kohler's rule. $\delta\rho/\rho_0 = F(H\tau) = F(H/\rho_0)$, where τ and ρ_0 ($\propto 1/\tau$) are the temperature-dependent scattering relaxation time and the zero-field resistivity, respectively [1]. Based on previous work on $La_{2-x}Sr_xCuO_4$ and $YBa_xCu_3O_{6+y}$ it has been argued that Kohler's rule is strongly violated in the cuprates. However, recently it was demonstrated for the model cuprate system Hg1201 that the planar magnetoresistivity does indeed obey Kohler's rule in the pseudogap state [2]. Here we report initial results that indicate that the *ab*-plane and *c*-axis magnetoresistivity of the electron-doped cuprate $Nd_{2-x}Ce_xCuO_{4+\delta}$ (NCCO) obeys Kohler's rule as well.

Experimental

Measurements of the magnetoresistance of NCCO have benefited from the large static DC fields (up to 35T for resistive magnets) available at the NHMFL.

Results and Discussion

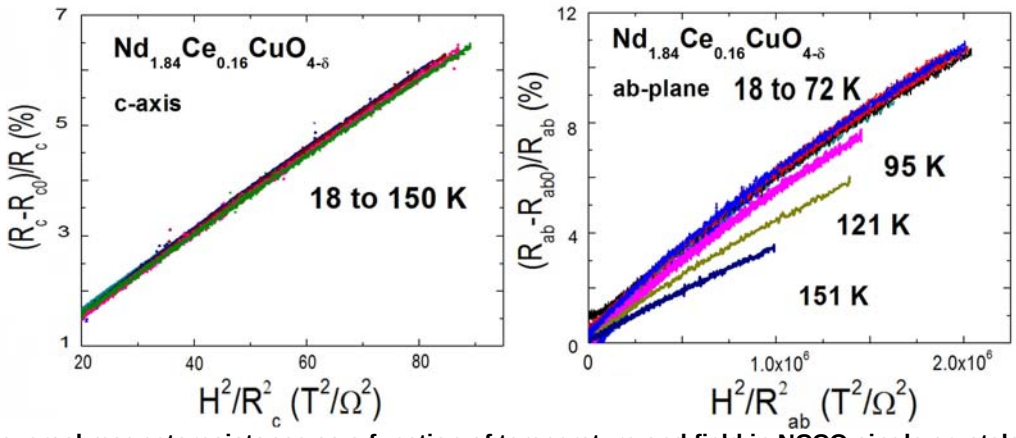

Figure 1. Transeversal magnetoresistance as a function of temperature and field in NCCO single crystals. (Left panel) *c*-axis magnetoresistance as a function of temperature for a *x*=0.16 sample, where Kohler's rule is obeyed at $18\ K \leq T \leq 150K$. (Right panel) *ab*-plane magnetoresistance as a function of temperature for a *x*=0.16 sample. The Kohler's rule is observed at $18\ K \leq T \leq 72K$. Deep in the strange metal regime, Kohler's rule is violated. The anisotropy of the magnetoresistance at high temperatures is not fully understood.

Conclusions

Magnetoresitivity is a powerful tool to investigate the normal state properties of the high-temperature superconductors [2] and can also provide key information about possible changes of the Fermi surface topology with field, doping, and temperature. The observation of quadratic temperature [3] and field dependencies and of the validity of Kohler's rule [4] intriguingly indicates that the transport properties of NCCO resemble those of a Landau Fermi liquid. The universality of this behavior in electron- and hole-doped cuprates suggests a common origin. We plan to perform additional experiments at the NHMFL in order to further study this behavior.

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References

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