SEVERE FERMI SURFACE RECONSTRUCTION IN $CA_{2-X}Sr_XRuO_4$ (FOR 0.2 < x < 0.5)

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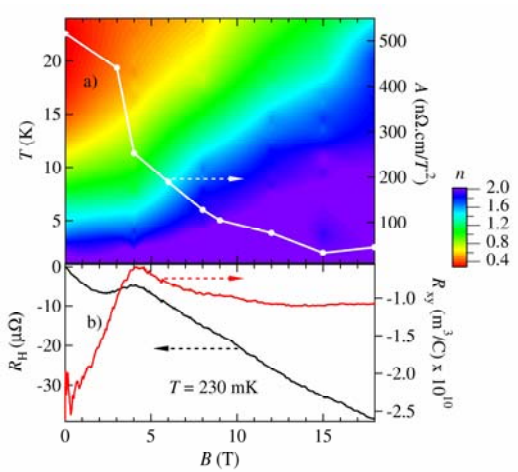
Introduction

The single layered ruthenates $Ca_{2-x}Sr_xRuO_4$ have a quite complex phase diagram as a function of doping x [1,2]. While Sr_2RuO_4 is a rare example of a well-defined two-dimensional Fermi liquid (FL) [3,4] displaying spin triplet superconductivity, the complete replacement of Sr by the isovalent element Ca produces the Mott insulator Ca_2RuO_4 [1,5]. A series of correlated metallic states are included between both extremes. To clarify the possible existence of localized carriers within a metallic *d*-electron system, we performed a detailed electrical transport study at high magnetic fields in $Ca_{2-x}Sr_xRuO_4$ single crystals for $x = 0{:}2$ and 0.5.

Experimental

We used many NHMFL facilities, i.e., resistive and superconducting magnets, ^{3}He and dilution fridge systems coupled to sample rotators to study the transport and magnetic properties of the $Ca_{2-x}Sr_xRuO_4$ series.

Results and Discussion



We studied the Hall effect and the angular dependence of the magnetoresistance or angular magnetoresistance oscillations (AMRO). The color plot in Fig. 1(a) shows the exponent $n = \partial ln(\rho - \rho_0)/\partial lnT$ of the in-plane resistivity ρ in a limited range of the *T*-*B* space. The purple regions emerging at low temperatures reveal the existence of a FL ground state (n =2). Notice how the characteristic temperature T_{FL}, below which FL-like behavior is observed, increases with *B*. The white line and markers indicate the evolution in *B* of the resistivity's $A = (\rho - \rho_0)/T^2$ coefficient, which shows a pronounced decrement at the transition. Figure 1(b) shows the most relevant result of this study, the Hall resistance $R_H = V_H/I$, where V_H is the Hall voltage and *I* the electrical current, and the Hall constant $R_{xy} = R_H t/B$, where *t* is the sample thickness, as a function of *B* at *T* = 230 mK. The absolute value of R_{xy} decreases through the metamagnetic transition from nearly $2{:}5 \pm 0{:}5 \times 10^{-10}$ m^3/C at very low fields and saturates at the value of $1 \pm 0{:}05 \times 10^{-10}$ m^3/C, which is precisely the value reported for Sr_2RuO_4. This indicates an important modification of its original FS.

Fig. 1. (a) The exponent $n = \partial ln(\rho - \rho_0)/\partial lnT$ of the in-plane resistivity ρ for a $Ca_{1.8}Sr_{0.2}RuO_4$ single crystal in the *B* - *T* plane. The Fermi-liquid ground state is always observed at lower *T*s. The white symbols describe the evolution of the resistivity A (= $(\rho - \rho_0)/T^2$) coefficient as a function *B*. (b) The Hall resistance R_H and the Hall constant R_{xy} as a function of *B* at *T* = 230 mK. Notice the sharp decrease in R_{xy} at the metamagnetic transition.

Conclusions

The Fermi surface of the $Ca_{2-x}Sr_xRuO_4$ system is strongly dependent on *x*. The anomalous polar AMRO and the severe field-induced Fermi surface reconstruction observed at the metamagnetic transition could be evidence for localized *d*-electronic states within the metallic phase seen for $0{:}2 \le x \le 0{:}5$.

Acknowledgements

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References

[1] Balicas, L., *et al*., Phys. Rev. Lett., **95**, 196407 (2005).