Measurements of Quantum Oscillations and Magnetoresistance in a Strong Magnetic Field at Various Pressures in $CeRhIn_5$

Weng, Z.F.; Jiao, L.; Yuan, H.Q. (Zhejiang U., Physics); Graf, D. (NHMFL); Bauer, E. (LANL)

Introduction

Previous quantum oscillations and specific heat measurements of $CeRhIn_5$ in both pulsed magnetic fields and DC magnetic fields at ambient pressure suggest a field-induced antiferromagnetic (AF) quantum critical point (QCP) at $B_{c0}\approx 50T$ was well established for $CeRhIn_5$. [1] More importantly, measurements of the dHvA effect and the Hall resistivity in high magnetic fields provided direct evidence for a sharp change of Fermi surface around B*=30T, being well inside the AF state of $CeRhIn_5$. Such a Fermi surface reconstruction is likely attributed to the field-induced delocalization of Ce-4f electrons as a result of Kondo screening. These findings suggest a field-induced SDW-type QCP in $CeRhIn_5$ and implicate multiple QCPs in the field-pressure phase diagram of this compound [1], which shed new lights on the theoretical understandings of the global phase diagram in heavy fermion systems [2].

Experimental

A series of measurements were performed, including the TDO-based resonant oscillations, magnetoresistance and Hall resistivity for $CeRhIn_5$ in a pressure range of 0~2.3GPa and a magnetic field using the 35T and 45T magnet systems of National High Magnetic Field Laboratory (NHMFL) in Tallahassee in April and September. All the measurements were done in the same pressure cell. The magnetoresistance and Hall resistivity were detected by a standard 4-contact method. The single crystals for both measurements showed very high sample quality with RRR~1000.

Results and Discussion

Fig. 1 shows the results of magnetoresistance and Hall resistivity of $CeRhIn_5$ at several selected temperatures at 1.14 GPa. A sharp jump, which shifts to higher field with increasing pressure is clearly seen at B_M in both the magnetoresistance $\rho_{xx}(B)$ and the Hall resistivity $\rho_{xy}(B)$. The nature of this transition is unclear and requires further measurements, but likely it corresponds to a metamagnetic transition. On the other hand, Shubnikov–de Haas (SdH) oscillations were observed in the magnetoresistance where he Hall resistivity ρ_{xy} (B) also shows a kink or a slope change.

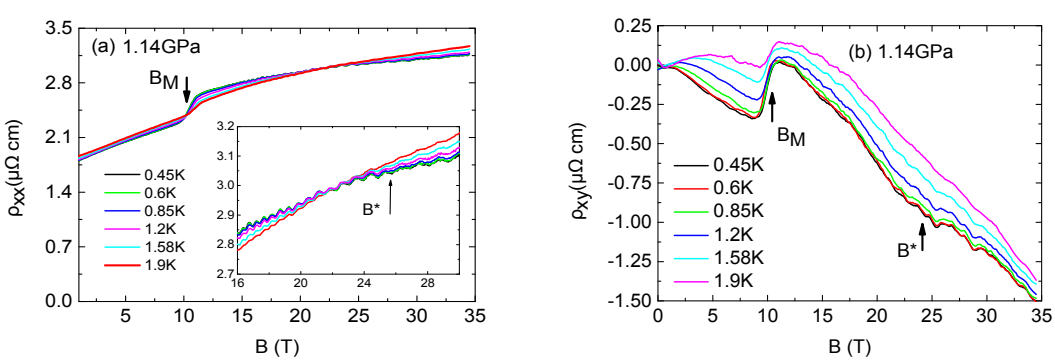

Fig. 1: Magnetoresistance $\rho_{xx}(B)$ and Hall resistivity $\rho_{xy}(B)$of $CeRhIn_5$ at various temperatures (H//c).

Acknowledgements

A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy. Part of the work is supported by the National Basic Research Program of China (973 Program) (Grant Nos. 2011CBA00103), the NSFC (Grant 11174245), Zhejiang Provincial Natural Science Foundation of China and the Fundamental Research Funds for the Central Universities.

References

[1] Jiao, L., et al. arXiv: 1308.0294 (2013). PNAS (in press)
[2] Q. Si, Phys Status Solidi B 247:476-484 (2010).