Magnetoresistance of $CeRhIn_5$ in a Pulsed Field

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Introduction

$CeRhIn_5$ is quite unique among the "Ce-115" family, which orders into an antiferromagnetic (AFM) state without a strong renormalization of the electron effective mass via Kondo effect at ambient conditions. In contrast, the 4f electrons in the superconductors $CeCoIn_5$ and $CeIrIn_5$ were shown to be itinerant with a heavy quasiparticle mass due to close proximity to quantum critical point (QCP). Upon applying a pressure, the AFM transition in $CeRhIn_5$ is eventually suppressed, leading to the occurrence of superconductivity in the quantum critical region too [1]. Therefore, $CeRhIn_5$ provides a great opportunity to study the interplays of quantum fluctuations, Kondo physics and superconductivity. Our previous dHvA measurements showed a sharp change of Fermi surface around $B^* \approx 35$T, attributed to the localized-itinerant transition of Ce 4f-electrons, while approaching a field-induced QCP around $B_c \approx 50$. These findings suggest a new scenario of multiple quantum phase transitions in the same compound under multiple tuning parameters.[2] In this study, we seek new evidence to support such a scenario by measuring magnetoresistance and Hall resistance in a pulsed field.

Experimental

Measurements of magnetoresistance and Hall resistance are highly challenging in a pulsed magnet for a good metal, like $CeRhIn_5$, due signal diminishing to microvolt levels in such a good metal, posing a challenge for measurements in pulsed magnet. We obtained preliminary results in 60T magnet of magnetoresistance and Hall resistivity for $CeRhIn_5$, which need be confirmed in future measurements.

Results and Discussion

The preliminary results of magnetoresisance (MR) and Hall resistance are shown in Fig. 1 in $CeRhIn_5$ at several temperatures (H//a). A maximum is observed in the MR between 30 and 45T, which position shifts to higher field with decreasing temperature. A positive MR appears to be a common feature of typical Kondo systems due to the breakup of Kondo singlets in a magnetic field. In $CeRhIn_5$, on the other hand, the magnetic field may also act as a tuning parameter to suppress the AFM correlation which favors the formation of a coherent Kondo state and, therefore, give rise to a negative MR.[3] The competition of these two opposite effects may lead to a broad peak in the MR of $CeRhIn_5$. With further increasing the magnetic field, the MR shows another minimum at B_{min}, which origin is unknown for the moment. One possibility is that a Kondo-coherence state is fully developed around B_{min}. Some features are also visible in the Hall resistance at similar magnetic fields. However, further work is needed in order to confirm all these features, especially on Hall resistivity, which is currently under plan.

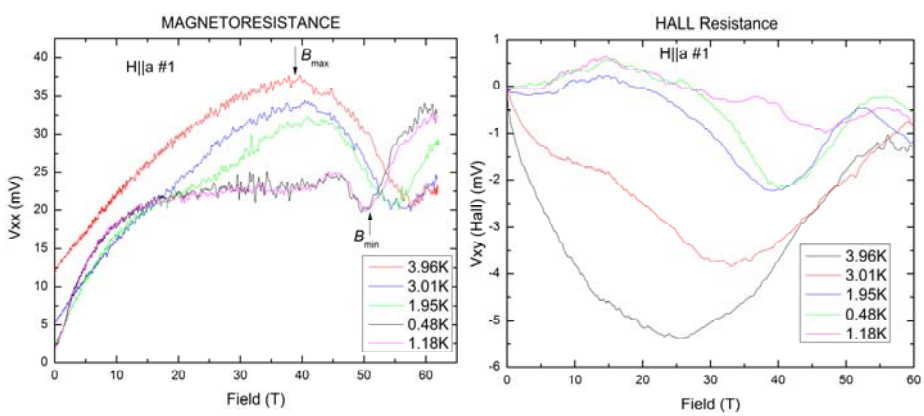

Figure 1 Magnetoresistance and Hall resistance of CeRhIn5 with H//a-axis.

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