Field-induced nematicity in $CeRhIn_5$

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Introduction

Recent studies of the heavy fermion antiferromagnet $CeRhIn_5$ indicated a phase transition in fields larger than H*~28T [1, 2]. The transition is accompanied by a large jump in the in-plane resistivity, yet the magnetization remains featureless across the transition.

Experimental

Single crystals of $CeRhIn_5$ were microstructured such that simultaneous in-plane – [100] and [010] or [110] and [1-10] – resistivity measurements could be performed at high magnetic fields, as shown in Fig. 1a. The microstructures are particularly suited for transport measurements at high fields, as the aspect ratio of the devices gives enhanced signal to noise in a material whose high conductivity would inhibit measurements on bulk crystals. To investigate the H*~28T phase, we performed angular-dependent measurements of the resistivity and non-linear conductivity in the high-field state by applying a dc-current bias to a small ac-current. This experiment was performed in the 45T hybrid system using a rotator probe.

Results and Discussion

Figure 1b shows the angle dependence of the in-plane resistivity taken at 35T along [110] and [1-10] (blue and red, respectively) as the field is tilted into the [1-10] direction. The anisotropy is present for all angles until it closes at zero, and does not exhibit any hysteresis. Figure 1c shows non-linear conductivity in the high field state where the field is aligned with the c-direction where no signature of the transition appears in the resistance. A dc-current bias was then added to a small ac-current (100μA). We find that, while the low field state is ohmic, non-linear conductivity appears in the high-field phase, the behavior of which is consistent with a nematic state aligned by an electric field. The results of this experiment are published in reference [3].

Conclusions

We found the H*~28T phase is due to an electronic in-plane symmetry breaking and not associated with magnetism. The data suggest that this phase consistent with an electronic nematic state and phenomenologically appears to be closely related to the unconventional superconductivity appearing in the system under pressure.

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 and the State of Florida. The project was supported by the Max-Planck-Society and by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – MO 3077/1-1.

References

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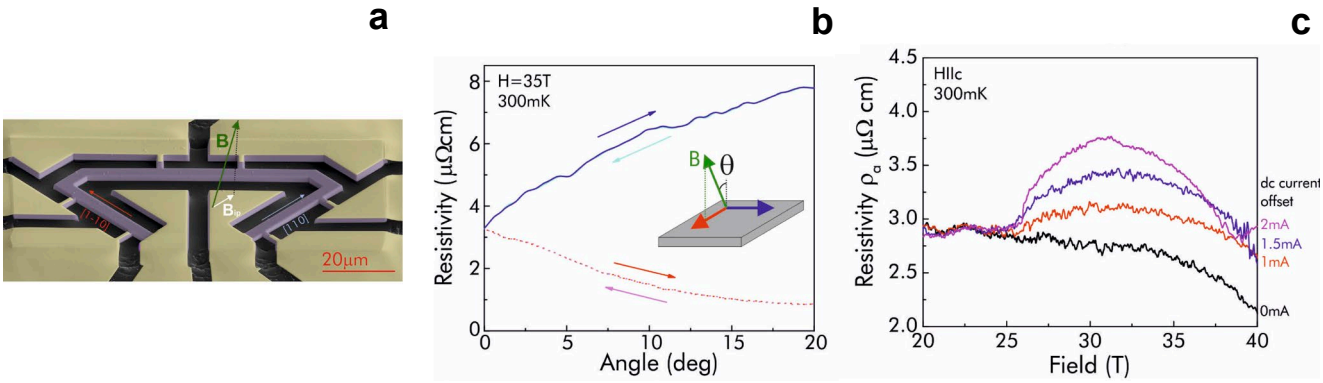

Fig.1 a) Electron beam micrograph of a $CeRhIn_5$ microstructure. Current is injected through the bottom contacts and passes the entire U-shaped structure with all three bars in series. b) Angle dependence of the in-plane resistivity at 35T. c) Non-linear conductivity in the high field state.