Evidence for Superconductivity in $YbRh_3Si_7$

Mozaffari, S. (Maglab and FSU, Physics); Zheng, W. (Maglab and FSU, Physics); Schoenemann R. (Maglab); Chiu, Y.-C. (Maglab and FSU, Physics); Rai, B. (Rice U. Physics); Morosan, E. (Rice U. Physics) Balicas. L. (Maglab and FSU, Physics)

Introduction

When a quantum critical (QC) behavior is developed in a system, the fluctuations in the order parameter often leads to departure from standard behavior, e.g. transformation from a Fermi-liquid to a non-Fermi liquid behavior and unconventional superconductivity. QC points can be best experimentally studied in Heavy Fermion (HF) compounds. Superconductivity is very rare in Yb-based HF compounds despite extensive searches over the past decades. One of the very few examples is β-$YbAlB_4$ with a superconducting transition at T_c = 80 mK[1]. Recently, magnetic and calorimetric measurements shows that $YbRh_2Si_2$ is another HF superconductor but with a T_c =2 mK[2].

Experimental

We have studied a Yb-based HF compound; the Kondo lattice $YbRh_3Si_7$, which exhibits metamagnetic transitions[3]. We used the 18 T magnet in SCM1 to measure electrical resistance in temperature range of 20 mK -- 1 K.

Results and Discussion

Transport measurement results for two samples of $YbRh_3Si_7$ are shown in **Fig. #1**. We observed a superconducting transition T_c at 360 mK in one sample and 480 mK in another sample. Superconductivity in this HF compound seems to be very fragile since the upper critical fields are very small compared to T_c while the superconducting transition temperature is sample dependent as observed in non-conventional superconductors such as URu_2Si_2. This would indicate an enormous coherence length with no clear renormalization of the upper critical fields (as one would expect for a heavy fermion superconductor). T_c on the other hand is pretty large if one compares, for instance, with $YbAlB_4$.

Conclusions

We have detected a clear superconducting transition with T_c~ 360 mK in one sample and 480 mK in two $YbRh_3Si_7$ samples. The upper critical fields seems to be very small compared to T_c values. The superconducting phase diagram is relatively well behaved.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. L.B. acknowledges support from DOE-BES through award DE-SC0002613.

References

[1] Nakatsuji, S., *et* al., Nature physics **4**, 603-607 (2008).
[2] Schuberth, E., *et* al., Science **351**, 485-488 (2016).
[3] Binod, K. R., *et* al., arXiv:1803.04013: PRX (in press)

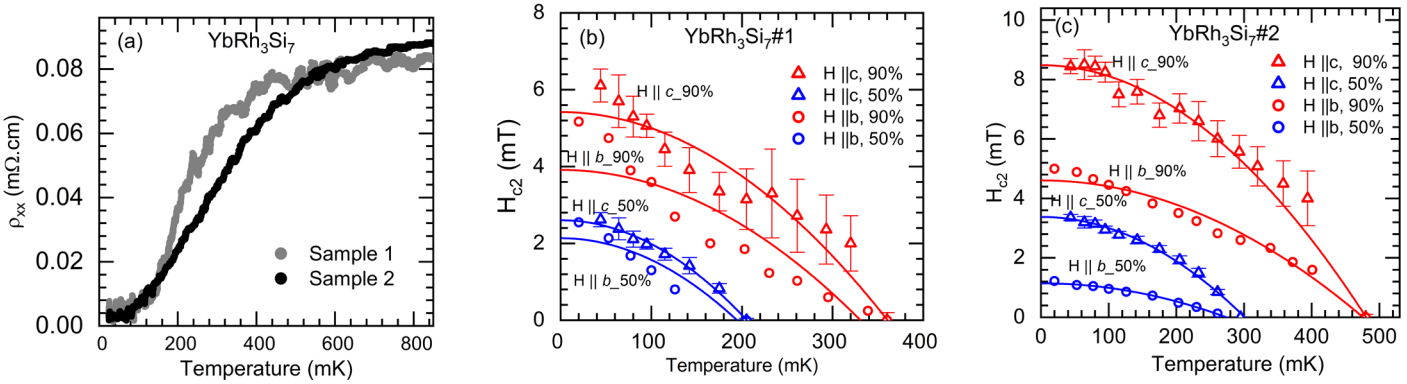

Fig.1 (a) Temperature dependence of the superconducting transition under zero field. A superconducting transition is observed at 360 mK and at 480 mK for samples 1 and 2, respectively. Upper critical fields H_{c2} as a function of the temperature for sample 1 (b) and sample 2 (c) following the criteria of 90% (red markers) and 50% (blue markers) of the value of the resistance of the normal state and respectively for fields applied along the b- (circle markers) or c-(triangle markers) crystallographic axis. Solid curves are fits to the Ginzburg-Landau expression.