PRELIMINARY STUDY OF THE HIDDEN ORDER TRANSITION IN URu$_{2-x}$Re$_x$Si$_2$

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Introduction

URu$_2$Si$_2$ exhibits a Hidden Order (HO) phase at low temperatures that remains unidentified. There is evidence for a 5f electronic configuration, a large effective mass and a $\Gamma_5$ doublet lowest lying crystal electric field level. We can say that there is a Heavy Fermi Liquid (HFL) composed of itinerant $\Gamma_5$ quasiparticles, coming from the hybridization between conduction electrons and 5f electrons. In a previous work it was observed that when doping with 4% of Rh the Hidden Order phase is not present and the phase diagram is simple, with a single field-induced phase (Phase II). We started now exploring the effect of Re-doping on the hidden order phase.

Experimental

Specific heat was measured in a 20T superconducting magnet at NHMFL-LANL between B=0T and B=18T (see Fig. 1). The magnetic contribution to the specific heat C shown below was obtained after subtracting the lattice contribution from previous measurements in ThRu$_2$Si$_2$.

![Specific heat C/T as a function of temperature after subtracting lattice contribution between 0 T and 18 T, for x=0.02(a) and for x=0.04(b). c) Resistance versus temperature at B=0, 12, and 18 T for both Re doping concentrations.](image)

**FIG. 1:** Specific heat C/T as a function of temperature after subtracting lattice contribution between 0 T and 18 T, for x=0.02(a) and for x=0.04(b). c) Resistance versus temperature at B=0, 12, and 18 T for both Re doping concentrations.

Results and Discussion

The hidden order transition is clearly present in both of them, and the size of the specific heat anomaly is comparable to that measured in pure URu$_2$Si$_2$. In these samples we found that the higher the Re concentration in the sample, the smaller the effect of the external field on the hidden order phase. From our low field (B < 18 T) measurements we estimate the magnetic field necessary to suppress the hidden order transition to be B = 36 T in pure URu$_2$Si$_2$, 43 T for the sample with x = 0.02, and 70 T when x = 0.04. These estimates have not been confirmed or ruled out yet by high field magnetization measurements since Re doping results in magnetization steps that are substantially washed out, making the determination of critical fields quite difficult.

Conclusions

These interesting results suggest the need for further exploration the effect of Re in the high field regime. We would like to know, for instance, what happens with the metamagnetic transition with increasing Re content and how does it interact with the hidden order phase.

Acknowledgements

This work was performed at NHMFL-LANL, and supported by US DOE Grant No. DE-FG03-03ER46036, by NSF Cooperative Agreement No. DMR-0084173 by the State of Florida and US DOE, and partially supported by NHMFL IHRP.