Angle-Dependent Magnetoresistance of $URu_{2-x}Fe_xSi_2$ Single Crystals

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Introduction

We continued to explore the system $URu_{2-x}Fe_xSi_2$ through angle-dependent measurements of magnetoresistance at high magnetic fields. Our goal was to determine whether the hidden order (HO) or other phases observed in $URu_{2-x}Fe_xSi_2$ could be perturbed by fields applied along the *ab*-plane of the single crystal. In Ref. 1, Scheerer *et al*. demonstrated that phases in the parent compound URu_2Si_2 only depend on magnetic field along the *c*-axis. In our investigation, we aimed to find out whether this was true across the entire Fe-substituted phase diagram.

Experimental

Electrical transport in single crystals of $URu_{2-x}Fe_xSi_2$ was measured in the 45 T hybrid magnet at NHMFL, FSU with a standard four-wire technique where voltage *V* was measured in the same direction as applied current *I* along the *ab*-plane. Samples of varying Fe concentration *x* were studied this way and the sample holder probe allowed rotation of the crystal's *c*-axis relative to the magnetic field *B*, described by angle θ. With multiple *x*, *B*, θ, and temperature *T*, we attempted a broad study of the phase diagram of $URu_{2-x}Fe_xSi_2$ where features in the magnetoresistance data could be identified as phase transitions, as shown in Fig. 1.

Results and Discussion

Our results showed that despite the large fields and high concentrations of Fe of the measured $URu_{2-x}Fe_xSi_2$ samples, the angle-dependent behavior was identical to that described in Ref. 1. This suggests that all *B*-dependent behavior of $URu_{2-x}Fe_xSi_2$ is actually dependent on the projection of the magnetic field *B* onto the *c*-axis ($B\cos\theta$). This behavior holds true across the entire phase diagram at all temperatures, even for the large moment antiferromagnetic (LMAFM) phase at large *x*. Fig. 2 shows a 3-D plot of this phase diagram which displays the evolution of the various phases as *x*, *T*, and B_z are changed.

Conclusions

Angle-dependent measurements of magnetoresistance of $URu_{2-x}Fe_xSi_2$ show that the several phases in this system are not influenced by magnetic field applied in the *ab*-plane. The phase diagram can be collapsed by adjusting the field to its projection along the *c*-axis; this phase diagram is in good agreement with prior results described in Ref. 2. The strict dependence of the phases of $URu_{2-x}Fe_xSi_2$ on B_z is consistent with studies showing the anisotropy of the system from the *g*-factor (Ref. 3) and the free energy (Ref. 4).

Acknowledgements

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References

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Figure 1:

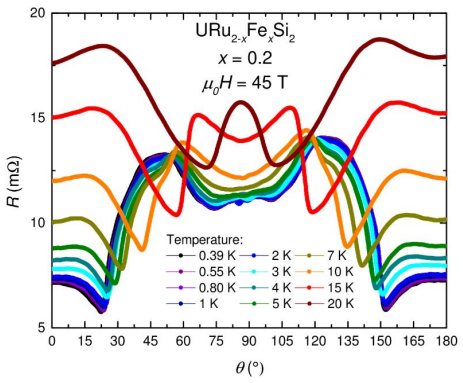

Figure 2: