Fermi Surfaces in the Antiferromagnetic Phase of GdSi

Y. Feng (Advanced Photon Source, Argonne Nat. Lab); D.M. Silevitch, N. Woo, T.F. Rosenbaum (James Franck Institute, Univ. of Chicago); A.V. Suslov (FSU, NHMFL)

Introduction

GdSi exhibits spin-density-wave (SDW) order arising from the cooperative interplay of sizeable local moments and a partially nested Fermi sea of itinerant electrons [1]. Here we probe the magnetic phase boundaries [2] together with shapes and sizes of the Fermi surface using both magneto-transport and de Haas van Alphen (dHvA) measurements with magnetic field directions aligned along all three major crystalline axes.

Experimental

Last year we used the 35T DC magnet in Cell 12. This year, we took more data with the 18-Tesla superconducting magnet in SCM2 together with a He3 probe and a sample rotator insert. Magneto-transport data was measured with a LS370 resistance bridge with a 3708 preamplifier. dHvA measurements were carried out using the torque cantilever technique with an AH 2700A capacitance bridge.

Results and Discussion

H-T phase diagrams of antiferromagnetic GdSi were mapped out up to 21 T, where the antiferromagnetic order is no longer stable, and for field directions along each of the three major crystal axes. The results were published in Ref. [2]. dHvA oscillations were measured in zones of the reciprocal lattice spanned by each pair of major axes. One series is shown in Fig. 1 with magnetic field aligned along the b-axis. From that, one could estimate sizes and shapes of the Fermi surface in three-dimension.

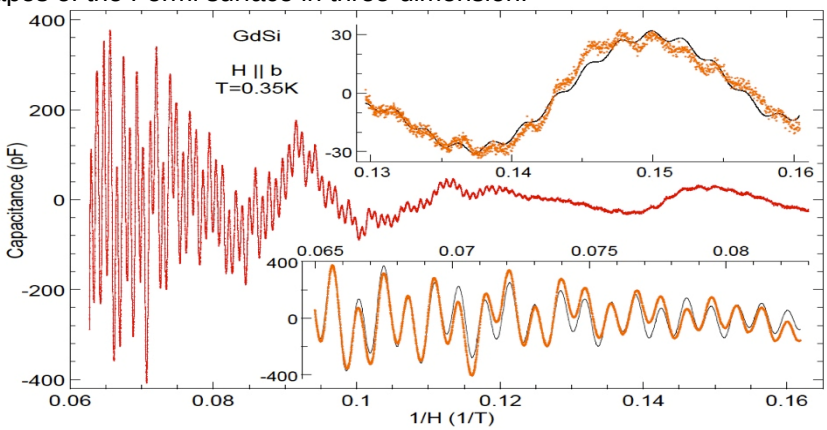

Fig. 1. dHvA oscillations of GdSi, plotted against the inverse field. The oscillations are mainly composed of two frequencies at high field with different damping rates. Only the low frequency wiggles are observed at low field. The existence of dHvA oscillations down to 6.25 Tesla testifies the high quality of our single crystal samples.

Conclusions

In the SDW phase, we found the Fermi surface of GdSi is composed of a couple of small pockets. This is consistent with the understanding that the SDW formation removes significant amount of density of states in the form of flat sheets at the Fermi surface.

Acknowledgements

The work at the Advanced Photon Source of the Argonne National Laboratory was supported by the U.S. DOE-BES under Contract No. DE-AC02-06CH11357. The work at the University of Chicago was supported by NSF Grant No. DMR-1206519 and used Materials Research Science and Engineering Centers shared facilities, NSF Grant DMR-0820054. Work at the NHMFL was done under NSF Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy.

References

[1] Feng, Y. *et al*., Proc. Nat. Acad. Sci. **110**, 3287-3292 (2013).
[2] Feng, Y. *et al*., Phys. Rev. B **88**, 134404 (2013), as an Editor's Suggestion.