High Pressure Studies of $CeIn_3$ in High Magnetic Fields

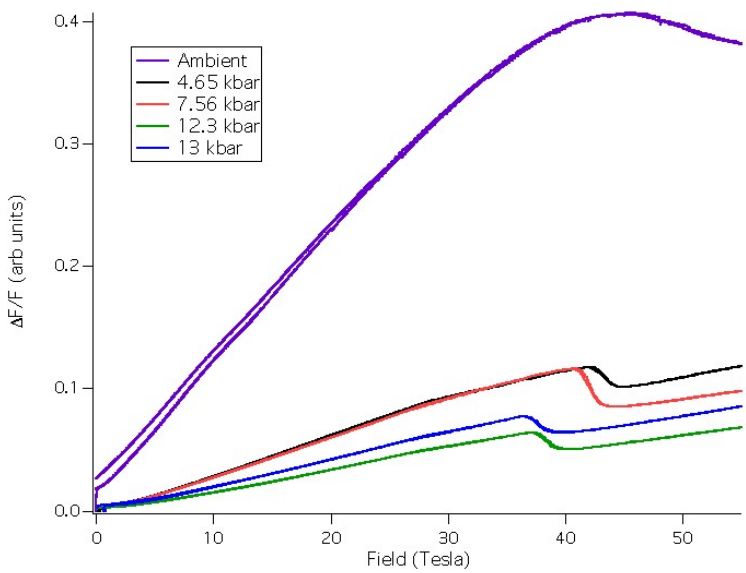
K.M. Purcell, S.W. Tozer (NHMFL-FSU); J.C. Cooley (LANL); R. Hu (Brown U, Physics);
R.D. McDonald (NHFML-LANL); C. Petrovic (Brookhaven Nat. Lab)

Introduction

$CeIn_3$ belongs to a family of Ce-based antiferromagnets that exhibit pressure-induced superconductivity in the vicinity of the critical pressure where the Neel temperature is suppressed to zero.[1] Understanding the interplay between antiferromagnetic and superconducting state requires detailed investigation of the electronic behavior within the Neel ordered phase. In this work, we study the pressure dependence of an observed anomaly in the skin depth if single crystal $CeIn_3$ within the Neel ordered phase utilizing the change in the resonant frequency of a tunnel diode oscillator (TDO).

Experimental

A single crystal $CeIn_3$ sample 70 microns thick and 400 micron in diameter was placed in resonant coil in a plastic diamond anvil cell in order to measure the pressure dependence of an observed anomaly in the skin depth. This experiment was performed in the 60 T Long Pulse magnet located at the pulsed field facility at NHMFL in a Helium-3 refrigerator.



Results and Discussion

The accompanying figure shows the normalized frequency as a function of field at 400 mK. A larger sample and coil were used for the ambient measurement, resulting in the obvious increase in signal. One can clearly see the anomaly in the skin depth at ~46 T and the decrease in field location with the application of pressure. The trend of the position of the anomaly with pressure suggests that with further increase in applied pressure, this anomaly will be suppressed to 0 T near the critical pressure where the Neel temperature is suppressed to zero and unconventional superconductivity appears.

Conclusions

This anomaly may prove to provide insight into the relationship between the antiferromagnetic and superconducting states and the nature of the f-electrons within the Neel ordered phase as antiferromagnetism is suppressed and unconventional superconductivity arises. Studies at higher pressure are underway at the DC Field Facility in Tallahassee with an interest in lower temperature measurements to investigate the nature of the Fermi surface at each side of this anomaly.

Acknowledgements

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References

[1] Mathur, N.D., et al. Nature **394**, 39-43 (1998)