Fermi Surface and Phase Diagram of Cein3 by the Tunnel Diode Oscillator Technique

W.A. Coniglio, R.L. Stillwell, S.W. Tozer (National High Magnetic Field Laboratory)

Heavy Fermion metal CeIn3 has a low temperature antiferromagnetic phase below 10 K, 2.6GPa, and 62 T. Within this phase also lies a Lifshitz transition at 45 T. The Fermi surface has been mapped by the de Haas von Alphen e_ect[1] and the resistive transitions have been observed using a tunnel diode oscillator.[2]

Following the plan laid out in magnet time request P02128-E013-PF, we endeavored to map out both the quantum oscillations (via the resistive Shubnikov de Haas e_ect) and transitions through their resistive signatures simultaneously over the entire temperature range of the antiferromagnetic phase. For this experiment, we took only ambient pressure data, saving high pressures for future work.

We conducted the experiment in the 62T short pulse magnet in Cell #1 using Ross McDonald's new rotating probe, which worked quite well almost immediately. We provided a few minor suggestions for the design, which will bene_t the user program directly with the probe's next iteration.

As will be discussed at the 2014 APS March Meeting, the presence of both the Lifshitz and N_eel transitions suppresses the resistive signature of the d-orbit oscillations between them, although the orbit remains intact in dHvA data. (See Fig. 1) The behavior is most striking in the temperature region where the N_eel transition is between 40 and 60 T, and increases in temperature reveal quantum oscillations at progressively lower _elds. We continue to work on the scienti_c implications of this work with a critical eye toward the di_erences in the way oscillations in the density of states a_ect magnetism and resistivity.

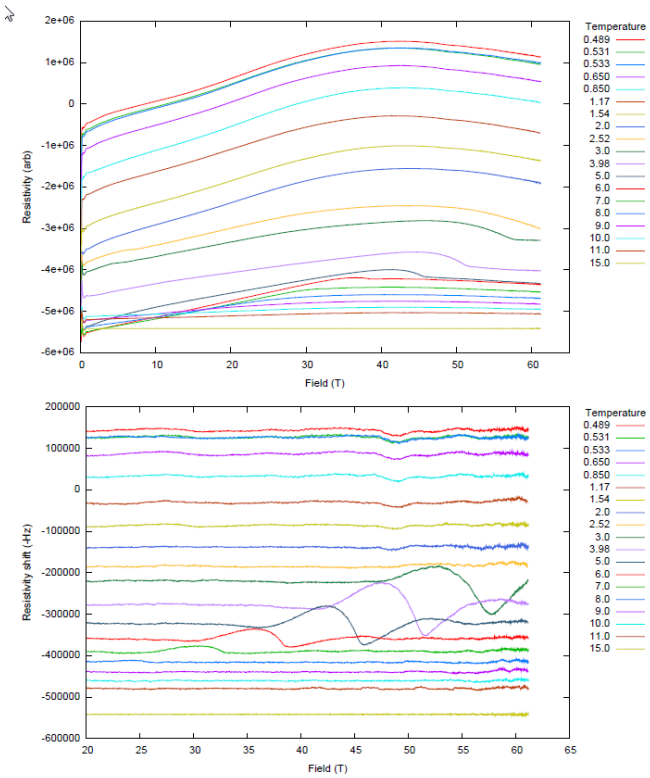

FIG. 1: Top: Frequency data from CeIn3 showing the Lifshitz and N_eel transitions. The smooth trend of the 15K dataset has been subtracted from each trace. Bottom: Subtracting the overall background trend from each trace reveals quantum oscillations, particularly the d-orbit at 3200 T.

Acknowledgement

We thank Chuck Mielke and NHMFL-LANL for generously supporting the cost of this 2.5 month trip and for providing magnet time and helium during a hectic fall. We appreciate the technical support of Red Schwartz, Vaughan Williams and the machine shop at NHMFL-Tallahassee as well as Jon Betts, Mike Pachecco, Billy Vigil, and the staff at NHMFL-LANL.

We appreciate ongoing support from the U.S. Department of Energy, NNSA SSAA DE-NA0001979. The National High Magnetic Field Laboratory is supported by National Science Foundation Cooperative Agreement No. DMR-0654118, the State of Florida, and the U.S. Department.