CeIn3 Fermi Surface Above 2 GPa (Antiferromagnetic and Paramagnetic)

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Background

The heavy fermion conductor $CeIn_3$ is a low temperature antiferromagnet with a Neel transition at 10 K, 2.6 GPa, and 62 T. Using pulsed fields, we have previously shown that Neél and Lifshitz transitions both introduce Fermi surface reconstruction, and the effective mass of the d-orbit as measured by Shubnikov de Haas oscillation is less in the paramagnetic phase by a factor of four. Our high-resolution resistivity probe is a tunnel diode oscillator that is mounted several centimeters from the pressure cell, which itself is in the rotation yoke of the probe. This configuration provides maximum sensitivity, as the resistivity of the sample is measured and converted to a robust frequency (100 MHz to 1 GHz) all at low temperature.

Results and Discussion

While we were able to detect quantum oscillations in the antiferromagnetic state at 1.5 GPa and probably at 2.15 GPa, they were only slightly above the noise floor, and we are unable to ascertain the effective mass. We did note that the Lifshitz transition appears under low temperatures at 39 T, confirming a previous pressure study.[1]

Additional Notes

Concurrently with the science, we were also able to investigate some advanced techniques for high magnetic field research. TDO measurements are known to react to NMR.[2] We are investigating the possibility of using available resonances for field calibration in DC and pulsed field experiments. Over the course of this experiment, we observed and identified resonances belonging to ^{1}H, ^{3}He, ^{13}C, ^{19}F, ^{63}Cu, and ^{65}Cu.

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References

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[2] C.C. Agosta, et al. J. Phy. Chem. Solids **67**, 586-589 (2006).

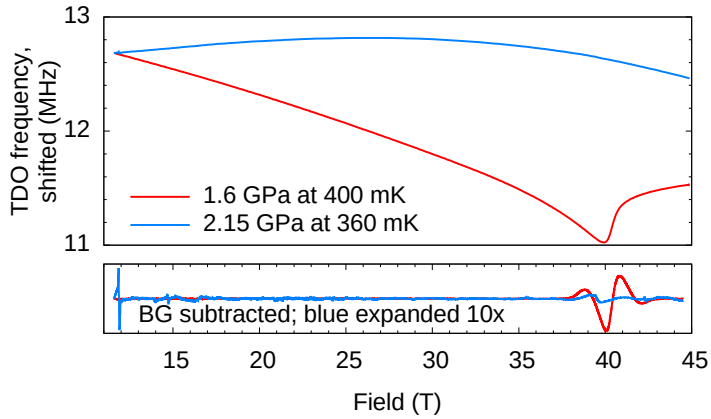

Figure 1: Base temperature TDO response of $CeIn_3$ at two pressures. At bottom, background subtracted traces, expanded for clarity. The Lifshitz transition remains at 40 T even though pressure has been used to drive the blue trace into the paramagnetic phase. Quantum oscillations exist in at least the red trace, although they are not discernible by eye. Visible NMR lines in the blue trace include ^{19}F (12 T), ^{3}He (14.8 T), ^{65}Cu (39.5 T; very faint), and ^{63}Cu (42.3 T).