Probing the Fermi Surface in Nd-Substituted $CeCoIn_5$

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Introduction

Heavy fermion systems, such as $CeCoIn_5$, continue to generate a great deal of interest due to the interplay between magnetism and superconductivity [1-2]. By tuning the Nd doping levels in $Ce_{1-x}Nd_xCoIn_5$ we can control the coupling of the 4f-conduction electrons and the evolution of the Fermi surface. This coupling results in coexisting magnetic and superconducting orders between x = 0.05 - 0.17 for temperatures below 1.4 K as evidenced in the phase diagram depicted in Figure 1 (taken from Ref. 1). Furthermore, according to prior studies the order parameters may be altered by applying a magnetic field [1].

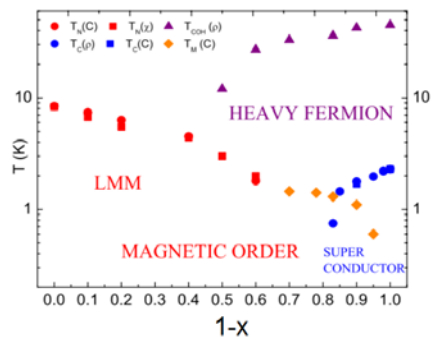

FIG. 1. Phase diagram at zero-field mapped out primarily using specific heat measurements indicating the Neel ordering temperature (T_N), Curie temperature (T_c), coherence temperature (T_{COH}), magnetic ordering (T_M), and local moment magnetic state (LMM). [1]

Experimental

A thin single crystal was placed on a capacitive beam cantilever to study the de Haas-van Alphen (dHvA) oscillations at low temperatures (below 4.2 K), allowing us to probe the evolution of the Fermi surface with varying doping levels. We used a rotating probe to extract the effective mass to compare with the parent compound as well as other substitutions. In addition to dHvA oscillations, complimentary NMR measurements are still in progress.

Results / Discussion / Conclusions

High field measurements conducted at the National High Magnetic Field Laboratory in Florida indicate dHvA oscillations are present for x=0.10 at T=1.45 K. The Fourier spectra, after the background subtraction, indicates frequencies of 19.6, 1018, and 2016 T. However, due to the signal-to-noise ratio, the only frequency that could be resolved over several angles was 19.6 T (see FIG. 2). Additional measurements using a larger sample and lower temperatures are necessary in order to better resolve the oscillations. Only doping levels below x=0.1 are predicted to show a magnetic transition below T_c, but in the future we also hope to test x=0.02 and study the temperature dependence of the effective mass to compare with the parent compound.

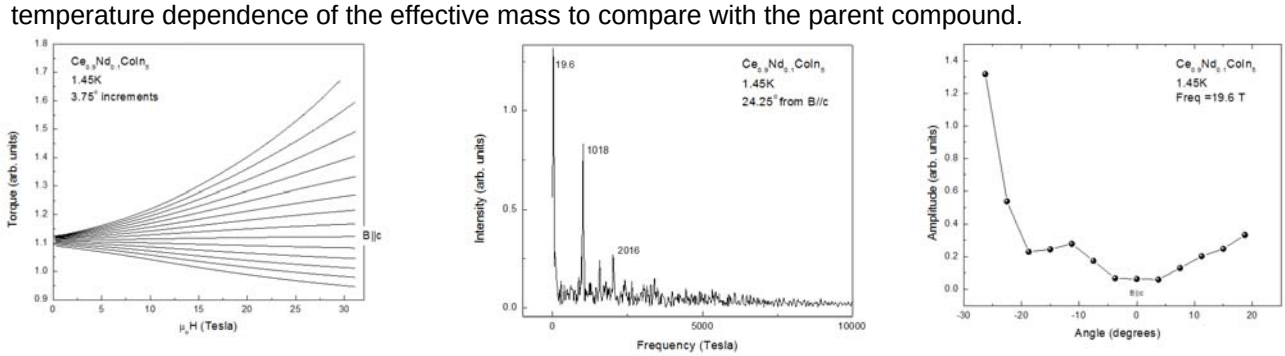

FIG. 2. (left) dHvA oscillations measured using a capacitive cantilever, rotating from B||c into a,b-plane at T=1.45 K. (middle) Background subtracted Fourier spectra 24.25o from B||c. (right) Angular dependence of the amplitude for the frequency of 19.6 T.

Acknowledgements

Part of this research was performed at the National High Magnetic Field Laboratory under NSF Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy and has been partially funded by the National Science Foundation (DMR-NSF-1005293) and Euromagnet II.

References

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[2] S. Raymond, S.M. Ramos, D. Aoki, G. Knebel, V. Mineev, and G. Lapertot, arxiv:1307.2592v1 (9 July 2013)