Investigations of Quantum Criticality in Ultra High Purity $Ce_2Rh_3Ge_5$ and $Ce_2Pt_3Si_5$: P02269-E001-DC

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Introduction

In order to develop an understanding of the correlated electron states in f-electron compounds, it is essential to investigate specimens with minimal disorder. In particular, the ability to measure the Fermi surface (e.g., by quantum oscillations) depends on sample quality. We recently synthesized high purity specimens of the heavy fermion antiferromagnets (HFAFM) $Ce_2Rh_3Ge_5$ and $Ce_2Pt_3Si_5$ at LANL (T_N = 5.5 K and 6.3 K, respectively). While $Ce_2Rh_3Ge_5$ exhibits a pressure driven quantum critical point at extremely low pressure (P_c ~ 5 kbar) [1], T_N for $Ce_2Pt_3Si_5$ is unchanged up to P < 15 kbar [2]. The contrasting P dependences between these seemingly similar HFAFMs is of interest because it may provide important clues for understanding what ingredients drive quantum criticality in f-electron systems. We performed experiments to measure quantum oscillations in both of these compounds, where possible FS differences might help to understand their contrasting behavior.

Experimental

Tunnel diode oscillator (TDO) measurements were performed for temperatures 0.33 K < T < 5 K, magnetic fields H < 35 T, and at several angles for $Ce_2Rh_3Ge_5$ and $Ce_2Pt_3Si_5$ at the DC magnetic field facility in Tallahassee.

Results and Discussion

While TDO measurements for $Ce_2Rh_3Ge_5$ do not reveal quantum oscillations, similar measurements for $Ce_2Pt_3Si_5$ uncover a well defined family of frequencies, which are related to different Fermi surface sections (Fig. 1). The lack of oscillations for $Ce_2Rh_3Ge_5$ is most likely related to sample quality: while the residual resistivity ratio (RRR) for $Ce_2Rh_3Ge_5$ is good (RRR = 30), the RRR > 100 for $Ce_2Pt_3Si_5$ is excellent. To address this issue, we are planning to refine our synthesis technique to produce higher quality crystals of $Ce_2Rh_3Ge_5$. In parallel, we are performing calculations to model the FS of $Ce_2Pt_3Si_5$ to compare to our experimental results. We expect that this effort will drive a better understanding of the HF antiferromagnetic state in $Ce_2Pt_3Si_5$.

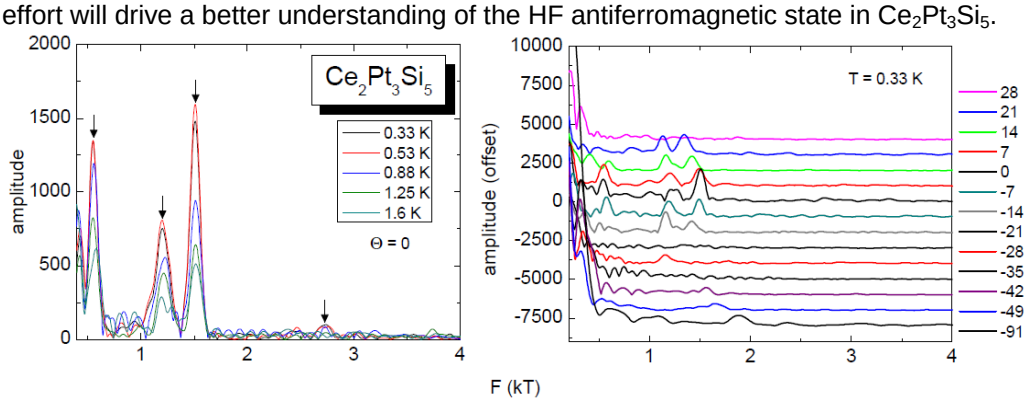

Fig. 1: Fourier transform of the oscillations in $Ce_2Pt_3Si_5$ at several temperatures at Θ = 0 (left panel) and at several different angles at T = 0.33 K (right panel) revealing different frequencies corresponding to Fermi surface sections.

Conclusions

We have measured quantum oscillations for the HFAFM $Ce_2Pt_3Si_5$. In order to compare to the closely related system $Ce_2Rh_3Ge_5$, we will continue synthesis experiments to produce higher quality specimens.

Acknowledgements

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References

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