Investigation of Shubnikov-de Haas Oscillations in Cd_3As_2 under Pressure

VanGennep, D.;[1] Chen K.-W.;[2] Graf, D.;[2] Tozer, S.W.;[2] Baumbach, R.;[2] Hamlin J.J.[1]
[1] Department of Physics;[2] National High Magnetic Field Laboratory

Introduction

Cd_3As_2 is a 3-D Dirac semimetal with an extremely large linear magnetoresistance at ambient pressure.[1] Recently, a pressure induced structural transition has been shown to lead to a breakdown the Dirac semimetal state and transition to a semimetallic state at at 2.6 GPa.[2] However, the pressure evolution of the electronic structure within the low pressure Dirac semimetal state has yet to be determined. We carried out a series of measurements of Shubnikov-de Haas oscillations in Cd_3As_2 at several pressures below 2 GPa.

Experimental

Hall and resistance measurements were performed on single crystals of $Cd3As_2$ at pressures up to 1.7 GPa, fields up to 18 tesla, and temperatures down to 1.5 K. The experiment was performed at the SCM-2 facility of the National High Magnetic Field Laboratory in Tallahassee.

Results and Discussion

Very clear quantum oscillations begin to emerge for fields as low as ~5 tesla. The presence of beats in the oscillation amplitude indicates the existence of two frequencies near 50 tesla. This is consistent with some earlier studies of Cd_3As_2 which show two frequencies for fields applied along certain crystallographic directions. The low frequency, nearness of the oscillation frequencies, and limited field range complicates the extraction of the exact values of the two frequencies and e.g. the masses.

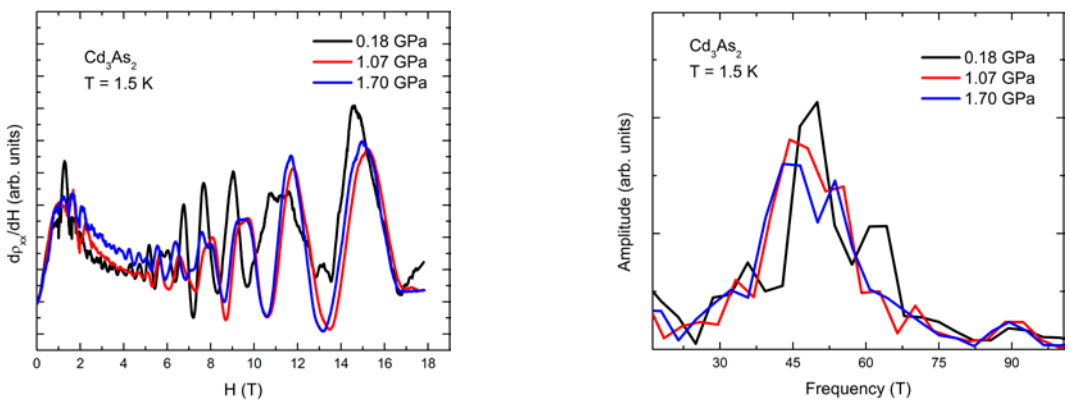

Fig. 1 Derivative of ρ_{xx} vs H (left) and FFT amplitude vs frequency (right) at selected pressures and 1.5 K.

Conclusions

The Fermi surface of Cd_3As_2 is rather insensitive to pressures up to ~1.7 GPa. This is consistent with the persistence of the very large magnetoresistance with pressure. Future studies as a function of angle or to higher fields could help to resolve the splitting.

Acknowledgements

A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy. DV and JJH acknowledge the National High Magnetic Field Laboratory's User Collaborative Grants Program (UCGP) for support.

References

[1] Jeon, S. *et al.*, Nat. Mat. **13**, 851-856 (2014)
[2] Zhang, S. *et al.*, arXiv, 1410.3213 (2014)