Extreme Magnetoresistance in Rare-Earth Monopnictides

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Introduction

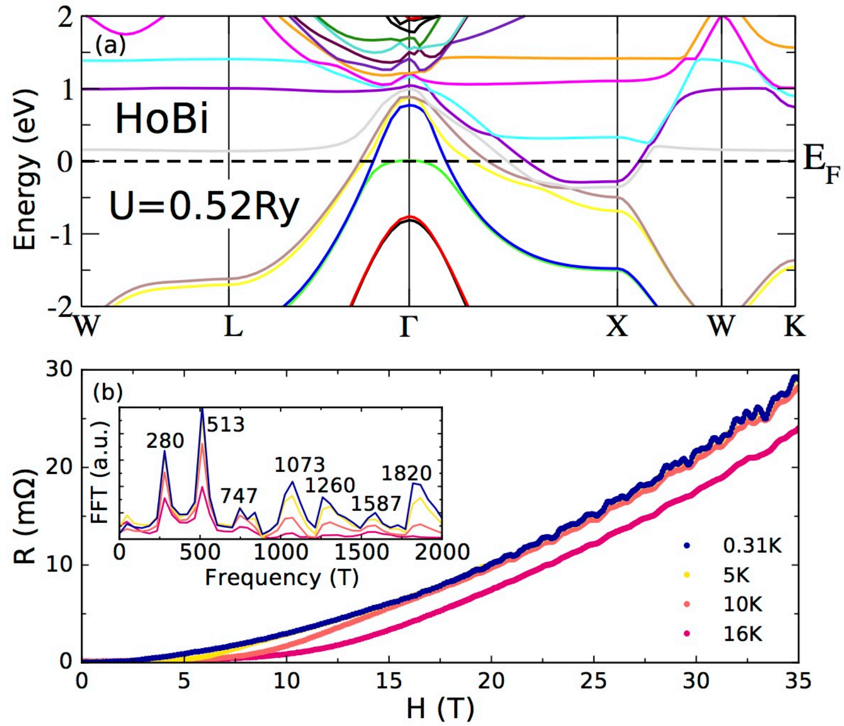
Extreme magnetoresistance (XMR) has been observed in non-magnetic semimetals. In this experiment, we revealed XMR in several magnetic rare-earth monopnictides including SmBi, HoBi, DyBi, and TbBi. We showed that (a) XMR exists in magnetic semimetals with the same magnitude as observed in non-magnetic systems, (b) it is directly controlled by the electron-hole compensation, and (c) it can be observed near the quantum limit.

Experimental

The experiment was performed at Tallahassee MagLab in Cell 9 using 31 T Bitter magnet with 50 mm bore diameter using a rotating sample stage. A top loading He-3 cryostat was used and four samples were measured in both resistivity and Hall configurations. A detailed analysis of quantum oscillation was performed and the results were published in PRB. Samples were grown in Tafti lab using flux method. Contacts were applied by H-20 silver epoxy.

Results and Discussion

The main objective of the experiment was to study quantum oscillations in HoBi and several related magnetic semimetals (SmBi, DyBi, TbBi). The oscillations appeared above 15 T so the 31 T magnet was perfectly suitable for this study. Six principal frequencies were observed in the Fourier transform including four hole and two electron pockets. The angle dependence of these frequencies gave a measure of the size and shape of the Fermi surfaces. We found effective masses of each pocket using Lifshitz-Kosevitch formula and compared the results to band structure calculations. The careful comparison of experimental data and theoretical results allowed us to understand the Fermi surface of these materials.



Conclusions

From the Fermi surface analysis of HoBi, we found a mixing between localized f- and itinerant d-states in the band structure that results in RKKY interactions responsible for antiferromagnetic ordering. We also found a close connection between transport and magnetic properties of these compounds. Specifically, HoBi shows several metamatgnetic (MM) transitions tuned by a magnetic field. The resistivity shows clear peaks at each MM transition. We showed that the magnetic phase diagram of HoBi can be mapped from its transport data. Such materials can be used as magnetic sensors especially at low temperatures. The results are published in PRB [1].

Acknowledgements

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References

[1] Yang, H.-Y. *et al*., Phys. Rev. B, **98**, 045136 (2018).