Unconventional Fermi surface in an insulating state

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Funding Grants: G.S. Boebinger (NSF DMR-1157490); S. E. Sebastian (ERC Grant Agreement 337425); L. Balicas (DOE-BES DE-SC0002613); G.Balakrishnan (EPSRC EP/L014963/1); N.Harrison (DOE-BES "Science of 100 Tesla"; G. G. Lonzarich (EPSRC EP/K012894/1).

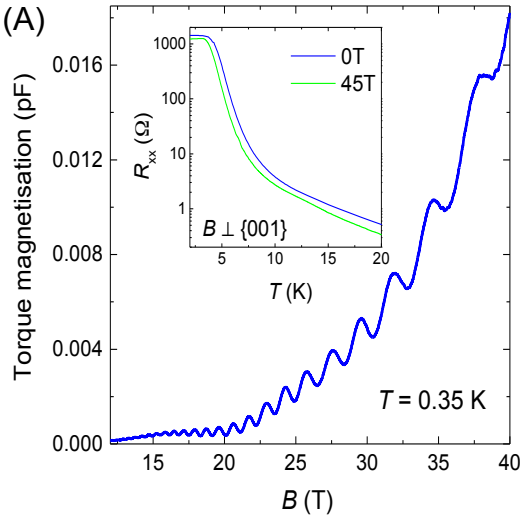
Samarium hexaboride, SmB_6, is a Kondo insulator at low temperatures due to an energy gap formed by collective hybridization between *d*- and *f*-electrons. Magnetic field measurements reveal a surprising finding of quantum oscillations arising from the insulating bulk of SmB_6 (Fig. A).

Electrical transport measurements find a strong insulating character of SmB_6, with a thousand-fold increase in resistance exhibited when the sample is cooled below 10K. However, using torque magnetometry in the 45 T hybrid magnet, quantum oscillations in the magnetization are clearly revealed, the angular dependence of which reveals a Fermi surface that corresponds to a large three-dimensional section occupying half the Brillouin zone (Fig. C).

Strikingly, at dilution refrigerator temperatures, the quantum oscillation amplitude measured as a function of temperature in SmB_6 deviates strongly from the well known Lifshitz-Kosevich form that is characteristic of fermionic quasiparticles in interacting metals (Fig. B).

The unconventional character of the SmB_6 ground state is therefore revealed by simultaneous electrically insulating behavior and quantum oscillations in the magnetisation, the temperature dependence of which deviates from the characteristic Lifshitz-Kosevich form universally observed in interacting metals.

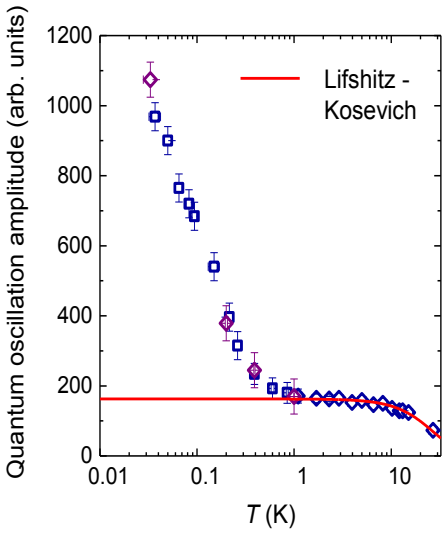
(A)



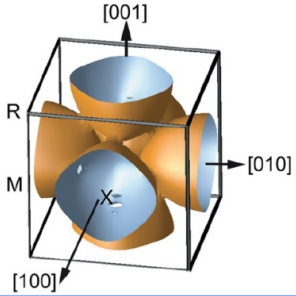
Quantum oscillations at 0.35K measured in magnetic fields to 40T in SmB_6; the inset shows electrical insulating behavior revealed by transport measurements in the same regime.

Temperature dependence of the quantum oscillation amplitude down to 0.035 K reveals a strong deviation from conventional metallic behavior.

(B)



(C)



The measured Fermi surface matches that of metallic rare earth hexaborides, equivalent to SmB_6 in which a substantial shift is made to the Fermi energy.

Facilities: 45 T hybrid & 35 T resistive magnets at DC field facility.

Citation: ***Unconventional Fermi surface in an insulating state***, B. S. Tan, Y.-T. Hsu, B. Zeng, M. Ciomaga Hatean, N. Harrison, Z. Zhu, M. Hartstein, M. Kiourlappou, A. Srivastava, M. D. Johannes, T. P. Murphy, J.-H. Park, L. Balicas, G. G. Lonzarich, G. Balakrishnan, S. E. Sebastian, **Science 349 (2015) 287-290.**