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.

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