Nontrivial topology in a kagome superconductor (KV_3Sb_5) probed by torque magnetometry up to 45T

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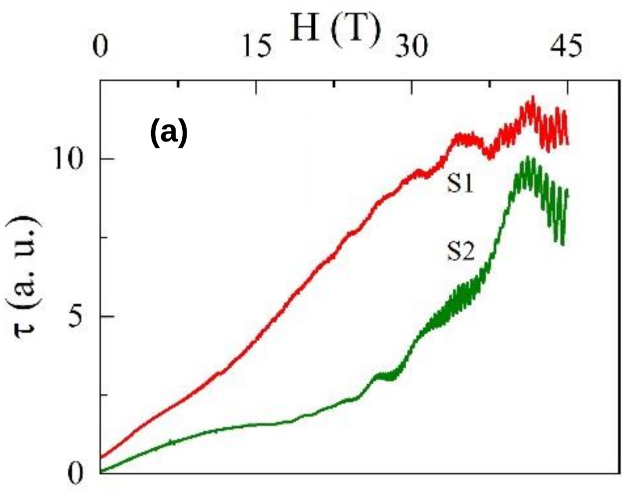
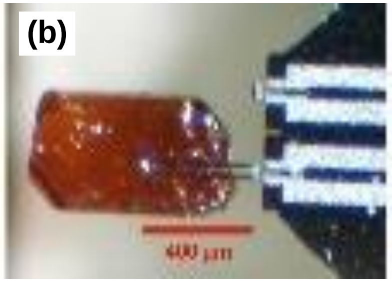
Topological materials represent a novel class of materials that holds promise for diverse applications in the development of powerful and efficient electronics. They possess highly conducting charge carriers that are both robust and insensitive to non-magnetic impurities, resulting in significantly enhanced efficiency compared to traditional conducting materials. Recently discovered Kagome compounds, AV_3Sb_5 (A = K, Cs, and Rb) exhibit multiple electronic orders, such as charge density wave, superconductivity, and non-trivial band topology; providing a suitable platform for interplay among these orders. A deeper understanding of CDW and SC in AV_3Sb_5 requires a thorough knowledge of the Fermi surface (FS), the physical construct that describes the energy and momentum of all of the highest energy electrons in the material. *Quantum oscillation measurements are one of the most effective methods to study the Fermi surfaces of materials and the magnitude of quantum oscillations increases exponentially with higher magnetic fields.*

MagLab users studied the FS of KV_3Sb_5 in the 45T hybrid magnet at temperatures down to 0.32K. Magnetic torque was measured using a miniature piezo-resistive torque magnetometer. To map the FS shape, the sample was rotated with respect to the applied field direction. The sample was then maintained at a fixed angle during field sweeps and this process was repeated for a number of temperatures.

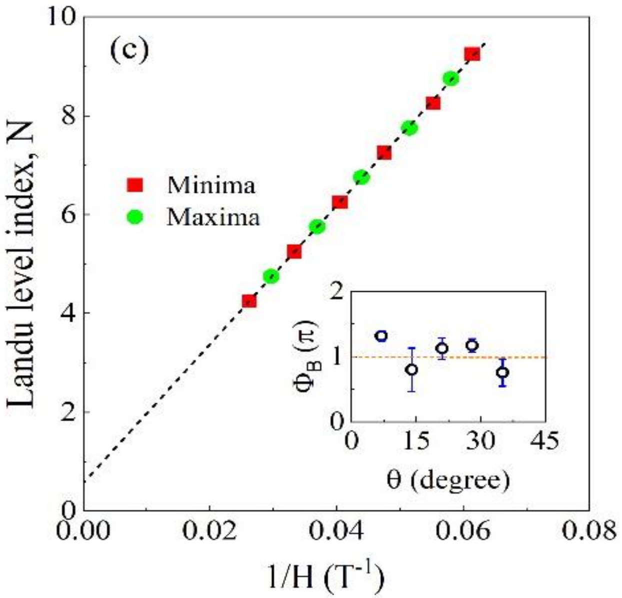
The torque signal up to 45T shows highly resolved oscillations with 14 frequencies ranging from 33T to 2149T, nine of which had not been previously reported. Angular dependence measurements of the dHvA oscillations and the Berry phase calculations showed that KV_3Sb_5 possesses a quasi-2D Fermi surface with non-trivial topology. *Understanding Fermi surface properties is crucial for understanding the charge density wave phase, the superconducting phase, and the nontrivial topology present in AV_3Sb_5, as well as the interplay among these three phenomena*.



(a) Magnetic torque vs magnetic field for two single crystals of KV_3Sb_5. Both samples show clear quantum oscillations with multiple frequencies above 20T. **(b)** A 0.4mm long sample mounted on a piezoresistive torque magnetometer.



(c) The Landau level fan diagram is constructed by assigning (N + 1/4) and (N − 1/4) to the minima and maxima of the oscillations, respectively. This is shown by the dashed line in the graph. The inset displays the angular dependence of the Berry phase (**Φ_B**), with a dashed line included as a guide for the eye. The value of **Φ_B** is nearly constant and approximately equal to π, confirming the non-trivial topology of this energy band in KV_3Sb_5.



Facilities and instrumentation used: 45T DC hybrid magnet system (Cell 15).

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