# Quasi-2D Fermi surface in the anomalous superconductor $UTe_2$

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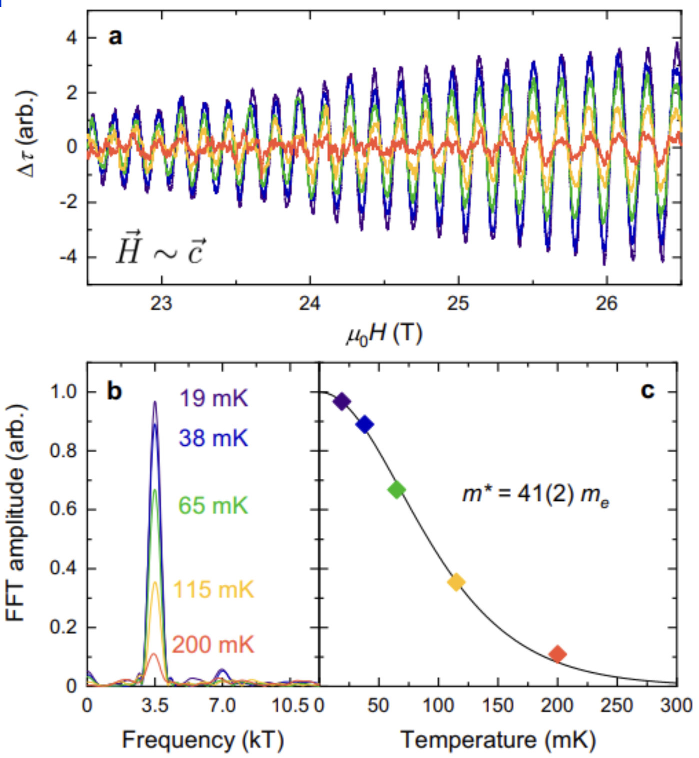
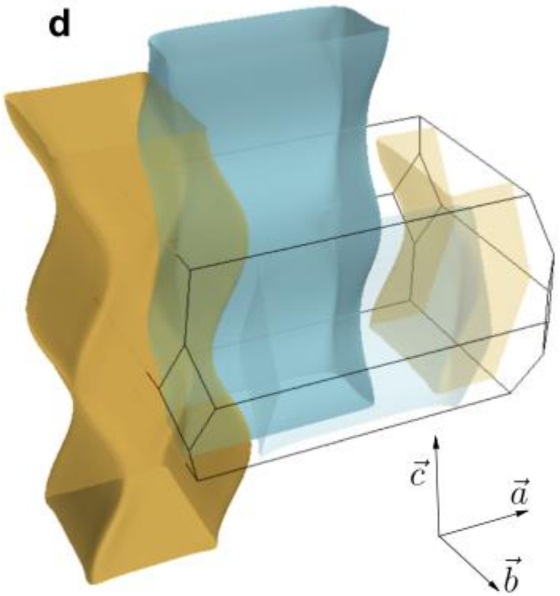
*Spin triplet superconductors are extremely rare in nature and are a promising avenue for next-generation topologically-protected quantum computation*. Furthermore, the spin-triplet superconductor $UTe_2$ exhibits a wealth of exotic physical phenomena, including a pair-density wave ground state and up to three distinct pressure- and field-induced superconducting phases. The key to understanding the underlying physical mechanisms of these exotic phenomena lies in attaining a detailed understanding of the normal state electronic properties. *Magnetic quantum oscillation measurements are a direct probe of a material's Fermi surface and effective quasiparticle masses but are challenging to perform as they require high magnetic field strengths and low temperatures to resolve the oscillations.*

MagLab users studied the Fermi surface of $UTe_2$ in the all-superconducting 32T magnet (SCM 4) using a dilution fridge sample space giving temperatures down to 19mK. These experiments were only possible using the world-unique sample environment of SCM 4, as the large superconducting critical field (~15T) necessitates access to high fields, and the heavy effective quasiparticle masses rapidly attenuate the oscillatory amplitude with increasing temperature.

The angular dependence of the quantum oscillations with respect to magnetic field tilt angle resolved a remarkably simple Fermi surface geometry, consisting of just two cylindrical sheets – in stark contrast to many other heavy fermion superconductors that typically feature multiple Fermi surfaces with complex shapes. *This surprising simplicity of the $UTe_2$ Fermi surface will greatly assist in refining our theoretical understanding of the origin of the numerous exotic physical phenomena exhibited by $UTe_2$, including the microscopic mechanism(s) underpinning its spin-triplet superconductivity.*




**(a)** Quantum oscillations in the magnetic torque of $UTe_2$. Oscillation colors correspond to the temperature of the measurement, as labeled in panel **(b)**. The amplitude of the quantum oscillations is plotted versus temperature in panel **(c)**, showing a rapid decrease in oscillation strength as the sample is warmed from 19mK to 200mK. This indicates an effective mass of 41 times the free electron mass, due to the extremely strong electron-electron interactions present in $UTe_2$.




**(d)** The Fermi surface of $UTe_2$. Unlike numerous other heavy fermion superconductors, $UTe_2$ has a very simple Fermi surface, consisting of just these two cylinders (colored orange and blue). This simplicity is very encouraging, as it suggests that accurate theoretical models of exotic $UTe_2$ superconductivity may soon be attainable.

**Facilities and instrumentation used:** 32T superconducting magnet system (SCM 4).
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