Multiple Superconducting Phases and Quantum Oscillations in Spin-Triplet Superconductor UTe_2

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Unconventional superconductivity in the heavy fermion paramagnet UTe_2 is one of the most exciting topics in strongly correlated electron systems[1]. Superconductivity is observed below T_c = 1.5-2.1K, with a large specific heat jump that suggests a strong coupling regime. The large, anisotropic upper critical field H_{c2} observed in UTe_2 is similar to that seen in ferromagnetic superconductors URhGe and UCoGe. However, while ferromagnetic fluctuations in UTe_2 have not been experimentally confirmed, antiferromagnetic fluctuations with an incommensurate q-vector have been directly detected via inelastic neutron scattering experiments. A key feature of UTe_2 is its field-reentrant superconductivity, which persists up to H_m = 35T when the field is applied along the b-axis of the orthorhombic structure. Another notable characteristic is the presence of multiple superconducting phases under pressure, suggesting different superconducting order parameters. These properties are consistent with a spin-triplet state due to the spin and orbital degrees of freedom. Determining the Fermi surface properties through quantum oscillation experiments with high-quality single crystals remains a crucial experimental objective. In this presentation, we will review our latest findings on UTe_2, emphasizing Fermi surfaces, multiple superconducting phases, and field-induced superconductivity.

[1] See a review paper, for example, D. Aoki, J. P. Brison, J. Flouquet, K. Ishida, G. Knebel, Y. Tokunaga, and Y. Yanase, J. Phys.: Condens. Matter 34, 243002 (2022).