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JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Seminar über Quanten-, Atom- und Neutronenphysik (QUANTUM)

Feb. 8, 2024 at 2 p.m.
IPH Lorentzraum 05-127

Prof. J.C. Séamus Davis
University of Oxford, Oxford, UK

Superconductive Topological Surface State Visualization in UTe2 and Attendant Pair Wavefunction Symmetry Determination

Although UTe2 appears to be the first 3D spin-triplet topological superconductor, its superconductive order-parameter Δ_k has not yet been established. If spin-triplet, it should have odd parity so that Δ_(-k)=-Δ_k and, in addition, may break time-reversal symmetry. A distinctive identifier of 3D spin-triplet topological superconductors is the appearance of an Andreev bound state (ABS) on all surfaces parallel to a nodal axis, due to the presence of a topological surface band (TSB). Moreover, theory shows that specific ABS characteristics observable in tunneling to an s-wave superconductor distinguish between chiral and non-chiral Δ_k. To search for such phenomena in UTe2 we employ s-wave superconductive scan-tip imaging of UTe2 [1] to discover a powerful zero-energy ABS signature at the (0-11) crystal termination [2]. Its imaging yields quasiparticle scattering interference signatures of two Δ_k nodes aligned with the crystal a-axis. Most critically, development of the zero-energy Andreev conductance peak into two finite-energy particle-hole symmetric conductance maxima as the tunnel barrier is reduced, signifies that UTe2 superconductivity is non-chiral. Overall, the discovery of a TSB, of its a zero-energy ABS, of internodal scattering along the a-axis, and of splitting the zero-energy Andreev conductance maximum due to s-wave proximity, categorizes the superconductive Δ_k as the odd-parity non-chiral B3u state [2], which is equivalent to the planar state of superfluid 3He.

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[1] Nature 618, 921 (2023)
[3] Gu, Wang, et al. Science (2023)