Search for topological superconductivity in UTe$_2$

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Topological superconductivity is a long-sought state of matter in bulk materials, and odd-parity superconductor UTe$_2$ is a prime candidate. UTe$_2$ possesses unusual phase diagrams for both applied pressure and magnetic field with both tuning parameters inducing additional superconducting phases. Further, several prior experiments provide evidence that the superconducting order parameter in UTe$_2$ is multicomponent and breaks time-reversal symmetry. Because UTe$_2$ has orthorhombic symmetry, proposals for its superconducting order parameter involve two nearly-degenerate irreducible representations (e.g., $B_{2u} + iB_{3u}$). Here, I will provide an overview of our efforts on improving UTe$_2$ crystal quality and the experimental search for topological superconductivity in this fascinating system. By applying symmetry-breaking uniaxial strain, we probe multicomponent superconductivity by looking for a splitting of the transition temperatures. We complement these efforts by performing measurements capable of probing whether the superconducting state breaks time-reversal symmetry on several UTe$_2$ samples - grown via two different techniques. Our results show no evidence for a spontaneous Kerr signal in zero field measurements. Although our results demonstrate that the superconducting state of UTe$_2$ does not intrinsically break time-reversal symmetry at zero pressure and field, future experiments will probe whether this occurs in other parts of the phase diagram.

Sean Thomas received his Ph.D. in Physics from the University of California at Irvine, in 2016. During his PhD he studied the topological Kondo insulator candidate SmB$_6$ and other strongly correlated systems. He later joined Los Alamos National Laboratory, in 2017. His main research interest is the characterization of strongly correlated quantum materials using a variety of techniques including electrical transport, thermal expansion, and torque magnetometry. Recently he has focused on using symmetry breaking uniaxial strain to understand emergent material properties.

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