MAR17-2016-001188

Abstract for an Invited Paper
for the MAR17 Meeting of
the American Physical Society

Topological nodal superconductivity in the heavy fermion metal UPt3[1]

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The concept of topological states of matter has captured the imagination of physicists in the last decade. Traditionally, such topological phases are predicted to occur in fully gapped insulating or superconducting materials and are characterized by topologically protected gapless excitations on the surface [1]. Recently, it has been realized that such protected surface states may also exist in certain classes of metallic materials with gapless bulk excitations. Here, I will demonstrate the application of this concept, focusing in particular on the low-temperature B-phase of the heavy fermion superconductor UPt_3. Josephson interferometry measurements provide strong evidence for the triplet, chiral pairing symmetry in UPt_3, which endow the Cooper pairs with orbital angular momentum $L_z = \pm 2$ along the c-axis [2]. Such pairing supports both line and point nodes in the superconducting gap, and we show that both types of nodal quasiparticles possess nontrivial topology in the momentum space. In particular, the point nodes located at the intersections of the closed Fermi surfaces with the c-axis act as the double monopoles and anti-monopoles of the Berry curvature [3]. Consequently, we predict that the B phase of UPt_3 should support an anomalous thermal Hall effect, various magneto-electric effects such as the polar Kerr effect, in addition to the topologically protected Majorana Fermi arcs on the (1,0,0) and (0,1,0) surfaces [3]. At the transition from the B-phase to the A-phase upon increasing temperature, the time reversal symmetry is restored, and the surface Fermi arcs disappear. The effect of quenched disorder on the topologically non-trivial B-phase will also be discussed.

References:
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[1]This research is supported by NSF grant no. DMR-1350237