The Cautionary Tale of Superconductivity in $PrOs_4Sb_{12}$

By many accounts superconductivity at 1.85 K in $PrOs_4Sb_{12}$ appears to be unconventional. As in other heavy fermion superconductors the large entropy associated with the fluctuations that generate the large effective mass in the normal state are clearly incorporated into the superconducting condensate. Furthermore, the presence of a high-field antiferroquadrupolar phase near the superconducting state suggests the importance of electric quadrupolar fluctuations. Early reports claimed multiple superconducting transitions, but this was later determined to be extrinsic. There are contradicting reports from thermal transport, penetration depth, μSR, NQR, and STM of nodal and fully gapped behavior of the superconducting state. Most strikingly, both μSR and polar Kerr measurements find evidence for broken time reversal symmetry onsetting at T_c, thereby setting the stage for possible time-reversal symmetry breaking topological superconductivity. Here we report a quadratic strain dependence of T_c in cubic $PrOs_4Sb_{12}$ along both [100] and [110] directions. This dependence, together with a lack of splitting of the transition, implies a single component order parameter, which is incompatible with the reports of broken time reversal symmetry. We further argue that $PrOs_4Sb_{12}$ is in fact an excitonic enhanced conventional superconductor. This opens the question as to what mechanisms can produce time reversal symmetry breaking onsetting at T_c, and/or transport and thermodynamic signatures that mimic nodal behavior. More broadly, it begs the question of how much can we confidently conclude about the superconducting gap structure from similar results in other systems?