Magnetization signature of topological surface states in a superconductor

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Abstract

Superconductors with non-trivial band structure topology represent a class of materials with potentially useful properties for quantum technologies. Recent years have seen much success in creating artificial hybrid structures exhibiting main characteristics of two-dimensional (2D) topological superconductors. Yet, bulk materials known to combine inherent superconductivity with nontrivial topology remain scarce, largely because distinguishing their central characteristic – topological surface states – proved challenging due to a dominant contribution from the superconducting bulk. I will present our recent work [1] where we found a highly anomalous behaviour of surface superconductivity in a topologically nontrivial 3D superconductor In_2Bi. Topologically protected surface states in this material result from its nontrivial band structure, which itself is a consequence of the non-symmorphic crystal symmetry and strong spin-orbit coupling. In contrast to smoothly decreasing diamagnetic susceptibility above the bulk critical field H_{c2}, as seen for surface superconductivity in conventional superconductors, we observe near-perfect, Meissner-like screening of low-frequency magnetic fields nearly up to the critical field of surface superconductivity, H_{c3}. We show that the anomalous screening and finite bulk diamagnetism above H_{c2} result from the contribution of superconducting topological surface states. Our experiments demonstrate the possibility to detect such states using macroscopic magnetization measurements, providing a new tool for discovery and identification of topological superconductors.

References

[1] W. Kuang et al, *Adv. Mater.* **33** (2021) 2103257.

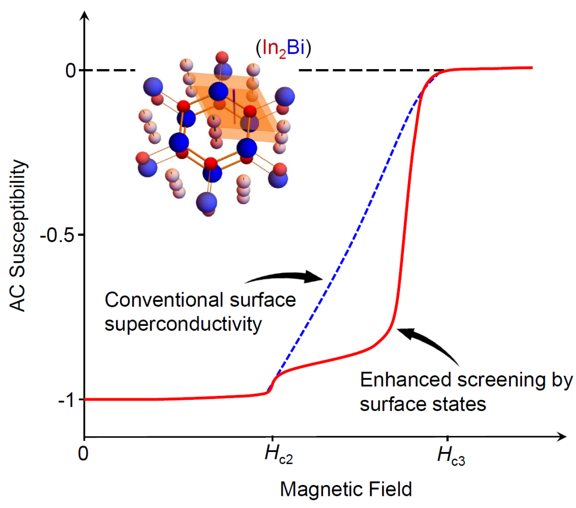

Figure 1: Crystal structure of In_2Bi and schematic magnetic susceptibility illustrating the contribution from topological surface states.