Superconductivity with two-fold symmetry—new evidence for topological superconductor SrxBi2Se3

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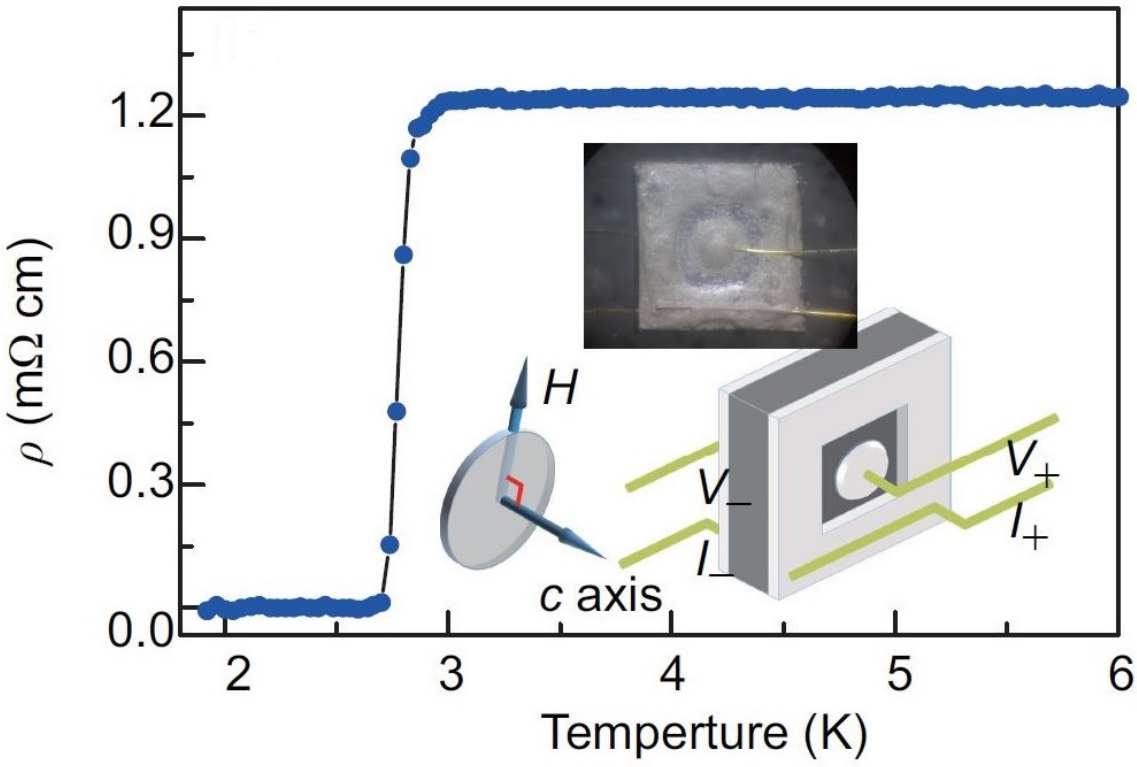
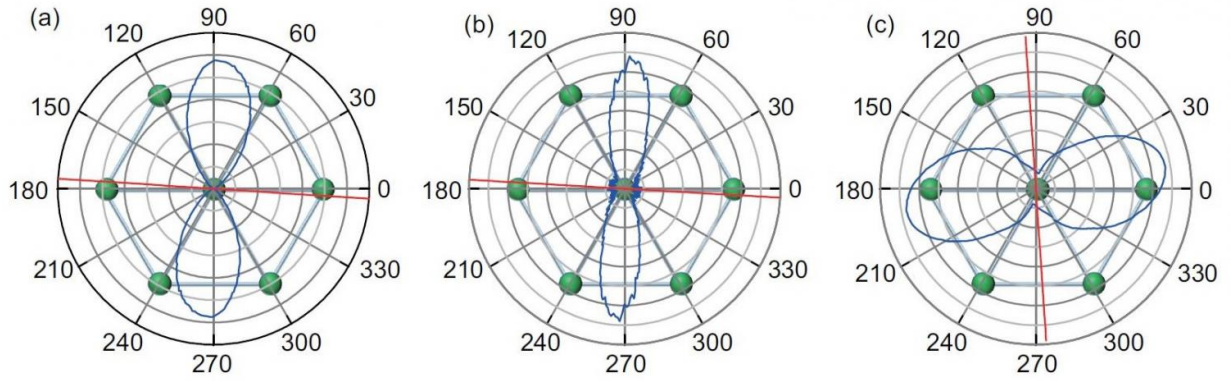


Temperature dependence of resistivity of S1 at zero field. The insets show the photograph of S1 with the electrodes (above) and the Corbino-shape like electrode configuration (below). Credit: ©Science China Press

The study of topological superconductors (TSCs) is a hotspot in the field of condensed matter physics, and has drawn great attention in recent years. Now, Prof. Hai-Hu Wen's group from Nanjing University has succeeded in detecting the two-fold symmetry of superconductivity in $Sr_xBi_2Se_3$, which provides new evidence for the argument that $Sr_xBi_2Se_3$ is a TSC.

The corresponding paper is published on *Science China Physics, Mechanics & Astronomy*. The researchers detected the c-axis resistivity measured on high-quality $Sr_xBi_2Se_3$ single crystals by using the Corbino-shaped electrode with the magnetic field rotating in the basal plane. With this configuration, the vortex contribution to resistivity is supposed to be the same for any angles and the intrinsic information of the superconductivity can be obtained.

Topological superconductors (TSCs) exhibit novel quantum phases. The unconventional superconductivity in TSCs cannot be connected to a topological trivial phase adiabatically without closing the superconducting gap. As a consequence, a TSC is supposed to possess robust, gapless excitations on the boundary or surface. Because of the particle-hole symmetry of superconducting states, the excitation at zero energy is composed of same weight of electrons and holes. Such a zero energy excitation satisfies the requirement of the Majorana fermion, whose antiparticle is identical to itself. The Majorana fermions in TSCs have various exotic phenomena and can help to realize topological quantum computation.



The analysis of orientation of the two-fold resistivity. The blue curves in (a)-(c) are the angular dependence of the resistivity data for S1-S3 respectively, measured at 1.9 K and 0.5 T. The red lines indicate θmin direction for each sample. The green balls here represent the Se atoms on the terminated layer. Credit: ©Science China Press

Doping-induced superconductors from topological insulators are predicted to be topological superconductors by theorists. Prof. Ando's group studied these materials via point contact tunneling measurements and proved that the superconductivity of the materials was consistent with the expectation of TSC. However, some other groups drew the opposite conclusion in scanning tunneling spectroscopy (STM) studies.

This researchers performed the c-axis resistivity measurements with an angle-dependent, in-plane magnetic field on four $Sr_xBi_2Se_3$ samples with the Corbino-shaped electrode configuration. Dramatic two-fold symmetry features were observed in all the angular dependent resistance measurements at low magnetic fields and temperatures. This is consistent with the earlier experiments by NMR and angle resolved magnetocaloric measurements. Prof. Fu modulated the theoretical

calculation and stated that the two-fold symmetry indicated the nontrivial topological order of the superconductivity in $Sr_xBi_2Se_3$.

"This research provides evidence of topological superconductivity in $Sr_xBi_2Se_3$," said the researchers, "and also widens and deepens our understanding of the topological superconductivity."

More information: Guan Du et al, Superconductivity with two-fold symmetry in topological superconductor $Sr_xBi_2Se_3$, *Science China Physics, Mechanics & Astronomy* (2017). DOI: 10.1007/s11433-016-0499-x

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