"Nematic superconductivity in intercalated Bi$_2$Se$_3$ systems"

Shingo Yonezawa, Kyoto University

Abstract: Unconventional superconductivity is characterized by the spontaneous symmetry breaking of the superconducting gap function in addition to the ordinary gauge-symmetry breaking. Recently, superconductivity with rotational-symmetry breaking in the gap amplitude or in the spin part of the order parameter has been termed as "nematic superconductivity" [1], and has been attracting much attention as a new-class of superconducting states with novel symmetry breaking.

Nematic superconducting nature in Cu$_x$Bi$_2$Se$_3$ has been first observed in the spin part of the superconducting order parameter by using the NMR technique [2], and subsequently in the superconducting gap amplitude by using the field-angle-resolved calorimetry [3]. Almost simultaneously to Ref. [3], nematicity in the upper-critical field of Sr$_x$Bi$_2$Se$_3$ investigated by magnetoresistivity [4] and in vortex-pinning anisotropy of Nb$_x$Bi$_2$Se$_3$ observed by torque magnetometry [5] has been also reported. More recently, nematic nature in these doped Bi$_2$Se$_3$ systems has been reported by other groups [6,7]. The observed nematic nature of superconductivity in doped Bi$_2$Se$_3$ is consistent with the $E_u$ representation states (the so-called $\Delta_{4x}$ and $\Delta_{4y}$ states), which have been theoretically proposed [8]. However, there remain some issues; in particular, it has not been settled which of the $\Delta_{4x}$ and $\Delta_{4y}$ states are actually realized. For example, the NMR study [2] favors the $\Delta_{4x}$ state but the calorimetry [3] favors the $\Delta_{4y}$ state. A recent experiment on Sr$_x$Bi$_2$Se$_3$ suggest that the favored states are actually sample dependent [6].

In this presentation, we explain our magneto-calorimetry study on Cu$_x$Bi$_2$Se$_3$ [3] and compare and discuss results reported by various groups.


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