

Anomalous Cooper pair interference through proximity-effect-induced superconducting surface of Bi_2Te_3 , a sign of 2π Berry phase for helical superconductivity

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It is believed that the edges of a chiral p-wave superconductor host Majorana modes, relating to a mysterious type of fermions predicted seven decades ago. Much attention has been paid to search for p-wave superconductivity in solid-state systems, including recently those with strong spin-orbit coupling. However, smoking-gun experiments are still awaited. Previous phase-sensitive measurements show only s-wave-like signature of superconductivity [1]. In this work, we have performed phase-sensitive measurements on particularly designed superconducting quantum interference devices constructed on the surface of topological insulators Bi_2Te_3 , in such a way that a substantial portion of the interference loop is built on the proximity-effect-induced superconducting surface. Two types of Cooper interference patterns have been recognized at low temperatures. One is s-wave like and is contributed by a zero-phase-loop inhabited in the bulk of Bi_2Te_3 . The other, being identified to relate to the surface states, is anomalous for that there is a phase shift between the positive and negative bias current directions. The results support that the Cooper pairs on the surface of Bi_2Te_3 have a 2π Berry phase which makes the superconductivity p_x+ip_y -wave-like [2]. Mesoscopic hybrid rings as constructed in this experiment are presumably arbitrary-phase loops suitable for studying topological quantum phenomena.

[1] *Strong superconducting proximity effect in Pb-Bi₂Te₃ hybrid structures*, F. M. Qu, F. Yang, J. Shen, Y. Ding, J. Chen, Z. Q. Ji, G. T. Liu, J. Fan, X. N. Jing, C. L. Yang, L. Lu, *Scientific Reports* 2, 339 (2012).

[2] *Anomalous Cooper pair interference on Bi₂Te₃ surface*, Jie Shen, Yue Ding, Yuan Pang, Fan Yang, Fanming Qu, Zhongqing Ji, Xiunian Jing, Jie Fan, Guangtong Liu, Changli Yang, Genghua Chen, and Li Lu, arXiv:1303.5598v3.