中央大學物理學系
Department of Physics, National Central University

Colloquium

Superconductivity of topological states induced by proximity and Josephson coupling

Prof. Tai Chang Chiang(江台章教授)

Professor Emeritus and Research Professor, Department of Physics, University of Illinois at Urbana-Champaign
Yushan Fellow, Dept. of Physics, NCU

Date: 2026/05/19 (Tue)
Venue: S4-625
Time: 14:00

Abstract :
Junctions of superconductors with metals and insulators have attracted great interest as building blocks for devices and qubits relevant to quantum computation. Such junctions involving topological materials are especially interesting where spin-polarized and topologically-protected surface states can be exploited. We have experimented with various ultrathin epitaxial films of topological insulators (TIs) of the M2X3 family prepared on superconducting substrates (Nb) by a novel flip-chip technique. The electronic structure of the TI films, including the bulk and surface states and their superconducting gaps, is measured by angle-resolved photoemission spectroscopy (ARPES) and scanning tunneling microscopy (STM). Films of Bi2Se3 and Sb2Te3 are naturally n- or p-doped and hence metallic, and their bulk and surface states are both superconducting with the same gap arising from proximity coupling to the Nb. With care, we have succeeded in preparing insulating films ((Bi1−xSbx)2Te3 and Bi2Te3) on Nb. Having no bulk carriers, Bi2Te3/Nb nevertheless shows a superconducting gap in the topological surface states. This gap, much smaller and invisible to ARPES but detectable by STM, follows a totally different dependence on the film thickness. The results suggest Josephson coupling arising from pair tunneling through the Bi2Te3 insulating bulk. We have thus created a SIS* Josephson junction (S = superconducting Nb, I = insulating bulk Bi2Te3, and S* = superconducting topological surface states of Bi2Te3). The S* component here is unusual as it is spin-polarized and two-dimensional with a minimal thickness. Opportunities for further experimentation and application involving topological superconductivity will be discussed.

In collaboration with Joseph A. Hlevyack, D. Flötotto, Meng-Kai Lin, Ro-Ya Liu, J. N. Eckstein, Sahand Najafzadeh, Shik Shin, Kozo Okazaki, Syu-You Guan, Tien-Ming Chuang, et al.