Probing Topological Materials with Spin-, Time-, and Angle-Resolved Photoemission Spectroscopy

H. Xiong[1,2], J.A. Sobota[1,2,3], H. Soifer[1,2], A. Gauthier[1,2], S.-L. Yang[1,2], C. Jozwiak[3], K. Gotlieb[3,4], A.F. Kemper[3,5], Y.-F. Chen[6], C.R. Rotundu[2], R.J. Birgeneau[3,4], M.-H. Lu[6], Z. Hussain[3], D.-H. Lee[3,4], D. Lu[2], M. Hashimoto[2], A. Lanzara[3,4], P. S. Kirchmann[2], Z.-X. Shen[1,2]

[1] Stanford University, Stanford, CA 94305, USA
[2] SLAC National Accelerator Lab, Menlo Park, CA 94025, USA
[3] Lawrence Berkeley National Lab, Berkeley, CA 94720, USA
[4] University of California, Berkeley, CA 94720, USA
[5] North Carolina State University, Raleigh, NC 27695, USA
[6] Nanjing University, Nanjing, Jiangsu 210093, China

Topological insulators have been the focus of intense investigation because of their unique spin-polarized surface states. Here we present detailed studies of two relevant materials: (1) We use laser-based ARPES to study the band structure of the potential topological insulator $ZrTe_5$. We find a small gap between the conduction and valence bands, which suggests that it is not a strong topological insulator. In addition, the bands exhibit a temperature-dependent binding energy shift which we associate with a variation of doping level. (2) We use time- and spin- resolved ARPES to study unoccupied states of the prototypical topological insulator Bi_2Se_3. We identify a surface resonance which is distinct from the topological surface state, yet shares a similar spin-orbital texture. Calculations show that these two distinct states can emerge from trivial Rashba-like states that change topology through the spin-orbit-induced band inversion.