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Passage from Spin-Polarized Surface States to Unpolarized Quantum Well States in Topologically Nontrivial Sb Films GUANG BIAN, University of Illinois at Urbana-Champaign, THOMAS MILLER, University of Illinois, TAI-CHANG CHIANG, University of Illinois at Urbana-Champaign, CNL TEAM
— Topological insulators, which possess robust gapless surface states as a result of strong spin-orbit coupling, have attracted much interest because of their unusual surface spin structures. When such materials are reduced to ultrathin films, the spin-split surface states must connect, by analytic continuation, to quantum well states, which are spin-unpolarized in centrosymmetric systems. We report herein a combined experimental and theoretical study of this passage from polarized to unpolarized states in Sb films. Bulk Sb is semimetallic with a negative band gap; nevertheless, it shares the same topological order as $Bi_{1-x}Sb_x$ ($0.07< x< 0.2$), the first material identified as a three-dimensional topological insulator. Angle-resolved photoemission (ARPES) from Sb films, aided by first-principles calculations, shows smooth dispersion relations associated with this passage; the spin polarizations of the two states fade away, while the energy splitting is maintained through the emergence of different charge density patterns of the resulting quantum well states.

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