Tuning the Surface States of Ultra-thin Topological Insulator Films

JIANXIN ZHONG, Xiangtan University — In this talk, I will introduce our recent progress on tuning the surface states of ultra-thin topological insulator films. Using first-principles methods, we explain the puzzling band-topology difference between Sb$_2$Se$_3$ and Bi$_2$Se$_3$ and propose an approach to tuning the topological phase by strain [1]. We demonstrate that Sb$_2$Se$_3$ can be converted into a topological insulator by applying compressive strain while the tensile strain can turn Bi$_2$Se$_3$ into a normal insulator. I will also show that the separation distance between quintuple layers (QL) in ultra-thin Bi$_2$Se$_3$ and Bi$_2$Te$_3$ films have a large increase after relaxation, leading to gap-opening at the surface Dirac cone, in good agreement with the experimental observation [2]. I will further show that Pb adlayers on Bi$_2$Se$_3$ result in splitting of the Dirac cones and large Rashba spin splitting of the quantum well states [3]. Most importantly, the quantum size effect of Pb adlayers leads to an oscillatory behavior of the Rashba splitting.


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