# Quantum Spin Hall Effect in IV-VI Topological Crystalline Insulators

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We predict the Quantum Spin Hall Effect in (111)-oriented thin films of SnSe and SnTe topological crystalline insulators [1]. Using a tight-binding approach supported by first-principles calculations of the band structures we demonstrate that in these films the energy gaps in the two-dimensional band spectrum depend in an oscillatory fashion on the layer thickness. These results as well as the calculated topological invariant indexes and edge state spin polarizations show that for films ~ 20–40 monolayers thick a two-dimensional topological insulator phase appears. In this range of thicknesses in both, SnSe and SnTe, (111)-oriented films edge states with Dirac cones with opposite spin polarization in their two branches are obtained. While in the SnTe layers a single Dirac cone appears at the projection of the $\Gamma$ point of the two-dimensional Brillouin zone, in the SnSe (111)-oriented layers three Dirac cones at $M$ points projections are predicted.

[1] S. Safaei, M. Galicka, P. Kacman and R. Buczko, arXiv:1501.04728 [cond-mat.mtrl-sci]

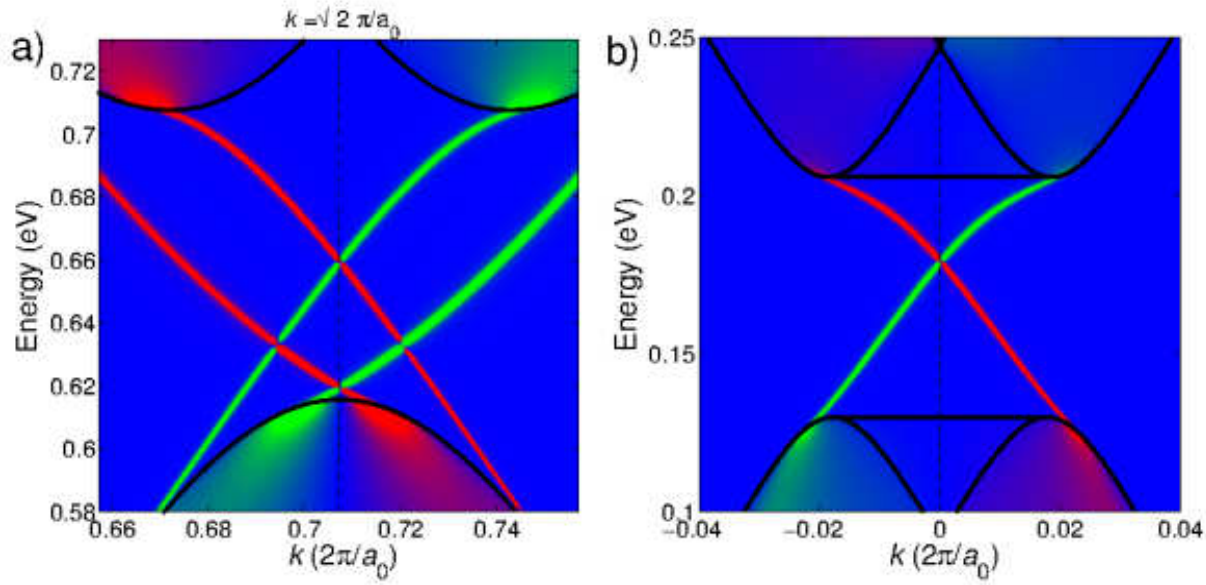


Fig.1 The (111)-oriented film edge spectral functions in the vicinity of the 1D BZ point (a) $k_x=\sqrt{2}\pi/a_0$ in 21-monolayer thick anion-terminated SnSe film; (b) $k_x=0$ in 18-monolayer thick SnTe film. Black lines denote local extrema of the 2D bands projected to the edge. Red and green lines represent the spin-down and spin-up polarization, respectively.