Condensed Matter Physics Seminar

Band structure engineering in three-dimensional topological insulators

Thursday

November 17

4:00 P.M.

Rm 184 NSH

Dr. Lukasz Plucinski

Peter Grünberg Institute PGI-6 and JARA-FIT

Three-dimensional topological insulators (3D TIs) are narrow-band-gap semiconductors which exhibit surface states protected by a combination of time-reversal and inversion symmetries. Due to the low formation energy of antisite defects and vacancies, obtaining intrinsic bulk samples of 3D TIs is challenging. A solution was found in the synthesis of ternary alloys [1]. However, this introduces additional disorder to the system. An alternative way of controlling the surface chemical potential is by growing a topological insulator heterostructure [2], where the Fermi level position at the sample surface is controlled by the thickness of the layers.

Additionally, changing the stoichiometry of binary 3D TI layered compounds such as Bi_2Te_3 and Bi_2Se_3¬ leads to a modified stacking sequence where quintuple layers can be alternated with Bi bilayers. Such structural modification leads to different types of topological protection and to the appearance of new topologically protected states [3].
I will present our recent results on controlling the chemical potential in Bi_2Te_3/Sb_2Te_3 heterostructures [2], and on the rich new physics of the stoichiometric Bi_1Te_1 compound [3], which combines two Bi_2Te_3 quintuple layers with a single Bi bilayer. In this collaborative work, structural properties were established by transmission electron microscopy and x-ray diffraction, topological protection was evaluated from ab-initio calculations, and electronic band structure was mapped by high-resolution spin-polarized angle-resolved photoemission.

[1] C. Weyrich, et al., J. Phys. Cond. Matter 28, 495501 (2016) and references therein.

[2] M. Eschbach, et al., Nature Communications 6, 8816 (2015).

[3] M. Eschbach et al., arXiv:1604.08886 (2016).