Topological Materials

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Venue: CV Raman Hall, IACS
Dates: 15th and 18th January Time: 3.30 – 6.00 pm (30 min break)

COURSE OUTLINE:

1. Symmetry of the band structure and kp method.
2. Introduction into Topology and Geometry of materials
3. Topological materials in general: their properties and symmetry classification

The tutorial lectures will describe the main physical properties of topological insulators starting with polyacetylene and moving to more complex examples of graphene in magnetic field, Quantum Spin Hall Effect and other strong topological insulators. The primary ideas that led to the discovery of topological insulators and Weyl semimetals will be highlighted and the formation of Majorana fermions in these systems will be discussed. The lectures will reveal how their outstanding electronic properties originate and their relation to the breaking of fundamental symmetries as well as an existence of the Dirac gapless spectrum. Description of simplest devices made of Dirac materials will be also be presented.

On a more advanced level the tutorial will encompass the following topics:

Studies of the phenomena associated with tilting of the Dirac cones: pressure, optics in electrical and magnetic fields.

1. Introduction of Effective Mass Hamiltonian (EMH) which is reproducing DFT results describing the tiling and the anisotropy (see, PRB, FVK *et al.* 2017). Focusing mostly on the monopnictides as the simple realistic target.
2. Chiral anomaly induced by electrical field oriented in the direction between the Weyl points.
3. Introduction of the deformational tensor, which influences the EMH and introducing the chiral anomaly. Effectively, the new effect here will be a deformational chiral anomaly. The deformation will induce the polarisation or the electrical field and therewith it will create the chiral anomaly, which can be displayed in the strong magneto-resistive changes in the materials.
4. Magneto-transport and optics of the chiral anomaly and the tilting of the Weyl cones.