Graduate Program in Spintronics

Topology – from the perspective of Material Science

We are inviting **Prof. Claudia Felser**,
a leading scientist in spintronics, to give us the following lectures.

November 26th (Thursday) 2015

16:40-17:40

Speaker: **Prof. Claudia Felser**

Max Planck Institute of
Chemical Physics for Solids,
Dresden

Place:

Room A401

Laboratory for Nanoelectronics
and Spintronics, RIEC

Katahira campus

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Topology – from the perspective of Materials science

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Topological insulators (TIs) are a new quantum state of matter, which have attracted interest of condensed matter science. The concept of topology is well established in chemistry in the context of molecules. Remarkable is that topological insulators can be predicted by ab initio theory and even understood from a chemist's perspective. Herein, a simple recipe based on bonds, bands, symmetry, and nuclear charge will be given to motivate a systematic search for new topologically nontrivial materials. The materials are small band gap insulators with robust gapless surface states. Starting with the theoretical prediction and experimental verification of two-dimensional TIs, the HgTe-based quantum wells, many new topological materials have been discovered. Currently known TI materials can be classified into two families, the HgTe relatives and the Bi_2Se_3 family.

Heusler compounds are a remarkable class of materials with more than 1,000 members and a wide range of extraordinary multifunctionalities [1] including tunable topological insulators (TI) [2] half-metallic high-temperature ferri- and ferromagnets [3], compensated ferrimagnets [4] multiferroic shape memory alloys, and with a high potential for spintronics, energy technologies and magnetocaloric applications. The tunabilty of this class of materials is exceptional and nearly every functionality can be designed. Therefore it is not surprising that we were able to design Heusler compounds with a band inversion and a non-trivial topology for multifunctional TI [2].

Many of these ternary zero-gap semiconductors in Heusler compounds (LnAuPb, LnPdBi, LnPtSb and LnPtBi) contain the rare-earth element Ln, which can realize additional properties ranging from superconductivity (for example LaPtBi) to magnetism (for example GdPtBi) and heavy fermion behavior (for example YbPtBi). These properties can open new research directions in realizing the quantized anomalous Hall Effect and topological superconductors. C1b Heusler compounds have been grown as single crystals and as thin films. The control of the defects, the charge carriers and mobilities can be optimized [5]. The band inversion is proven by ARPES [6]. Heusler compounds are similar to a stuffed diamond, correspondingly, it should be possible to find the "high Z"' equivalent of graphene in a graphite-like structure or in other related structure types with 18 valence electrons and with inverted bands [7]. Dirac cones and Weyl points can occur at the critical points in the phase diagrams of TI. Weyl points, a new class of topological phases was predicted in NbP, NbAs and TaP [8]. We founds ultrahigh magneto resistance, mobilities and Fermi arcs in this class, proving their topological electronic state [9-11].

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