Low-temperature quantum phenomena in topological systems

[ON6 – MagTop project]

Topology is a branch of mathematics concerned with properties of objects, which are preserved under continuous deformations, including stretching and bending. In past few years a new field of topological materials has emerged in condensed matter physics, based on the wide range of consequences that result from the realization that certain properties of physical systems can be expressed as topological invariants, which are insensitive to local perturbations. The language of topology allows to connect seemingly separate physical phenomena occurring in high-energy and condensed matter physics to each other. Topological quantum numbers are the foundation for the most accurate quantization of observables in condensed matter systems e.g. the ratio of the frequency and dc voltage in the ac Josephson effect and the quantization of the conductance in the quantum Hall effect. The same robustness and accuracy may soon be utilized to revolutionize the field of quantum computing with the help of topological qubits. Moreover, the consideration of the momentum space topology is currently guiding the search of new exotic phases of matter.

We offer three experimental PhD research projects aiming in searching for manifestations of topological effects in materials combining magnetism and superconductivity with topological characteristics. The samples will be grown by epitaxial and bulk growth methods available at the Institute of Physics, Polish Academy of Sciences (MagTop including) as well in collaborating international laboratories. Experimental studies will make of use of the Institute's nanostructure processing capabilities, dilution refrigerator (temperatures down to 10 mK), SQUID systems, and related set ups. The three topics include: (i) topological insulators of mercury [eg. (Hg,Cd,Mn)Te] and bismuth chalcogenides [eg. (Bi,Sb,Fe)Se], in which magnetism and superconductivity leads to quantized Hall resistance ih/e^2 with i = 1 and ½, respectively; (ii) topological crystalline insulators [eg. (Pb,Sn,Mn)Te], in which surface atomic steps results in zero-mode excitations, presumably associated with the presence of Majorana fermions; (iii) Weyl semimetals showing a specific Andreev reflection when interfaced with superconductors [e.g., NbP/Nb]. The experimental studies will be strongly supported by MagTop's theoretical teams.

For candidates selected by internationally opened calls (see www.MagTop.ifpan.edu.pl) we offer **a stipend for 4 years (3 500 – 4 500 PLN per month, no taxes)** to work at the International Centre for Interfacing Magnetism and Superconductivity with Topological Matter - MagTop (Scientific Division ON-6). The successful candidate is expected to **actively take part in international collaboration** in terms of **short-term research stays** and by **participating in conferences** with the funding provided by MagTop.

contact:
Tomasz.Dietl@MagTop.ifpan.edu.pl

webpage: www.MagTop.ifpan.edu.pl

Further reading relevant for the proposed projects:
1) Press Release: The Nobel Prize in Physics 2016
https://www.nobelprize.org/nobel_prizes/physics/laureates/2016/press.html
(Including the popular science background and scientific background.)

European Funds Smart Growth
Republic of Poland
FNP Foundation for Polish Science
European Union European Regional Development Fund