

SEMINAR ON MAGNETISM AND SUPERCONDUCTIVITY

We kindly inform You that on **Wednesday**

May 17th at 10:00

there will be an **on-line seminar (link is provided on the IP PAS website),**

where

prof. dr hab. Tomasz Dietl

*(International Research Centre MagTop, Institute of Physics,
Polish Academy of Sciences, Warsaw)*

will deliver a lecture on:

“Charge dopants control quantum spin Hall materials”

Unlike in the quantum Hall effect and quantum anomalous Hall effect, the quantization precision in the quantum spin Hall effect depends on unavoidable background impurities and defects. However, doping with magnetic ions restores the quantization accuracy.

Semiconductors' sensitivity to electrostatic gating and doping accounts for their widespread use in information communication and new energy technologies. In the talk, I will present outcomes of two companion papers [1,2], inspired by experimental data accumulated in Wuerzburg and Warsaw for HgTe and (Hg,Mn)Te quantum wells and bulk crystals. Results of those papers demonstrate quantitatively and with no adjustable parameters that the presence of paramagnetic acceptor dopants elucidates a variety of hitherto puzzling properties of two-dimensional topological semiconductors at the topological phase transition and in the regime of the quantum spin Hall effect. The concepts of resonant states, charge correlation, Coulomb gap, exchange interaction between conducting electrons and holes localized on acceptors, strong coupling limit of the Kondo effect, the Luttinger correlations, and bound magnetic polaron explain a short topological protection length, high hole mobilities compared with electron mobilities, and different temperature dependence of the spin Hall resistance in HgTe and (Hg,Mn)Te quantum wells. A new concept of precessional dephasing of a carrier spin by a dense bath of localized spins is put forward. It is concluded that while electrostatic gating is widely used to reveal the unique properties of quantum materials, the obtained results demonstrate that charge dopants play an important and unanticipated role in the physics and applications of topological semiconductors.

[1] T. Dietl, "Effects of charge dopants in quantum spin Hall materials", *Phys. Rev. Lett.* 130, 086202 (2023).

[2] T. Dietl, "Quantitative theory of backscattering in topological HgTe and (Hg,Mn)Te quantum wells: Acceptor states, Kondo effect, precessional dephasing, and bound magnetic polaron", *Phys. Rev. B* 107, 085421 (2023) [Editors' Suggestion].

We sincerely invite You

**Roman Puźniak
Andrzej Szewczyk
Henryk Szymczak**