SEMINAR ON MAGNETISM AND SUPERCONDUCTIVITY

We kindly inform You that on **Wednesday**

April 16th at 10:00

there will be a **ZOOM seminar**

- link is provided on IP PAS website

where

Prof. Dr. Vladimir Dyakonov

(Chair of Experimental Physics 6, Faculty of Physics and Astronomy,
Julius-Maximilian-University Würzburg, Germany)

will deliver a lecture on:

"Perovskites: One Structure, Many Unique Properties"

Perovskites are a class of materials that share a specific crystal structure ABC_3, where A and B are cations and C is an anion. It was originally found in a mineral of calcium titanate $CaTiO_3$, called perovskite. Over the years, the term has been extended to all materials with ABC_3 crystal structure. Although they all have the same basic structure, perovskites are very versatile. They exhibit a variety of unique and useful properties, such as ferroelectricity, superconductivity and, more recently, the conversion of light into electricity and vice versa, electroluminescence.

In the last 15 years, a new class of semiconducting perovskites has attracted a great attention worldwide. These *hybrid* perovskites can be described by the same stoichiometric formula ABC_3, where A now represents an organic cation (e.g. $CH_3NH_3^+$) that fills the space formed by the eight neighboring octahedra consisting of metal cations B, usually Pb or Sn, and the halide anions C, usually I, Cl or Br. This combination of organic and inorganic constituents leads to a unique set of properties, fundamentally different from organic and conventional inorganic semiconductors. Hybrid organic-inorganic perovskites show ionic character of the lattice, which is quite soft, leading to several phase transitions, often with a transition close to or above room-temperature. The inorganic framework yields in high absorption coefficients in the visible range. The different combinations lead to changes in crystal symmetry, bond length, which in turn changes the width of the semiconducting bandgap between 1.2 and 3.1 eV. In just ten years, perovskite solar cells have achieved a power conversion efficiency of over 25%, which is comparable with silicon photovoltaics. And all this with an inexpensive material that is relatively easy to process, either by solution processing or by vacuum evaporation at a moderate temperature.

While semiconducting perovskites have been extensively studied for optoelectronic applications and have almost reached technological maturity, little is known about spin-related applications of this class of materials. In 2020, a "strong temperature-dependent magnetic response" at temperatures below 30 K was reported by adding iron into $Cs_2AgBiBr_6$ perovskites. More recently, in 2024, ferromagnetism was reported in a solution-processable lead-based hybrid perovskite $CH_3NH_3PbCl_3$ with well-saturated magnetic hysteresis loops below 12 K. This has encouraged us to start growing perovskite single crystals and investigate the possibility of doping them with different chemical elements such as Na and Fe, which could be useful as dopants because their unpaired electrons can induce magnetic behavior, making them interesting for quantum and spintronic applications.

In my talk, I will give an overview of the basic properties of semiconducting perovskites, such as the tunability of the band gap, charge carrier dynamics, and give examples of efficient solar cells. If time permits, I will share some preliminary results on iron-doped perovskite single crystals.

The lecture will be in English.

We sincerely invite You

Roman Puźniak / Andrzej Szewczyk / Henryk Szymczak