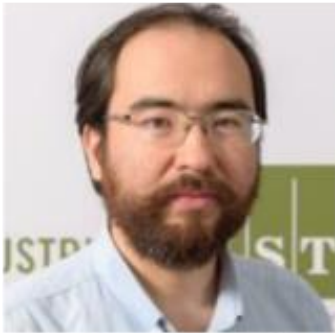


Condensed Matter Physics Seminar Series

Shining light on Lead-Halide Perovskites: what optics can tell about the inner workings of the Solar-Cell-champion material

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Lead halide perovskite are remarkable in many respects. Even samples with relatively unassuming quality were demonstrated to exhibit some of the most fundamental phenomena in semiconductor physics, such as laser cooling and room-temperature quantum coherence in the form of super-radiance. Perovskites are also known for their “resilience” against formation of deep defects that can act as charge traps, making them excellent materials for photo-voltaic applications: perovskite-based solar cells have recently nearly reached the levels of the state-of-the-art conventional Si- based devices in terms of efficiency. Amongst these achievements, perhaps the most puzzling fact is that there is still no clear understanding as to what is underlying this remarkable performance in the microscopic level.

In this presentation I will discuss how much can one learn about the basic properties of perovskites by means of optics. First, I will talk about Faraday rotation and the complex refractive index in a paradigmatic perovskite $\text{CH}_3\text{NH}_3\text{PbBr}_3$ in a broad wavelength range, and demonstrate that in order to account for the experiment even on the qualitative level, one needs to amend the usual minimal coupling scheme and to introduce an atomic-level coupling between electric field and the spin degree of freedom (!). This term has far reaching consequences for the low-energy phenomenology of perovskites and provide a few examples of the novel exotic phenomena predicted by our model.

Then I will proceed with the optical response of $\text{CH}_3\text{NH}_3\text{PbBr}_3$ in the mid-infrared range will falls into the domain of the vibrational excitations of ion. I will show how the properties of the semi-autonomous organic cation molecule depend on the local lattice configuration, and hence can be used to shed light on the challenging problem of the interaction between the quasi-free organic cation molecule and the soft, anharmonic and dynamically disordered inorganic cage.

Zhanybek Alpichshev received his B.S. in Applied Physics and Mathematics from Moscow Institute of Physics and Technology (*MIPT*) in 2005. He later went on to receive a Ph.D. in Physics from Stanford University in 2012. He was a research assistant at Stanford University from 2005–2012, a postdoc researcher at Massachusetts Institute of Technology from 2012–2017 and a visiting scientist at Max Planck Institute for Structure and Dynamics of Matter from 2017–2018. He is currently an assistant professor at the Institute of Science and Technology (IST) Austria.

Friday, May 5th, 2023 at 1:00 PM
4-330 PAB