HL 15: Spin phenomena in semiconductors

Time: Tuesday 9:30–10:30 Location: POT 361

HL 15.1 Tue 9:30 POT 361

Photoexcited charge carrier and spin dynamics in methylammonium lead bromide doped by magnetic transition metals. — •Stanislav Bodnar, Jonathan Zerhoch, Shangpu Liu, Andrii Shcherbakov, and Felix Deschler — PCI, Universität Heidelberg, Im Neuenheimer Feld 253, 69120 Heidelberg

One of the most challenging tasks for LED applications is emitting 100% polarized light from the device. Typically, this is achieved by introducing an additional layer of polarization filter which leads to losing half of the light intensity. To overcome this issue, one has to find a system with a high degree of photoluminescence (PL) polarization. A promising approach here is using magnetic metal doping in combination with a highly efficient semiconductor. We have chosen to use transient absorption (TA) spectroscopy at cryogenic temperatures to investigate changes in the optical properties induced by magnetic metal doping in CH3NH3PbBr3 since it gives spectral information about the energies of electronic states and dynamic properties of the photoexcited carriers. We find a change in the main ground state bleach (GSB) peak position in doped CH3NH3PbBr3, which depends on the transition metal used. The main GSB peak of pure CH3NH3PbBr3 at 4 K is at 2.32 eV. Doping CH3NH3PbBr3 with Mn leads to a shift of the main peak to lower energies by 0.04 eV. The modifications of the TA spectra are associated with changes in the bandgap energy, which is the result of doping-induced lattice expansion. Additionally, we observed changes in the spin lifetime by an order of magnitude which could be associated with modification of the Rashba field.

HL 15.2 Tue 9:45 POT 361

Mode locking of hole spin coherences in $CsPb(Cl,Br)_3$ perovskite nanocrystals — •Erik Kirstein[1], Nataliia E. Kopteva[1], Dmitri R. Yakovlev[1,2,3], Evgeny A. Zhukov[1,2], Elena V. Kolobkova[4,5], Maria S. Kuznetsova[6], Vasily V. Belykh[3], Irina A. Yugova[6], Mikhail M. Glazov[2], Manfred Bayer[1], and Alex Greilich[1] — [1]Experimental Physics 2, Department of Physics, TU Dortmund, 44227 Dortmund, Germany — [2]St. Petersburg, Russia — [3]Moscow, Russia — [4]St. Petersburg, Russia — [5]St. Petersburg, Russia — [6]St. Petersburg, Russia

The spin physics of perovskite nanocrystals is attracting increasing attention, both for fundamental studies and spintronic applications. Here, stable $CsPb(Cl_{0.5}Br_{0.5})_3$ lead halide perovskite nanocrystals embedded in a fluorophosphate glass matrix are studied by time-resolved optical spectroscopy to unravel the coherent spin dynamics of holes and their interaction with nuclear spins of the ^{207}Pb isotope. We demonstrate the spin mode locking effect and nuclear induced frequency focussing leading to the synchronization of the hole spin Larmor precession frequencies of the nanocrystal ensemble.

HL 15.3 Tue 10:00 POT 361

Spin-flip Raman scattering on resident electrons and holes in two-dimensional (PEA)2PbI4 perovskites — •Carolin Harkort[1], Dennis Kudlacik[1], Natalia E. Kopteva[1], Dmitri R. Yakovlev[1], Marek Karzel[1], Erik Kirstein[1], Oleh Hordiichuk[2,3], Maksym V. Kovalenko[2,3], and Manfred Bayer[1] — [1]Experimentelle Physik 2, Technische Universität Dortmund, 44221 Dortmund — [2]Laboratory of Inorganic Chemistry, Department of Chemistry and Applied Biosciences, ETH Zürich, CH-8093 Zürich, Switzerland — [3]Laboratory for Thin Films and Photovoltaics, Empa-Swiss Federal Laboratories for Materials Science and Technology, CH-8600 Dübendorf, Switzerland

Two-dimensional lead halide perovskites are promising material systems for photovoltaic and optoelectronic applications. They are attractive for optical control of carrier spins due to an increased chemical stability compared to bulk lead halide perovskites. With the technique of Spin-flip Raman scattering we investigated in 2D Ruddlesden-Popper type $(PEA)_2PbI_4$ perovskites the Zeeman splitting of carrier spins, resident electrons and holes, that can be detected through the exciton emission. The Landé-factors of these electrons and holes and their anisotropy are measured at a low temperature of 2 K. We show that the hole Zeeman splitting is affected by the Overhauser field resulting from the dynamic nuclear polarization which allows us to define the sign of the hole Landé-factor. In this structure the Overhauser field has a maximum value of 600 mT.

HL 15.4 Tue 10:15 POT 361

Microscopic origin of the effective spin-spin interaction in a semiconductor quantum dot ensemble — Fredrik Vonhoff[1,2], Andreas Fischer[1], •Kira Deltenre[1], and Frithjof B. Anders[1] — [1]Department of Physics, TU Dortmund University, D-44227 Dortmund — [2]Department of Physics, Technical University of Munich, D-85748 Garching

We present a microscopic model for a singly charged quantum dot (QD) ensemble to reveal the origin of the long-range effective interaction between the electron spins in the QDs. Wilson's numerical renormalization group (NRG) is used to calculate the magnitude and the spatial dependency of the RKKY interaction mediated by the growth-induced wetting layer.

Using the NRG results obtained from realistic parameters as input for a semiclassical simulation for a large QD ensemble, we demonstrate that the experimentally reported phase shifts in the coherent spin dynamics between single and two-color laser pumping can be reproduced by our model [1], solving a longstanding open problem of the microscopic origin of the inter-QD electron spin-spin interaction.

[1] F. Vonhoff, A. Fischer, K. Deltenre, and F. B. Anders, Phys. Rev. Lett. **129**, 167701 (2022)