Experimentelle Physik 2

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Optical orientation of exciton, electron, and hole spins in lead-halide perovskites

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Lead halide perovskite semiconductors are attracting research interest due to for their photovoltaic efficiencies and optoelectronic properties. They also show remarkable spin properties, well suitable for the spintronic applications [1]. The optical orientation of the exciton spins and charge carriers is a fundamental phenomenon in spin physics [2]. Circularly polarized photons generate spin-oriented excitons and carriers whose spin polarization and spin dynamics can be detected by polarized photoluminescence, Faraday/Kerr rotations, etc. The perovskite band structure and selection rules provide 100% spin polarization of the carriers at optical orientation and allow for 100% polarized photoluminescence, compared to a maximum of 25% circular polarized emission in conventional III-V and II-VI semiconductors.

Here, we demonstrate a giant degree of optical orientation up to 85% can be achieved for excitons in $FA_{0.9}Cs_{0.1}PbI_{2.8}Br_{0.2}$ perovskite crystals in time-resolved photoluminescence [3]. It is remarkably stable against laser excitation energy detuning from exciton resonance up to 0.5 eV, which proves the suppression of the mechanisms of spin relaxation of carriers characteristic of the usual III-V and II-VI semiconductors. This is also confirmed by non resonantly excited coherent spin beats of the exciton in the magnetic field.

[1] Hybrid Organic Inorganic Perovskites: Physical Properties and Applications. (eds. Vardeny, Z. V. and Beard, M. C.) (World Scienti c, 2022).
[2] Optical Orientation. (eds. Meier, F. and Zakharchenya, B. P.) (North Holland, Amsterdam, 1984).
[3] N. E. Kopteva, D. R. Yakovlev, E. Yalcin, I. A. Akimov, M. O. Nestoklon, M. M. Glazov, M. Kotur, D. Kudlacik, E. A. Zhukov, E. Kirstein, O Hordiichuk, D. N. Dirin, M. V. Kovalenko, M. Bayer, Highly-Polarized Emission Provided by Giant Optical Orientation of Exciton Spins in Lead Halide Perovskite Crystals. Adv. Science **11**, 2403691 (2024).