Spin physics of excitons, carriers and nuclei in perovskite semiconductors

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We provide a survey of our experimental studies of coherent spin dynamics of electrons, holes and excitons in lead halide perovskite semiconductors: bulk crystals [1-4], nanocrystals [5-7] and 2D structures [8]. Time-resolved Faraday/Kerr rotation and optical orientation techniques are used for that, measurements are performed at cryogenic temperatures and in strong magnetic fields. We measure spin relaxation and spin coherence times, evaluate electron and hole Lande g-factors for a representative set of perovskites with the band gap energy varying from 1.5 to 3.2 eV. We establish universal trends for the g-factors on the band gap energy in bulk materials and show that they are modified by the quantum confinement in perovskite nanocrystals. Strong interaction of hole spins with nuclear spins is found, which is considerably stronger that the one for the electron. Optically detected nuclear magnetic resonance highlights the dominating role of Pb ions in interaction with electrons and holes. Spin mode locking effect based on spin synchronization under periodic laser excitation is found in nanocrystals in glass. Experimental approaches of spin physics give reach information about band structure and spin-dependent properties of the lead halide perovskite semiconductors and their nanostructures.

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