Doctoral dissertation

"Determination of the Exciton Fine Structure in Two-Dimensional Metal-Halide Perovskites"

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In recent years, two-dimensional (2D) hybrid lead-halide perovskites emerged as an interesting alternative for optoelectronic and photovoltaic applications. Due to both quantum and dielectric confinement, the exciton binding energy in these materials is greatly enhanced and can reach up to a few hundreds of milielectronvolts. This makes 2D perovskites attractive objects for the investigation of exciton physics, since all excitonic effects are greatly enhanced in this system. It also results in significant splitting of states within the exciton fine structure, which can have a dramatic impact on the performance of light emitters or other devices based on these 2D materials.

Using polarisation-resolved optical spectroscopy techniques combined with the use of an external magnetic field, the exciton fine structure was investigated. The study was performed on a series of archetypical 2D perovskite compounds $(PEA)_2(MA)_{n-1}Pb_nI3_{n+1}$ with an increasing number of octahedra layers *n* within a slab, *i.e.* increasing width of the quantum well.

For the compound with *n* =1 the full exciton fine structure was revealed, including the dark state. The energy ordering and spacing between the states was determined, providing strong experimental evidence and resolving the ongoing dispute in literature.

Further magneto-optical studies on the perovskite compounds with *n* =2, 3 and 4 shown the evolution of the energy of the bright *in plane*-oriented excitonic states with respect to the magnetic field. This allowed extracting the values of the bright excitonic g-factors, as well as the values of the diamagnetic shift with respect to the number of inorganic layers.

The results presented in this work provide valuable information about the evolution of the optoelectronic properties of 2D perovskites when passing from 2D to 3D limit, as the quantum well thickness increases. These findings serve as a solid benchmark for theoretical modelling of phenomena in 2D perovskites. It also contributes to better understanding of the properties of these fascinating materials.