Neutral and charged exciton fine structure in single lead halide perovskite nanocrystals revealed by magneto-optical spectroscopy

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Lead halide perovskties have proven to be revolutionary semiconductor materials for a new generation of low-cost solar cells, and have been used for perovskite-based light-emitting diodes (LEDs), photodetectors and lases.[1] The recent advances in the colloidal synthesis of strongly emitting perovskie nanocrystals (NCs) opens up new possibilities for the fabrication of devices with enhanced performances.[2] Indeed, these materials favorably combine improved optical properties with respect to their bulk counterparts, versatile surface chemistry allowing their dispersion into a variety of solvents and matrices and eventual incorporation into device architectures.

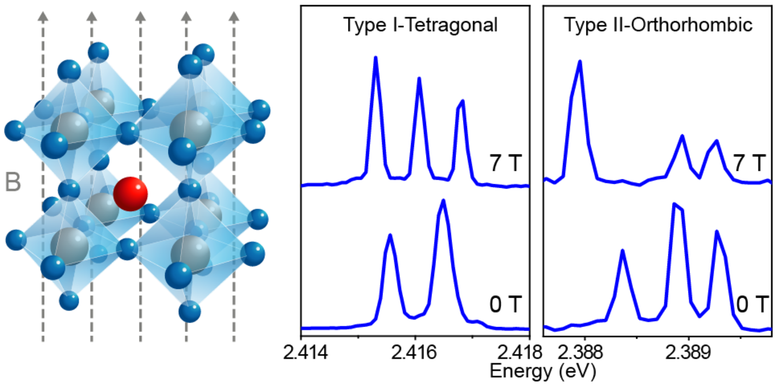

Fig. 1 The two or three sublevels exciton fine structure of $CsPbBr_3$ perovskites determined by the single nanocrystal magneto-photoluminescence spectroscopy.

Revealing the crystal structure of perovsites, which has a major impact on their stability and optical properties,is essential for the optimization of their photovoltaic and light emitting applications.[3] We use magneto-photoluminescence spectroscopy of individual perovskite $CsPbBr_3$ nanocrystals as a unique tool to determine their crystal structure, which imprints distinct signatures in the excitonic sublevels of charge complexes at low temperatures. At zero magnetic field, the identification of two classes of photoluminescence spectra, displaying either two or three sublevels in their exciton fine structure, shows evidence for the existence of two crystalline structures, namely tetragonal D_{4h} and orthorhombic D_{2h} phases (Fig. 1). Magnetic field shifts, splitting and coupling of the sublevels provide a determination of the diamagnetic coefficient and valuable information on the exciton g-factor and its anisotropic character. Moreover, this spectroscopic study reveals the optical properties of charged excitons which allow the extraction of the electron and hole g-factors for perovskite systems.

1) F. Bella *et al.*, *Science*, **2016**, *354*, 203; B. R. Sutherland *et al.*, *Nat. Photonics*, **2016**, *10,* 295.
2) H. Huang*et al.*, *NPG Asia Mater.*, **2016**, *8*, e328.
3) A. Swarnkar *et al.*, *Science*, **2016**, *354*, 92.