Fine structure splitting of the bright exciton in a bulk $MAPbBr_3$ single crystal

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The exchange interaction between the electron and the hole lifts the degeneracy between the dark singlet and bright triplet excitonic states. The bright states can be further split in the presence of a symmetry breaking leading to bright excitonic fine structure. To date, investigations have largely focused on semiconductor nanostructures where quantum confinement greatly enhances the exchange interaction and breaks the symmetry of the system.

To the best of our knowledge, the fine structure splitting of the bright exciton triplet state has never been observed in a bulk semiconductor. Here we report on the observation a giant FSS of the bright 1s exciton states in a bulk high quality $MAPbBr_3$ single crystal. We have performed a detailed magneto-optical investigation to reveal the FSS as large as 200μeV. Such a large FSS in bulk material indicates a strong symmetry breaking in the orthorhombic crystal lattice and/or significant Rashba enhancement of the FSS. For our bulk single crystal quantum confinement can be excluded so our results give direct insight into the FSS related solely to crystal structure of bulk $MAPbBr_3$.

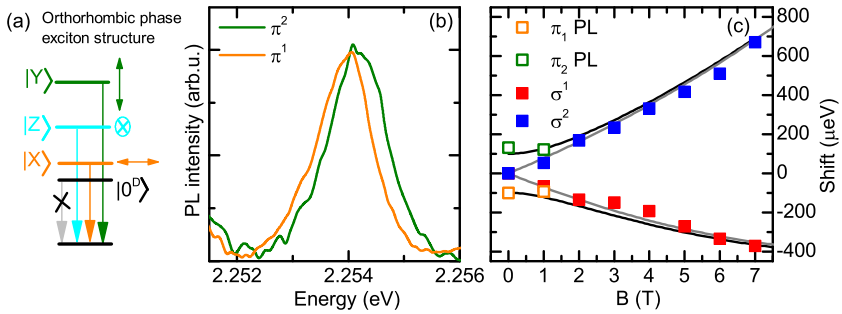

Figure 1: (a) Scheme of exciton fine structure in orthorhombic crystal lattice phase. (b) two linearly polarized components of photoluminescence. (c) dependence of PL peak position as a function on magnetic field detected with linear and circular polarization base.

Our investigation provide valuable insight for the future understanding of the contribution of different mechanisms, such as confinement anisotropy or Rashba effect, to the FSS of excitons in perovskite based nanostructures. This represent a crucial step in the understanding of fine structure splitting in lead-halide perovskites.