Revealing excitonic properties of 2D perovskites by means of magnetooptical studies

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High environmental stability and surprisingly high efficiency of solar cells based on 2D perovskites have renewed interest in these materials. These natural quantum wells consist of planes of metal-halide octahedra, separated by organic spacers (Fig. 1(a)). The exciton binding energy in this structure is greatly enhanced by quantum and dielectric confinement, therefore 2D metal halide perovskites provide great platform to study exciton physics in 2D limit. Remarkable feature of 2D perovskites is the great number "knobs" which control they optoelectronic response. The most unique knob, absent in other semiconductor structures, is provided by organic spacers which imposes octahedral distortions (Fig. 1(b)) and in this way controls band structure and carriers-phonon coupling. The characteristic for ionic crystal coupling of excitonic species to lattice vibration became particularly important in case of soft perovskite lattice. The nontrivial mutual dependencies between lattice dynamics, organic spacers and electronic excitation manifest in a complex absorption and emission spectrum which detailed origin is subject of ongoing controversy. Moreover many of the 2D perovskites exhibit temperature driven phase transition, absent for example in epitaxial semiconductors, providing method for rapid optical properties change.

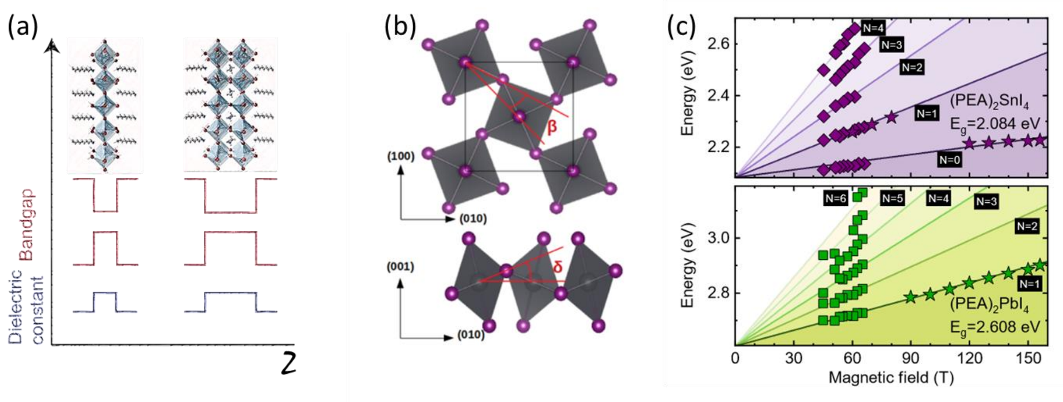

Fig.1 ***(a)*** *Scheme of 2D perovskites with quantum and dielectric confinement profile.* ***(b)*** *illustration of octahedral units distortion* ***(c)*** *Fan chart of the interband Landau transitions as a function of magnetic field for 2D perovskites, from which effective mass can be extracted.*

In this presentation, I will highlight how the use method of optical spectroscopy in extreme magnetic fields can provide insightful tool to unravel some of the electronic properties of 2D perovskites and understand how they evolve with the change of distortions angles. This conceptually simply idea of tracking optical transition in magnetic field provides access to carrier effective mass [1,2] (Fig. 1(c)), exciton fine structure, and also exciton-phonon coupling [3].

[1] M. Baranowski et al., ACS Energy Lett. **4**, 2386 (2019)
[2] M. Dyksik et al., ACS Energy Lett., **5**, 3609 (2020)
[3] J.Urban et al. J. Phys. Chem. Lett., **11**, 5830 (2020).