Energy level alignment at 2D/3D perovskite interfaces and challenges in photoemission studies of perovskites in general

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Inter alia, the application of 2D phenylethylammonium lead quaternary iodide (PEA2PbI4)/ three-dimensional (3D) metal halide perovskite (MHP) interfaces has improved various optoelectronic devices, where a staggered type-II energy level alignment was often assumed. However, a type-II heterojunction seems to contradict the enhanced photoluminescence observed for 2D PEA2PbI4/3D MHP interfaces, which raises fundamental questions about the electronic properties of such junctions. Using direct and inverse photoelectron spectroscopy, we reveal that a straddling type-I energy level alignment is present at 2D PEA2PbI4/3D methylammonium lead triiodide (MAPbI3) interfaces, thus explaining that the photoluminescence enhancement of the 3D perovskite is induced by energy transfer from the 2D perovskite.

On another note, a comprehensive overview of the challenges in obtaining reliable energy levels from interfaces with perovskites from photoemission spectroscopy will be given. One key obstacle is that the UV or X-ray flux used to create the photoelectrons can already induce operando-type level re-alignment. The aim of this part of the presentation is to enable the audience making own critical assessment of published photoemission data and their interpretation.