Quasiparticle dispersions of the structural ground state $CH_3NH_3PbI_3$ observed by angle-resolved photoelectron spectroscopy

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Lead halide perovskites (LHP) are a novel class of semiconducting materials which have attracted a tremendous research interest in a wide range of optoelectronic applications due to their long charge carrier lifetimes and carrier diffusion lengths despite the low-cost fabrication method. Different hypotheses, including the Rashba effects and Fröhlich large polaron formation, have been proposed to elucidate the microscopic origin of their peculiar charge carrier dynamics. Although these effects are generally accompanied by the modifications of their underlying electronic structure, the key experimental evidence has not been precisely estimated so far. Here, we investigate the electronic structure of structural ground state of $CH_3NH_3PbI_3$, the archetypical LHP material, studied via angle-resolved photoelectron spectroscopy (ARPES) combined with *ab initio* density functional theory (DFT) calculations. By establishing careful optimizations of sample preparations and experimental protocols, we present the pristine quality of ARPES with the key spectral features revealed for the first time. With the highest quality of our measurements, we discuss the possibility of the Rashba effect and Fröhlich large polaron formation in the uppermost valence band of $CH_3NH_3PbI_3$.