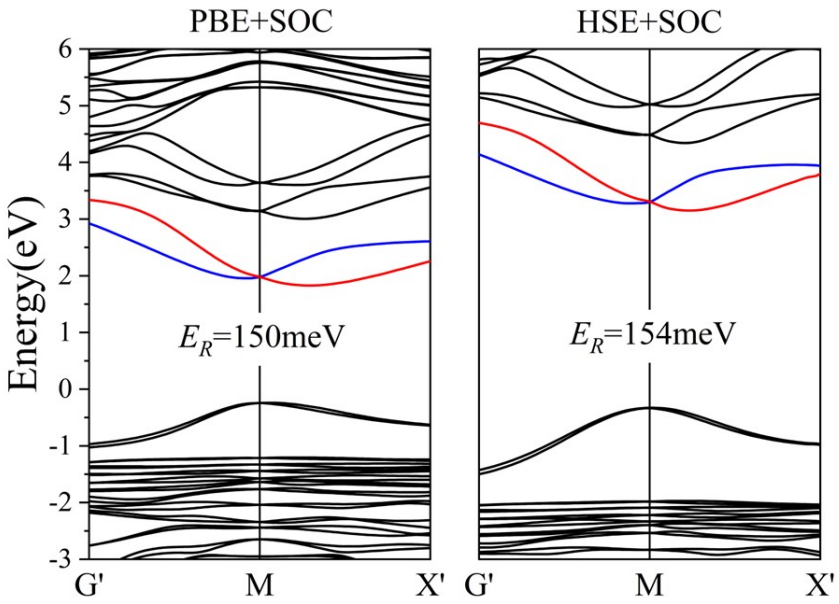
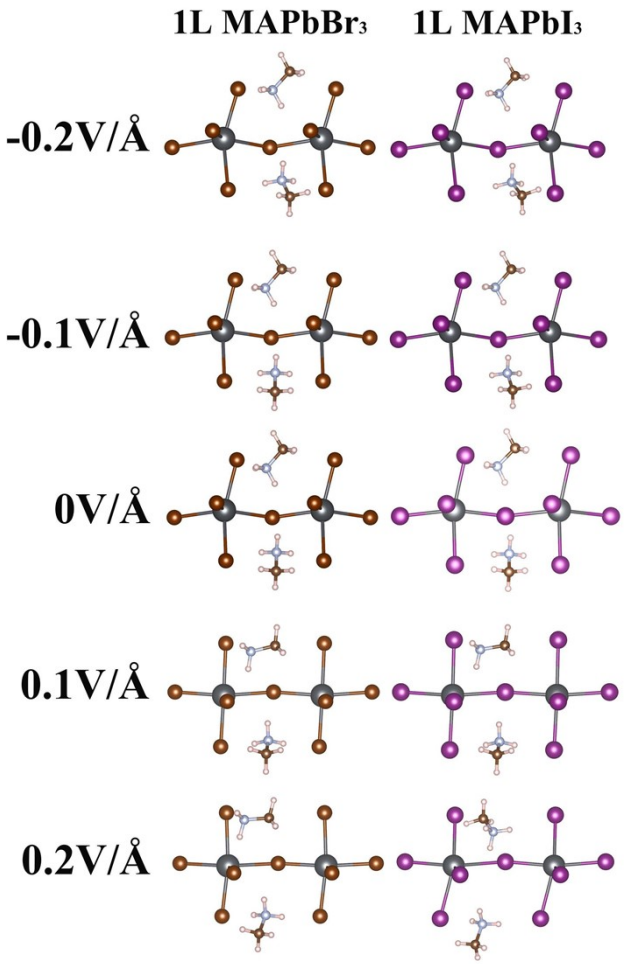
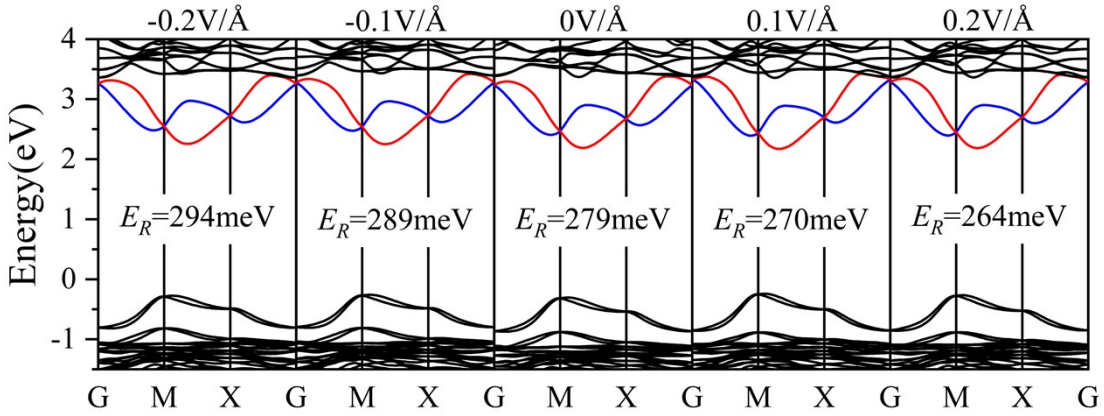


SFig.1 The energy bands of 1L $MAPbBr_3$ calculated by PBE+SOC and HSE+SOC methods.



SFig.2 The structures of 1L $MAPbBr_3$ and $MAPbI_3$ under EEF of -0.2 V/Å to 0.2 V/Å.



SFig.3 The energy bands of $(PEA)_2PbBr_3$ under EEF of -0.2 V/Å to 0.2V/Å. The split spin states of CBM have been highlighted by blue and red colors respectively.