Hybrid perovskite-based high energy photon detectors

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Radiation spectroscopy is widely needed in security, medical treatment, nuclear material monitoring as well as space science. It quantifies the gamma-ray energies by single radiation photon counting devices. The key is to precisely count gamma-ray photons using highly sensitive detectors. Solid-state detectors employing high density semiconductors to convert gamma-ray photon signal directly into electrical pulses offers promising solution. It outperforms scintillator technologies in count rate and sensitivities with high energy resolutions.

In this talk, I will introduce our recent progress on methylammonium lead halide perovskite single crystal detectors. We show that the single crystal detectors can efficiently count single gamma-ray photon events with electrical pulses. We further investigate the operational principles of the bromide-perovskite solid-state detectors and find using high work function contacts can block out the dark noise from thermally injected electrons and thus allow for efficient pulse collection at higher electrical fields. As a result, we observe strong and reproducible electrical pulses when exposing the detector under several radioactive sources corresponding to gamma-rays at various energies. However, we also discover that the bromide-perovskite detector suffers from voltage instability and slow response which cannot generate reliable energy resolved spectrum. Replacing the bromide by iodide in the crystal, we are able to operate the detector at much higher voltage and deliver sharp electrical pulses at room temperature. By counting the pulses under gamma-ray photons, we constructed the spectrum for ^{137}Cs that clearly shows the expected Compton scatter structure along with signals from photo-electric effect. Our results lay the foundation towards the robust operation of efficient perovskite- detector.