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SIMULATION OF CHARGE CARRIERS IN SMALL-PIXEL CZT DETECTORS

Jason Tang

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Hard X-ray astronomy is used to study high-energy astrophysical objects such as neutron stars, black holes, and supernova remnants. The energies of interest are typically in the 5-80 keV range. Cadmium Zinc Telluride (CZT) detectors are often used in X-ray astronomy because they are room temperature semiconductors with excellent quantum efficiency and good energy resolution. Our group is leading the development of new small-pixel CZT detectors with center-to-center pitch of 150 microns, as opposed to the 600-micron pitch in the current NuSTAR space-based X-ray telescope. These smaller pixels will match newly-developed X-ray focusing optics that will allow for much higher angular resolution than NuSTAR. X-rays that hit the detector trigger a chain of interactions, depositing energy into the detector and creating clouds of electron-hole pairs which expand as they propagate in the detector. The electronic signal is generated from charges induced on the pixels due to the movement of these charge carriers. In small-pixel detectors, the charge carriers will induce a charge on multiple pixels, resulting in charge sharing. I will present Monte Carlo simulations of photon interactions inside the CZT detectors and the resulting signals in the pixel electrodes, including these charge-sharing effects. By considering the signals from multiple pixels, we can achieve improved energy resolution, reconstruct the depth of the interactions, and potentially achieve sub-pixel resolution.