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P1.73: 3-Dimensional photoelectron track reconstruction and the future X-ray polarimeter

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The field of X-ray imaging polarimetry has expanded significantly since the development of the first photoelectron-based X-ray polarimeter. This sophisticated system measures the polarization of X-ray photons by reconstructing the initial direction of the photoelectron track created by an interaction of an incident photon with a gas mixture. The current photoelectron-based X-ray polarimeter, the Gas Pixel Detectors (GPD) on board the Imaging X-ray Polarimetry Explorer (IXPE), has shown efficient performance as the first imaging X-ray polarimeter mission since its successful launch on December 9, 2021. Despite the remarkable achievements of IXPE, the window of X-ray polarimetry is still restricted by the brightness of the source and the long exposure time required for faint objects. To expand our perspective and reach deeper into the universe with X-ray polarimetry, it is essential to improve sensitivity. One effective approach to improve the modulation factor, which expresses the amplitude of polarization properties from measurements, is to refine the photoelectron track reconstruction process. Currently, polarization properties are extracted from a two- dimensional projected track image using standard moment analysis. Thus, a three-dimensional understanding of the track geometry will enhance the sensitivity of polarimetry measurement. The future X-ray polarimeter will employ a three-dimensional track reconstruction as exploiting the timing information as a z-axis, which can be achieved with the TIMEPIX3, a hybrid readout chip with a high time resolution. This advancement will provide new opportunities to expand our views of the polarized X-ray sky with shorter exposure times and a broader energy range. Therefore, in this talk, we will present our reconstruction algorithms and prospective improvements in X-ray polarimetry.

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