Nuclear Tomography through Entanglement Enabled Spin Interference

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Photonuclear interactions have been known for decades as a direct probe of the gluon distribution within nuclei and nucleons. However, a long-standing puzzle, where the extracted radii of nuclei appeared much too large, prevented the extraction of precise nuclear geometry information from photonuclear interactions in ultra-peripheral heavy-ion collisions for nearly two decades. Recent measurements have demonstrated that the quasi-real photons manifest in ultra-peripheral collisions are linearly polarized. Utilizing the photon polarization resolves the two-decade old puzzle - revealing that the true nuclear geometry distribution is hidden by a novel interference effect mediated by entanglement. In this talk, we will present the discovery of quantum interference between distinguishable particles and illustrate how taking it into account allows precise tomographic reconstruction of the gluon distribution within large nuclei. This new technique further provides a potential method of probing initial state entanglement within nucleons and nuclei.