Contribution ID: **281** Type: **Contributed Talk**

Probing the Nucleus with Linearly Polarized Photons

Wednesday, 25 March 2020 16:48 (18 minutes)

Ultra-relativistic heavy ion collisions are expected to produce some of the strongest magnetic fields ($10^{13} - 10^{16}$ Tesla) in the Universe[1].
These intense electromagnetic fields have been proposed as a source of linearly-polarized, quasi-real photons[2] that can interact via the Breit-Wheeler process to produce e^+e^- pairs[3]. Demonstration that these photons are linearly polarized provides a precision tool for the study of open questions in Quantum Chromodynamics.

In this talk we present STAR measurements of e^+e^- pair production and diffractive photo-production of the ρ^0-meson (and direct $\pi^+\pi^-$ pairs) in ultra-peripheral Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. The pairs produced in the $\gamma\gamma \rightarrow e^+e^-$ process display a striking 4th-order azimuthal modulation which is a direct result of vacuum birefringence[4,5].
Using the same technique we present measurements of azimuthal modulations in $\pi^+\pi^-$ pairs from diffractive photo-production of the ρ^0 and of direct $\pi^+\pi^-$ pairs.
The measured $\pi^+\pi^-$ pairs reveal a similar 4th-order azimuthal modulation. We will discuss the implications of these measurements for the study of gluon transverse momentum dependent (TMD) distributions within nuclei[6,7] at existing experiments and at a future Electron Ion Collider.

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Session Classification: Small-x, Diffraction and Vector Mesons

Track Classification: Small-x, Diffraction and Vector Mesons