Contribution ID: **67** Type: **not specified**

Investigating Entanglement Enabled Spin Interference in photonuclear $\rho^0 \to \pi^+\pi^-$ and $\gamma\gamma \to \pi^+\pi^-$ in Au+Au collisions at STAR

Friday 13 June 2025 09:50 (20 minutes)

In ultraperipheral collisions, the invariant mass spectrum of $\pi^+\pi^-$ pairs is very complex due to the numerous production channels and intermediate states. The quantum ambiguity between production channels, referred to as the Entanglement Enabled Spin Interference (EESI) effect, leads to angular anisotropy in the final state. The most dominant contribution to the invariant mass spectrum of $\pi^+\pi^-$ is $\gamma A \to \rho^0(770) \to \pi^+\pi^-$, but other photonuclear (γA) and light-by-light ($\gamma\gamma$) channels also must be considered. EESI between the $\gamma\gamma$ and γA channels is expected to produce $A_{1\Delta\phi}$ and $A_{3\Delta\phi}$ signals. This new window into hadronic light-by-light production may provide new theoretical constraints on the anomalous magnetic moment of the muon, where the hadronic light-by-light contribution is one of the largest uncertainties.

In this talk, the first measurement of EESI between photonuclear and light-by-light production of $\pi^+\pi^-$ pairs, including the strong EESI signal associated with the $f_2(1270)$ resonance, will be presented. The EESI observables are then used to isolate $\gamma\gamma \to \pi^+\pi^-$ in ultraperipheral $Au + Au$ collisions at $\sqrt{s_{NN}} = 200$ GeV.

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Session Classification: Photon-photon physics, precision tests of SM and BSM

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