Investigating Entanglement Enabled Spin Interference in continuum $\pi^+\pi^-$ and ρ^0 photoproduction in Au+Au collisions at STAR

Sam Corey, Leszek Kosarzewski, and Xinbai Li (for the STAR Collaboration)

Abstract

The interplay of various $\pi^+\pi^-$ photoproduction mechanisms creates a rich environment to explore the Entanglement Enabled Spin Interference (EESI) effect in different contexts. The resonance and continuum $\pi^+\pi^-$ production originate from distinct γA and $\gamma\gamma$ processes offering unique opportunities to investigate production mechanisms and interference dynamics. The continuum $\pi^+\pi^-$ production is dominated by single virtual π^+/π^- nucleus scattering in the Drell-Söding process, which has never been precisely measured. Due to the absence of the intermediate ρ^0 and its unique production mechanism, the Drell-Söding measurement could provide a new and unprecedented insight into the entanglement purity and interference dynamics. The $\gamma\gamma \to \pi^+\pi^-$ process also contributes to the continuum $\pi^+\pi^-$ production. EESI between the $\gamma\gamma$ and γA pathways produces a clean $A_{1\Delta\phi}$ signal that can be used to isolate the hadronic light-by-light process from the dominant Drell-Söding process for the first time: a result that may provide new theoretical constraints on the anomalous magnetic moment of the muon. In addition, the measurement of $\pi^+\pi^-$ photoproduction in peripheral collisions could investigate the possible decoherence caused by interactions with the created medium and the impact parameter dependence of EESI as well as decoherence due to breakup of the nucleus.

In this talk, we present the first measurement of the diffractive p_T spectrum and the EESI through $A_{2\Delta\phi}$ for the Drell-Söding process and the first measurement to utilize EESI observables to isolate the $\gamma\gamma \to \pi^+\pi^-$ in ultraperipheral $Au + Au$ collisions at $\sqrt{s_{NN}} = 200$ GeV. We also report the first measurement to study the impact of the quark-gluon medium on the coherence of the EESI system in peripheral $Au + Au$ collisions at $\sqrt{s_{NN}} = 200$ GeV.