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The spin interference effects with photoproduced ρ^0 and J/ψ in Ultra Peripheral Collisions at STAR

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In ultra-peripheral heavy-ion collisions (UPCs), vector meson photoproduction, e.g., ρ^0 and J/ψ , has been considered one of the most sensitive probes for studying the gluonic structure in heavy nuclei. The linear polarization of the photons involved in these processes can help to image the nucleus through the so-called spin interference effect in vector meson photoproduction. Many efforts have been made to study this interference effect in RHIC and LHC experiments. Recently, STAR at RHIC discovered the spin interference effect from the ρ^0 vector meson photoproduction in Au+Au and U+U UPCs. However, the possibility that the interference can happen at the level of vector mesons cannot be falsified using ρ^0 data due to its shorter lifetime. The J/ψ vector mesons, having much longer lifetime and non-localized wave function, bring new insight into these.

In this talk, we will report measurements of the differential cross sections of photoproduced ρ^0 and J/ψ in Au+Au UPCs at $\sqrt{s_{NN}} = 200$ GeV recorded by STAR. The results will be presented for different combinations of neutron emissions. These data provide important constraints for nuclear parton distribution functions and sub-nucleonic shape fluctuations in heavy nuclei. We also present the latest measurements of angular modulation arising from the spin interference effect for the coherent ρ^0 and J/ψ photoproduction. We observe a large $\cos(2\Delta\phi)$ modulation in the angular separation between the vector mesons and one of its decay daughters, predicted to be a signature of the spin interference effect. Finally, we will discuss the future prospects during the final RHIC runs in 2023-2025.

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