Probing Quantum Numbers and Decay Branching Ratios of Exotic States via Entanglement-Enabled Spin Interference

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In ultra-peripheral heavy-ion collisions (UPCs), vector mesons are coherently photoproduced from two spatially separated yet quantum-mechanically indistinguishable nuclei. The coherent superposition of the two production amplitudes leads to production-site entanglement, resulting in measurable spin-interference patterns in the angular distributions of the decay products.

In this contribution, we present a new method for probing intermediate-state quantum numbers and relative decay branching ratios through entanglement-enabled spin interference. Using the decay $\rho(1450) \to \pi^+\pi^-\pi^+\pi^-$ as an example, we simulate the $a_1(1260)\pi$, $\rho(\pi\pi)_{S\text{-wave}}$, and $\pi(1300)\pi$ decay chains and extract their corresponding azimuthal $\cos(2\Delta\phi)$ modulations. We will further demonstrate the feasibility of extracting the relative branching ratio of the $\pi(1300)\pi$ channel from spin-interference measurements. The prospects for applying this method to the spectroscopy of other exotic hadrons will be discussed.