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The 185th HENPIC seminar by Prof. Zhangbu Xu

Title: Quantum Entanglement Enabled Nuclear Tomography

Abstract: A linearly polarized photon can be quantized from the Lorentz-boosted electromagnetic field of a nucleus traveling at ultra-relativistic speed. When two relativistic heavy nuclei pass one another at a distance of a few nuclear radii, these photons from the two nuclei can interact with each other in the Breit-Wheeler process. I will discuss how the experimental measurements of the Breit-Wheeler process in ultra-relativistic heavy-ion collisions can be used to quantitatively measure the nuclear charge radius. The extracted parameters show potential centrality dependence, and can be used to study the initial charge fluctuation and final-state magnetic field effect in hadronic interactions. Conversely, photon from one nucleus may interact through a virtual quark-antiquark pair with gluons from the other nucleus forming a short-lived vector meson (e.g. $\rho 0$). I will discuss how the polarization was utilized in diffractive photoproduction to observe a unique spin interference pattern in the angular distribution of $\rho 0 \longrightarrow \pi + \pi -$ decays. The observed interference is a result of an overlap of two wave functions at a distance an order of magnitude larger than the $\rho 0$ travel distance within its lifetime. The strong-interaction nuclear radii and neutron skins were extracted from these diffractive interactions. The observable is demonstrated to be sensitive to the nuclear geometry and quantum interference of non-identical particles. I will also discuss future experimental measurements and tests of quantum entanglement.

Summary