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Title: Discovery of the Breit-Wheeler Process and its Application to Nuclear Charge and Mass Radii Measurements.

Abstract: Only a handful of fundamental interactions between light and matter are allowed by the theory of quantum electrodynamics, almost all of which have been observed in the 80+ years since their prediction. Among the tree level interactions, only the Breit-Wheeler process, the simplest mechanism for converting 'light quanta' into matter and antimatter, eluded observation despite being hotly pursued. The key challenge has been obtaining a photon source with sufficiently high intensity and energy, such that two photons will collide with a center-of-mass energy of at least twice the electron mass.

In this talk I present the recent discovery of the Breit-Wheeler process by the STAR collaboration achieved by harnessing photons manifest from the ultra-Lorentz boosted Coulomb fields of colliding heavy nuclei. In this experimental setup, the linear polarization of the colliding photons leads to an angular modulation in the momentum of the produced electron-positron pairs that uniquely identifies the Breit-Wheeler process. Furthermore, the momentum distribution of the produced electron-positron pairs provides precise information about the spatial distribution of the colliding electromagnetic fields and the underlying nuclear charge distributions - information which at first seems to violate the uncertainty principle.

The discovery of the Breit-Wheeler process also provides a novel tool for studying the mass distribution of heavy nuclei at high energies and helps resolve a decade long puzzle -- the anomalously large nuclear mass radii extracted from photonuclear interactions in heavy-ion collisions. By utilizing a technique in photonuclear interactions that was developed for the Breit-Wheeler process which is sensitive to photon polarization, it is possible to measure the mass radii of large nuclei at high energy to sub-femtometer precision. Finally, I'll close with perspectives on photon physics in existing and future high energy experiments.