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Collision-energy dependence of the Breit-Wheeler process in heavy-ion collisions and its application to nuclear charge radius measurements

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In ultra-relativistic heavy-ion collisions, strong electromagnetic fields arising from the Lorentz-contracted, highly charged nuclei can be approximated as a large flux of high-energy quasi-real photons that can interact via the Breit-Wheeler process to produce e^+e^- pairs. The collision energy dependence of the cross section and the transverse momentum distribution of dielectrons from the Breit-Wheeler process in heavy-ion collisions are calculated with lowest-order EPA-QED. Within a given experimental kinematic acceptance, the cross section is found to increase while the pair transverse momentum decreases with increasing beam energy. The corresponding results are also compared with STAR measurements, which are consistent with each other and found to be sensitive to the nuclear charge distribution and the infrared-divergence of the ultra-Lorentz boosted Coulomb field. Following this approach we demonstrate that the experimental measurements of the Breit-Wheeler process in ultra-relativistic heavy-ion collisions can be used to quantitatively constrain the nuclear charge radius. The extracted parameters show sensitivity to the impact parameter dependence, and can be used to study the initial-state and final-state effects in hadronic interactions.

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