Probing Extreme Electromagnetic fields with the Breit-Wheeler Process

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Ultra-relativistic heavy ion collisions are expected to produce some of the strongest magnetic fields ($10^{13} - 10^{16}$ Tesla) in the Universe[1]. Recently, there has been increased interest in the magnetic fields produced by heavy ion collisions and their possible observational impacts through emergent magnetohydrodynamical phenomena in Quantum Chromodynamics[2]. The initial strong electromagnetic fields produced in heavy ion collisions have been proposed as a source of linearly-polarized, quasi-real photons[3] that can interact via the Breit-Wheeler process to produce e^+e^- pairs[4].

In this talk I will present STAR measurements of e^+e^- pair production in ultra-peripheral and peripheral Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. A comprehensive study of the pair kinematics is presented to distinguish the $\gamma\gamma \rightarrow e^+e^-$ process from other possible production mechanisms. Furthermore, I will present and discuss the first observation of a 4th-order azimuthal modulation of e^+e^- pairs produced in heavy-ion collisions. The striking fourth-order angular modulation is a direct result of vacuum birefringence[5], a phenomenon predicted in 1936 in which empty space can split light according to its polarization components when subjected to a strong magnetic field. These measurements and their implications for the magnetic field produced in heavy-ion collisions will be discussed.

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