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Exploring light-by-light scattering with next-generation detectors

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The physics of ultraperipheral ultrarelativistic heavy-ion collisions
gives an excellent opportunity to study photon-photon interaction.
Vast moving charged particles (nuclei) are surrounded by an electromagnetic field that can be considered as a source of (almost real) photons. The photon flux scales as the square of the nuclear charge, so ^{208}Pb has a considerable advantage over protons as far as a flux of photons is considered.

Here we discuss possible future studies of photon-photon scattering using a planned ALICE 3 apparatus. ALICE 3 is planned as a next-generation heavy-ion detector for the LHC Runs 5 and 6. The broad range of (pseudo)rapidities and lower cuts on transverse momenta open a necessity to consider not only dominant box contributions but also other, not yet studied, subleading contributions, such as double-hadronic photon fluctuations, t/u-channel neutral pion exchange or resonance excitations ($\gamma\gamma \to R$) and deexcitation ($R \to \gamma\gamma$). Here we include $R = \pi^0, \eta, \eta'$ contributions. The resonance contributions give intermediate photon transverse momenta. However, these contributions can be eliminated by imposing windows on diphoton invariant mass. We study in detail individual fermionic box contributions. The electron/positron boxes dominate at low $M_{\gamma\gamma} < 1$ GeV diphoton invariant masses.

The $PbPb \to PbPb\gamma\gamma$ cross section is calculated within equivalent photon approximation in the impact parameter space. Several differential distributions will be presented and discussed. We predict a huge cross section for typical ALICE 3 cuts, a few orders of magnitude larger than for current ATLAS or CMS experiments. We also consider the two-π^0 background, which can, in principle, be separated/eliminated at the new kinematical range for the ALICE-3 measurements by imposing dedicated cuts.

Collaboration / Activity

Theory

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