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#1-3 Search for massive gravitons coupling to photons with colliders

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Light-by-light scattering is a quantum-mechanical phenomenon that is forbidden in the classical framework of electrodynamics. It was first anticipated over 70 years ago by Heisenberg and Euler. This process becomes achievable at the Large Hadron Collider due to the significant electromagnetic field intensities produced during the high-energy collisions of lead ions. Through the analysis of data from 480 μb^{-1} of lead-lead collisions, which occurred at a center-of-mass energy per nucleon pair of 5.02 TeV and were recorded by the ATLAS detector, researchers have presented the first evidence of light-by-light scattering occurring in these collisions. Gravitons are hypothetical particles that have yet to be directly observed, but they are predicted by various theories, including quantum gravity. One process that allows for the production of particles that couple to photons, such as massive gravitons, is light-by-light scattering. In this work, we investigate the potential to discover massive graviton-like spin-2 particles coupled to standard model fields, produced in photon-photon collisions at the LHC and in electron-positron colliders. Our experimental setup involved implementing appropriate selection criteria for each detector to ensure data integrity. Through comprehensive analysis and interpretation of existing experimental bounds on the Axion-Like-Particle(ALP)-photon coupling from the Large Hadron Collider (LHC) and e^+e^- colliders, such as Belle II and BES-III, we establish exclusion limits on the graviton-photon coupling down to $g_{G\gamma} \approx 1$–0.05~TeV^{-1} for graviton masses $m_G \approx 100$ MeV–2 TeV. These limits could be significantly enhanced by a factor of 100 at BelleII for lower mass regimes and by a factor of 4 at the High-Luminosity LHC for higher mass regimes, considering their anticipated full integrated luminosities.

\keywords{LHC, ATLAS, CMS, LEP, BelleII, BESIII, Massive graviton , graviton-photon coupling}

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