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Measurements of the light-by-light scattering and the Breit–Wheeler processes, and searches for axion-like particles in ultraperipheral PbPb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV

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Measurements of the light-by-light scattering (LbL, $\gamma\gamma \to \gamma\gamma$) and the Breit–Wheeler (B–W, $\gamma\gamma \to \mathrm{e}^{+}\mathrm{e}^{-}$) processes are reported in ultraperipheral collisions at 5.02 TeV using the 2018 CMS lead-lead data sample of $1.65\ \mathrm{nb}^{-1}$. Events with a pair of exclusively produced photons or electrons are selected, each with transverse energy $E_{\mathrm{T}}^{\gamma,\mathrm{e}} > 2$ GeV, pseudorapidity $|\eta^{\gamma,\mathrm{e}}| < 2.2$, pair invariant mass $m^{\gamma\gamma,\mathrm{ee}} > 5$ GeV, pair transverse momentum $p_{\mathrm{T}}^{\gamma\gamma,\mathrm{ee}} < 1$ GeV, and pair azimuthal acoplanarity $A_{\phi} < 0.01$. The measured B–W fiducial cross section, $\sigma_{\mathrm{fid}}(\gamma\gamma \to \mathrm{e}^{+}\mathrm{e}^{-}) = 271.5 \pm 1.9\ (\mathrm{stat}) \pm 18.3\ (\mathrm{syst})\ \mu\mathrm{b}$, as well as the differential distributions for various kinematic observables, are in agreement with standard model (SM) predictions. The observed significance of the LbL signal with respect to the background-only hypothesis is above five standard deviations. The fiducial LbL scattering cross section, $\sigma_{\mathrm{fid}}(\gamma\gamma \to \gamma\gamma) = 107 \pm 33\ (\mathrm{stat}) \pm 20\ (\mathrm{syst})\ \mathrm{nb}$, is consistent with SM predictions. Limits on the production of axion-like particles coupling to photons are set over the mass range $m_{\mathrm{a}} = 5$–100 GeV, including the most stringent limits in 5–10 GeV.

Category

Experiment

Collaboration

CMS

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