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## Evidence for light-by-light scattering and searches for axion-like particles in ultraperipheral PbPb collisions at root s(NN)=5.02 TeV

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### Abstract

Evidence for the light-by-light scattering process,  $\gamma\gamma \rightarrow \gamma\gamma$ , in ultraperipheral PbPb collisions at a centre-of-mass energy per nucleon pair of 5.02 TeV is reported. The analysis is conducted using a data sample corresponding to an integrated luminosity of 390  $\mu\text{b}^{-1}$  recorded by the CMS experiment at the LHC. Light-by-light scattering processes are selected in events with two photons exclusively produced, each with transverse energy  $E_T(\gamma) > 2$  GeV, pseudorapidity  $|\eta(\gamma)| < 2.4$ , diphoton invariant mass  $m(\gamma\gamma) > 5$  GeV, diphoton transverse momentum  $p_T(\gamma\gamma) < 1$  GeV, and diphoton acoplanarity below 0.01. After all selection criteria are applied, 14 events are observed, compared to expectations of  $9.0 \pm 0.9$  (theo) events for the signal and  $4.0 \pm 1.2$  (stat) for the background processes. The excess observed in data relative to the background-only expectation corresponds to a significance of 3.7 standard deviations, and has properties consistent with those expected for the light-by-light scattering signal. The measured fiducial light-by-light scattering cross section,  $\sigma(\text{fid})(\gamma\gamma \rightarrow \gamma\gamma) = 120 \pm 46(\text{stat}) \pm 28(\text{syst}) \pm 12(\text{theo})$  nb, is consistent with the standard model prediction. The  $m(\gamma\gamma)$  distribution is used to set new exclusion limits on the production of pseudoscalar axion-like particles, via the  $\gamma\gamma \rightarrow a \rightarrow \gamma\gamma$  process, in the mass range  $m(a) = 5\text{-}90$  GeV. (C) 2019 The Author(s). Published by Elsevier B.V.

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