

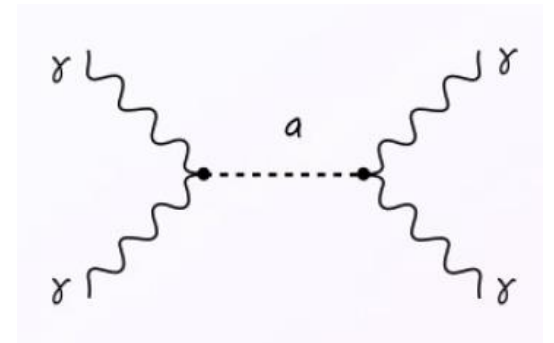
Observation of light-by-light scattering and search for axion-like particles with the CMS experiment

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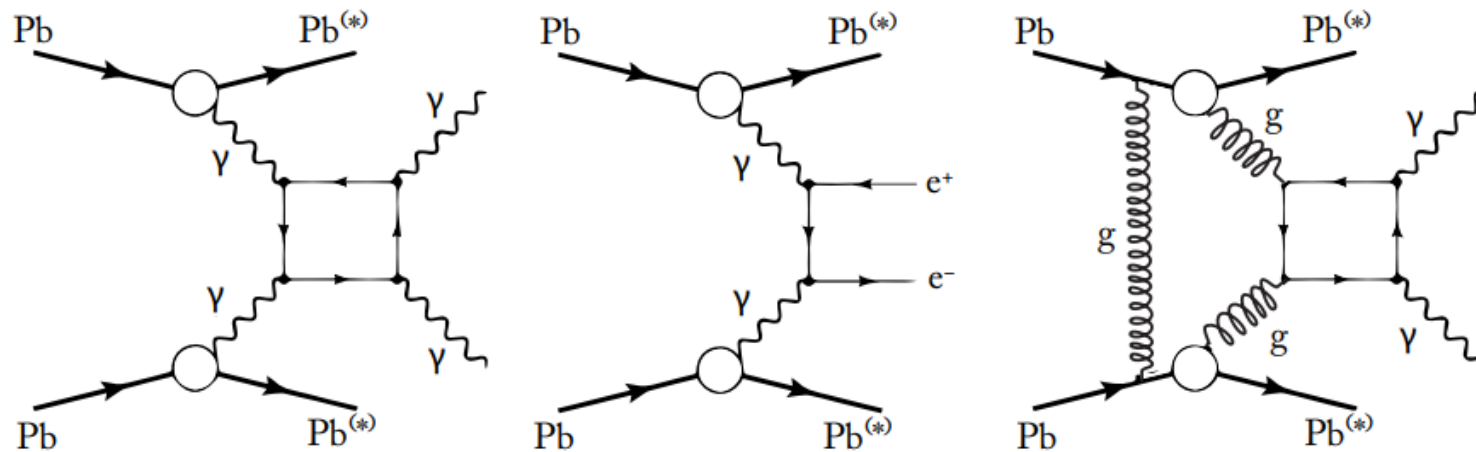
ON BEHALF OF THE CMS COLLABORATION

Axion-like particle (ALP) search at LHC

- Hypothetical particles, which could be a component of cold dark matter
- Can be observed in ultra-peripheral interactions of ions
- Dominant background of the theoretical $\gamma\gamma \rightarrow a \rightarrow \gamma\gamma$ process:
 - Light-by-light (LbL) scattering $\gamma\gamma \rightarrow \gamma\gamma$
 - QED dielectron production $\gamma\gamma \rightarrow e^+e^-$
 - Central exclusive diphoton production (CEP) $gg \rightarrow \gamma\gamma$

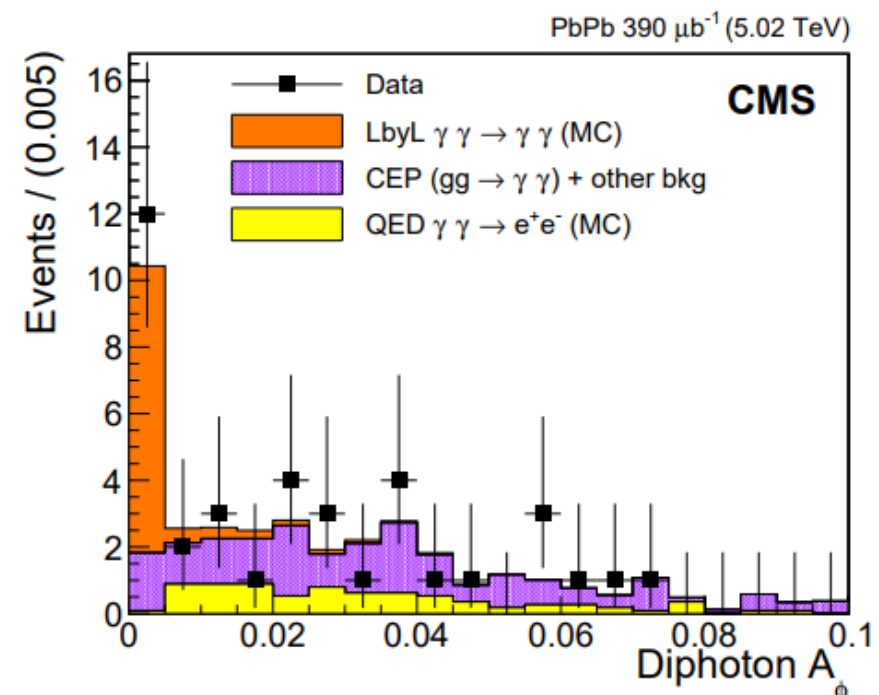
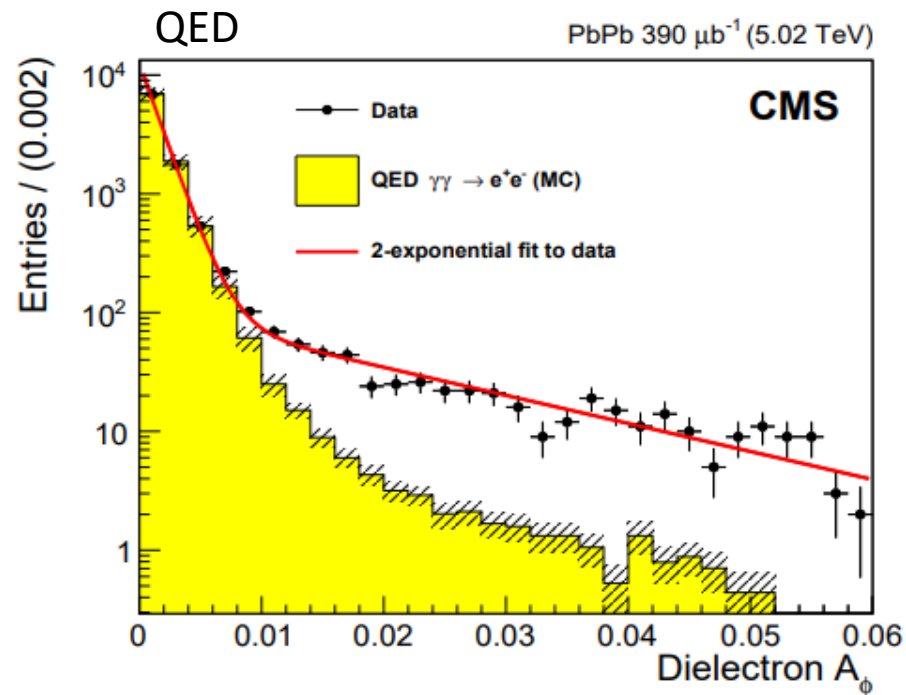


- Photon flux scales with Z^2 of ion:
 $\gamma\gamma$ scattering cross sections in PbPb collisions are enhanced by $Z^4 \approx 5 \cdot 10^7$



Investigation of LbL scattering

- Study of $\gamma\gamma \rightarrow \gamma\gamma$ process, using $390 \mu\text{b}^{-1}$ of PbPb collision data recorded by CMS at $\sqrt{s_{NN}} = 5.02 \text{ TeV}$ (Phys. Lett. B 797 (2019) 134826)
- Signal consists of exclusive, back-to-back (low acoplanarity $A_\phi < 0.01$) $\gamma\gamma$ events
- Background estimation: QED e^+e^- taken from Starlight simulation while prediction for CEP + other processes is scaled in high acoplanarity range to data



LbL distributions and ALP exclusion limit

- 14 events observed for 9.0 ± 0.9 (theo) LbL and 4.0 ± 1.2 (stat) background expected
- 3.7σ significance
- The ratio of fiducial LbL to total QED: $R = (25.0 \pm 9.6$ (stat) ± 5.8 (syst)) $\times 10^{-6}$
- Cross section of fiducial LbL: $\sigma_{fid}(\gamma\gamma \rightarrow \gamma\gamma) = 120 \pm 46$ (stat) ± 28 (syst) ± 12 (theo)nb

