

Measurement of the electroweak production of $Z\gamma$ and two jets in proton-proton collisions at $\sqrt{s} = 13$ TeV and constraints on anomalous quartic gauge couplings

Wednesday, 10 August 2022 16:55 (15 minutes)

The first observation of the electroweak (EW) production of a Z boson, a photon, and two forward jets ($Z\gamma jj$) in proton-proton collisions at a center-of-mass energy of 13 TeV is presented. A data set corresponding to an integrated luminosity of 137 fb^{-1} , collected by the CMS experiment at the LHC in 2016-2018 is used. The measured fiducial cross section for EW $Z\gamma jj$ is $\sigma_{\text{EW}} = 5.21 \pm 0.52 \text{ (stat)} \pm 0.56 \text{ (syst)} \text{ fb} = 5.21 \pm 0.76 \text{ fb}$. Single-differential cross sections in photon, leading lepton, and leading jet transverse momenta, and double-differential cross sections in m_{jj} and $|\Delta\eta_{jj}|$ are also measured. Exclusion limits on anomalous quartic gauge couplings are derived at 95% confidence level in terms of the effective field theory operators M_0 to M_5 , M_7 , T_0 to T_2 , and T_5 to T_9 .

Summary

This paper presents the first observation of the electroweak (EW) production of a Z boson, a photon, and two jets ($Z\gamma jj$) in $\sqrt{s} = 13 \text{ TeV}$ proton-proton collisions recorded with the CMS detector in 2016–2018 corresponding to an integrated luminosity of 137 fb^{-1} . Events were selected by requiring two opposite-sign leptons with the same flavor from the decay of a Z boson, one identified photon, and two jets that have a large separation in pseudorapidity and a large dijet mass. The measured cross section in the fiducial volume for EW $Z\gamma jj$ production is $5.21 \pm 0.52 \text{ (stat)} \pm 0.56 \text{ (syst)} \text{ fb} = 5.21 \pm 0.76 \text{ fb}$, and the fiducial cross section of EW and QCD-induced production is $14.7 \pm 0.80 \text{ (stat)} \pm 1.26 \text{ (syst)} \text{ fb} = 14.7 \pm 1.53 \text{ fb}$. Both the observed and expected signal significances are well in excess of 5 standard deviations. Differential cross sections for EW and EW+QCD are measured for several observables and compared to standard model predictions computed at leading order. Within the uncertainties, the measurements agree with the predictions. Constraints are set on the effective field theory dimension-8 operators M_0 to M_5 , M_7 , T_0 to T_2 , and T_5 to T_9 , giving rise to anomalous quartic gauge couplings. These constraints are either competitive with or more stringent than those previously obtained.

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Session Classification: Parallel Session VI (1): TeV and BSM Physics

Track Classification: TeV 物理和超出标准模型新物理