AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY
Faculty of Physics and Applied Computer Science

Doctoral thesis

Measurement of diffractive jets production in proton-proton collisions with ALFA detectors in the ATLAS experiment

Abstract

The dissertation presents measurements of diffractive dijet production in proton-proton collisions at the centre-of-mass energy $\sqrt{s} = 13$ TeV. The measurements are based on data with an integrated luminosity of 725 nb^{-1}, which were collected with the ATLAS detector in October 2015. The LHC was running with special beam conditions: high-β^* optics ($\beta^* =$ 90 m) and low average expected number of interactions ($\mu = 0.1$). Both single and central diffraction processes are analysed, in which one or both protons remain intact and can be measured by the ALFA forward detectors. This is the first measurement of dijet production in single diffraction with proton tagging in the ATLAS experiment and the first measurement of dijet production in central diffraction at the LHC.

The fiducial region of the measurements is limited by the ALFA detectors acceptance: relative energy loss of protons is in the range $0.002 < \xi < 0.160$ and the squared four-momentum transfers are 0.02 GeV$^2 < |t| < 1.00$ GeV^2. In addition, the requirement of high efficiency of the jet trigger imposes limits on jets: the transverse momentum and pseudorapidity of the leading jet have to meet conditions $p_{\mathrm{T}}^{\mathrm{LJ}} > 30$ GeV and $|\eta^{\mathrm{LJ}}| < 3.0$, and in the case of the secondary jet they are $p_{\mathrm{T}}^{\mathrm{SJ}} > 20$ GeV and $|\eta^{\mathrm{SJ}}| < 4.0$.

The measured total fiducial cross section for dijet production in single diffraction is $\sigma_{\mathrm{JJ}}^{\mathrm{SD}} = 57.2 \pm 0.8(\mathrm{stat})\, ^{+9.6}_{-8.7}(\mathrm{syst})$ nb. The differential cross sections are measured in terms of ξ, t, $p_{\mathrm{T}}^{\mathrm{LJ}}$, $|\eta^{\mathrm{LJ}}|$ and the fraction β^{JJ} of the Pomeron momentum carried by jets. Results are compared with model predictions based on the Pythia 8 and EPOS generators. Both models do not describe the data well. The ratio of single diffractive to total inclusive dijet production cross sections in the fiducial region is estimated to be $R_{\mathrm{SD}} = 0.0238 \pm 0.0004(\mathrm{stat})\, ^{+0.0063}_{-0.0028}(\mathrm{syst})$.

For central diffraction, the total cross section for dijet production is equal to $\sigma_{\mathrm{JJ}}^{\mathrm{CD}} = 329 \pm 59(\mathrm{stat})\, ^{+61}_{-71}(\mathrm{syst})$ pb. The differential cross sections are presented in terms of ξ and $p_{\mathrm{T}}^{\mathrm{LJ}}$, and are compared with models using Pythia 8, EPOS and Herwig generators. The dissertation is complemented by the search for exclusive dijet production, a special case of central diffraction, where the central state consists of only two jets without any Pomeron remnants.

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