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The measurement of $\phi(1020)$ meson production in proton-proton collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector at the LHC.

Summary

This thesis presents the measurement of $\phi(1020)$ meson production in different types of proton-proton (pp) inelastic scattering:

- Single Diffraction (SD), $pp \to Xp$ or $pp \to pY$,
- Central Diffraction (CD), $pp \to pXp$,
- Non-Diffractive processes (ND), $pp \to X$.

Proton-proton collision data collected by the ATLAS Experiment at the LHC at $\sqrt{s} = 13$ TeV were analysed to obtain $p_{\mathrm{T},\phi}$ spectrum at midrapidity $|y_\phi| < 0.8$ and y_ϕ spectrum integrated over $0.6 < p_{\mathrm{T},\phi} < 1.5$ GeV. The ϕ production rates in SD were also measured in three ξ ranges: $\xi < 0.035$, $0.035 < \xi < 0.08$ and $0.08 < \xi < 0.16$, separately.

The processes in which at least one of two incoming protons stays intact after the interaction were selected based on data gathered by the ARP detectors that enable forward-scattered protons' detection. The decay channel $\phi \to K^+K^-$ was used in these measurements. Charged particles whose tracks are reconstructed in the ATLAS Inner Detector were identified to select kaons and to suppress background coming from pairs of oppositely charged particles that are not kaons.

The thesis consists of nine Chapters. The first two show the theoretical framework and the experimental apparatus. The subsequent steps of the analysis are presented in Chapters 3-7. The particle identification procedure which is based on tracks' ionisation energy loss and momentum measurements is explained in Chapter 3 while Chapter 4 contains details on the event selection. The ϕ meson candidate selection and corrections applied to data are discussed in Chapters 5 and 6, respectively. Chapter 7 includes closure tests and systematic uncertainty analysis. Results and their deeper discussion are presented in Chapter 8. Chapter 9 contains the summary of the most important results obtained in this thesis. The dissertation also includes two Appendices where some additional figures relevant for the analysis are shown.

The measured spectra were compared to predictions of two phenomenological models PYTHIA 8 and EPOS. The best agreement between data and expectations was observed in CD and ND analysis for EPOS and for SD analysis for $\xi < 0.035$, also for EPOS.

The ϕ production measured in ND was compared to the measurement of $\phi \to K^+K^-$ production cross section in proton-proton collisions at $\sqrt{s} = 7$ TeV obtained earlier by the ATLAS Collaboration. There is a good agreement between the spectra measured at $\sqrt{s} = 13$ TeV and $\sqrt{s} = 7$ TeV.

The results obtained for the ϕ meson production in SD, CD and ND were compared. The

highest production rates were measured for ND while the lowest ones for CD. The highest spectra in SD were obtained for the range $0.08 < \xi < 0.16$ while the lowest ones for $\xi < 0.035$. Thus, one can conclude that the different ϕ production rates in ND, CD and SD, and in SD among different ξ ranges are related to the mean number of selected particles in the given sample. Hence, the greater multiplicity of produced particles is, the bigger ϕ meson production is measured. It suggests that ϕ mesons originate predominantly from the fragmentation and the sensitivity of ϕ production to the initial states in the given processes, Pomeron- proton in SD, Pomeron-Pomeron in CD, and proton-proton in ND, is not observed.

The $p_{\mathrm{T},\phi}$ and y_ϕ spectra measurement presented in this thesis can provide valuable input to the development of the phenomenological hadroproduction models. In particular, the results may help with making constraints on the models' free parameters what can lead to a better theoretical description of high-energy physical processes at low momentum transfer.

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