

Abstract

This Thesis focuses on the study of the strange D-mesons production in proton-proton (pp) and lead-lead (Pb–Pb) collisions employing the data collected by the ALICE experiment at the CERN Large Hadron Collider. The study of the production of D_s^+ mesons in small collision systems at LHC energies is extremely important to test the predictions based on pQCD calculations and to provide a benchmark for the heavy-ion measurements where, given the high energy densities and temperatures, the nuclear matter is expected to undergo a phase transition to a colour-deconfined state called Quark-Gluon Plasma (QGP). Considering the small distance travelled by the D_s^+ meson inside the ALICE apparatus ($\sim 151 \mu\text{m}$), to perform the analyses presented in this Thesis the D_s^+ mesons were reconstructed in their hadronic decay channel $D_s^+ \rightarrow \phi\pi^+ \rightarrow K^+K^-\pi^+$ from their decay products. This is made possible by exploiting the excellent spatial resolution of the ALICE detector, which allows us to separate the D_s^+ meson decay vertex from the interaction point of the LHC beams. In this Thesis, multiclass classification algorithms are employed to select the D_s^+ meson candidates. This approach not only allows for optimal separation between the signal and the background, mainly derived from the wrong association of triplets of charged tracks, but it also provides a powerful tool to discriminate between the D_s^+ mesons originated from the charm quark hadronisation, i.e. prompt, and from the decay of beauty hadrons, i.e. non-prompt. The latter consists of $\sim 5\%$ of the D_s^+ meson produced in Nature, making the study of their production a challenging task. To this end, a Boosted Decision Tree algorithm is adopted, given its robustness, its efficient performance, and the minimal number of input variables required for the algorithm training. In this Thesis, the measurement of prompt and non-prompt D_s^+ meson p_T -differential production cross sections in pp collisions at $\sqrt{s} = 13 \text{ TeV}$ are presented. The measurements are in agreement with the predictions based on pQCD calculations. In addition, by measuring the relative production of strange and non-strange D-mesons, the fragmentation fractions of charm and beauty quarks were measured. Furthermore, a preliminary measurement of the production of excited D_s^+ meson states, the D_{s1}^+ and the D_{s2}^{*+} mesons, is presented for the first time at the LHC energies. Moreover, the first measurement of non-prompt D_s^+ meson production in central and peripheral Pb–Pb

collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV is presented. The measurement is compared to the one of prompt D_s^+ mesons and non-prompt D^0 mesons and the ratios of the nuclear modification factor are calculated. In central collisions, where the QGP-induced effects are expected to be more pronounced, the ratios exhibit a hint of enhancement in the $4 < p_T < 12$ GeV/ c interval, with a statistical significance of 1.6 and 1.7σ , respectively. Finally, a preliminary measurement of the D_s^+ meson production in pp collisions at $\sqrt{s} = 13.6$ TeV obtained using the data collected by the ALICE experiment in the current data-taking period, Run 3, is presented.