TRANSVERSE MOMENTUM SPECTRA OF D- AND B-MESONS IN HADRON COLLISIONS AT HIGH ENERGIES

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Transverse momentum spectra of charmed and beauty mesons produced in proton-proton and antiproton-proton collisions at high energies are analyzed within the modified quark-gluon string model (QGSM). We got a satisfactory description of the experimental data on p_t spectra of *D*- and *B*-mesons produced in the $p - \bar{p}$ collisions which were obtained by the CDF Collaboration at the Tevatron at $1.5(GeV/c) < p_t < 20(GeV/c)$. Our results are similar to the calculations within the NLO of QCD at $p_t > 6(GeV/c)$, which have a big uncertainty, except for the kinematic region of very high p_t, where $p_t > 20.(GeV/c)$. It can be due to the contribution of gluons inside the colliding proton and antiproton which can interact with other gluons and quarks(antiquarks) and fragmentate to charmed mesons. This effect is not included in the presented QGSM. The results show that the QGSM can be used to analyze transverse momentum spectra of charmed and beauty mesons produced both in $p - p$ and $p - \bar{p}$ collisions at very high energies up to the LHC energies. We compare also our predictions for the LHC with the calculations on the charm and beauty quark production in $p - p$ collision obtained within the NLO QCD by the ALICE Collaboration.

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[†]A footnote may follow.

The multiple hadron production in hadron-nucleon collisions at high initial energies and large transfers is usually analyzed within the hard parton scattering model. This is significantly improved by applying the QCD parton approach implemented in the modified minimal-subtraction renormalization and factorization scheme. It provides a rigorous theoretical framework for a global data analysis [1]; however, it has some uncertainties related to different scale parameters. In this paper we analyze the D-meson production in the $p - p$ and $p - \bar{p}$ collisions within the QGSM including the transverse motion of quarks and diquarks in colliding protons [2]. The general form for the invariant inclusive spectrum of hadrons produced, for example in the $p - \bar{p}$ collision calculated within the QGSM has the following form:

$$E\frac{d\sigma^{p\bar{p}}}{d^3\mathbf{p}} = (1-\omega)\sum_{n=0}^{\infty}\sigma_n(s)\phi_n^{p\bar{p}}(x,p_t) + \omega\tilde{\phi}(x,p_t) , \tag{1}$$

where $1 - \omega$ is the probability of contribution of the cut one-cylinder (one-Pomeron exchange) and cut multicylinder (multi-Pomeron exchanges) graphs, see the details in [2, 3], whereas ω is the probability of the contribution of the three-chain diagram corresponding to the total $p - \bar{p}$ annihilation [3]; σ_n is the cross section for production of the n-Pomeron chain (or $2n$ quark-antiquark strings) decaying into hadrons, calculated within the "quasieikonal approximation", see [2] and references therein; $\phi_n^{p\bar{p}}(x,p_t)$ and $\tilde{\phi}(x,p_t)$ are the interaction functions [3]. For $p - p$ collision $\omega = 0$ [3] because in this case there is not annihilation processes like in the $p - \bar{p}$ collision.

The inclusive p_t spectra of D^0- and B^+-mesons produced in the $p - \bar{p}$ collision at the Tevatron energy are presented in Fig.1. One can see rather satisfactory description of the experimental data [4] for D^0- and B^+-mesons using $\omega = 0.1$ and $B_0 = 0.65$ for D-mesons, and $B_0 = 0.55$ for B-mesons, $\lambda = 2\alpha'_{D^*(B^*)}(0) < p_t^2 >$, $\alpha'_{D^*(B^*)}(0) \simeq 0.5(GeV/c)^{-2}$ is the slope of the D^*- or B^*-Regge trajectory, $< p_t^2 >$ is the mean transverse momentum squared of the D-meson or B-meson; B_0 is the slope of the transverse momentum k_t distribution of quarks (antiquarks) and diquarks (antidiquarks) $f(k_t) = (B_0/2\pi)\exp(-B_0 k_t)$ in the colliding protons or proton-antiproton. One can see that to describe the experimental data on p_t spectra of the meson produced in $p - \bar{p}$ collisions at very high energies and big values for p_t within the QGSM we cannot include the three-chain graph corresponding to the total $p - \bar{p}$ annihilation [3]. The predictions for inclusive p_t spectra of D^0- and B^+-mesons produced in the $p - p$ collision at LHC energies and the NLO calculation for the produced charmed quarks [5] are presented in Fig.2.

Acknowledgements

References

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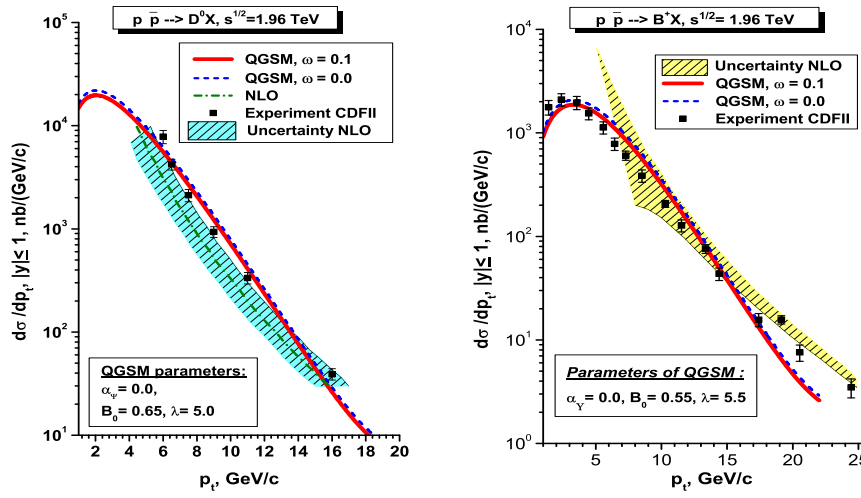
Figure 1: The inclusive p_t-spectrum for D^0-mesons (left) and B^+-mesons (right) produced in the $p - \bar{p}$ collision at the Tevatron energy $\sqrt{s} = 1.96$ TeV [4].
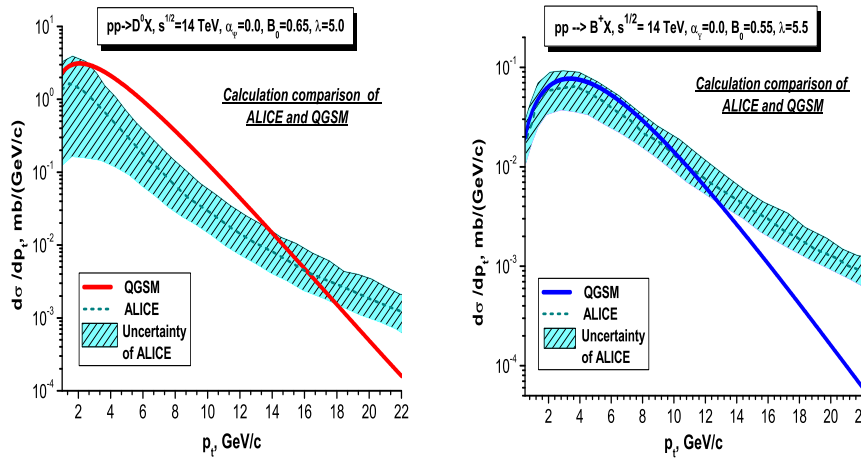

Figure 2: The inclusive spectrum for D^0-mesons produced in the $p - p$ collision (left) and the same spectrum for B^+-mesons (right) at the LHC energy $\sqrt{s} = 14$ TeV (right) obtained within the QGSM for charmed and beauty mesons and the NLO QCD for c- and b-quarks [5].

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