

On x -independence of $R^Q = F_L^Q/F_2^Q$ ratio at low x

N. A. Abdulov⁺¹⁾, A. V. Kotikov⁺¹⁾, A. V. Lipatov^{+*1)}

⁺Joint Institute for Nuclear Research, 141980 Dubna, Russia

^{*}Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, 119991 Moscow, Russia

Submitted 21 January 2023

Resubmitted 8 February 2023

Accepted 8 February 2023

DOI: 10.31857/S1234567823060010, EDN: qrpvxz

An important new data on the cross sections for the open charm and beauty production in deep inelastic electron-proton scattering (DIS) have appeared [1] by combining the results of research from the H1 and ZEUS collaborations at HERA. Measurements have shown that the production of heavy flavor Q in DIS occurs predominantly due to the photon-gluon fusion process $\gamma g \rightarrow Q\bar{Q}$ and therefore depend strongly on gluon density in the proton and mass m_Q of produced heavy quark ($Q = c, b$ and t). Theoretical studies usually serve to confirm that available HERA data can be described by perturbative heavy flavor generation in QCD (see, for example, review [2] and references therein). Further investigations are planned at future lepton-hadron and hadron-hadron colliders [3–5], such as eIC, LHeC, FCC-eh and FCC-hh, where the measurements can be performed with much increased precision and extended to much smaller x and high Q^2 values.

In our previous consideration [6, 7] we have analyzed latest experimental data [1] taken by the H1 and ZEUS Collaborations at HERA. In particular, we have studied the heavy quark contributions to the proton structure function (SF) $F_2(x, Q^2)$ and reduced charm and beauty cross sections $\sigma_{\text{red}}^{c\bar{c}}(x, Q^2)$ and $\sigma_{\text{red}}^{b\bar{b}}(x, Q^2)$ measured mostly at small values of the Bjorken variable x in a wide region of Q^2 [8–11]. An additional important result of the evaluations [7] is that the compact analytical expressions for these DIS coefficient functions have been presented up to next-to-next-to-leading order (NNLO) accuracy. These expressions were used very recently to investigate the top quark production in the FCC-he kinematical regime [12, 13]. Here we continue

our study [6, 7]. Using the previously derived expressions for DIS coefficient functions, we study the ratio $R^Q(x, Q^2) = F_L^Q(x, Q^2)/F_2^Q(x, Q^2)$ in the first three orders of perturbation theory. We demonstrate an approximate x -independence of this ratio for non-large Q^2 values, namely, $Q^2 \leq 8 \div 10m_Q^2$. Moreover, we show a very slow ratio's dependence on the choice of used gluon density.

This is an excerpt of the article “On x -independence of $R^Q = F_L^Q/F_2^Q$ ratio at low x ”. Full text of the paper is published in JETP Letters journal. DOI: 10.1134/S002136402360012X

1. H. Abramowicz, I. Abt, L. Adamczyk et al. (H1 and ZEUS Collaboration), *Eur. Phys. J. C* **78**(6), 473 (2018).
2. J. Gao, L. Harland-Lang, and J. Rojo, *Phys. Rep.* **742**, 1 (2018).
3. S. Amoroso, A. Apyan, N. Armesto et al. (Collaboration), arXiv:2203.13923 [hep-ph].
4. K.D. J. André, L. Aperio Bella, N. Armesto, et al. (Collaboration), *Eur. Phys. J. C* **82**(1), 40 (2022).
5. M. Klein, arXiv:1802.04317 [hep-ph].
6. A. V. Kotikov, A. V. Lipatov, B. G. Shaikhatdenov, and P. Zhang, *JHEP* **2002**, 028 (2020).
7. A. V. Kotikov, A. V. Lipatov, and P. M. Zhang, *Phys. Rev. D* **104**(5), 054042 (2021).
8. ZEUS Collaboration, *JHEP* **1409**, 127 (2014).
9. H1 Collaboration, *Eur. Phys. J. C* **71**, 1769 (2011).
10. H1 Collaboration, *Eur. Phys. J. C* **72**, 2252 (2012).
11. H1 Collaboration, *Eur. Phys. J. C* **65**, 89 (2010).
12. G. R. Boroun, arXiv:2109.09583 [hep-ph].
13. G. R. Boroun, arXiv:2301.03261 [hep-ph].

¹⁾e-mail: nizami.abdulov@gmail.com; kotikov@theor.jinr.ru; artem.lipatov@mail.ru