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α_s in DIS scheme

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Deep inelastic scattering data on F_2 structure function accumulated by various collaborations in fixed-target experiments are analyzed in the nonsinglet approximation and within $\overline{MS}$ and DIS schemes. The study of high statistics deep inelastic scattering data provided by BCDMS, SLAC and NMC collaborations, is carried out by applying a combined analysis. The application of the DIS scheme leads to the resummation of contributions that are important in the region of large x values. It is found that using the DIS scheme does not significantly change the strong coupling constant itself but does strongly change the values of the twist-four corrections.

We work within the framework of the variable-flavor-number scheme (VFNS) (see [1]). Nevertheless, to make it more clear the effect of changing the sign for twist-four corrections, the fixed-flavor-number scheme (FFNS) with $n_f = 4$ is also used.

As is seen from Table 1 the central values of $\alpha_s(M_Z^2)$ are fairly the same given total experimental and theoretical errors (see [1–4]):

$$\pm 0.0022 \quad \text{(total exp. error)}, \begin{cases} +0.0028 \\ -0.0016 \end{cases} \text{(theor. error)}. \tag{1}$$

Table 1. Parameter values of the twist-four term in different cases obtained in the analysis of data (314 points: $Q^2 \geq 2\,\mathrm{GeV}^2$) carried out within VFNS (FFNS)

x	NLO $\overline{MS}$ scheme $\chi^2 = 246(259)$ $\alpha_s(M_Z^2) = 0.1195$ (0.1192)	NLO DIS scheme $\chi^2 = 238(251)$ $\alpha_s(M_Z^2) = 0.1177$ (0.1179)	NNLO $\overline{MS}$ scheme $\chi^2 = 241(254)$ $\alpha_s(M_Z^2) = 0.1177$ (0.1170)	NNLO DIS scheme $\chi^2 = 242(249)$ $\alpha_s(M_Z^2) = 0.1178$ (0.1171)
0.275	-0.25 ± 0.02 (-0.26 ± 0.03)	-0.18 ± 0.01 (-0.17 ± 0.02)	-0.19 ± 0.02 (-0.20 ± 0.02)	-0.14 ± 0.01 (-0.17 ± 0.01)
0.35	-0.24 ± 0.02 (-0.25 ± 0.02)	-0.11 ± 0.01 (-0.13 ± 0.01)	-0.19 ± 0.03 (-0.19 ± 0.02)	-0.13 ± 0.02 (-0.15 ± 0.01)
0.45	-0.19 ± 0.02 (-0.19 ± 0.02)	-0.04 ± 0.04 (-0.09 ± 0.01)	-0.17 ± 0.03 (-0.16 ± 0.01)	-0.11 ± 0.09 (-0.10 ± 0.02)
0.55	-0.12 ± 0.03 (-0.10 ± 0.03)	-0.11 ± 0.01 (-0.09 ± 0.04)	-0.17 ± 0.05 (-0.14 ± 0.03)	-0.12 ± 0.03 (-0.08 ± 0.04)
0.65	0.05 ± 0.08 (0.12 ± 0.08)	-0.17 ± 0.04 (-0.09 ± 0.05)	-0.14 ± 0.14 (-0.05 ± 0.06)	-0.22 ± 0.05 (-0.10 ± 0.05)
0.75	0.34 ± 0.12 (0.48 ± 0.12)	-0.57 ± 0.08 (-0.44 ± 0.18)	-0.11 ± 0.19 (0.06 ± 0.10)	-0.59 ± 0.08 (-0.32 ± 0.12)

From Table 1, it can also be seen that upon resumming at large x values (i.e. in the DIS scheme [5]), the twist-four corrections become large and negative in this x region. Moreover, it appears that they rise as $1/(1-x)$ at large x but this observation needs additional investigations.

Such a behavior is completely contrary to the analyses [1–4, 6, 7] performed in $\overline{MS}$ scheme, where twist-four corrections are mostly positive at large x and rise as $1/(1-x)$. Note that this rise is usually less pronounce in higher orders (see [1–3, 6]) and sometimes is even absent at NNLO level (see Table 1).

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1. B. G. Shaikhatdenov, A. V. Kotikov, V. G. Krivokhizhin, and G. Parente, Phys. Rev. D **81**, 034008 (2010).
2. A. V. Kotikov, V. G. Krivokhizhin, and B. G. Shaikhatdenov, JETP Lett. **101**, 141 (2015).
3. A. V. Kotikov, V. G. Krivokhizhin, and B. G. Shaikhatdenov, J. Phys. G **42**, 095004 (2015).
4. A. V. Kotikov, V. G. Krivokhizhin, and B. G. Shaikhatdenov, Phys. Atom. Nucl. **81**, 244 (2018).
5. G. Altarelli, R. K. Ellis, and G. Martinelli, Nucl. Phys. B **143**, 521 (1978).
6. J. Blumlein and H. Bottcher, Phys. Lett. B **662**, 336 (2008).
7. S. I. Alekhin, Phys. Rev. D **63**, 094022 (2001).