Global analysis of $q_T$ distributions in $2b_*$ parametrization

*Internal note*

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Abstract

I summarize the results of our fits in the $2b_*$ prescription

1 Best-fit parameters

The investigated parametrization of $S_{NP}(b,Q)$ is

$$S_{NP}(b,Q) = b^2 \left[ a_1 + a_2 \ln \left( \frac{Q}{2Q_0} \right) + a_3 \ln (100x_A x_B) \right].$$

Note that $a_3$ is identical to the combination $g_1 g_3$ in the BLNY parametrization. This parametrization of $S_{NP}(b,Q)$ can be called from Legacy by choosing $\text{inonpert}=8$ and $\text{iflag_c3}=21$ ($24$) for $C_3 = b_0$ ($C_3 = 2b_0$).

In addition to the best-fit parameter set $a_{\text{best}} = \{a_1, a_2, a_3\}$, we quote six “extreme” parameter sets $a_{(i)}^\pm$ ($i = 1, 2, 3$), which can be used to estimate correlated 1σ errors for any observable $X$ (e.g., $d\sigma/dq_T$) within the Hessian method approach. The employed method is identical to that used in the latest CTEQ and MRST analyses to estimate the PDF errors for arbitrary hadronic observables. Each extreme set corresponds to the increase of the global $\chi^2$ by 1 from the best-fit $\chi^2$ along one of three eigenvectors of the Hessian matrix in space of the parameters $a_i$. The 1σ error in $X$ can be estimated by

$$\delta X = \frac{1}{2} \sqrt{\sum_{i=1}^{3} \left( X(a_{(i)}^+) - X(a_{(i)}^-) \right)^2}.$$  

The best-fit parameters for $C_3 = b_0$ are $b_{\text{max}} = 1.5$ GeV$^{-1}$, $Q_0 = 1.6$ GeV, and

$$a_1 = (0.201 \pm 0.011) \text{ GeV}^2, \quad a_2 = (0.184 \pm 0.018) \text{ GeV}^2, \quad a_3 = (-0.026 \pm 0.007) \text{ GeV}^2.$$  

The parameters of six extreme sets $a_{i}^\pm$ are quoted in Table 1.

The best-fit parameters for $C_3 = 2b_0$ are $b_{\text{max}} = 1.5$ GeV$^{-1}$, $Q_0 = 1.6$ GeV, and

$$a_1 = (0.247 \pm 0.016) \text{ GeV}^2, \quad a_2 = (0.158 \pm 0.023) \text{ GeV}^2, \quad a_3 = (-0.049 \pm 0.012) \text{ GeV}^2.$$  

The parameters of six extreme sets $a_{i}^\pm$ are quoted in Table 2.
<table>
<thead>
<tr>
<th>Set/parameter</th>
<th>$a_1$</th>
<th>$a_2$</th>
<th>$a_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a^+_{11}$</td>
<td>0.208</td>
<td>0.198</td>
<td>-0.034</td>
</tr>
<tr>
<td>$a^-_{11}$</td>
<td>0.192</td>
<td>0.168</td>
<td>-0.017</td>
</tr>
<tr>
<td>$a^+_{21}$</td>
<td>0.21</td>
<td>0.169</td>
<td>-0.024</td>
</tr>
<tr>
<td>$a^-_{21}$</td>
<td>0.192</td>
<td>0.199</td>
<td>-0.029</td>
</tr>
<tr>
<td>$a^+_{31}$</td>
<td>0.208</td>
<td>0.195</td>
<td>-0.024</td>
</tr>
<tr>
<td>$a^-_{31}$</td>
<td>0.193</td>
<td>0.174</td>
<td>-0.029</td>
</tr>
</tbody>
</table>

Table 1: Parameters of the six “extreme” sets $a^\pm_{(i)}$ ($i = 1, 2, 3$) for $C_3 = b_0$.

<table>
<thead>
<tr>
<th>Set/parameter</th>
<th>$a_1$</th>
<th>$a_2$</th>
<th>$a_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a^+_{11}$</td>
<td>0.262</td>
<td>0.181</td>
<td>-0.059</td>
</tr>
<tr>
<td>$a^-_{11}$</td>
<td>0.233</td>
<td>0.135</td>
<td>-0.039</td>
</tr>
<tr>
<td>$a^+_{21}$</td>
<td>0.240</td>
<td>0.182</td>
<td>-0.055</td>
</tr>
<tr>
<td>$a^-_{21}$</td>
<td>0.254</td>
<td>0.134</td>
<td>-0.044</td>
</tr>
<tr>
<td>$a^+_{31}$</td>
<td>0.232</td>
<td>0.153</td>
<td>-0.057</td>
</tr>
<tr>
<td>$a^-_{31}$</td>
<td>0.262</td>
<td>0.162</td>
<td>-0.042</td>
</tr>
</tbody>
</table>

Table 2: Parameters of the six “extreme” sets $a^\pm_{(i)}$ ($i = 1, 2, 3$) for $C_3 = 2b_0$. 
2 Scan over $b_{\text{max}}$ cum figuris

2.1 Global $\chi^2$ and best-fit parameters

Figure 1: $\chi^2$ vs. $b_{\text{max}}$

Figure 2: $a_1$ vs. $b_{\text{max}}$
Figure 3: $a_2$ vs. $b_{\text{max}}$

Figure 4: $a_3$ vs. $b_{\text{max}}$
2.2 Normalizations of the experimental data

![Figure 5](image1.png)

Figure 5: The normalization adjustment parameter $N_{E288}$ multiplying the E288 data. The values of $N_{E288}$ within the shaded area deviate from unity by less than one published standard deviation $\delta N_{exp} = 25\%$.

![Figure 6](image2.png)

Figure 6: The normalization adjustment parameter $N_{E605}$ multiplying the E605 data. The values of $N_{E605}$ within the shaded area deviate from unity by less than one published standard deviation $\delta N_{exp} = 15\%$. 
Figure 7: The normalization adjustment parameter $N_{CDF}$ multiplying the CDF data. The values of $N_{CDF}$ within the shaded area deviate from unity by less than one published standard deviation $\delta N_{exp} = 3.34\%$.

Figure 8: The normalization adjustment parameter $N_{D0}$ multiplying the DØ data. The values of $N_{D0}$ within the shaded area deviate from unity by less than one published standard deviation $\delta N_{exp} = 4.5\%$. 
Figure 9: The normalization adjustment parameter $N_{R209}$ multiplying the R209 data. The values of $N_{R209}$ within the shaded area deviate from unity by less than one published standard deviation $\delta N_{exp} = 10\%$.

Figure 10: The normalization adjustment parameter $N_{R209}$ multiplying the R209 data. The values of $N_{R209}$ within the shaded area deviate from unity by less than one published standard deviation $\delta N_{exp} = 10\%$.
2.3 $\chi^2$ for individual experiments

Figure 11: E288

Figure 12: E605
Figure 13: CDF

CDF Z (Run 1):
20 data points

Figure 14: DØ
Figure 15: R209

10 data points

\[ \chi^2 \text{ [R209]} \]

\[ b_{\text{max}} \text{ (GeV}^{-1}) \]

R209

10 data points
2.4 \( a \) vs \( b_{\text{max}} \)

2\(b_{\text{c}}\), \(b_{\text{max}}=1.5 \text{ GeV}^{-1}\)
Nonperturbative coefficient in \(e^{-ab^2}\)

![Graph showing \(a(Q)\) vs. \(Q\) with data points from E288, E605, CDF Z, D0 Z, and R209.]

Figure 16: \(a(Q)\) vs. \(Q\)