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Effect of the parameterization of the distribution functions on the longitudinal structure function at small x

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I use a direct method to extract the longitudinal structure function in the next-to-leading order approximation with respect to the number of active flavor from the parametrization of parton distributions. The contribution of charm and bottom quarks corresponding to the gluon distributions (i.e., $G_{n_f=3}(x,Q^2)$ and $G_{n_f=5}(x,Q^2)$) is considered. I compare the obtained longitudinal structure function at $n_f = 4$ with the H1 data [1] and [2] and the result L. P. Kaptari et al. [3] which is based on the Mellin transforms. These calculations compared with the results from CT18 [4] parametrization model. The nonlinear effects on the gluon distribution improve the behavior of the longitudinal structure function in comparison with the H1 data and CT18 at low values of Q^2. In Figure 1, the Altarelli–Martinelli equation with Gribov–Levin–Ryskin and Mueller–Qiu (GLR-MQ) correction is used to evaluate the longitudinal structure function at low x and Q^2. As can be seen in this figure, the nonlinear correction is very important to slow down the longitudinal structure function behavior at low Q^2 values. The evolutions of the nonlinear correction to F_L with Q^2 at fixed value of the invariant mass W and the comparisons with the H1 data and CT18 are shown in this figure. The nonlinear effects of the longitudinal structure function are observable for $x < x_0 = 0.01$ at hotspot point where gluons are populated across the proton as it is equal to $\mathcal{R} \simeq 2$ GeV^{-1}. As can be seen, the nonlinear results at hot spot point at low and moderate Q^2 values seem to be compatible with the H1 data and CT18 at NLO and NNLO approximations. Indeed he nonlinear corrections here are negative and result in a better agreement with data and parameterization method.

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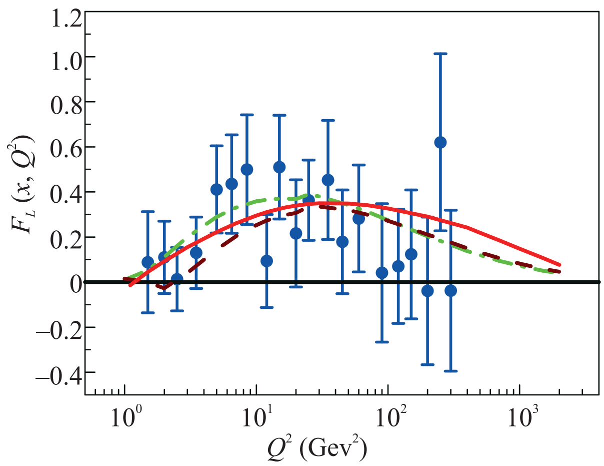

Fig. (Color online) The obtained longitudinal structure function $F_L(x,Q^2)$ from the nonlinear gluon distribution as a function of variable Q^2 at fixed value of the invariant mass $W = 230$ GeV at hotspot point. The dashed and dashed-dot lines represent the CT18 [4] at the NNLO and NLO approximation respectively. The solid line represents nonlinear behavior of the longitudinal structure function at $n_f = 4$ within the NLO approximation. Experimental data are from the H1-Collaboration [1] as accompanied with total errors

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