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Short Communication

Parton Distribution Functions in the CTEQ framework

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***Abstract*:** Parton distribution functions (PDFs) are important to study the structure of the proton and hence the dynamics of quarks and gluons inside it. We study some of the PDFs from global CTEQ (Coordinated Theoretical-Experimental project on QCD) analysis in a wide range of momentum fraction x and different Q^2 range. The numerical values of PDFs are taken from the LHAPDF library and the plots are obtained using APFEL.

Keywords: Parton distribution functions, Quarks, Gluons, Momentum fraction *x*.

Introduction

The distribution of momentum fraction x of partons in the relevant kinematic range is important to calculate the production cross sections at the Large Hadron Collider (LHC). These parton distribution functions (PDFs) are determined by the global fits to data from deep inelastic scattering (DIS). CTEQ is one of the major groups which provide updates to parton distribution when new data become available. Lepton-lepton processes provide the measurement of $\alpha_s(Q^2)$ and of the fragmentation functions of partons. Measurement of structure functions in lepton-hadron scattering and of lepton pair production cross sections in hadron-hadron collisions provide the main source of quark distributions $f(x,Q)$ inside hadrons. The gluon distribution function $g(x,Q)$ enters directly in hadron-hadron scattering processes at leading order with direct photon and jet final states. In (Pumplin et al., 2009, Lai et al., 2010) the determination of PDFs by CTEQ collaboration is presented. In this paper, we study PDFs in the CTEQ framework that are based on LHAPDF library. We obtain the plots using APFEL, a new PDF evolution package, and also compare the different flavours.

Methodology

Studies of PDFs open a new way to a better understanding of the partonic quark-gluon structure of the nucleon. The CTEQ6.6 PDF set (Nadolsky et al., 2008) was released for general purpose in 2008. The new data set have been published in the global QCD (Quantum Chromodynamics) analysis by H1 and Zeus collaborations in HERA (H1 and ZEUS Collaborations, Aaron, F. D. *et al*., 2010) as well as vector boson production and inclusive jet production (DØ Collaboration, Abazov, V. M. *et al*., 2008a, 2008b). All these data

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are included in the global analysis, named as CT10 (Lai et al., 2010) and are used in phenomenological predictions for Tevatron, LHC and other experiments. The code APFEL, which stands for a parton distribution function evolution library, based on the solution of QCD and QED (Quantum Electrodynamics) evolution equations and their combination. APFEL solves the QCD $\otimes$ QED evolution equations in *x*-space followed by Runge-Kutta solution of the resulting discretised evolution equations. In (Bertone et al., 2014), the APFEL library has been studied and PDF evolution libraries have been discussed in (Ball et al., 2013). We obtain the plots of PDFs using graphical user interface (APFEL GUI) of this library. The theoretical prediction of DIS observables can be computed through APPLgrid interface (Carli et al., 2010).

Results and Discussion

PDFs are also available from leading order fits to the same data sets used in the NLO (next-to-leading order) fits. The PDFs from CT10 and CT10 NLO are plotted for different flavors in Fig. 1 and Fig. 2 respectively at a *Q* value of 1.41 GeV.

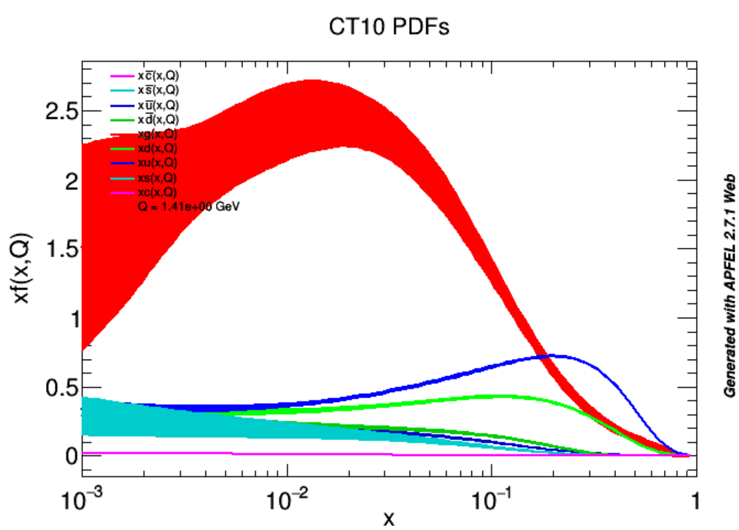

Fig. 1: The different flavors of PDF from CT10 plotted at a *Q* value of 1.41 GeV.

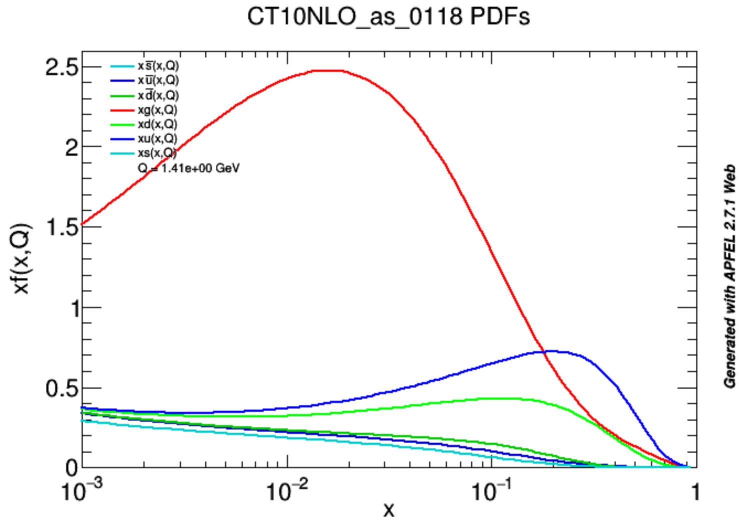

Fig. 2: The different flavors of PDF from CT10 NLO plotted at a *Q* value of 1.41 GeV.

In Fig. 3 and Fig.4, the gluon distributions from CT10 and CT10 NLO are plotted on a linear scale in *x* to accentuate the high-*x* region.

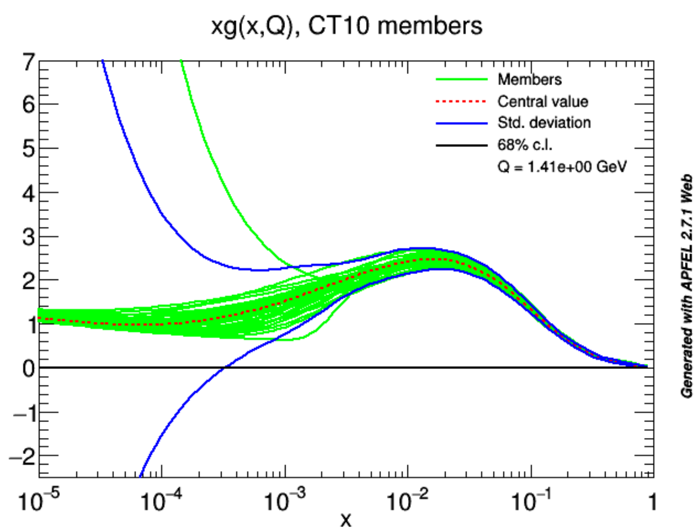

Fig. 3: The gluon distribution from CT10 plotted at a *Q* value of 1.41 GeV using a linear scale in *x*.

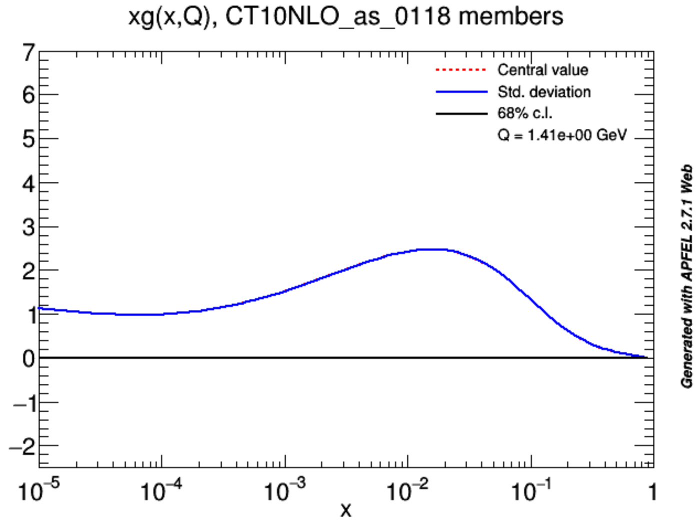

Fig. 4: The gluon distribution from CT10 plotted at a *Q* value of 1.41 GeV using a linear scale in *x*.

Some significant features have been observed in the PDF result: the gluons dominate at small *x* and fall steeply as *x* is increased. The expected behavior of PDFs, wherein they fall as *x* approaches 1, can also be observed from the plots. The slight bump towards the intermediate *x* range might be due to the next-to-leading order (NLO) effect.

Conclusion

Plots of gluon *vs x* as well as proton structure function *vs x* for a few representative values of *Q* using APFEL have been analyzed. We have studied the data sets from CTEQ/CT in the structure-function plot as a function of *x* for a given value of *Q* and different flavors. The difference in the dynamics of LO (leading order) and NLO have also been shown through the plots of gluons and different flavors.

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