Some Recent Results

on

Large-x PDFs

J.F. Owens
Physics Department, Florida State University

Argonne National Laboratory
December, 2008

Outline

- Introduction
  - Players
  - Goals
- Tools
- Preliminary results
- Relation to other PDF results
- Conclusion and Outlook

Introduction

Cast of characters - Cynthia Keppel, Eric Christy, Peter Monaghan, Wally Melnitchouk, JFO, Jorge Morfín, and Alberto Accardi

Multiple goals for a long requested analysis (Thia, Jorge)

- Extend PDF fits to larger values of x and lower values of Q
- Current PDF fits are limited to $Q > 2$ GeV and $x < .65$
- Wealth of data from older SLAC experiments and newer JLAB experiments including BONUS (measuring d/u)
- Study effects of different target mass correction methods
- Explore role of higher twist contributions

Target Mass Corrections

Several different methods available

- Standard Georgi-Politzer method
- Collinear Factorization
  - Jianwei Qiu and Alberto Accardi - arXiv:0805.1496 [hep-ph], JHEP 0807:090, 2008.
  - See also Jianwei's talk at the 2005 JLAB meeting/workshop on the CTEQ web page
- Naive TMC - to be defined below

Come comments on TMCs

- Nachtmann variable: $\xi = \frac{2x_B}{1+\sqrt{1+4x_B^2 m_N^2/Q^2}}$

  - In the standard GP formalism $\xi < 1$ when $x_B = 1$
  - Leads to non-zero structure functions at $x_B \geq 1$

- Collinear factorization gives structure functions as a convolution which respects the kinematic boundaries

$$F_{T,L}(x_B, Q^2, m_N^2) = \int_\xi^{\xi/x_B} \frac{dx}{x} h_{f|T,L}(\xi/x_B, Q^2)\phi_f(x, Q^2)$$

  where h_f is a parton-level helicity structure function and ϕ is the respective PDF

- Naive

$$F_{T,L}(x_B, Q^2, m_n^2) = F_{T,L}(\xi, Q^2)$$

Higher Twist parametrization

Parametrize the higher twist contribution by a multiplicative factor

$$F_2(data) = F_2(TMC) * (1 + C(x)/Q^2)$$

where

$$C(x) = a * x^b(1 + c * x + d * x^2)$$

Comments:

- Parametrization is sufficiently flexible to give a good fit to the data
- Parameter d not really needed since for x near 1 there is not a lot of difference between x and x^2

Fitting Package

We are using my NLO DGLAP fitting package which I have continued to update and extend

- Can fit DIS, Drell-Yan, W lepton asymmetry, jets, and γ + jet
- Routines for the DØ γ+ jet data recently added
- W lepton asymmetry routine allows for a single p_T cut, but a generalization to allow for multiple p_T cuts has been developed
- Added PDF errors (Hessian method)
- Multiple TMC and HT terms added (Alberto Accardi)
- Some correlated errors added
- Options for nuclear corrections added

Technical Aside

- W asymmetry routine

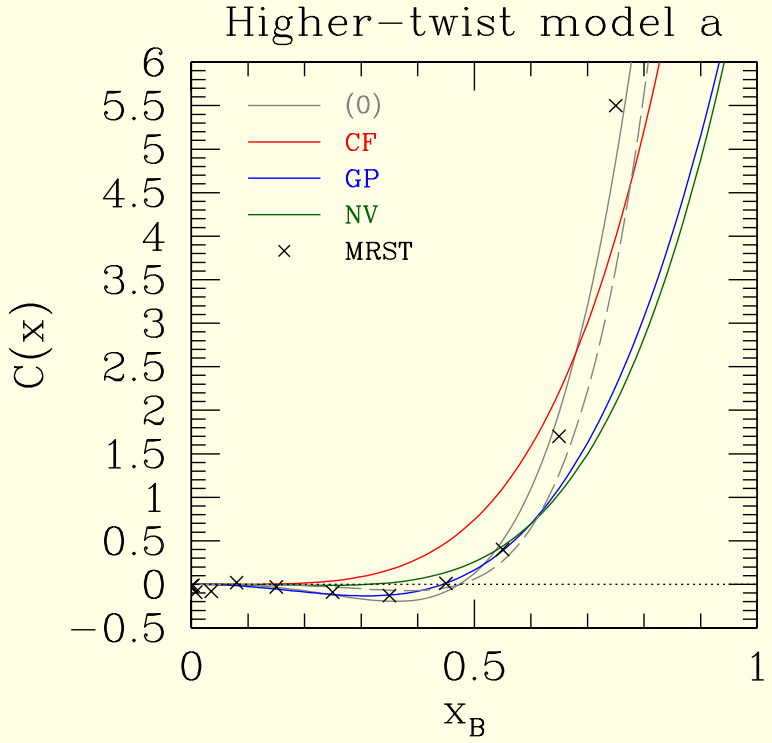
  - Used MCFM to generate appropriate K-factors to enable fast calculation of NLO results for both the CDF and DØ data
  - Generalized my old LO routine to include multiple p_T cuts and this is in the works - required for newer data sets.

- DØ γ + jet routine

  - Calculated LO and NLO using one of my phase space slicing programs
  - Generated appropriate K-factors for each rapidity and p_T range
  - Wrote a LO routine to interface with the fitting package which then uses the K factors to give a fast NLO result.

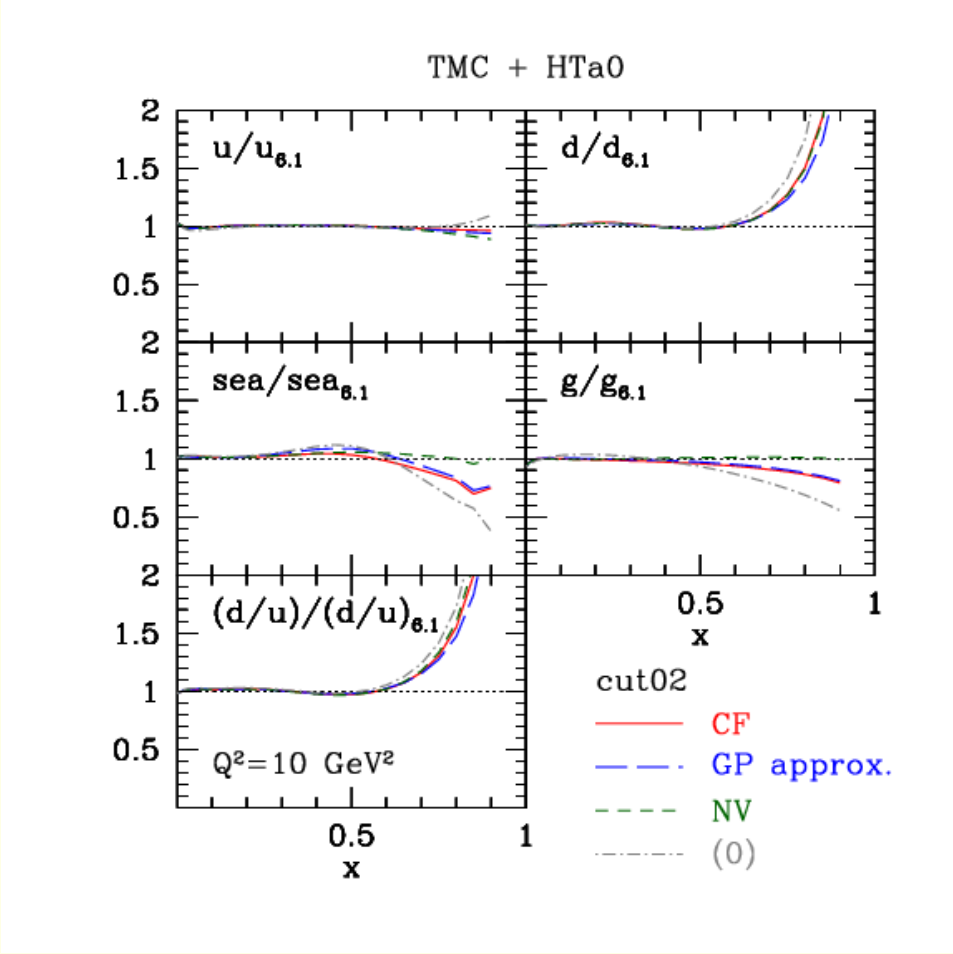
Preliminary Results

Extracted higher twist term depends on the type of TMC used



- $Q^2 > 4$ GeV^2 and $W^2 > 4$ GeV^2 (Referred to as Cut02 henceforth)
- Solid curves have $d = 0$ and small errors on $a, b,$ and c
- Dashed curve has $d \neq 0$, but with large errors on all four parameters

- Extracted twist-2 PDFs much less sensitive to the choice of TMC
- Fitted higher twist function compensates the TMC so that the twist-2 PDFs are relatively stable
- Plots are relative to the CTEQ6.1 PDFs
- Largest effect is on the d distribution



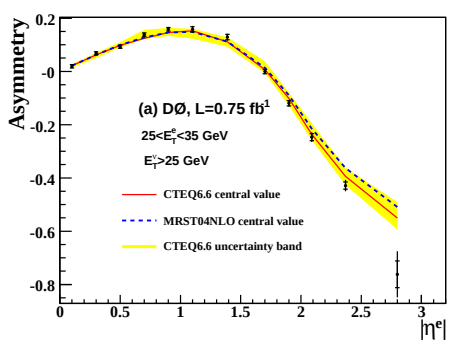
Discussion

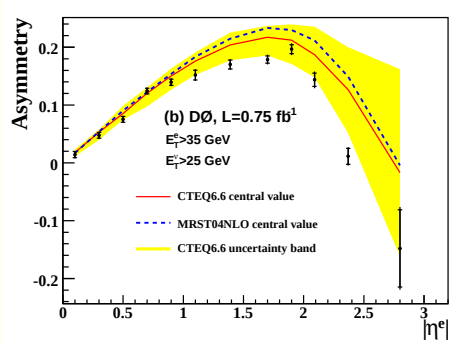
- Results depend somewhat on the deuteron nuclear correction model used - mostly Fermi smearing at large x. Topic is under study.
- See similar effects in other studies

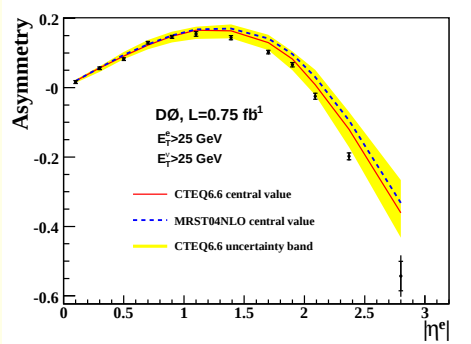
  - Global fit including E-866 lepton pair data and NuTeV and CHORUS neutrino data show enhanced d/u ratios
  - DØ W electron asymmetry lie below predictions of current PDFs suggesting an enhanced d/u ratio for x near 0.4-0.5

- Next step is to include Wally Melnitchouk's deuteron smearing model and study its effects on the fits
- After that, the aim is to quantify the PDF uncertainties using the extended kinematic range and data versus using the previous cuts and data sets

More on the W Asymmetry







- W asymmetry is approximately in LO given by

$$A = \frac{R_{du}(x_2) - R_{du}(x_1)}{R_{du}(x_2) + R_{du}(x_1)}$$

- R_{du} is the d/u ratio and $x_{1,2} = M_W/\sqrt{s}\exp(\pm\eta)$
- DØ data suggest that d/u may need to be increased

Conclusions

- A new series of fits is underway with an expanded kinematic range and enlarged data set
- Preliminary indications suggest that the d/u ratio will be increased over previous fits in the large x region
- Other analyses and data sets also suggest that an increase in d/u may be needed
- Eventual goal is to see if the PDF errors can be reduced using new JLAB data