Structure Function Theory Summary

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Highlights of theory presentations to the Structure Functions working group are summarized.

Even if you went to talks all the time during the parallel session (as I did in my role as convenor) you missed $>80\%$ of all talks at the conference. Here is a brief index of what you missed if you didn't attend all of the SF sessions. For details, see the writeups of the talks.

1 F_L Measurement

We will raise our glasses tonight at the banquet to those who did the political, experimental, and theoretical work to get the F_L measurement done before the disassembly of HERA! On the theory side, this measurement is very important for our understanding of applied QCD— even if the statistical accuracy will not be good enough to provide strong new constraints on PDFs.

2 $\gamma\, p$ total cross section

A bonus from the F_L measurement was the need to run HERA at a lower energy, which will eventually provide a measurement of the energy-dependence of the total cross section for photoproduction (see Aharon Levy's talk). This can be compared with predictions from Donnachie/Landshoff, or your personal favorite model for total cross sections.

This old-fashioned physics may transition to new non-perturbative physics at LHC, where the interaction range in impact parameter receives a contribution from the Regge-expansion of the pomeron that is for the first time comparable to the range coming from the intrinsic proton size.

3 $\gamma - Z$ Interference

Another experimental highlight is the difference observed between e^+p and e^-p at high Q, which displays the effect of $\gamma - Z$ interference. This will no doubt be discussed in the experimental summary. I emphasize it here because of its potential use in constraining flavor ratios in the PDF analyses. Such information is useful because much of the current flavor information comes from neutrino DIS, whose reliability may be compromised by nuclear target effects.

4   Management Issue

Two thirds of HERA data is still to be analyzed and reported. We can hope and perhaps lend support to the organizational efforts that are needed to get this data out and available in archival form, in the presence of departures of people and interest to new machines!

5 New directions

A major theme in our post-HERA machine world is to find new sources of information on PDFs. We had two talks on how forward W and Z measurements at LHCb could provide wonderful parton information down to $x \sim 10^{-5}$. Discussed less at this meeting, but prominent at other workshops, has been the importance of W^+, W^-, Z^0, and $t\bar{t}$ measurements in Atlas and CMS for future PDF determinations.

At next year's DIS meeting, we will hopefully see mature results from HERA run II along with important Standard Model results from the LHC. There will be lots of SM physics to be done in combining the information from the two—even as we may be happily diverted by discoveries of BSM physics.

6 Parton Distributions

Our community will live many years with the LHC broadband beams of quarks and gluons, especially as plans for the ILC recede into the future. A major application of DIS is its impact on determining PDFs. But it is probably high time to change the name of our working group from Structure Functions (the input data) to Parton Distributions (the output measurement).

There were presentations on the work of the major PDF suppliers by Watt, Thorne, Nadolsky, Alekhin, Cooper-Sarkar; along with related talks by Olness and Pumplin. Some of the topics:

6.1 Heavy quarks

The treatment of heavy quarks in PDF analysis has settled down, as shown for example by predictions for the W and Z "standard candle" processes at LHC, which are now in acceptable agreement between the groups.

6.2 Strange quarks

There has been progress in strangeness PDFs: more information on $s + \bar{s}$, and some limits on $s - \bar{s}$. Both of these are potentially important at LHC.

6.3 Parametrization dependence

Each of the PDF fitting groups uses different functional forms for parametrization of PDFs at their chosen Q_0 starting point for DGLAP evolution. This automatically provides some safeguard to the community on the error introduced by the parametrization choice. Some other ways to study this theoretical systematic error were presented and discussed.

The parametrization-free neural net approach (Rojo) continues to show promise, with systematic steps in progress toward becoming a full-fledged alternative method for PDF determination.

6.4 Higher Twist

Most PDF fitting is done in leading-twist approximation, with cuts on Q and hadronic energy W imposed to try to make that a good approximation. We heard talks by Bluemlein and Alekhin on studying the non-leading power corrections.

These corrections are necessarily embraced as a subject of interest at JLAB, where they are kinematically unavoidable—especially until the 12 GeV upgrade is completed.

6.5 Color Dipoles

Much of the interest in Structure Functions is for their central importance in measuring PDFs via NLO or NNLO pQCD. However there is also interest in other approaches to SFs, which might expand our understanding of the standard approach, and which can be extended to low Q and/or low W. We had two talks (Schildknecht, Utermann) applying the color dipole picture to calculating SFs.

6.6 Scaling Laws

We had a talk (Royon) on scaling laws based on an Extended Balitsky-Kovchegov equation in DIS. (Comment: It would be nice to do the same analysis on the NLO and NNLO fits. If the scaling law works better for the data than for perturbative theory, that could point to a need to modify the perturbative theory, e.g. by resummation.)

6.7 BFKL

We had two talks on BFKL—one by L himself. A talk by Marzani calculated NNLO corrections to BFKL: Unfortunately, the NNLO correction appears to be as large as the NLO correction at physical α_s, which may lead to pessimism about the convergence of the series—let alone the adequacy of stopping at NNLO.

7 Thanks and advice

Thanks to the conference organizers for an excellent conference/workshop! Thanks to my co-convenors Daniel Kollar and Voica Radescu for a delightful collaboration! My advice to the next convenor: try to be more successful than I was at breaking 20 minute talks into 15' slides + 5' discussion, so as to have less of a conference and more of a workshop.

A link to the original slides for this talk is given below [1].

References

[1] Slides:
http://indico.cern.ch/materialDisplay.py?contribId=7&sessionId=8&materialId=slides&confId=24657