THE ROLE OF SEMI-INCLUSIVE DATA IN POLARIZED PDF GLOBAL FITS

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We discuss the role of longitudinally polarized semi-inclusive deep inelastic scattering data in the extraction of spin dependent parton densities from next to leading order QCD global fits to polarized data.

1. Motivation

As it is well known, the wealth of inclusive polarized deep inelastic scattering (pDIS) data available at present, by itself, fail to constrain the quark, anti-quark and gluon polarization in the nucleon. These experiments simply cannot distinguish between quarks and anti-quarks unless we make strong assumptions on spin and flavour symmetry, which need to be tested. In the absence of charged current pDIS data, one of the alternatives is to exploit longitudinally polarized semi-inclusive deep inelastic scattering (pSIDIS), where choosing different targets and hadronic final states, we have a grip on different combinations of quarks and anti-quarks. The pSIDIS observables can then be included in global QCD fit along with pDIS data as in a standard fit[1,2]. Inclusive measurements help us to fix, the total up, down, strange, and gluon densities, while semi-inclusive data should give access to anti-quarks, individually.

2. Consistency

The first thing we would like to check in a combined global fit is that pSIDIS data is consistent with pDIS data: i.e. the former mainly fix sea quark densities without spoiling the total distributions, nor degrading the

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fit to pDIS data. The interplay between both sets of data can be put in evidence changing artificially the relative weight in the fit between both data sets by means of the Lagrange multiplier technique[3,6]. Looking for fits with different weights one goes from a fit with just pDIS data to one with only pSIDIS data. The star in Figure 1 corresponds to the best standard fit, obtained with 313 pDIS plus 165 pSIDIS data points[1]. As we reduce the weight of semi-inclusive data, we approach a fully inclusive fit. Doing this the inclusive contribution to χ^2 improve just a couple of units, what tell us that pSIDIS data is not really spoiling the fit to inclusive data. The fits along the horizontal lines are equivalent from the point of view of pDIS data, but are increasingly disfavored by pSIDIS measurements, so the fit is also learning something from it.

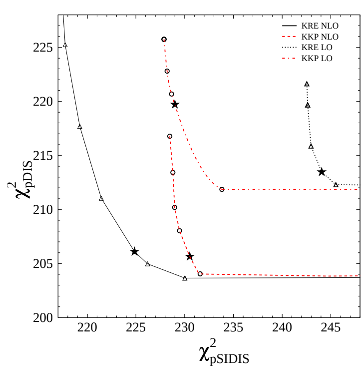

Figure 1. Interplay between pDIS and pSIDIS data in NLO and LO global fits.

Pure pSIDIS fits are not bad, with the main difference being that pSIDIS have less low x_{Bj} data and allows behaviors that are strongly penalized by the better constrained inclusive asymmetries. The results were obtained with two different sets of fragmentation functions labeled as KRE[4], and KKP[5], respectively, obtaining slightly different χ^2, which gives an idea of the uncertainties coming from this choice. The same analysis but at LO (dotted and dashed-dotted lines) show much higher values of χ^2.

3. Uncertainties

The next question is if the new data have any real effect on the distributions, actually constraining the sea quark densities. To answer this, again we appeal to the Lagrange multiplier method. The idea is to relate the range of variation of the first moment of the different parton densities with the χ^2 used to judge the goodness of that fit. The results are shown in Figure 2 again for the two sets of fragmentation functions.

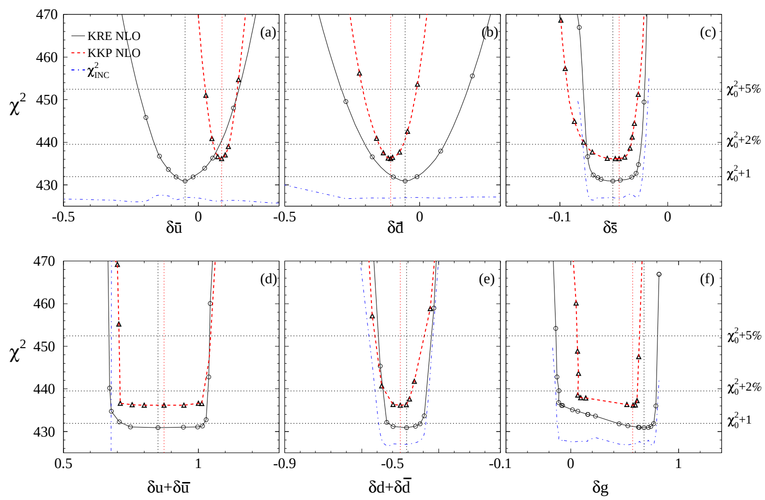

Figure 2. χ^2 profiles for NLO fits.

In an ideal situation where every source of uncertainty is well known and accounted for, one expects to get parabolic profile, with the 1-σ deviation corresponding to a variation in χ^2 of one unit. In unpolarized fits, however most groups take between a 2% and 5% variation as a more conservative estimate in order to account for many sources of uncertainty[7].

4. Other observables and forthcoming data

The results obtained form the combined fits not only lead to remarkably good fits for inclusive and semi-inclusive data[1], but also nice predictions for observables not included in the fit. As an example, in Figure 3a we have the expectation for $\Delta g/g$ at 1 GeV^2 together with the uncertainty band coming from a 2% variation in χ^2, plus that coming from varying Q^2 up to 10 GeV^2, against preliminary data from COMPASS[8], and previous measurements[10,11]. In Figure 3b we show the expectation for the double spin asymmetry, measured at RHIC [9].

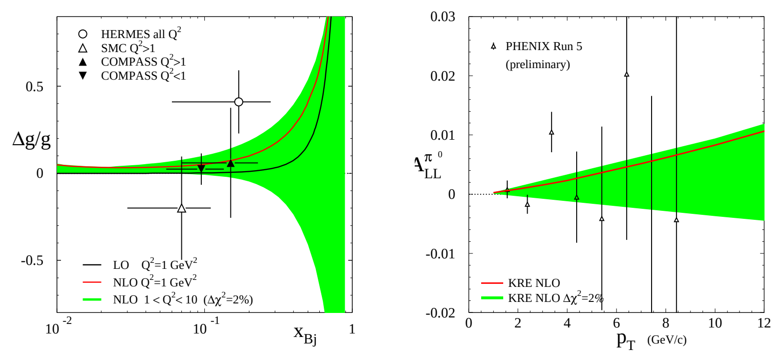

Figure 3. Estimates for observables not included in the global fit.

Forthcoming semi-inclusive DIS data can really make a difference in the future, not only constraining parton densities but also fragmentation functions. In reference[12], we have estimated the effect on the fit of the data expected to be obtained at the planned JLAB experiment E04-113[13]. With the projected statistical accuracy, and using only proton data, the reduction in the uncertainties would be quite significant for $\Delta\overline{u}$. On the opposite situation, the same experiment but on helium targets would be able to constrain much more $\Delta\overline{d}$ and indirectly on the gluon density, because the main difference between the different gluonic alternatives is precisely the sea quarks content.

References

1. D. de Florian, G. A. Navarro and R. Sassot, *Phys. Rev. D* **71**, 094018 (2005).
2. D. de Florian and R. Sassot, Phys. Rev. D **62**, 094025 (2000).
3. J. Pumplin, D. R. Stump and W. K. Tung, *Phys. Rev. D* **65**, 014011 (2002).
4. S. Kretzer, *Phys. Rev. D* **62** (2000) 054001.
5. B. A. Kniehl, G. Kramer and B. Potter, *Nucl. Phys. B* **582** 514 (2000).
6. G. A. Navarro and R. Sassot, *Eur. Phys. J. C* **28**, 321 (2003).
7. A. D. Martin et al., *Eur. Phys. J. C* **28** 455 (2003).
8. E. S. Ageev *et al.*, Phys. Lett. B **633**, 25 (2006).
9. PHENIX collaboration, K. Boyle, talk given at the XVIIth Particles and Nuclei International Conference (Panic05), http://www.panic05.lanl.gov/
10. A. Airapetian *et al.*, Phys. Rev. Lett. **84**, 2584 (2000).
11. B. Adeva *et al.*, Phys. Rev. D **70**, 012002 (2004).
12. X. Jiang, G. A. Navarro and R. Sassot, arXiv:hep-ph/0602236.
13. X. Jiang, P. Bosted, M. Jones and D. Day, arXiv:hep-ex/0412010.