INSIGHTS INTO NUCLEON STRUCTURE FROM PARTON DISTRIBUTIONS

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We discuss new insights into the quark and gluon structure of the nucleon that have been gained from global QCD analysis of parton distribution functions (PDFs). For spin-averaged PDFs, recent data on W-boson asymmetries in $p\bar{p}$ collisions at the Tevatron have resulted in a significantly better determination of the valence d-quark distribution at large parton momentum fractions, x. For sea quarks, the *SeaQuest* Drell-Yan experiment at Fermilab has confirmed the large excess of $\bar{d}$ antiquarks over $\bar{u}$, while LHC data on W asymmetries has suggested a sizeable light antiquark asymmetry also at small x. In the strange quark sector, the associated production of W bosons with charm quarks at the LHC, along with new data from neutrino deep-inelastic scattering, offers the prospect of determining the s and $\bar{s}$ distributions in the proton independently. Any asymmetry between these would be a dramatic confirmation of the predictions from chiral symmetry breaking in QCD. Charm meson production may also provide a means of detecting a nonperturbative charm content of the proton at large x, evidence for which has remained elusive in past searches.

For spin-dependent PDFs, the first indications for nonzero polarized glue have recently been found in jet production in polarised pp collisions at RHIC. Further constraints on Δg have been obtained from the Q^2 dependence of the high-precision deep-inelastic data from Jefferson Lab, which have also allowed the first flavor decomposition of the twist-3 PDFs in the proton.

On the theory front, we review recent advances in the analysis of PDFs using Monte Carlo techniques, which allows for more rigorous treatment of PDF uncertainties, and preview future endeavors which will attempt simultaneous fits to polarized and unpolarized PDFs, as well as fragmentation functions. Progress in the calculation of the x dependence of PDFs from first principles in lattice QCD is also reviewed. Finally, we outline experimental programs at future facilities, such as the Electron Ion Collider (EIC), that will further advance our understanding of the flavor and spin content of the nucleon's constituents.