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Unpolarized and polarized Gluon Distribution Functions in Leading Order and Next-to-Leading Order at small-x

Content :

The gluon distribution function is the most important physical observable that governs the physics at high energy (small Bjorken x) in the Deep Inelastic Scattering (DIS). The basic information about the gluon distribution function of the nucleon can be obtained from a measurement of the DIS structure function $F_2(x, Q^2)$ and its scaling violation. The measurement of the proton structure function by the H1 [1, 2] and ZEUS [3] group at HERA over a wide kinematics region has enabled us to know about the gluon also in the previously unexplored region in x and Q^2. In the small x region where gluon, being the dominant parton, drives the structure function $F_2(x, Q^2)$ through the transition . The steep rise of $F_2(x, Q^2)$ towards small x observed at HERA, also indicates in perturbative QCD a similar rise of the gluon towards small x. For polarized particles the experimental data on DIS made in SLAC, CERN and DESY. The results were analyzed by many groups and polarization quark structure functions as well as gluon distribution functions were presented. The spin of the nucleon is known to be 1/2 (considering =1). However, the EMC experiment has found that the spin of the quarks contribute only by a small fraction to the proton spin. Ever since it has been a longstanding problem how the nucleon spins are divided among the quarks and gluons. The spin density contribution of the quarks to the nucleon spin can be probed in deep inelastic scattering. The result obtained by the HERMES collaboration is = 0.30 ±0.04 ± 0.09, clearly showing that the gluon contributions to the nucleon spin are needed. The gluon spin density can be probed in the photon-gluon fusion process as planned in the COMPASS experiment. The first direct exploration of the gluon polarization has been performed by the HERMES collaboration and found a value of G/G = 0.41 ± 0.18 (stat) ± 0.03 (syst) at an average fraction of the nucleon momentum carried by the struck gluon of . Due to limitations in large angle tracking it is planned to start with the measurement of g_1 at small x values, which is important for the study of possible scaling violations.

In this paper, the unpolarized and polarized gluon distribution functions have been obtained by solving Dokshitzer, Gribove, Lipatov, Alterelli, Parisi (DGLAP) evolution equations in Leading Order (LO) and Next-to-Leading Order (NLO) at the small-x limit. Here we have used a Taylor Series expansion and then the method of characteristics [4-8] to solve the evolution equations. We have also calculated t and x-evolutions of gluon distribution functions and the results are compared with various

parameterizations and experimental data [9, 10, 11].

Keywords: DIS; DGLAP equation; small-x; method of characteristics; structure function.
PACS Nos. : 12.35 Eq.; 12.38-t; 12.39-x; 13.60 Hb.

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