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Gluon density from the Berger–Block–Tan form of the structure function F_2

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For experimental studies of hadron-hadron processes on the LHC collider, it is necessary to know in detail the values of the parton (quark and gluon) distribution functions (PDFs) of nucleons, especially at small values of Bjorken variable x. The basic information about PDF properties can be extracted from the process of deep inelastic lepton-hadron scattering (DIS).

In the small-x regime, nonperturbative effects were expected to give important contributions. However, what is observed up to very low $Q^2 \sim 1$ GeV^2 values, traditionally explained by soft processes, is described reasonably well by perturbative QCD evolution. This evolution leads to a rather singular PDF behavior at small x values, which violates the Froissard boundary.

Recently the new form of the DIS structure function $F_2(x, Q^2)$ was proposed by E.L. Berger, M.M. Block, and C.I. Tan (BBT). The structure function $F_2^{\rm BBT}(x, Q^2)$ leads to the low x asymptotics of the (reducted) DIS cross-sections $\sim \ln^2 1/x$, which is in turn in an agreement with the Froissard predictions.

In the present paper we study the behaviour of the gluon density at small values of x, using the structure function $F_2^{\rm BBT}(x, Q^2)$ and following to our previous studies in the framework of perturbative QCD.

We show that, the small x behaviour of the corresponding gluon density $xf_g^{\rm BBT}(x, Q^2)$ can be extracted directly from the values of $F_2^{\rm BBT}(x, Q^2)$ at the leading order of perturbation theory.

The obtained gluon density $f_g^{\rm BBT}(x, Q^2)$ is significantly less singular in comparison with the corresponding PDFs in perturbation theory. It will be used for future study of the high-energy behavior of photon, neutrino and proton cross sections.

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