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Linearly polarized gluon density at low x

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Based on a solution of DGLAP evolution equations at small values of Bjorken variable x, a simple analytic approximation for the perturbative part of so-called linearly polarized gluon density $h_1^{\perp g}(x, b_t^2, Q^2)$ is obtained at the leading order of perturbation theory. We demonstrate that derived expressions reproduce the main features of complicated numerical calculations performed by the parametrization groups.

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Determination of parton (quark and gluon) distribution functions in a proton, dependent on the transverse momentum (TMDs), is a rather important task for modern high energy physics. In particular, detailed knowledge of the latter is necessary for experiments planned at the Large Hadron Collider (LHC) and future colliders, such as Electron-Ion Collider (EIC), Future Circular hadron-electron Collider (FCC-he), Electron-Ion Collider in China (EicC) and Nuclotron-based Ion Collider fAcility (NICA) [1–5]. As it is known, one can extract the information about the TMDs from the experimental data on various processes that are sensitive to the parton content of the proton, like as Drell–Yan pair and Higgs production, semi-inclusive deep inelastic scattering (DIS) and electron-positron annihilation to di-hadrons. However, while TMD quark densities are currently extensively studied both experimentally and theoretically, the gluon one is not well constrained. In fact, for an unpolarized proton, there are distribution of unpolarized gluons denoted as $f_1^g(x, k_t^2, Q^2)$ and distribution of linearly polarized gluons $h_1^{\perp g}(x, k_t^2, Q^2)$ [6, 7], that corresponds to interference between ± 1 gluon helicity states. The latter is extremely poorly known at the moment.

Based on a solution [8–11] of DGLAP evolution equations at small values of Bjorken variable x, we derive a simple analytical expression for the perturbative part of the linearly polarized gluon density in a proton $h_1^{\perp g}(x, b_t^2, Q^2)$ at low b_t values. We found that at $x \to 0$ the linearly polarized gluon distribution rises faster than the unpolarized one $f_1^g(x, b_t^2, Q^2)$.

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