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Numerical solution of NLO Q^2 evolution equations for spin-dependent structure functions

M. Hirai, S. Kumano, and M. Miyama *

Department of Physics
Saga University
Saga 840, Japan

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* Email: 96sm18, kumanos, 96td25@cc.saga-u.ac.jp.
Information on their research is available at
http://www.cc.saga-u.ac.jp/saga-u/riko/physics/quantum1/structure.html.

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Department of Physics, Saga University, Saga 840, Japan

ABSTRACT

Numerical solution of DGLAP Q^2 evolution equations is studied for polarized parton distributions by using a "brute-force" method. NLO contributions to splitting functions are recently calculated, and they are included in our analysis. Numerical results in polarized parton distributions and in the structure function g_1 are shown. In particular, we discuss how numerical accuracy depends on number of steps in the variable x and in Q^2.

Spin-dependent structure functions are measured in polarized lepton-nucleon scattering. They depend on two kinematical variables, x and Q^2. The Q^2 dependence is calculated within perturbative QCD, and it is described by integrodifferential equations so called DGLAP equations. Because the Q^2 evolution equations are often used in theoretical and experimental studies, it is useful to have a computer code for solving the equations numerically. Our studies are important, for example, in getting optimal parton distributions by analyzing g_1 experimental data, particularly in obtaining gluon polarization by studying scaling violation of g_1.

In general, the DGLAP equations are coupled integrodifferential equations:

$$\frac{\partial}{\partial t}\Delta q_i(x,t) = \int_x^1 \frac{dy}{y}\left[\sum_j \Delta P_{q_iq_j}\left(\frac{x}{y}\right)\Delta q_j(y,t) + \Delta P_{qg}\left(\frac{x}{y}\right)\Delta g(y,t)\right] , \quad (1a)$$

$$\frac{\partial}{\partial t}\Delta g(x,t) = \int_x^1 \frac{dy}{y}\left[\sum_j \Delta P_{gq_j}\left(\frac{x}{y}\right)\Delta q_j(y,t) + \Delta P_{gg}\left(\frac{x}{y}\right)\Delta g(y,t)\right] . \quad (1b)$$

where the variable t is defined by $t = -(2/\beta_0)\ln[\alpha_s(Q^2)/\alpha_s(Q_0^2)]$, $\Delta q_j(x,t)$ and $\Delta g(x,t)$ are polarized j-flavor quark and gluon distributions, and $\Delta P_{ij}(x)$ are splitting functions. Each term in Eqs. (1a) and (1b) describes the process that a parton p_j with the nucleon's momentum fraction y splits into a parton p_i with the momentum fraction x and another parton. The splitting function determines the probability of such a splitting process.

Next-to-leading-order (NLO) splitting functions for spin-dependent parton distributions are evaluated recently [1]. Therefore, we can study numerical solution of the NLO spin-dependent Q^2 evolution equations [2]. A brute-force method was studied for solving spin-independent evolution equations and for those with parton-recombination effects [3]. The same method is applied to the spin-dependent case. We divide variables into small steps (N_x steps in the Bjorken variable $\ln x$ and N_t

We show that