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The Deep Inelastic Scattering of the Neutrino and the Antineutrino on the Polarized the Protons and the Neutrons with the Neutral Current

E.S. Timoshin* and S.I. Timoshin†
Sukhoi State Technical University of Gomel
Prospect Octiabria, 48, 246746, Gomel, Republic of Belarus

The expressions were obtained for the contributions of the quark flavors $(\Delta u + \Delta\bar{u}), (\Delta d + \Delta\bar{d}), (\Delta s + \Delta\bar{s})$ and the valence quarks $(\Delta u_V, \Delta d_V)$ to the nucleon spin through the first moments of the polarization structure functions proton Γ_1^p, Γ_6^p and the neutrons Γ_1^n, Γ_6^n measurable in the deep inelastic scattering the neutrino and antineutrino on the polarized the protons and the neutrons with the neutral current.

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The measurements of the neutrino DIS on the polarized targets have the important meaning for the establishment the spin structure of nucleon. With the neutrino beams from the muon collider such the experiments become possible, since the target mass order 20 kg shall provide the excellent statistics [1, 2]. The advantage of the neutrino DIS is the possibility to measure individually the contributions of the valence and the sea quarks in the nucleon spin. We consider DIS of the neutrino and the antineutrino on the polarized protons and the neutrons with the neutral current

$$\begin{aligned} &\nu(\bar{\nu}) + \vec{N} \longrightarrow \nu(\bar{\nu}) + X, \\ &N = p, n \end{aligned} \tag{1}$$

The spin-dependent party of the cross-section processes (1) contain two structure functions (SF) $g_1(x, Q^2)$ and $g_6(x, Q^2)$. These SF in leading order QCD for the scattering on the polarized protons are

$$\begin{aligned} g_1^p(x, Q^2) &= \frac{1}{2}\sum_q (q_V^2 + q_A^2)_q \big[\Delta q(x, Q^2) + \Delta\bar{q}(x, Q^2)\big], \\ g_6^p(x, Q^2) &= \sum_q (g_V g_A)_q \big[\Delta q(x, Q^2) - \Delta\bar{q}(x, Q^2)\big], \end{aligned} \tag{2}$$

where $q = u, d, s; g_{Vu} = \frac{1}{2} - \frac{4}{3}\sin^2\Theta_W, g_{Au} = \frac{1}{2}, g_{Vd} = g_{Vs} = \frac{1}{2} + \frac{2}{3}\sin^2\Theta_W, g_{Ad} = g_{As} = -\frac{1}{2}, \Theta_W$ - Weinberg angle.

The quark contributions in the nucleon spin connect with the first moments SF $g_{1,6}(x, Q^2)$:

$$\Gamma_{1,6}(Q^2) = \int_0^1 g_{1,6}(x, Q^2)dx. \tag{3}$$

*E-mail: etimoshin@gstu.by
†E-mail: timoshin@gstu.by

From (2), (3) we obtain for the first moment Γ_1^p in QPM

$$\Gamma_1^p = a_u(\Delta u + \Delta\bar{u}) + a_d(\Delta d + \Delta\bar{d}) + a_s(\Delta s + \Delta\bar{s}), \tag{4}$$

where $a_q = \frac{1}{2}(g_V^2 + g_A^2)_q$, $\Delta q(\Delta\bar{q})$ is the contribution of quark q (antiquark $\bar{q}$) to nucleon spin.

The first moment Γ_1^n for polarized neutrons is obtain from (4) through $\Delta u \longleftrightarrow \Delta d, \Delta\bar{u} \longleftrightarrow \Delta\bar{d}$:

$$\Gamma_1^n = a_d(\Delta u + \Delta\bar{u}) + a_u(\Delta d + \Delta\bar{d}) + a_s(\Delta s + \Delta\bar{s}) \tag{5}$$

For extraction the quark contributions from (4), (5) we use octet axial charge $a_8 = 0,579 \pm 0,025$, which in QPM is

$$a_8 = (\Delta u + \Delta\bar{u}) + (\Delta d + \Delta\bar{d}) - 2(\Delta s + \Delta\bar{s}). \tag{6}$$

Then from (4), (5), (6) we obtain the contributions quark flavors to the nucleon spin

$$\Delta u + \Delta\bar{u} = \frac{(2a_d + a_s)(\Gamma_1^n - a_u a_8) - (2a_u + a_s)(\Gamma_1^p - a_d a_8)}{2(a_d - a_u)\sum_{q=u,d,s} a_q},$$

$$\Delta d + \Delta\bar{d} = \frac{(2a_d + a_s)(\Gamma_1^p - a_u a_8) - (2a_u + a_s)(\Gamma_1^n - a_d a_8)}{2(a_d - a_u)\sum_{q=u,d,s} a_q},$$

$$\Delta s + \Delta\bar{s} = \frac{\Gamma_1^p + \Gamma_1^n - (a_u + a_d)a_8}{2\sum_{q=u,d,s} a_q}.$$

In neutrino DIS on polarized targets is the violating parity SF $g_6(x, Q^2)$. The first moments SF of proton $g_6^p(x, Q^2)$ and of neutron $g_6^n(x, Q^2)$ were obtained in form

$$\begin{aligned} \Gamma_6^p &= b_u \Delta u_V + b_d \Delta d_V, \\ \Gamma_6^n &= b_d \Delta u_V + b_u \Delta d_V, \end{aligned} \tag{7}$$

where $b_q = (g_V g_A)_q; q = u, d; \Delta q_V = \Delta q - \Delta\bar{q}$.

The expressions (7) give access to the contributions of valence quarks Δu_V and Δd_V in nucleon spin

$$\Delta u_V = \frac{b_u\Gamma_6^p - b_d\Gamma_6^n}{b_u^2 - b_d^2},$$

$$\Delta d_V = \frac{b_u\Gamma_6^n - b_d\Gamma_6^p}{b_u^2 - b_d^2}.$$

Thus, using the first moments Γ_1^p, Γ_6^p of proton and Γ_1^n, Γ_6^n of neutron in neutrino DIS were obtained the expressions for the contributions of quarks and antiquarks $(\Delta u + \Delta\bar{u}), (\Delta d + \Delta\bar{d}), (\Delta s + \Delta\bar{s})$ and the valence quarks $(\Delta u_V, \Delta d_V)$ in nucleon spin.

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