Lowest Order Electroweak Radiative Corrections to the Single W Production in Polarized Hadron-Hadron Collisions

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Abstract

The processes of the single W-production in polarized hadron-hadron collisions are suggested for investigation of the proton spin. An approach is proposed for the determination quark spin densities at low x. The electroweak radiative corrections of $O(\alpha^3)$ to the observable quantities are calculated. The numerical calculations of the cross sections and the single spin asymmetries taking into consideration electroweak corrections at RHIC energies have been made.

1 Introduction

The spin crisis has induced a number of new experiments to investigate the longitudinal spin structure of the nucleon in more details by measuring polarization asymmetry in lepton-nucleon deep inelastic scattering (DIS). At the present moment from the analysis of inclusive data on polarized DIS of leptons on the fixed targets at CERN and SLAC the following conclusions can be drawn: all present data are in good mutual agreement and show that Ellis-Jaffe sum rule is violated by more then 2σ and Bjorken sum rule is found to be confirmed within 1σ. Nevertheless, it should be mentioned that purely inclusive measurements determining the longitudinal spin structure function $g_1(x, Q^2)$ for nucleons and deuteron are unfortunately restricted to probe only certain combinations of the polarized parton contributions to the nucleon spin. A full analysis would require additional inputs from other measurements to separate different components.

Some new combinations of the polarized parton contributions can be obtain from experimental data on single spin asymmetries, when the polarized target is used in conjunction with an (un)polarized proton beam. This opportunity is offered by the planning experiment HERA-$\vec{N}$ [1] utilizing an internal polarized nucleon target in the $820 GeV$ HERA proton beam. Later polarized protons should become available [2], the same set-up will be used to measure the double spin asymmetries. Such experiments will be done in the nearest future, after the original program of HERA-B has been finished, using that detector, but by that time the most interesting questions will possible have already been answered by RHIC. The dedicated RHIC spin program at BNL [3] is supposed to start in a short period of time. Collider polarized experiments STAR and PHENIX at the RHIC energy ($\sqrt{s} \approx 500 GeV$) will be the point where a high energy nucleon-nucleon spin physics will be studied by measuring a variety of double spin asymmetries.

In this paper we are concerned with experiments which may provide direct measurements of new independent combinations of the quark densities in polarized nucleon. We will focus on inclusive single W-boson production in hadron-hadron interactions with one longitudinally polarized beam

$$N + \vec{N} \to W^{\pm} + X \to l^{\pm} + X.$$

In Sec. 2 of our paper we get formulas for single asymmetries of this process for the case when in the final state only charged lepton is detected. More, we will show the possibility of proposing reactions to study the form of polarized quark densities in the region of small x.

Radiative events originating from the loop diagrams and (as we consider the inclusive process) the processes with the emission of real photons, cannot be removed by experimental methods and so they have to be calculated theoretically and subtracted from measured cross sections of proposed reactions. In this paper the total $O(\alpha^3)$ electroweak radiative corrections (EWC) to cross section and single asymmetries have been calculated. In Sec. 3 and 4 we present the contributions of additional virtual and emitting particles respectively. Numerical analysis and conclusions can be found in Sec. 5.

2 Born cross section and single asymmetries

The cross section for the inclusive hadronic reaction is given in Quark Parton Model (QPM) by the usual formula (see for example [4])

$$d\sigma(N\vec{N} \to l^\pm X) = \Sigma_{i,i'} f_i^1 f_{i'}^2 d\hat{\sigma}_{ii'},$$

where f_i^j is the probability of finding consistent i in hadron j and $d\hat{\sigma}_{ii'}$ is the cross section for the elementary process leading to the desired final state.

The process of the single W-boson production at hadron-hadron collision could be described by two pair of quark-antiquark subprocess. So for the W^- production we have

$$q_i(p_1) + \bar{q}_{i'}(p_2) \to W^- \to l^-(k_1) + \bar{\nu}(k_2), \quad (1)$$

$$\bar{q}_i(p_1) + q_{i'}(p_2) \to W^- \to l^-(k_1) + \bar{\nu}(k_2), \quad (2)$$

and for W^+ one

$$q_i(p_1) + \bar{q}_{i'}(p_2) \to W^+ \to l^+(k_1) + \nu(k_2), \quad (3)$$

$$\bar{q}_i(p_1) + q_{i'}(p_2) \to W^+ \to l^+(k_1) + \nu(k_2). \quad (4)$$

Our notations are the following: p_1 is 4-momentum of first unpolarized (anti)quark with flavor i and mass m_1; p_2 is 4-momentum of second (anti)quark with flavor i' (i' denotes the weak isospin partner of the quark i), mass m_2 and polarization vector η_2; k_1 is 4-momentum of final charged lepton l^- or l^+ (m); k_2 is 4-momentum of (anti)neutrino. We use the standard set of Mandelstam invariants for the partonic elastic scattering

$$s = (p_1 + p_2)^2,\ t = (p_1 - k_1)^2,\ u = (k_1 - p_2)^2. \quad (5)$$

Squaring the matrix element of partonic subprocess we get the invariant parton-parton cross section in the Breit-Wigner form

$$d\sigma = \frac{\alpha^2}{4N_c s_w^4} \frac{B_{ii'}}{s((s - m_W^2)^2 + m_W^2 \Gamma_W^2)} \delta(p_1 + p_2 - k_1 - k_2) \frac{d^3k_1}{k_{10}} \frac{d^3k_2}{2k_{20}},$$

where
$1/N_c = 1/3$ is the color factor, $s_w = \sqrt{1 - c_w^2}$ is the sine of the weak mixing angle, $c_w = m_W/m_Z$, m_Z is the Z-boson mass, Γ_W is the W-boson width,

$$B_{ii'} = \begin{cases} u^2 - \text{ for (1) and (4) subprocesses,} \\ t^2 - \text{ for (2) and (3) subprocesses.} \end{cases}$$

According to QPM we substitute $p_{1(2)} \to x_{1(2)} P_{1(2)}$, where $P_{1(2)}$ is 4-momenta of initial nucleons with masses m_N, $x_{1(2)}$ is the fraction of the first(second) nucleon momentum that is carried by the incoming quarks. We shall denote this procedure by operator "hat". Then we multiply on parton densities of first and second hadrons and sum over helicity of quarks (we use the covariant expression for the polarization vector of i' parton from [5]).

Let us introduce the Mandelstam variables for hadronic reaction $S = 2P_1P_2$, $T = -2P_1k_1$, $U = -2P_2k_1$, and integrate w.r.t. x_2 with help of δ-function taking into consideration that in QPM

$$\delta(\hat{s} + \hat{t} + \hat{u} - m_1^2 - m_2^2 - m_l^2) = \frac{1}{D}\delta(x_2 + \frac{x_1(T + m_N^2) + m_l^2}{D}), \quad D = x_1 S + U + m_N^2.$$

We can see that in this case $x_2 = x_2^0 \equiv -(x_1(T + m_N^2) + m_l^2)/D$ and this substitution corresponds to born kinematics and we denote this by subscript "0".

Finally, let us consider the general form of the cross section of hadronic process. We use standard in this case variables: centre-of-mass energy ($\sqrt{S}$), component of the 4-vector of the detected particle transverse to the beam direction ($|k_{1\perp}| \equiv k_{1T}$), and pseudorapidity ($\eta$); then we have for T and U

$$T = -\sqrt{S}|k_{1\perp}|e^{-\eta},\ U = -\sqrt{S}|k_{1\perp}|e^{\eta}.$$

Integrating w.r.t. azimuth Φ (it's possible as the first initial hadron is unpolarized and the second one is longitudinally polarized) we have phase space $d^3k_1/k_{10} \Rightarrow \pi d\eta dk_{1\perp}^2$, and hence

$$\sigma_0^{\pm} = \sum_{i,i'} \int dx_1 f_i(x_1, Q^2)\Sigma_0, \tag{6}$$

where we use the set of general abbreviations

$$\sigma^{\pm} \equiv \frac{d\sigma_{N\vec{N}\to l^{\pm}X}}{d\eta dk_{1\perp}^2} \equiv \bar{\sigma}^{\pm} + p_{N_2}\Delta\sigma^{\pm}. \tag{7}$$

Born cross section is proportional to factor

$$\Sigma_0 = \Sigma|_{x_2=x_2^0} = \frac{\pi\alpha^2}{4N_c s_w^4} \frac{|V_{ii'}|^2 \hat{B}_{ii'}}{\hat{s}((\hat{s}-m_W^2)^2 + m_W^2\Gamma_W^2)D} F_{i'}^{(2)}|_{x_2=x_2^0}, \tag{8}$$

and the summation runs over all types of quark and antiquarks both of initial hadrons. In the expressions (6),(8) $V_{ii'}$ is Cabibbo-Kobayashi-Maskawa mixing matrix, and the combination of quark densities for second nucleon has the form

$$F_{i'}^{(2)} = f_{i'}^{+}(x_2, Q^2) - c_{i'} p_{N_2} f_{i'}^{-}(x_2, Q^2),$$

where $f_i^{+(-)}(x, Q^2)$ are spin averaged (longitudinally polarized) quark densities, $c_{i'} = -1(+1)$ for quark(antiquark), p_{N_2} is the degree of longitudinal polarization of second hadron.

Supposing that CKM matrix has diagonal form and neglecting the contributions of the heavy quarks (c,b,t) we can write the single asymmetries as

$$A_{l^{\pm}} = \frac{\Delta\sigma_0^{\pm}}{\bar{\sigma}_0^{\pm}}, \tag{9}$$

$$A_{l^+} = -\frac{\int dx_1(u'(x_1)\Delta\bar{d}(x_2^0) - \bar{d}'(x_1)\Delta u(x_2^0))}{\int dx_1(u'(x_1)\bar{d}(x_2^0) + \bar{d}'(x_1)u(x_2^0))},\ A_{l^-} = A_{l^+}(u \leftrightarrow d). \tag{10}$$

Here

$$u'(x_1) = K_t u(x_1),\ \bar{u}'(x_1) = K_t\bar{u}(x_1),\ d'(x_1) = K_u d(x_1),\ \bar{d}'(x_1) = K_u\bar{d}(x_1),$$

$$K_{t(u)} = \frac{\hat{t}^2(\hat{u}^2)}{\hat{s}((\hat{s}-m_W^2)^2 + m_W^2\Gamma_W^2)D}|_{x_2=x_2^0}.$$

The physically allowed region of x_1 and x_2 is given by

$$-\frac{U + m_N^2 - m_l^2}{S + T + m_N^2} \le x_1 \le 1, \quad x_2^0 \le x_2 \le 1.$$

Let us remark that in the region of large x_1 and small $|k_{1\perp}|/\sqrt{S}$ the expression x_2^0 does not depend on x_1 practically ($x_2^0 \approx -T/S$). Dividing the region of integration in (10) by parameter x_1^* (we can choose such value of x_1^* in order to have well defined polarized quarks densities in the region $x_1 > x_1^*$) we obtain the expression

$$\Delta u(-T/S)\int_{x_1^*}^1 dx_1\bar{d}'(x_1)\ -\ \Delta\bar{d}(-T/S)\int_{x_1^*}^1 dx_1 u'(x_1) = \tag{11}$$

$$= A_{l^+}\int_{x_1^{min}}^1 dx_1(u'(x_1)\bar{d}(x_2^0) + \bar{d}'(x_1)u(x_2^0)) - \int_{x_1^{min}}^{x_1^*} dx_1(\Delta u(x_2^0)\bar{d}'(x_1) - \Delta\bar{d}(x_2^0)u'(x_1))$$

and an analogical one for A_{l^-} by replacing $u \leftrightarrow d$.

The expression $-T/S$ in conditions of collider experiment can reach very small values, so using, for example, RHIC kinematics point $\sqrt{S} = 500GeV$, $|k_{1\perp}| = 25GeV$, $\eta = 2$ we can see that $-T/S$ do not exceed 0.007. It gives the possibility to use equations (11) for the investigation the polarized quark densities in the region of small x.

So, equations (11) connect the polarized quark densities in the region of small x with the observable single asymmetries, combination of unpolarized quarks densities (which is proportional to spin averaged part of hadronic cross section $\bar{\sigma}$) and polarized quark densities in the region where they are well defined. If the three of the supplementary measurable quantities (for example double asymmetries $A_{\pm}(x,y)$ from Ref.[6] and QPM-expression for $g_1(x)$) are used, equations (11) allow to determine the low-x behavior of all polarized quark and antiquark distributions in nucleon.

3 Contribution of additional virtual particles

To extract the reliable data on single asymmetries with high precision from hadron collider experiment, it is necessary to consider higher order electroweak radiative corrections. The final state photonic corrections to processes of W-production in unpolarized pp-collisions were calculated in Ref.[7]. More accurate calculation of these electroweak corrections have been suggested in Refs.[8] and [9], where both initial and final state radiation have been included. In this paper we present new explicit formulae for EWC to inclusive single W-production in polarized hadron-hadron collisions. As in final state only charged lepton is detected, as well as Ref.[9] we use for calculation the covariant method [10], which has conclusive advantage: the results of calculations are independent of poor defined parameter – maximum soft photon energy E_{cut} (see for example Ref.[8]).

The one-loop contribution of additional virtual particles (V-contribution) has been calculated in t'Hooft-Feynman gauge and in on-mass renormalization scheme which uses α, m_W, m_Z, Higgs boson mass m_H and the fermion masses as independent parameters.

The cross section of V-contribution is proportional to the Born cross section and could be written as

$$\sigma_V^{\pm} = \sum_{i,i'} \int dx_1 f_i(x_1,Q^2) \hat{\delta}_V^{ii'}|_{x_2=x_2^0} \Sigma_0. \tag{12}$$

Here factor $\delta_V^{ii'}$ consists of six terms

$$\delta_V^{ii'} = \delta_W + \delta_{Vl} + \delta_{Vq}^{ii'} + \delta_{Sl} + \delta_{Sq} + \delta_{\gamma W}^{ii'}. \tag{13}$$

We do not repeat here the explicit expressions for all these contributions but refer the readers to Ref.[11]. So, the meaning of various terms in (13) is as follows
the W-boson self-energy contribution

$$\delta_W = 2\Re \frac{s - m_W^2 - i m_W \Gamma_W}{(s-m_W^2)^2 + m_W^2 \Gamma_W^2} \hat{\Sigma}_T^W(s); \tag{14}$$

leptonic and quark vertex corrections

$$\delta_{Vl} = 2\Re \delta F^{We\nu}(s);\ \delta_{Vq}^{ii'} = 2\Re \delta F^{Wii'}(s); \tag{15}$$

neutrino self energy contribution

$$\delta_{Sl} = \frac{\alpha}{4\pi} Q_l^2 \left(\ln \frac{m_Z^2}{m_l^2} - 2 \ln \frac{m_l^2}{\lambda^2} + \frac{3}{2} \right); \tag{16}$$

up-quarks self energy contribution (down-quarks self energy contribution equals zero)

$$\delta_{Sq} = -\frac{\alpha}{4\pi} \left[Q_u^2 \left(\ln \frac{m_Z^2}{m_u^2} - 2 \ln \frac{m_u^2}{\lambda^2} \right) - Q_d^2 \left(\ln \frac{m_Z^2}{m_d^2} - 2 \ln \frac{m_d^2}{\lambda^2} \right) + \frac{3}{2} \right]; \tag{17}$$

γW box contribution

$$\delta_{\gamma W}^{u\bar{d}} = \delta_{\gamma W}^{\bar{u}d} = \delta_{\gamma W},\ \ \delta_{\gamma W}^{d\bar{u}} = \delta_{\gamma W}^{\bar{d}u} = \delta_{\gamma W}(t \leftrightarrow u, i \leftrightarrow i'), \tag{18}$$

where

$$\delta_{\gamma W} = \frac{2\alpha}{\pi}\Re Q_l(Q_i I_1^{\gamma W,i}(s,t) + Q_{i'} I_2^{\gamma W,i'}(s,u)), \tag{19}$$

and quantities $I_{1,2}^{\gamma W}$ can be found in Ref.[12], $Q_u \equiv Q_{\bar{u}} = +2/3$, $Q_{l^-} \equiv Q_{l^+} = -1$, $c_l = +1(-1)$ for the processes 1, 4 (2, 3).

Infrared divergent (IR) part of V-contribution is regularized with the help of photon mass λ and can be presented by formula (12) with

$$\delta_V^{IR} = \frac{\alpha}{2\pi}\log\frac{s}{\lambda^2}J(0), \tag{20}$$

where the expression for $J(0)$ will be considered in the next section and the rest part of V-contribution cross section contains finite correction

$$\delta_V^{ii'} - \delta_V^{IR} = \delta_V^{ii'}(\lambda^2 \to s).$$

4 Contribution of bremsstrahlung $N\vec{N} \to l\nu_l\gamma$

In order to get infrared finite results for the hadronic process cross section we have to include the real bremsstrahlung correction.

The differential cross section for the process with emission of one real photon reads

$$d\sigma = \frac{\alpha^3}{2^6\pi^2 s_w^4 N_c}\frac{1}{s}\bar{\Sigma}|R|^2\delta(p_1+p_2-k_1-k_2-k)\frac{d^3k_1}{2k_{10}}\frac{d^3k_2}{2k_{20}}\frac{d^3k}{2k_0},$$

where squared matrix element is the sum of initial state, final state and interference terms respectively.

Then we introduce W-boson propagators $\Pi_l(\Pi_q)$ in the case of the lepton(quark) bremsstrahlung

$$\Pi_l = 1/(s - m_W^2 + im_W\Gamma_W),\ \Pi_q = -1/(s - 2kq - m_W^2 + im_W\Gamma_W) = 1/(z + t_{w\Gamma}),$$

and $t_{w\Gamma} = t_w - im_W\Gamma_W$, $t_w = v - s + m_W^2$. As the kinematical variables of the radiated process we use in this case $z = 2kk_1$, $z_1 = 2kp_1$, $u_1 = 2kp_2 = v + z - z_1$, $v = 2kk_2 = s + u + t - m_1^2 - m_2^2 - m_l^2$, where k is 4-momentum of radiated photon.

After transition to hadron-hadron cross section according to prescription of QPM, we can present the cross section of bremsstrahlung (R-contribution) splitting it into a soft IR-part and a hard contribution [10]

$$\sigma^R_{N\vec{N}\to l\nu_l\gamma} = \sigma_R^{IR} + \sigma_R^F. \tag{21}$$

The infrared divergent part (the first term) of expression (21) reads (we had done the substitution $dx_2 = d\hat{v}/D$)

$$\sigma_R^{IR} = \sum_{i,i'}\int dx_1 f_i(x_1,Q^2)\hat{\Sigma}_R^{IR}, \tag{22}$$

where

$$\hat{\Sigma}_R^{IR} = -\frac{\alpha}{\pi}\int_{\hat{v}_{min}}^{\hat{v}_{max}} d\hat{v}\Sigma I[\hat{F}^{IR}]. \tag{23}$$

The procedure of integration over the photon phase space defined as $I[A]$ is described, for example, in Ref.[6]), and for F^{IR} we find

$$F^{IR} = Q_l^2\frac{m_l^2}{z^2} + c_lQ_lQ_i\frac{t}{zz_1} - c_lQ_lQ_{i'}\frac{u}{zu_1} + Q_i^2\frac{m_1^2}{z_1^2} - Q_iQ_{i'}\frac{s}{z_1u_1} + Q_{i'}^2\frac{m_2^2}{u_1^2}.$$

Introducing $J(\hat{v}) = \hat{v}\lim_{\lambda\to 0} I[\hat{F}^{IR}]$ we'll have two parts of the soft cross section:

$$\hat{\Sigma}_R^{IR} = -\frac{\alpha}{\pi}\Sigma_0 J(0)\int\limits_{\hat{v}_{min}}^{\hat{v}_{max}}\frac{d\hat{v}}{\hat{v}} + \frac{\alpha}{\pi}\int\limits_0^{\hat{v}_{max}} d\hat{v}(\Sigma_0 J(0)/\hat{v} - \Sigma I[\hat{F}^{IR}]). \tag{24}$$

The second term is infrared free, and the first one contains IR divergence. In the center-of-mass-system of initial hadrons the limits of integration are

$$\hat{v}_{min} = (\vec{k} = 0) = 2\lambda k_{20} = \lambda\tilde{v}, \quad \tilde{v} \approx \frac{D^2 + TU}{D\sqrt{S}}, \quad \hat{v}_{max} = (x_{2max} = 1) = D(1 - x_2^0) \tag{25}$$

and the infrared divergent part of bremsstrahlung cross section has the form $-\alpha/\pi\Sigma_0 J(0)\log(\hat{v}_{max}/\lambda\tilde{v})$.

Summing up IR-parts of the V- and R- contributions we get

$$\begin{aligned}\sigma_R^{IR} \quad +\sigma_V^{IR} &= \sum_{i,i'} \int dx_1 f_i(x_1, Q^2)\frac{\alpha}{2\pi}\Sigma_0 J(0)\log\frac{\tilde{v}^2\hat{s}_0}{\hat{v}^2_{max}} \\ &+ \sum_{i,i'} \int dx_1 f_i(x_1, Q^2)\frac{\alpha}{\pi}\int\limits_0^{\hat{v}_{max}} d\hat{v}\frac{\Sigma_0 J(0) - \Sigma J(\hat{v})}{\hat{v}},\end{aligned} \tag{26}$$

as a result infrared divergence has cancelled successfully. Expression $J(\hat{v})$ has the form

$$J(\hat{v}) \quad = \quad Q_l^2 - c_l Q_l Q_i \log\frac{\hat{t}^2}{m_l^2 m_1^2} + c_l Q_l Q_{i'}\log\frac{\hat{u}^2}{m_l^2 m_2^2} + Q_i^2 - Q_i Q_{i'}\log\frac{\hat{s}^2}{m_1^2 m_2^2} + Q_{i'}^2. \tag{27}$$

After extraction of IR singularity from partonic process cross section and integrating with respect to k_2 remaining part of R-contribution has the form

$$d\Sigma_R^F = \frac{\alpha^3}{2^6\pi^2 s_w^4}\frac{1}{s}\sum_{j=l,q,w}^{-} |R_j|^2 d\Gamma \tag{28}$$

with phase space

$$d\Gamma = \frac{1}{4}\frac{d^3k_1}{k_{10}}\frac{d^3k}{k_0}\delta[(p_1 + p_2 - k_1 - k)^2]. \tag{29}$$

Integrating over whole phase space of real photon gives bremsstrahlung cross section on parton level as

$$\begin{aligned}\frac{d\Sigma_R^F}{d\eta dk_{1\perp}^2} \quad &= \quad \frac{\alpha^3}{8s_w^4 s N_c}|V_{ii'}|^2(Q_l^2\Pi_l\Pi_l^+ V_l + Q_l\Re[\Pi_l V_{lq}] + V_q \\ &+Q_l\Pi_l\Pi_l^+\Re[V_{lw}] + \Re[\Pi_l]V_{qw} + \Pi_l\Pi_l^+ V_w),\end{aligned} \tag{30}$$

where

$$\Pi_l\Pi_l^+ = 1/((s - m_W^2)^2 + m_W^2\Gamma_W^2).$$

The subscript in V means the origin of bremsstrahlung photon: $l/q/w$ refer to the radiation from lepton/ quark / W-boson legs respectively. Double subscript corresponds to the same interference term. As the expressions for V are bulky they are not resulted here. At last, a hard contribution cross section of inclusive process $N\vec{N} \to l^{\pm}\nu_l\gamma$ has the form

$$\sigma_R^F = \sum_{i,\ i'} \int dx_1 dx_2 f_i(x_1, Q^2)F_{i'}^{(2)}\hat{\Sigma}_R^F. \tag{31}$$

5 Discussion of numerical results and conclusions

To estimate the scale of radiative effects and it's influence on observable quantities in the processes of the single $W^{\pm}$-production in hadron-hadron collisions, the numerical calculations of the cross sections, the total EWC $\delta^{a,p}_{e^-(+)}$ to them

$$\sigma^{\pm} = \sigma_0^{\pm\,a}(1 + \delta^a_{l\pm}) + p_{N\,2}\sigma_0^{\pm\,p}(1 + \delta^p_{l\pm})$$

and the single spin asymmetries $A_{l\pm}$ taking into consideration EWC at typical values for future experiment STAR at the collider RHIC ($\sqrt{S} = 500\ GeV$, $-2 \leq \eta \leq 2$, $\Delta\Phi = 2\pi$) have been made (Born cross section is denoted by index "0"). We used the following standard set of electroweak parameters and the parton densities from Ref.[14].

We present the numerical results for the total correction to the spin-averaged and polarization parts of cross section. As can be seen that both δ^a and δ^p increase in the region $k_{1T} < m_W/2$, $k_{1T} > m_W/2$ and decrease in the vicinity of $k_{1T} = m_W/2$ (similar behavior of EWC was it revealed in Ref.[8]). So, the correction $\delta^a_{e^-}(\delta^p_{e^-})$ has a maxima at $k_{1T} \approx 39GeV$ /$\sim 11\%(17\%)$/ and minimum at $k_{1T} \approx 40.9GeV$ /$\sim -27\%(-23\%)$/. Accordingly, correction $\delta^a_{e^+}(\delta^p_{e^+})$ has a maxima at $k_{1T} \approx 39GeV$ /$\sim 10\%(6\%)$/ and minimum at $k_{1T} \approx 40.9GeV$ /$\sim -28\%(-31\%)$/.

Such sharp modification of spin-averaged cross section correction in the resonance vicinity (marked as well in Ref.[9]) specifies necessity to take into consideration of EWC at the experimental data analysis on measurement of m_W at hadron-hadron colliders (e.g. Tevatron). In the region of rather small k_{1T} which interests us in this paper all corrections $\delta^{a,p}_{e^-,+}$ are significant. So, at $k_{1T} = 25GeV$ we find for these corrections $\delta^a_{e^-} \approx -14\%$, $\delta^p_{e^-} \approx -12\%$, $\delta^a_{e^+} \approx -18\%$, $\delta^p_{e^+} \approx -22\%$.

We investigated the influence of EWC to observable spin single asymmetries (see Sect.1). The analysis has shown that total electroweak correction reduces Born asymmetry A_{e^-} by about $1-2\%$ practically in the whole region of k_{1T} except for $k_{1T} > 45GeV$, where EWC effect is not significant. Similar behavior can be seen for asymmetry A_{e^+} in the region of $k_{1T} < 45GeV$, EWC effect is absent for $k_{1T} \sim 45GeV$, and for $k_{1T} > 45GeV$ electroweak correction increases Born asymmetry by about 1%.

In conclusion we have presented the scheme to use the possible at hadron-hadron collider processes of the single W-boson production for the investigation of the proton spin structure. An approach is proposed for the determination of the contributions to the proton spin the quark flavors by a set of the observable quantities. Analytic formulas for both the virtual one-loop and the real one-photon bremsstrahlung corrections are made available. The obtained formulae do not depend on any parameters of the infrared divergence extraction (e.g. maximum soft photon energy). Our results can be used for studies of nucleon spin at hadron-hadron colliders (RHIC, HERA-$\vec{N}$, Tevatron). The analysis of the numerical results shows that the procedure of radiative correction will occupy an important place in these experiments.

References

[1] Nowak W.-D 1996 DESY 96-095

[2] Gehrman T, Stirling W J 1995 *preprint DTP/95/82, Durham*;
Stratmann M, Vogelsang W, Weber A 1995 *CLRC Tech.Rep. RAL-TR-95-043*

[3] RSC coll. Proposal on spin Physics using the RHIC Polarized Collider. 1992, August

[4] Berman S M et.al 1971 *Phys.Rev.* vol D4 p 3388

[5] Akushevich I V, Shumeiko N M 1994 *J.Phys.G* vol 20 p 513

[6] Shumeiko N M, Timoshin S I, Zykunov V A 1997 *J.Phys G* vol 23 p 1593

[7] Berends F, Kleiss R 1985 *Z.Phys.C* vol 27 p 365

[8] Baur U, Keller S, Wackeroth D 1998 *hep-ph/9807417*

[9] Akushevich I V, Ilychev A N, Shumeiko N M, Zykunov V A, *talk to 5-th annual RDMS CMS Coll. meeting 'Physics Program with the CMS Detector' ITEP, Moscow,* 22-24 Nov., 2000

[10] Bardin D Yu, Shumeiko N M 1977 *Nucl.Phys.* vol B127 p 242; 1979 *Sov.J.Nucl.Phys.* vol 29 p 969

[11] Böhm M et.al 1986 *Forschr.Phys.* vol 34 p 687

[12] Böhm M , Spiesberger H 1987 *Nucl.Phys.* vol B304 p 749

[13] Berends F, Kleiss R 1985 *Z.Phys.* vol C27 p 365

[14] Bartelski J, Tatur S 1996 *Acta Phys.Pol.* vol B27 p 911