Erratum to: "Azimuthal asymmetry in electro-production of neutral pions in semi-inclusive DIS"

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Recently it became clear that the expression Eq. (115) in the paper [1] for the description of azimuthal sin φ spin asymmetries in semi-inclusive hadroproduction in DIS on longitudinally (with respect to the lepton momentum) polarized target contains a misprint in sign of the twist 3 term. This sign was corrected later in the paper [2] (Eq. (2)). However, all authors [3–6] (including us) aiming at describing these phenomena did not notice this very important change and, as a result, use the same sign for longitudinal (with respect to the virtual photon momentum) contribution as for the transversal one. With the correct sign in Eq. (115) of Ref. [1] these contributions obtain opposite signs with positive sign for the longitudinal part if the z-axis is chosen in the direction of the virtual photon and positive target polarization is defined opposite to this direction, see Fig. 1. So all these descriptions should be recalculated with possibly different parameters for the Collins fragmentation function \( H_1^\perp \).

Concerning our paper [5], the azimuthal angle \( \phi \) should be replaced by \( -\phi \), see caption of Fig. 1. Due to this the expression for \( \sigma_{UT} \) in Eq. (7), \( B_T \) in Eq. (11) and in Fig. 3(a) should have a minus sign (and similar changes in [6]). With these changes and with using for Collins analyzing power the so-called “most reliable” value

![Fig. 1. Correction to Fig. 2 in Ref. [5]. Kinematics of the process \( lp \rightarrow l'hX \). Note the orientation of the azimuthal angle \( \phi \) which corresponds to the convention of HERMES [9]. In Refs. [1,2] the azimuthal angle is defined as \( 2\pi - \phi \).](image-url)
Fig. 2. Correction to Fig. 3(c) in Ref. [5]. The contribution of longitudinal ($L$, dashed) and transverse ($T$, dotted) spin part to the total (tot, solid line) azimuthal $\pi^0$ asymmetry $A_{UL}^{\sin \phi}(x)$ and data from [8] vs. $x$.

Fig. 3. Corrections to Fig. 4(a), (b) and (c) in Ref. [5]. Azimuthal asymmetries $A_{UL}^{W(\phi)}(x, \pi^0)$ weighted by $W(\phi) = \sin \phi$ (solid line) and $\sin 2\phi$ (dashed line) for the production of $\pi^0$, $\pi^+$ and $\pi^-$ as function of $x$. The experimental data are from Refs. [8,9]. Rhombus (squares) denote data for $A_{UL}^{\sin \phi}$ ($A_{UL}^{\sin 2\phi}$). The theoretical curves have an uncertainty due to the statistical and systematical error of the DELPHI result, Eq. (1), and the theoretical uncertainty of the model.

$$|\langle H_{\perp}^+ \rangle / \langle D_1 \rangle| = (6.3 \pm 2.0)\%$$ of DELPHI [7], such recalculation results in asymmetry values about twice smaller than the experimental data. A better agreement is, however, achieved with the “optimistic” value of DELPHI

$$\left| \frac{\langle H_{\perp}^+ \rangle}{\langle D_1 \rangle} \right| = (12.5 \pm 1.4)\%$$

obtained from the whole available interval of polar angles $15^\circ < \theta < 165^\circ$ in the DELPHI experiment [7]. The results of these recalculations in comparison with the HERMES data are presented in Figs. 2 and 3 which replace Figs. 3(c) and 4 of Ref. [5].

It is interesting to note that the negative sign of the transversal contribution leads to a change of sign of asymmetries for $x > 0.4$. This is due to a harder behaviour of $h_1(x)$ with respect to $h_L(x)$ (as seen in Fig. 3(b) of Ref. [5]). It should be noted that the prediction of $A_{UL}^{\sin \phi}(x, \pi) = 0$ at $x \simeq (0.4 - 0.5)$ is sensitive to the approximation of favoured flavour fragmentation, which has been used in Ref. [5]. In principle one could conclude from data, how well this approximation works. However, the upper $x$-cut is $x < 0.4$ in the HERMES experiment [8,9].
Fig. 4. Corrections to Fig. 5 in Ref. [5]. (a) $H_{1}^{\perp}(z)/D_{1}(z)$ vs. $z$, as extracted from HERMES data [8,9] on the azimuthal asymmetries $A_{UL}^{\sin\phi}(z)$ for $\pi^{+}$ and $\pi^{0}$ production using the prediction of the chiral quark-soliton model for $h_{1}^{T}(x)$ [10]. The error-bars are due to the statistical error of the data. (b) The same as (a) with data points from $\pi^{+}$ and $\pi^{0}$ combined. The dashed line in both figures is the best fit to the form $H_{1}^{\perp}(z)/D_{1}(z) = az$ with $a = 0.33$.

The corrected values for the totally integrated asymmetries are

$$A_{UL}^{\sin\phi} = \begin{cases} 
0.015 & \text{for } \pi^{0}, \\
0.021 & \text{for } \pi^{+}, \\
-0.003 & \text{for } \pi^{-},
\end{cases} \quad \text{and } A_{UL}^{\sin2\phi} = \begin{cases} 
0.009 & \text{for } \pi^{0}, \\
0.012 & \text{for } \pi^{+}, \\
-0.002 & \text{for } \pi^{-},
\end{cases}$$

and replace the numbers in Table 1 of Ref. [5]. The numbers in Eq. (2) have an uncertainty due to the statistical and systematic error of the DELPHI result, Eq. (1), and moreover an uncertainty of around 20% due to the theoretical uncertainty of results from the chiral quark soliton model.

The new estimate of the $z$-dependence of the analyzing power $H_{1}^{\perp}(z)/D_{1}(z)$ from the $z$-behaviour of experimental asymmetries, using as an input the transversities from the chiral-quark soliton model [10], is presented at Fig. 4 with a linear fit

$$H_{1}^{\perp}(z) = (0.33 \pm 0.06)zD_{1}(z)$$

and with average $\langle H_{1}^{\perp}\rangle/\langle D_{1}\rangle = (13.8 \pm 2.8)\%$ which is in good agreement with DELPHI result Eq. (1).

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References