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TWIST-2 POLARIZED FRAGMENTATION FUNCTION IN THE OPEN CHARM PRODUCTION IN DIS

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Abstract

Arestov Yu.I. Twist-2 Polarized Fragmentation Function in the Open Charm Production in DIS : IHEP Preprint 2001-3. – Protvino, 2001. – p. 3, figs. 4.

To extract the polarized fragmentation function G_1, the transmitted polarization parameter D_{LL} has been considered in the semi-inclusive leptoproduction process $e^-_\uparrow + p \to e^- + \Lambda^+_{c\uparrow} + X$ with both longitudinally polarized electron and charmed lambda. The polarization transfer $\hat{d}_{LL}$ for the lepton-gluon subprocess $e^-_\uparrow + g \to e^- + Q_\uparrow \bar{Q}$ was carefully studied, and it appeared to be sizable. The quantitative estimates of $\hat{d}_{LL}$ were made at the gluon momentum fraction $x_g = 0.2$.

Аннотация

Арестов Ю.И. Поляризованная функция фрагментации твиста-2 в образовании открытого чарма в DIS.: Препринт ИФВЭ 2001-3. – Протвино, 2001. – 3 с., 4 рис.

Для определения поляризованной функции фрагментации G_1 твиста-2 рассматривается параметр переданной поляризации D_{LL} в полуинклюзивном процессе $e^-_\uparrow + p \to e^- + \Lambda^+_{c\uparrow} + X$ с поляризоваными электронами и Λ^+. Детально изучена передача поляризации от $e^-_\uparrow$ к тяжелому кварку в лептон-глюонном подпроцессе $e^-_\uparrow + g \to e^- + Q_\uparrow \bar{Q}$, где она оказывается значительной. Сделаны количественные оценки $\hat{d}_{LL}$ при импульсе глюона $x_g = 0.2$.

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The polarized charmed lambda production is considered in SIDIS reaction

$$e^-_\uparrow + p \to e^- + \Lambda^+_{c\uparrow} + X \tag{1}$$

with the longitudinally polarized lepton beam shown in fig. 1 in the LO approximation. The polarization transmission parameter D_{LL} is defined as

$$D_{LL} = \frac{\sigma_{++} + \sigma_{--} - \sigma_{+-} - \sigma_{-+}}{\sigma_{++} + \sigma_{--} + \sigma_{+-} + \sigma_{-+}}, \tag{2}$$

where the subscripts $\{++\}$ etc. relate to the helicity states of the lepton and Λ^+_c.

In the absense of the initial polarization, Λ^+_c may be polarized only transversely to the production plane. A longitudinal component of the Λ^+_c polarization vector may arise due to the longitudinal lepton polarization in the initial state.

The polarization transmission coefficient which can be measured experimentally relates to the fragmentation function $G_1(z, \mu^2)$ (FF) through the following expression:

$$D_{LL} \sim G(x_g) \cdot \hat{d}_{LL} \cdot G_1, \tag{3}$$

where $G(x_g)$ is the gluon distribution in the (unpolarized) proton and $\hat{d}_{LL}$ is the polarization transmission coefficient in the heavy quark pair production in the lepton–gluon scattering

$$e^-_\uparrow + g \to e^- + Q_\uparrow \bar{Q}. \tag{4}$$

In order to plan measurements of the unknown FF G_1, it would be instructive to know the range of the values of $\hat{d}_{LL}$ in subprocess (4). The matrix element of reaction (4) incorporates the contributions of u-channel ($Q\bar{Q}$ configuration in Fig. 1), t-channel with the permuted Q's and the interference term. Below these contributions are referred to as uu, tt and tu terms.

As is seen from Fig. 2, the d_{LL} properties may be quite different depending on t or u-channel that is on the $Q\bar{Q}$ configuration in the diagram. The azimuthal angle ϕ counts from the lepton scattering plane. The total

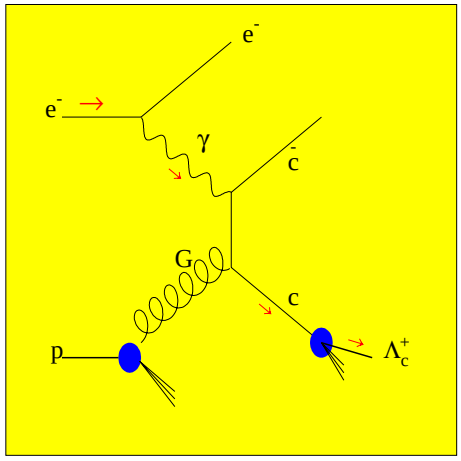

Fig. 1. The SIDIS reaction (1).

ϕ-dependence integrated over p_T exhibits a remarkable behaviour with a deep minimum at $\phi = 180^0$ and a positive maximum at $\phi = 0^0$ (360^0). The maximum of the absolute value of d_{LL} may reach 0.3.

Apart from p_T dependence it can be interesting to track down the $\hat{d}_{LL}$ dependence on E_Q, the quark energy, and on $\cos(Q, q)$, the cosine of the scattering angle in respect to the virtual photon direction. In Fig. 3 the corresponding two- and one-dimensional plots are shown in two regions: $\phi = 0 \pm 30^0$ and $\phi = 180 \pm 30^0$.

Finally, Fig. 4 presents the quark energy E_Q dependence of the polarization coefficient $\hat{d}_{LL}$ integrated in separate hemispheres in respect to the virtual photon momentum. It is seen that at the reasonable values of the quark energy, the coefficient $\hat{d}_{LL}$ appears to be sizable.

From the above consideration, it follows that the model expectations for the fragmentation function G_1 (see (3)) may be quite reasonable because the underlying subprocess exhibits the large values of $\hat{d}_{LL}$ in some regions of the phase space.

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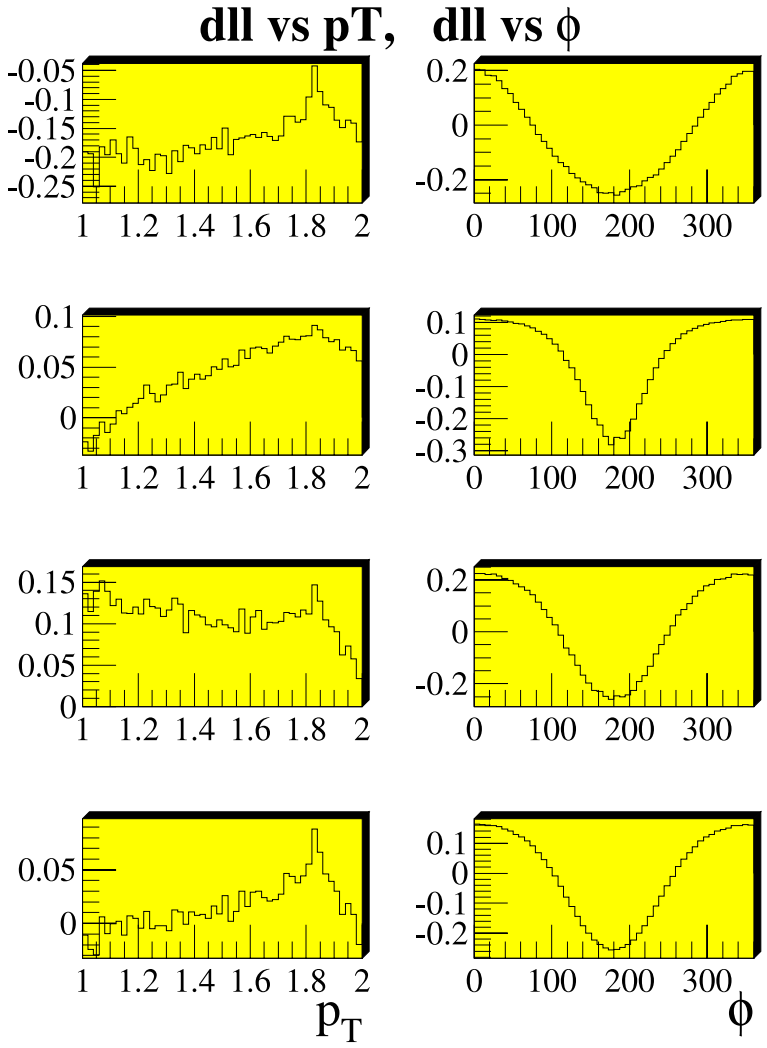

Fig. 2. $\hat{d}_{LL}$ versus p_T and ϕ for (from up to down) tt, uu, tu and total terms.

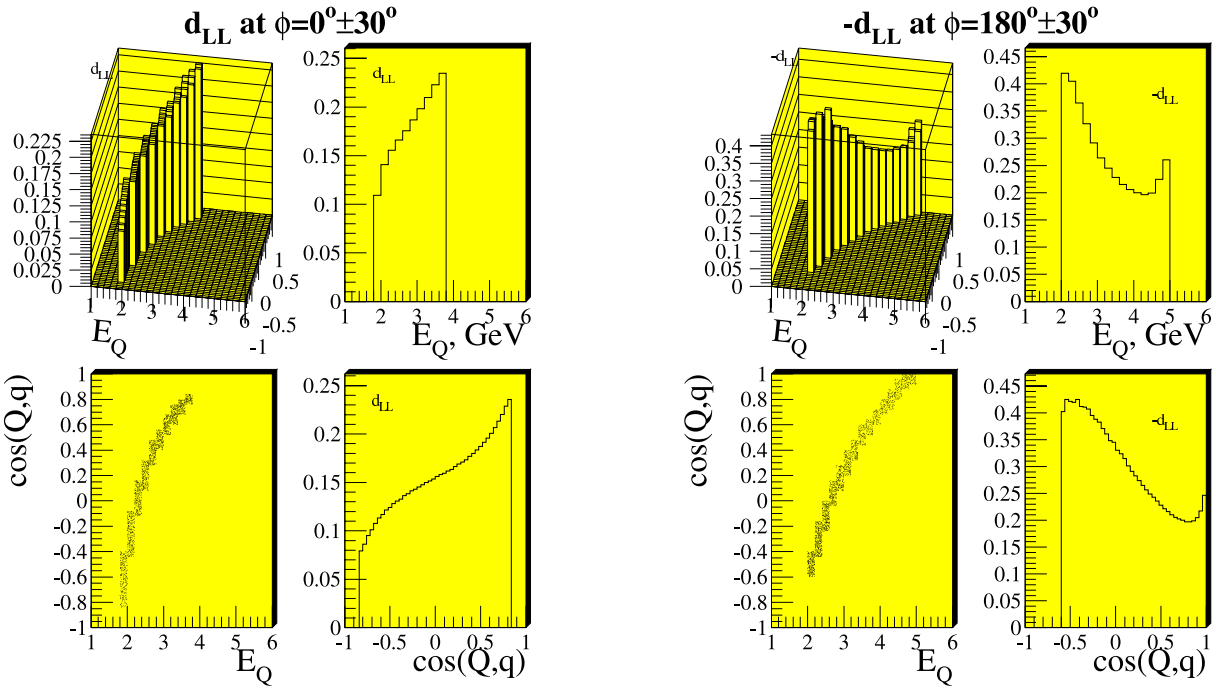

Fig. 3. $\hat{d}_{LL}$ dependence on the quark energy E_Q and (Q,q) angle (see the text).

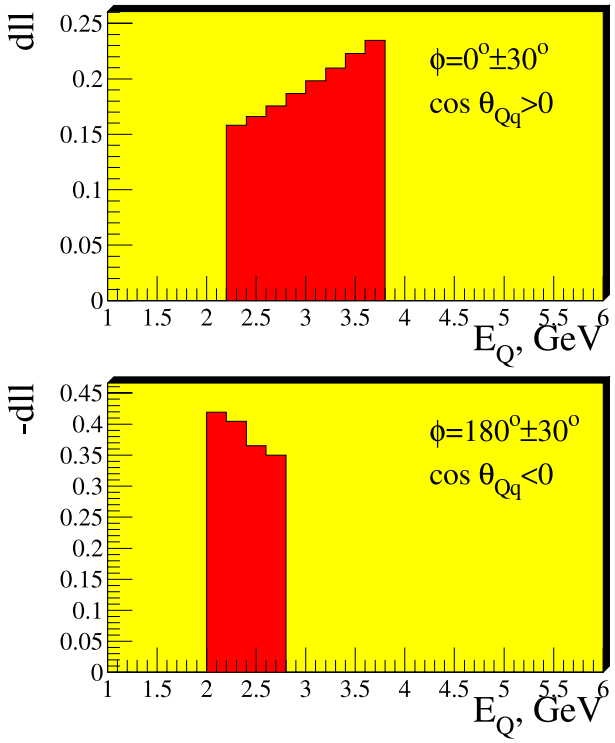

Fig. 4. The quark energy dependence of $\hat{d}_{LL}$ in the forward and backward hemispheres.

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