DOUBLE SPIN ASYMMETRIES FOR HADRON PRODUCTION IN SEMI-INCLUSIVE DIS

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High energy experiment with polarized beams and targets has opened a new window for

revealing QCD dynamics and hadron structures. In this we study the hadron production in polarized semi-inclusive deep inelastic scattering (DIS) off nucleon:

$$\ell^{\mp}(\lambda)+N(h_N)\Rightarrow \ell^{\mp}+h+X, \quad (1) \qquad \nu_\mu(\bar{\nu}_\mu)+N(h_N)\Rightarrow \nu_\mu(\bar{\nu}_\mu)+h+X, (2)$$

$$\nu_\mu(\bar{\nu}_\mu)+N(h_N)\Rightarrow \mu^-(\mu^+)+h+X, (3) \qquad \mu^{\mp}(\lambda)+N(h_N)\Rightarrow \nu_\mu(\bar{\nu}_\mu)+h+X, \quad (4)$$

where λ is the lepton spirality, h_N is the longitudinal polarization of nucleon-target.The cross-section for the production of a hadron h in the current fragmentation region are given by

$$\frac{d\sigma(\lambda; h_N)}{dxdydz}=\sum_{q,h_q} f_{q(h_q)}^{N(h_N)}(x, Q^2)\frac{d\hat{\sigma}}{dy}D_q^h(z, Q^2) \quad (5)$$

where $f_{q(h_q)}^{N(h_N)}(x, Q^2)$ is the distribution function of polarized quarks in the polarized nucleon, $D_q^h(z, Q^2)$ is the fragmentation function of the quark into the detected hadron h, $d\hat{\sigma}/dy$ is the elementary cross-section, x, y and z are the usual DIS variables.

Instead of the usual asymmetry $A_N^h=(N_{\uparrow\uparrow}^h-N_{\uparrow\downarrow}^h)/(N_{\uparrow\uparrow}^h+N_{\uparrow\downarrow}^h)$ one has to measure so called "difference asymmetry" $A_N^{h^+-h^-}$ which is expressed in term of the respective counting rate as

$$A_N^{h^+-h^-}=[(N_{\uparrow\uparrow}^{h^+}-N_{\uparrow\downarrow}^{h^-})-(N_{\uparrow\downarrow}^{h^+}-N_{\uparrow\downarrow}^{h^-})]/[(N_{\uparrow\uparrow}^{h^+}-N_{\uparrow\uparrow}^{h^-})+(N_{\uparrow\downarrow}^{h^+}-N_{\uparrow\downarrow}^{h^-})], \quad (6)$$

where $N_{\uparrow(\downarrow)}^h$ are the number of events for parallel (antiparallel) orientations of here lepton and target nuclear spins for hadrons of type h registered.

We consider separately the different processes and derive explicit expressions for the double spin asymmetries in term of elementary dynamics, spirality amplitudes, quark distribution and fragmentation functions. For example, in the processes (1) expressions for the difference asymmetries look like:

$$A_p^{\pi^+-\pi^-}=f(y)\frac{4\Delta u_v-\Delta d_v}{4u_v-d_v}, \qquad A_n^{\pi^+-\pi^-}=f(y)\frac{4\Delta d_v-\Delta u_v}{4d_v-u_v},$$

$$A_p^{K^+-K^-}=f(y)\frac{\Delta u_v}{u_v}, \qquad A_n^{K^+-K^-}=f(y)\frac{\Delta d_v}{d_v},$$

$$A_d^{\pi^+-\pi^-}=A_d^{K^+-K^-}=f(y)\frac{\Delta u_v+\Delta d_v}{u_v+d_v}, \; f(y)=\frac{1-(1-y)^2}{1+(1+y)^2}. \quad (7)$$

Asymmetries (7) contain only valence quark polarized densities, and to be free any fragmentation functions.