STUDY OF STRANGE PARTICLE PRODUCTION IN HERMES EXPERIMENT

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Semi-inclusive reactions with Λ, $\bar{\Lambda}$, and K_s in the final states are studied in the HERMES experiment using unpolarized gas targets and the polarized 27.5 Gev positron beam of the HERA collider at DESY. Kinematic distributions for the events accepted by the HERMES spectrometer are studied showing a good agreement with LEPTO based Monte Carlo calculations. Λ polarization and polarization transfer from the polarized positron to the Λ are measured. The false asymmetry resulting from the spectrometer acceptance is excluded by compiling the data with opposite beam polarizations in one 'helicity balanced' data set. In current fragmentation region ($x_F > 0$) we have obtained preliminarily $P_\Lambda = 0.03 \pm 0.06(stat) \pm 0.03(syst)$ and polarization transfer $\tau = 0.10 \pm 0.17(stat) \pm 0.09(syst)$. Prospects of the Λ polarization measurements in the target fragmentation region are discussed.

The HERMES spectrometer [1] is designed to study spin structure of the nucleon using the polarized positron (electron) beam of the HERA collider and the internal polarized gas target.

The spectrometer allows to detect the scattered positron in coincidence with the hadrons produced in deep inelastic semi-inclusive reactions at 27.5 Gev of the incident positron energy.

Here we report on experimental study of the semi-inclusive reactions with Λ, $\bar{\Lambda}$, and K_s in the final states.They are detected through their $p\pi^-$, $\bar{p}\pi^+$, and $\pi^+\pi^-$ decays ,respectively, secondary hadrons ($p\pi$, $\pi\pi$) being measured in coincidence with the scattered positron.

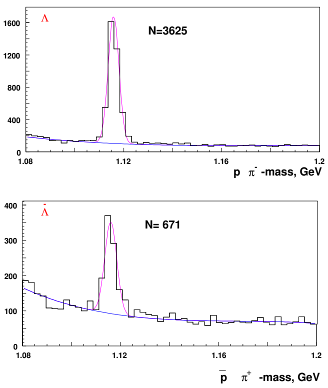

Figure 1: Invariant mass spectra for Λ and $\bar{\Lambda}$ events at integrated luminosity of 163 pb^{-1}.

Two sets of data were obtained in a dedicated run of 1996-1997 years with beam polarizations of the opposite signs ($P_B \simeq \pm 0.52$) and unpolarized H, D, ^{3}He, and ^{14}N targets (unpolarized run).The target density was increased by a factor of $\simeq 10$, being restricted mostly by the positron beam life time. The number of inclusive DIS positrons detected by the spectrometer in unpolarized run was $7.24 \cdot 10^6$ at integrated luminosity 163 pb^{-1}.

The Λ ($\bar{\Lambda}$,K_s) events are selected under conditions that at least one of the detected particles has been identified as the scattered positron and two others as the hadrons. Invariant mass spectra for Λ and $\bar{\Lambda}$ events with the cuts suppressing background are shown in Fig.1. Kinematics of the scattered positron have been restricted by the DIS cuts: Q^2 >1 Gev^2, y <0.85, 0.02< x_Bj <0.8. With DIS cuts applied most of experimentally measured kinematic distributions show a good agreement with LEPTO based HERMES Monte Carlo calculations (HMC). An example of that is given in Fig.2.

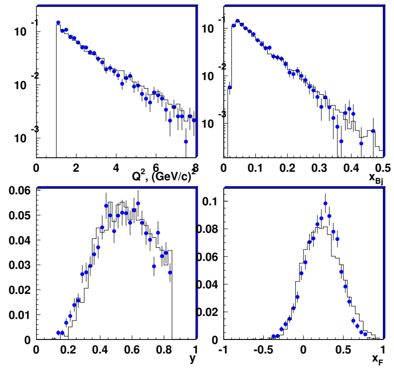

Figure 2: Kinematic distributions for semi-inclusive Λ production. Both experimental and HMC distributions are normalized to unity.

In the HERMES kinematic domain current fragmentation dominates with u (d) quarks mostly knocked out from the target. As HMC shows, 96% of Λ-s are produced via parent u(d) quarks and only 4% via parent s quark.These numbers comprise both string fragmentation case ($\simeq$ 40%) and Λ-s coming from Σ^0 and resonances. Note that for independent fragmentation $D_d^\Lambda = D_u^\Lambda$ since Λ is isosinglet. Thus in QPM Λ yield is dominated by the D_u^Λ fragmentation function which can be directly reconstructed from the data .

If longitudinal Λ polarization is measured in a polarized beam experiment then the spin-dependent part ΔD_u^Λ of D_u^Λ can be also found, or at least estimated. Importance of the Λ polarization measurements in current fragmentation region has been recently pointed out by Jaffe [2]. Under assumption of u-dominance Λ polarization becomes

$$P_\Lambda = \tau P_u = \frac{\Delta D_u^\Lambda}{D_u^\Lambda} \frac{y(2-y)}{1+(1-y)^2} P_B, \tag{1}$$

where P_u is polarization of the u quark resulting from the beam polarization and $\tau = \frac{\Delta D_u^\Lambda}{D_u^\Lambda}$ is polarization transfer from the u quark to the Λ. Proceeding from realistic spin structure of Λ hyperon [2 3 4] one can expect that very roughly $\tau \simeq -0.15 \pm 0.1$.

In order to find Λ polarization the 1996-1997 years data with opposite beam polarizations were compiled in a 'beam helicity balanced' data set such that the spectrometer acceptance function was ruled out from the analysis. After the background suppression, data quality and DIS cuts 1692 Λ events were selected to extract the Λ polarization. In the kinematic domain with $x_F > 0$ and mean values of Q^2=2.48 Gev^2, z=0.446, and $D_y = \frac{y(2-y)}{1+(1-y)^2}$=0.694 we have preliminarily obtained

$$P_\Lambda = 0.03 \pm 0.06(stat) \pm 0.03(syst) \quad \tau = 0.10 \pm 0.17(stat) \pm 0.09(syst).$$

It is very interesting to measure Λ polarization in target fragmentation region [5]. In order to access the target fragmentation the spectrometer acceptance is planned to enlarge with the help of two round silicon strip detectors (Lambda Wheels) to be mounted in the HERMES target vacuum chamber early in 1999. It is expected that using Lambda Wheels and better detecting the front tracks will increase significantly Λ yield (Fig.3) and improve acceptance particularly for the low momentum pions coming from Λ decay.

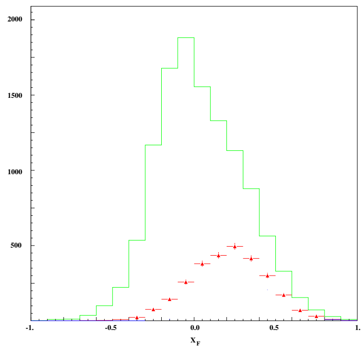

Figure 3: x_F distributions of Λ events for present (experimental points) and future (histogram) configurations of the HERMES spectrometer.

References

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