MEASUREMENT OF TRANSVERSE Λ POLARISATION AT COMPASS*

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ON BEHALF OF THE COMPASS COLLABORATION

Preliminary data on spontaneous transverse Lambda polarisation obtained at COMPASS are presented. While Λ polarisation transverse to the production plane is a well-established experimental fact in hadronic high-energy collisions, the underlying polarisation mechanism is not yet settled. COMPASS extends this field to high-energy photo production. We have extracted the polarisation at different values of the Feynman variable x_F and transverse momentum p_T. A bias cancelling method has been used to reduce systematic effects.

1. Introduction

The polarisation of Λ particles from various high-energetic processes is of interest in many aspects. With polarised target or projectile, the respective spin dependent polarisation transfer can be understood in polarised distribution and fragmentation functions[1], in the longitudinal as well as in the transverse case. However, it is known since a long time that polarisation of Λ is also observed in the collision of unpolarised particles, first in hadronic reactions at Fermilab[2]. This polarisation in proton-nucleus scattering is transverse to the production plane, and found to be negative, as almost always also for other hyperons, and linearly increasing with the transverse momentum of the Λ up to values of about 20%. The effects can at least be qualitatively understood in a phenomenological model of DeGrand and Miettinen[3], where the polarisation is explained semi-classically as a spin precession effect of the accelerated or decelerated strange quark.

COMPASS offers the possibility to study all aspects of Λ polarisation in detail, with muon and hadron beams on polarised and unpolarised targets.

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The analysis presented here considers the case of spontaneous transverse polarisation of Λ particles from a collision of a quasi-real photon with a nucleon. The used coordinate system is depicted in Fig. 1.

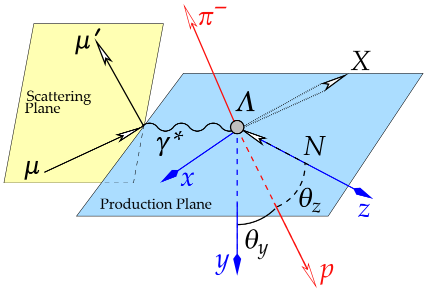

Figure 1. Coordinates in the rest system of the produced Λ. The z axis is chosen along the Λ momentum in the laboratory frame, antiparallel to the target nucleon momentum in the Λ rest system. The y axis is normal to the production plane $\vec{y} = \vec{\gamma} \times \vec{z}$, and $\vec{x} = \vec{y} \times \vec{z}$

2. Measurement at COMPASS

COMPASS runs as fixed target experiment at the CERN Super Proton Synchrotron and accumulated data in 2002, 2003 and 2004. The analysis described in the following has been performed on the data taken in 2002, where a muon beam of 160 GeV/c momentum hit a solid-state ^{6}LiD target, that has been polarised about 20% of the beam time transversely to, and 80% longitudinally with the beam direction. Only data with longitudinally polarized target are considered in this analysis.

The tracks of the outgoing particles are measured in the spectrometer[4] with two stages for low and high momenta, respectively, each equipped with a combination of tracking detectors and calorimetry. Muons are identified using filters from iron and concrete walls, especially in front of the trigger scintillator system.

The events are required to have a primary interaction with fully reconstructed beam and scattered muon inside the polarised target volume. All vertices with two outgoing particles, being not identified as muons, of opposite charge are investigated with the positive track assumed to be a p (π^+) and the negative to be a π^- ($\bar{\mathrm{p}}$) to obtain the mass of the Λ ($\bar{\Lambda}$).

In order to suppress background from converted photons, small longitudinal decay angles are cut at $-0.7 < \cos\theta_z < 0.8$.

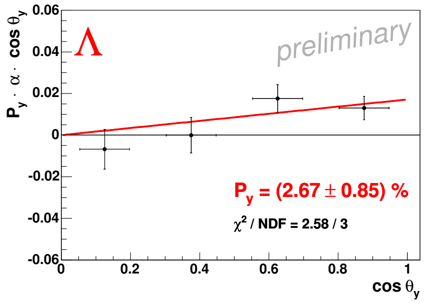

Figure 2. The experimental data, presented in the form of Eq. 1

The Λ reveals its polarisation in the angular asymmetry of the weak decay $\Lambda \to p\pi^-$ with the analysing power $\alpha = 62.4\%$. In order to reduce systematic effects, the complete sample is divided into two subsamples U and D, with the Λ momentum pointing up or down in the laboratoy frame. Due to the parity flip when mirroring processes in the up and down half of the spectrometer, the acceptances for the subsamples $U_+ = U(+\cos\theta_y)$ and $D_- = D(-\cos\theta_y)$ are related. It follows that in the definition

$$R = \frac{\sqrt{U_+D_+} - \sqrt{U_-D_-}}{\sqrt{U_+D_+} + \sqrt{U_-D_-}} = \alpha P_y \cos\theta_y \tag{1}$$

acceptance effects (like the cut in θ_z) cancel and P_y can be directly extracted by fitting the distribution of R defined in Eq. 1.

The respective distribution for Λ, including the fit result, is shown in Fig. 2, and the complete list of extracted polarisations for all examined particles is given in Fig. 3.

3. Discussion

The spontaneous transverse polarisation of Λ produced in the collision of quasi-real photons on nucleons is found to be on average $+2.67\pm0.85\%$ in the examined kinematical range, while the polarisation of $\overline{\Lambda}$ is consistent with zero. The cross check on kaons yielded the expected unpolarised result.

The transverse Λ polarisation is positive, which may be understood in the semi-classical model of DeGrand and Miettinen[3] via the deceleration

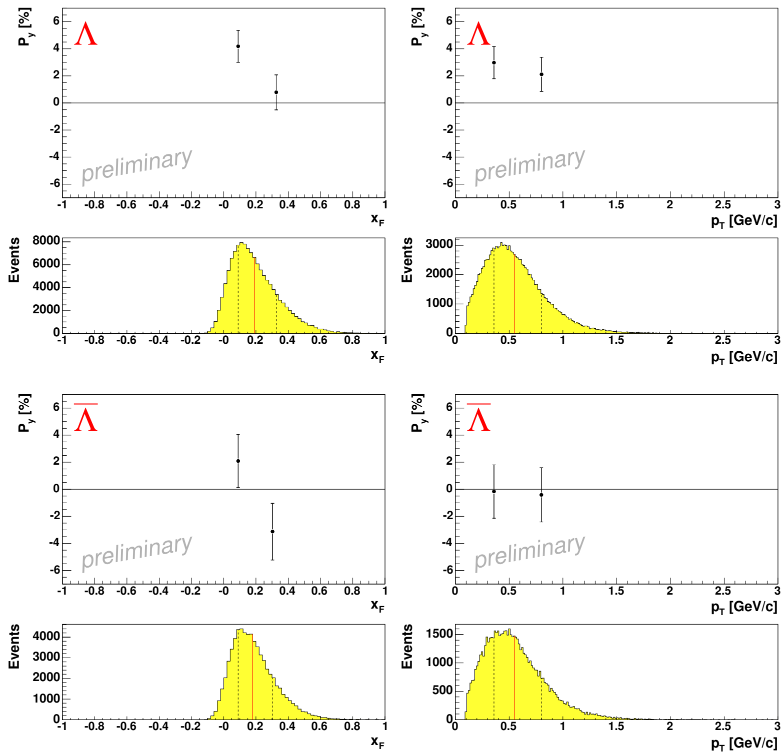

Figure 3. Transverse Λ (upper plots) and $\overline{\Lambda}$ (lower plots) polarisation dependent on kinematical variables x_F (left) and p_T (right). The respective distributions of these variables are also shown.

of a leading strange quark steming from the hadronic $s\bar{s}$ component of the photon. The polarisation effect shows some increase towards smaller x_F, while no significant dependence on p_T is found. A significant increase in the number of reconstructed hyperons by using 2003 and 2004 data will allow to draw more quantitative conclusions.

References

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