A-dependence of the transverse $\Lambda$ polarization

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On behalf of the HERMES collaboration
Introduction

Spontaneous $\Lambda$ polarization \textit{(neither beam nor target is polarized)} is directed along $\hat{n}$

$$\vec{P}_\Lambda = P_\Lambda \cdot \hat{n}, \quad \hat{n} = \frac{\vec{p}_e \times \vec{p}_\Lambda}{|\vec{p}_e \times \vec{p}_\Lambda|}$$

Polarized $\Lambda$ decay in $\Lambda$ rest frame

$$\frac{dN}{d\Omega_p} = \frac{dN_0}{d\Omega_p} (1 + \alpha P_\Lambda \cos \theta_p)$$

$\Lambda \rightarrow p\pi^-$
Formalism of \( \Lambda \) polarization extraction is based on up/down mirror (geometrical) symmetry of the detector.

\[
< \cos \theta >^\text{up}_0 = - < \cos \theta >^\text{down}_0
\]

\[
P_\Lambda = \frac{\langle \cos \theta \rangle_p}{\alpha \langle \cos^2 \theta \rangle_p} = \frac{1}{N_\Lambda} \sum_{i=1}^{N_\Lambda} \cos \theta_p
\]

\[
\frac{1}{N_\Lambda} \sum_{i=1}^{N_\Lambda} \cos^2 \theta_p
\]
Results for HERA Run I

Quasi-real photoproduction: \( e + N \Rightarrow \Lambda \uparrow + X \) at 27.6 GeV

\[
\zeta < 0.25 \\
P_{\Lambda} = 0.099 \pm 0.008
\]

\[
\zeta > 0.25 \\
P_{\Lambda} = 0.049 \pm 0.008
\]

\[
\zeta = \frac{E_{\Lambda} + p_{\Lambda z}}{E_e + p_e}, \quad p_{\Lambda T} = \sqrt{p_{\Lambda x}^2 + p_{\Lambda y}^2}
\]

**A-dependence in pA collisions**

**Experiment @ FNAL**

\[ p \ A \rightarrow \Lambda \ X \]

(targets Cu, Pb, Be)

\[ p_{\text{beam}} = 400 \ \text{GeV} \]

**Experiment @ BNL**

\[ p \ A \rightarrow \Lambda \ X \]

(targets H, D, Be)

\[ p_{\text{beam}} = 28 \ \text{GeV} \]
Reconstruction of $\Lambda$ events

Quasi-real photoproduction, $Q^2 < 0.05 \text{ GeV}^2$ for 80% of the events

$\nu \rightarrow \Lambda \pi^- p$

Background suppression cuts:
- Threshold Cherenkov det. 1996-1997
- Ring imaging Cherenkov det. 1999-2005
- Vertex separation cut is 15 cm

$N(\Lambda) = 385 \cdot 10^3$

($^1H, ^2D, ^3He, ^4He, ^{14}N, ^{20}Ne, ^{84}Kr \text{ and } ^{131}Xe$)

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A-dependence of the polarization

$0 < \zeta < 1$

$\zeta < 0.25$

$\zeta > 0.25$

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$A/Z$-dependence of the polarization

$0 < \zeta < 1$

$\zeta < 0.25$

$\zeta > 0.25$

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Conclusion

- **Transverse Λ polarization has been measured in photoproduction regime.** Low momentum Λ’s ($\zeta < 0.25$, target fragmentation) shows larger polarization than high momentum Λ’s ($\zeta > 0.25$, current fragmentation).

- There is an indication of $A (A/Z)$ - dependence of $P_\Lambda$, in particular pronounced in the case of high momentum Λ’s.
polarized positron beam $E_e = 27.5$ GeV,
polarized and unpolarized internal gas targets H, D, He, Ne, N, Kr, Xe
GOOD RICH PID for hadron separation: $\pi / K / p$
detector is up/down symmetric