Scaled momentum distributions for $K^0_s$ and $\Lambda/\bar{\Lambda}$ in DIS

Why, How, What

DESY 11-205

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Motivation

It is not just perturbative QCD

A miracle happens

Lund string model + leading log parton shower MC

fragmentation functions – leading – twist collinear factorisation

Data to fit
Predictions

Factorisation:

\[ \sigma(ep \rightarrow e + H + X) = \sum_{j,j' = q, \bar{q}, g} f_{j/p}(x, Q) \otimes \delta_{j,j'}(x, Q, z) \otimes F_{H/j'}(z, Q) \]

NLO QCD

AKK+CYCLOPS: Albino, Kniehl, Kramer
DSS: De Florian, Sassot, Stratmann

Monte Carlo: LEPTO
CDM color dipole model [ARIADNE]
MEPS model [LEPTO]
Lund string model
Experiment

Standard NC event selection $\ 330 \text{ pb}^{-1}$

Track and Secondary Vertex based selection of $K_0^s$ and $\Lambda/\bar{\Lambda}$

Details in DESY 11-205

$10 < Q^2 < 40000$

$0.001 < x < 0.75$

$x_p = \frac{2 P^\text{Breit}}{\sqrt{Q^2}}$

$q=(0,0,-Q)$ Breit frame

Estimator of the fraction that the hadron carries from the parton momentum
Signal

- **$K^0_s$**
  - 806505 events
  - 238153 in current region of Breit frame

- **$\Lambda / \bar{\Lambda}$**
  - 165875 events
  - 40728

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Scaled Momentum Distribution

\( \frac{1}{N} n(K_S^0) / \Delta x_p \)

**K_S^0**

scaling violation: 
Q increases
\( \Rightarrow \)
more soft gluon radiation
\( \Rightarrow \)
more particles with low \( x_p \)

\( 0.0 < x_p < 0.1 \)
\( 0.2 < x_p < 0.3 \)
\( 0.4 < x_p < 0.6 \)
\( 0.1 < x_p < 0.2 \)
\( 0.3 < x_p < 0.4 \)
\( 0.6 < x_p < 1.0 \)

\( Q^2 (\text{GeV}^2) \)
Scaled Momentum Distribution

$\frac{1}{N} \frac{n(K_{S}^{0})}{\Delta x_{p}}$

$0.0 < x_{p} < 0.1$

$K_{S}^{0}$

- ZEUS 330 pb$^{-1}$
- CDM
- MEPS

$0.2 < x_{p} < 0.3$

$0.3 < x_{p} < 0.4$

$0.4 < x_{p} < 0.6$

$0.6 < x_{p} < 1.0$

$Q^{2}$ (GeV$^{2}$)

$10^{2} - 10^{3}$

$K_{S}^{0}$

Fragmentation Functions, based on $e^{+} e^{-}$ only, fail. The ones based also on pp and ep don’t do much better. MCs are quite reasonable.
Scaled Momentum Distribution

$K^0_s$ Fragmentation Functions predict too steep spectra.

They just had not enough previous input.
Scaled Momentum Distribution

\[ \frac{1}{N} \frac{n(\Lambda)}{\Delta x_p} \]

\[ \Lambda/\bar{\Lambda} \]
again: scaling violations

MC are still reasonable

Fragmentation Functions, based on e^+ e^- only, fail
Scaled Momentum Distribution

Fragmentation Functions, based on $e^+ e^-$ only, predict a too steep spectrum.

MC are still reasonable.
Scaled Momentum Distribution

\[ \frac{1}{N} \frac{n}{\Delta x_p} \]

\[ 0.1 < x_p < 0.2 \]

\[ 0.2 < x_p < 0.3 \]

\[ 0.3 < x_p < 0.4 \]

inclusive charged particles:
- \( \square \) ZEUS 440 pb\(^{-1}\)
- \( \blacksquare \) ZEUS 38 pb\(^{-1}\)

strange hadrons:
- \( \bigcirc \) \( K_S^0 \) ZEUS 330 pb\(^{-1}\)
- \( \bigtriangleup \) \( \Lambda \)

Strange hadrons are not different, but for mass effects.

And FFs based on \( e^+ e^- \) only, already failed for the inclusive case.
Summary

Scaled Momenta distributions were measured for strange hadrons in ep DIS.

So far, the fragmentation functions were not constrained to describe strange hadron production... and they do not.

We hope the data are useful to further improve the fragmentation functions.
Scaled Momentum Distribution

Inclusive scaled momenta from charge tracks and various FF predictions