Fragmentation in DIS

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1 Fragmentation

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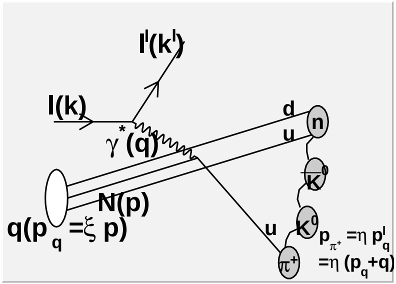
Assumption in analysis of semi-inclusive data:

$$\sigma \propto \sum e_q^2 q(x) D_q^h(z)$$

fragmentation function $D_q^h(z)dz$:
number of hadrons h in $[z, z+dz]$ originating from quark q.



$$x_{Bj} = \frac{Q^2}{2p\cdot q}$$
$$z = \frac{p\cdot p_h}{p\cdot q}$$

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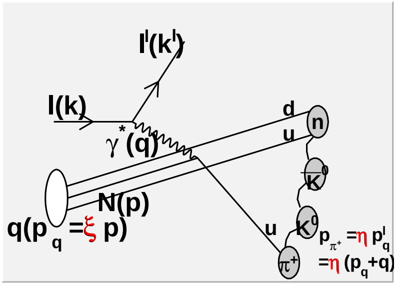

In QPM:

$$x_{Bj} = \frac{Q^2}{2p\cdot q} \equiv \xi$$

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$$A^h = \frac{\Delta\sigma}{\sigma} = \frac{\sum e_q^2 \Delta q(x) D_q^h(z)}{\sum e_q^2 q(x) D_q^h(z)}$$

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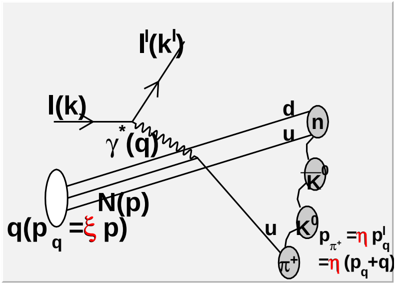

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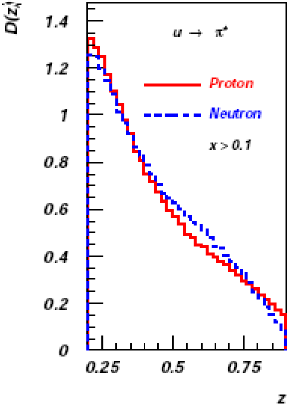
Fragmentation functions

$$D_q^h(z) \longrightarrow D_{q,N}(z,x)$$

dependence on target particle

breaking of factorizationn



Aram Kotzinian
Eur.Phys.J.C44:211,2005.
e-Print: hep-ph/0410093
LUND/JETSET MC
$s = 51 GeV^2$

Spin Dependence of Fragmentation Functions

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$$D_q^h(z) \rightarrow D_q^h(z) + \Delta D_q^h(z)$$

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- fragmentation process does not violate parity

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- if fragmentation is independent of target remnant

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- fragmentation process does not violate parity ✓
- if fragmentation is independent of target remnant ?

$$D_{q\uparrow}^h = \sum_{\lambda_h} \langle q, \uparrow \qquad |T|h, \lambda_h \qquad \rangle =$$
$$\sum_{\lambda_h} \langle q, \downarrow \qquad |T|h, \lambda_h \qquad \rangle = D_{q\downarrow}^h$$

Spin Dependence of Fragmentation Functions

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$$D_{q\uparrow}^h = \sum_{\lambda_h} \langle q, \uparrow, \text{tgt rem.} | T | h, \lambda_h, \text{hads.} \rangle = \sum_{\lambda_h} \langle q, \downarrow, \text{tgt rem.} | T | h, \lambda_h, \text{hads.} \rangle = D_{q\downarrow}^h ?$$

Effect on double spin asymmetries

$$A^h = \frac{\sum e_q^2 \Delta q(x) D_q^h(z)}{\sum e_q^2 q(x) D_q^h(z)}$$

Effect on double spin asymmetries

$$A^h = \frac{\sum e_q^2 \Delta q(x) D_q^h(z) + q(x)\Delta D_q^h(z)}{\sum e_q^2 q(x) D_q^h(z) + \Delta q(x)\Delta D_q^h(z)}$$

- additional term in denominator can be neglected ($\Delta q \Delta D \ll qD$)
- term in numerator is dangerous because $\Delta q D$ maybe of same order as $q \Delta D$

- M. Glück & E. Reya
  hep-ph/0203063
- A. Kotzinian
  Eur.Phys.J.C44:211,2005
  e-Print: hep-ph/0410093

Experimental Situation

Unpolarized $s(x)$

$$s(x)_{semi-incl.} \neq s(x)_{incl} \; ?$$

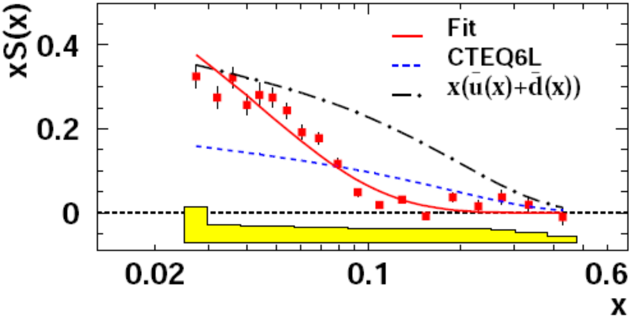


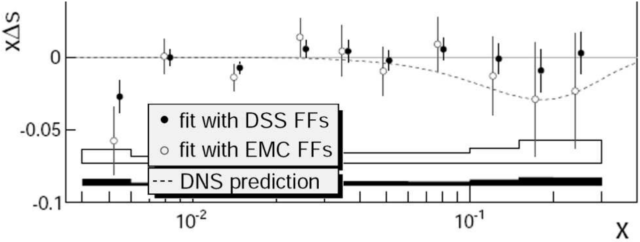
FIG. 3: The strange parton distribution $xS(x)$ from the measured HERMES multiplicity for charged kaons evolved to $Q^2 = 2.5\ \mathrm{GeV}^2$ assuming $\int \mathcal{D}^K(z)dz = 1.27 \pm 0.13$. The solid

Helicity distribution $\Delta s(x)$

$$\Delta s(x)_{semi-incl.} \neq \Delta s(x)_{incl} \ ?$$

Inclusive (x-range:$0-1$)	$-0.09 \pm 0.01 \pm 0.02$
HERMES (semi-incl.) (x-range:$0.023-0.6$)	$0.037 \pm 0.019 \pm 0.027$

COMPASS:



Summary

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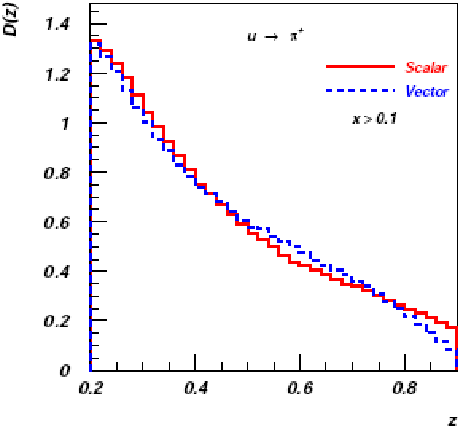
- It's important to understand the fragmentation process to interpret semi-inclusive data
- $\vec{e}\vec{N}$ collider (at moderate s) is ideal tool to do this
- Possible observables
  - analyze semi-inclusive asymmetries at different z and extract $\Delta q(x)$
  - compare inclusive with semi-inclusive results
  - study target fragmentation region (Λ polarization?)
  - .....

Spare



Dependence of FF on di-quark remnant.
Red: scalar di-quark, blue: vector-diquark.
$(s = 51 GeV^2)$
LUND/JETSET MC
A. Kotzinian, Eur.Phys.J.C44:211,2005