The difference asymmetries in SIDIS

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Ekaterina Christova

Institute for Nuclear Research, BAS, Sofia

based on papers written with

Elliot Leader - Imperial College

The goal

to obtain the polarized parton densities

$$\Delta u \Rightarrow \Delta u_V, \quad \Delta \bar{u}$$
$$\Delta d \Rightarrow \Delta d_V, \quad \Delta \bar{d}$$
$$\Delta s, \Delta \bar{s}$$
$$\Delta G$$

We have:

DIS: $\quad \overrightarrow{l} + \overrightarrow{N} \rightarrow l' + X$

$$A_N^{DIS} = \frac{\Delta \sigma^{DIS}}{\sigma^{DIS}} = \frac{\sum e_q^2 (\Delta q + \Delta \bar{q})}{\sum e_q^2 (q + \bar{q})} = \frac{g_1^N}{F_1^N}$$

determine only the combinations $(\Delta q + \Delta \bar{q})$:

$$\Delta u + \Delta \bar{u}, \quad \Delta d + \Delta \bar{d}, \quad \Delta s + \Delta \bar{s}, \quad \Delta G.$$

SIDIS: $\quad \vec{l} + \vec{N} \to l' + h + X, \quad h = \pi^{\pm}, K^{\pm}.$

$$A_N^h = \frac{\Delta\sigma_N^h}{\sigma_N^h} = \frac{\sum e_q^2\,(\Delta q\, D_q^h + \Delta\bar{q}\, D_{\bar{q}}^h)}{\sum e_q^2\,(q\, D_q^h + \bar{q}\, D_{\bar{q}}^h)}$$

HERMES & SMC

- advantage: determines Δq and $\Delta\bar{q}$ separately $\to D_q \neq D_{\bar{q}}$
- but: we need to know the FFs: D_q and $D_{\bar{q}}$
- up to now D_q^h are not well known:
- $e^+e^- \to h + X \Rightarrow D_q^h + D_{\bar{q}}^h$ only

$\sim$ in DIS $\Rightarrow (q + \bar{q})$, $(\Delta q + \Delta\bar{q})$ only

- $l + N \to l' + h + X \Rightarrow D_q^h$ & $D_{\bar{q}}^h$

$\Rightarrow$ but low sensitivity to D_s^h etc.

EMC (1989), HERMES (2001)

- in SIDIS D_q^h and $D_{\bar{q}}^h$ needed separately $\Rightarrow$ always additional theor. assumptions about favoured and unfavoured transitions are made.
- different isospin relations about polarized sea:

$$\Delta\bar{u} = \Delta\bar{d} = \Delta\bar{s} \quad \text{or} \quad \Delta\bar{u}/\bar{u} = \Delta\bar{d}/\bar{d} = \Delta\bar{s}/\bar{s}$$

SIDIS experiments

done:

1) SMC (CERN) $h^{\pm}$ on p and d

2) HERMES (DESY) $\pi^{\pm}$, $K^{\pm}$ on p and d

results:

a) HERMES: $(\Delta s + \Delta \bar{s}) \simeq 0 \Rightarrow$ SU(3) totally

. broken E.Leader & D.Stamenov

DIS: $(\Delta s + \Delta \bar{s}) < 0$

b) HERMES: $\Delta \bar{u} - \Delta \bar{d} \simeq 0$

DIS: $\int dx(\bar{u} - \bar{d}) = .118 \pm .012$

TH: chiral models:

$\Delta \bar{u} - \Delta \bar{d} \neq 0$ - LO; $(\bar{u} - \bar{d}) \neq 0$ - NLO

coming:

1) COMPASS (CERN:)

approved 1998

taking data since 2002 $\Rightarrow \Delta G = ?$

2) Semi-SANE E04 113 (JLAB,USA)

approved summer 2004

start taking data 2006-2007 $\Rightarrow A_N^{h-\bar{h}}$

We consider SIDIS

$$l + N \to l' + h + X, \qquad \vec{l} + \vec{N} \to l' + h + X$$

What can we learn from SIDIS - pol. and unpol. without assuming any knowledge:

- about D_q^h and $D_{\bar{q}}^h$
- about $\Delta\bar{u}$, $\Delta\bar{d}$, Δs, $\Delta\bar{s}$, ΔG

- We suggest to measure the difference asymmetries:

$$A_N^{h^+-h^-} = \frac{\Delta\sigma_N^{h+} - \Delta\sigma_N^{h-}}{\sigma_N^{h+} - \sigma_N^{h^-}}$$

$$R_N^{h^+-h^-} = \frac{\sigma_N^{h+} - \sigma_N^{h-}}{\sigma_N^{DIS}}$$

We show that one can determine directly:

- Δu_V , Δd_V $\to$ LO and NLO – JLab
- $\Delta\bar{u} - \Delta\bar{d}$ $\to$ LO and NLO – JLab
- $s(x) - \bar{s}(x)$, $\Delta s(x) - \Delta\bar{s}(x)$ $\to$ LO and NLO
- $D_u^{\pi^+-\pi^-}$ $\to$ LO and NLO
- possible tests of LO

to be measured in JLab – with A-rating approved last summer!

PROBLEMS

DIS & SIDIS polarized $\Rightarrow Q^2 =$ **small,** $Q^2 \geq M^2$

$$\Downarrow$$

HERMES: $Q^2 \simeq 1{-}10\ GeV^2$, $< Q^2 > \simeq 2,5\ GeV^2$
JLab: $Q^2 \simeq 1,3 - 3,5\ GeV^2$

perturb. QCD: $Q^2 \gg M^2$ **– Higher twists needed?**

How HT's modify the difference asymmetries?
Thinking of possible ways out.

$\overrightarrow{l} + \overrightarrow{N} \to l' + h + X$

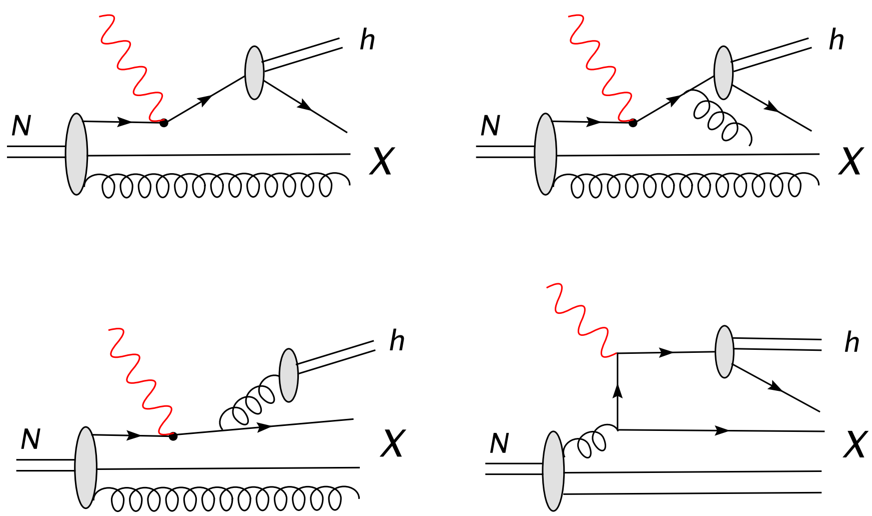
The general formula in SIDIS, $Q^2 \gg M^2$:

$$\Delta\tilde{\sigma}_N^h \;\propto\; \sum_q e_q^2 \Big\{ \Delta q \otimes \Delta\hat{\sigma}(\gamma q \to qX) \otimes D_q^h$$
$$+ \Delta q \otimes \hat{\sigma}(\gamma q \to GX) \otimes D_G^h$$
$$+ \Delta G \otimes \Delta\hat{\sigma}(\gamma G \to q\bar{q}X) \otimes (D_q^h + D_{\bar{q}}^h) \Big\}$$

$\Delta q(x,t)$ and $D_q^h(z,t) \Rightarrow$ from experiment

$\Delta\hat{\sigma}_{ff'} \Rightarrow$ theor. calculated in perturb. QCD:

$$\Delta\hat{\sigma}_{ff'} = \Delta\hat{\sigma}_{ff'}^{(0)} + \frac{\alpha_s}{2\pi} \Delta\hat{\sigma}_{ff'}^{(1)} + \ldots$$



The difference asymmetries $A_N^{h-\bar{h}}$

C-inv. implies: $D_G^{h-\bar{h}} = 0$, $D_q^{h-\bar{h}} = -D_{\bar{q}}^{h-\bar{h}}$

$\Rightarrow$ In all orders in QCD all gluons cancel :

$$\begin{aligned}
\Delta\tilde{\sigma}_N^{h-\bar{h}} &\propto \Big[4\Delta u_V \otimes D_u^{h-\bar{h}} + \Delta d_V \otimes D_d^{h-\bar{h}} \\
&\quad + (\Delta s - \Delta\bar{s}) \otimes D_s^{h-\bar{h}}\Big] \otimes \Delta\hat{\sigma}(\gamma q \to qX) \\
\Delta\hat{\sigma}_{qq} &= \Delta\hat{\sigma}_{qq}^{(0)} + \frac{\alpha_s}{2\pi}\Delta\hat{\sigma}_{qq}^{(1)} + \ldots
\end{aligned}$$

- only NS $\Rightarrow$ gluons do not reappear in Q^2-evol.
- each term is a NS
- sensitive to Δu_V, Δd_V & $(\Delta s - \Delta\bar{s})$ only

Further $\Delta\tilde{\sigma}_N^{h-\bar{h}}$ depends on the final hadron h.

$\overrightarrow{l} + \overrightarrow{N} \to l' + \pi^{\pm} + X$

SU(2) and C: $D_u^{\pi^+-\pi^-} = -D_d^{\pi^+-\pi^-}$, $D_s^{\pi^+-\pi^-} = 0$

$\Delta u_V, \Delta d_V - LO$:

$$A_p^{\pi^+-\pi^-}(x, \underline{\underline{z}}, Q^2) = \frac{4\Delta u_V - \Delta d_V}{4u_V - d_V}(x, Q^2)$$
$$A_n^{\pi^+-\pi^-}(x, \underline{\underline{z}}, Q^2) = \frac{4\Delta d_V - \Delta u_V}{4d_V - u_V}(x, Q^2)$$

The FFs completely cancel!

Frankfurt et al, P.L. B (1989)

E. Ch. & E. Leader, P.L. B (1999)

$\Rightarrow$ 2 <u>*algebraic*</u> eqs. for Δu_V and Δd_V:

$$\Delta u_V = \left\{4(4u_V - d_V)A_p^{\pi^+-\pi^-} + (4d_V - u_V)A_n^{\pi^+-\pi^-}\right\}$$
$$\Delta d_V = \left\{4(4d_V - u_V)A_n^{\pi^+-\pi^-} + (4u_V - d_V)A_p^{\pi^+-\pi^-}\right\}$$

z = passive observable - test of LO

NLO

LO		NLO
alg. eqs. (simple products)	$\Rightarrow$	int. eqs. (convolutions)

$$q(x, U^2) \ \Rightarrow \ \int \frac{dx'}{x'} q\left(\frac{x}{x'}\right) C(x') = q \otimes C$$

$$q(x, Q^2) D(z, Q^3) \ \Rightarrow \ \int \frac{dx'}{x'} \int \frac{dz'}{z'} q\left(\frac{x}{x'}\right) C(x', z') D\left(\frac{z}{z'}\right)$$

$$= \ q \otimes C \otimes D$$

C are ***known*** Wilson coefficients.

LO : $\Rightarrow$ no gluons in the cross section

NLO : $\Rightarrow$ gluons in $d\sigma$: $G(x)$, $\Delta G(x)$, $D_G^h(z)$

- polarized DIS

$$g_1^p(x, Q^2) \ = \ \frac{1}{2} \sum_i e_i^2 \left[\Delta q_i \left(1 + \otimes \frac{\alpha_s(Q^0)}{2\pi} \delta C_q \right) + \right. \\ \left. + \frac{\alpha_s(Q^2)}{2\pi} \Delta G \otimes \delta C_G \right]$$

- unpolarized DIS

$$\tilde{\sigma}^{DIS}|_{LO} = 2F_1 \quad \Rightarrow \quad \tilde{\sigma}^{DIS}|_{NLO} = 2F_1 \left[1 + 2\gamma(y) R \right],$$

$$R = \frac{\sigma_L}{\sigma_T}, \qquad \gamma(y) = \frac{1 - y}{1 + (1 - y)^2}.$$

$\underline{\underline{\Delta u_V, \Delta d_V - NLO}}$

E. Ch. & E. Leader, N.P. B (2001)

- From polarized SIDIS $\Rightarrow$ Δu_V and Δd_V:

$$A_p^{\pi^+-\pi^-} = \frac{(4\Delta u_V - \Delta d_V)[1 + \otimes(\alpha_s)\Delta C_{qq}\otimes] D_u^{\pi^+-\pi^-}}{(4u_V - d_V)[1 + \otimes(\alpha_s)C_{qq}\otimes] D_u^{\pi^+-\pi^-}}$$

$$A_n^{\pi^+-\pi^-} = \frac{(4\Delta d_V - \Delta u_V)[1 + \otimes(\alpha_s)\Delta C_{qq}\otimes] D_u^{\pi^+-\pi^-}}{(4d_V - u_V)[1 + \otimes(\alpha_s)C_{qq}\otimes] D_u^{\pi^+-\pi^-}}$$

correct to any order in QCD:

$$\Delta C_{qq} = \Delta C_{qq}^{(1)} + \alpha_s \Delta C_{qq}^{(2)} + \ldots$$

$\Rightarrow$ 2 eqs. for Δu_V and Δd_V

- From unpolarized SIDIS $\Rightarrow$ $D_u^{\pi^+-\pi^-}(z, Q^0)$:

$$R_p^{\pi^+-\pi^-} = \frac{[4u_V - d_V][1 + \otimes(\alpha_s)C_{qq}\otimes] D_u^{\pi^+-\pi^-}}{18F_1^p\,[1 + 2\gamma(y)\,R^p]}$$

$$R_n^{\pi^+-\pi^-} = \frac{[4d_V - u_V][1 + \otimes(\alpha_s)C_{qq}\otimes] D_u^{\pi^+-\pi^-}}{18F_1^n\,[1 + 2\gamma(y)\,R^n]}.$$

$\Rightarrow$ 2 eqs. for $D_u^{\pi^+-\pi^-}(z, Q^2)$

$\Rightarrow$ Δu_V, Δd_V and $D_u^{\pi^+-\pi^-}(z, Q^2)$ are non-singlets and don't mix with other PDs and FFs

$\mathrm{SU(2)}$ for the polarized sea : $(\Delta\bar{\mathrm{u}} - \Delta\bar{\mathrm{d}})$

We have in any order in QCD:

$$(\Delta\bar{u} - \Delta\bar{d}) = \Delta q_3 + \Delta d_V - \Delta u_V$$

where

$$\Delta q_3(x, Q^2) = (\Delta u + \Delta\bar{u}) - (\Delta d + \Delta\bar{d}).$$

Here Δq_3 is obtained directly from DIS:

LO :

$$g_1^p(x, Q^2) - g_1^n(x, Q^2) = \frac{1}{6}\Delta q_3$$

NLO :

$$g_1^p(x, Q^2) - g_1^n(x, Q^2) = \frac{1}{6}\Delta q_3 \otimes \left(1 + \frac{\alpha_s(Q^2)}{2\pi}\delta C_q\right)$$

not through $(\Delta u+\Delta\bar{u})$ & $(\Delta d+\Delta\bar{d})$ that depend on Δs & ΔG.

$\Rightarrow$ no influence from Δs and ΔG.

$(\Delta\bar{u} - \Delta\bar{d}) \simeq$ *small* $\mapsto$ NLO needed

SIDIS – $\pi^{\pm}$

Δu_V, Δd_V and $\Delta\bar{u} - \Delta\bar{d}$ determined in LO and NLO:

- no assumptions about FFs
- no assumptions about polarized sea densities, even $s \neq \bar{s}$ and $\Delta s \neq \Delta\bar{s} \Leftarrow D_s^{\pi^+ - \pi^-} = 0$
- only SU(2) and C inv. of strong ints. assumed
- only unpolarized u_V and d_V to be known
- SU(2) breaking of the sea without knowledge of $\Delta\bar{u}$ and $\Delta\bar{d}$
- test for LO $\Rightarrow z =$ passive observable

  If a small dependence on $z \Rightarrow$ it can be considered as a system. th. error in LO analysis

SIDIS – $K^{\pm}$

$\Rightarrow$ SU(2) does not relate $D^{K^{\pm}}$ $\Rightarrow$ assumptions needed:

1. $D_d^{K^+-K^-} = 0$ – unfav. trans. are equal (but not small)
2. $\Delta s - \Delta\bar{s} = 0$ ($D_s^{K^+-K^-} \neq 0$)

instead: $\Delta u_V, \Delta d_V$ known from SIDIS $\pi^{\pm}$ without any assumptions, then $K^{\pm}$ determine $\Delta s - \Delta\bar{s}$ - LO and NLO

SIDIS – $\Lambda, \bar{\Lambda}$

$\Rightarrow$ SU(2): $D_u^{\Lambda-\bar{\Lambda}} = D_d^{\Lambda-\bar{\Lambda}}$,

but $D_s^{\Lambda-\bar{\Lambda}} \neq 0 \Rightarrow \Lambda, \bar{\Lambda}$ determine $\Delta s - \Delta\bar{s}$ without any assumptions

$\underline{\Delta s - \Delta\bar{s} =?, SIDIS - K^{\pm}}$, $\underline{\underline{\text{LO}}}$

$$\underline{\underline{D_d^{K^+-K^-} = 0 \text{ assumed}}}$$

[recall: $K^+ = (\bar{s}u), K^- = (s\bar{u})$]

$$A_p^{K^+-K^-} = \frac{4\Delta u_V D_u^{K^+-K^-} + (\Delta s - \Delta\bar{s}) D_s^{K^+-K^-}}{4u_V D_u^{K^+-K^-}}$$

$$A_n^{K^+-K^-} = \frac{4\Delta d_V D_u^{K^+-K^-} + (\Delta s - \Delta\bar{s}) D_s^{K^+-K^-}}{4d_V D_u^{K^+-K^-}}$$

$\Rightarrow (\Delta s - \Delta\bar{s}) D_s^{K^+-K^-} =?$

$\longrightarrow$ note: $D_s^{K^+-K^-}$ is not small

$\Rightarrow$ inform. about $(\Delta s - \Delta\bar{s}) \neq 0$?

From unpolarized SIDIS: $\Rightarrow D_u^{K^+-K^-}(z, Q^2)$:

$$R_p^{K^+-K^-} = \frac{u_V D_u^{K^+-K^-}}{\sigma_p^{DIS}}$$

$$R_n^{K^+-K^-} = \frac{d_V D_u^{K^+-K^-}}{\sigma_n^{DIS}}$$

If $(\Delta s - \Delta\bar{s}) = 0$:

$$A_p^{K^+-K^-}(x, z) = \frac{\Delta u_V}{u_V}(x), \quad A_n^{K^+-K^-}(x, z) = \frac{\Delta d_V}{d_V}(x)$$

$\Delta s - \Delta\bar{s} =? - SIDIS - K^{\pm}$, NLO

NLO: the same quantities enter

$$A_p^{K^+-K^-} = \frac{[\Delta u_V D_u + (\Delta s - \Delta\bar{s}) D_s] \otimes (1 + (\alpha_s)\Delta C_{qq}\otimes)}{u_V \otimes (1 + (\alpha_s)\, C_{qq}\otimes) D_u^{K^+-K^-}}$$

$$A_n^{K^+-K^-} = \frac{[\Delta d_V D_u + (\Delta s - \Delta\bar{s}) D_s] \otimes (1 + (\alpha_s)\Delta C_{qq}\otimes)}{d_V \otimes (1 + (\alpha_s)\, C_{qq}\otimes) D_u^{K^+-K^-}}$$

$\Rightarrow$ 2 eqs. for $(\Delta s - \Delta\bar{s}) \otimes (1 + (\alpha_s)\Delta C_{qq}\otimes) D_s^{K^+-K^-}$.

$\Rightarrow$ inform about $(\Delta s - \Delta\bar{s}) \neq 0$?

From unpolarized SIDIS: $\Rightarrow D_u^{K^+-K^-}(z, Q^2)$:

$$R_p^{K^+-K^-} = \frac{2\, u_V\, [1 + \otimes(\alpha_s/2\pi) C_{qq}\otimes] D_u^{K^+-K^-}}{9 F_1^p\, [1 + 2\gamma(y)\, R^p]}$$

$$R_n^{K^+-K^-} = \frac{d_V\, [1 + \otimes(\alpha_s/2\pi) C_{qq}\otimes] D_u^{K^+-K^-}}{18 F_1^n\, [1 + 2\gamma(y)\, R^n]}.$$

$\underline{\underline{s - \bar{s} = ?}}$

$\underline{\underline{D_d^{K^+ - K^-} = 0 \text{ assumed}}}$

LO:

$$R_p^{K^+ - K^-} = \frac{4\, u_V D_u^{K^+ - K^-} + (s - \bar{s}) D_s^{K^+ - K^-}}{\sigma_p^{DIS}}$$

$$R_n^{K^+ - K^-} = \frac{4\, d_V D_u^{K^+ - K^-} + (s - \bar{s}) D_s^{K^+ - K^-}}{\sigma_n^{DIS}}$$

NLO:

$$R_p^{K^+ - K^-} = \frac{[4\, u_V D_u^{K^+ - K^-} + (s - \bar{s}) D_s^{K^+ - K^-}](1 + \otimes \alpha_s C_{qq})}{\sigma_p^{DIS}}$$

$$R_n^{K^+ - K^-} = \frac{[4\, d_V D_u^{K^+ - K^-} + (s - \bar{s}) D_s^{K^+ - K^-}](1 + \otimes \alpha_s C_{qq})}{\sigma_n^{DIS}}$$

Testing LO

LO:

$$\Delta\sigma_p^{h+\bar{h}} = 4\Delta\tilde{u}D_u^{h+\bar{h}} + \Delta\tilde{d}D_d^{h+\bar{h}} + \Delta\tilde{s}D_s^{h+\bar{h}}$$
$$\Delta\tilde{q} = \Delta q + \Delta\bar{q}$$

C-inv: $D_q^{h+\bar{h}} = D_{\bar{q}}^{h+\bar{h}}$

$$\frac{\Delta\sigma_p^{h+\bar{h}} - \Delta\sigma_n^{h+\bar{h}}}{\sigma_p^{h+\bar{h}} - \sigma_n^{d+\bar{h}}}(x, z, Q^2) = \frac{\Delta\tilde{u} - \Delta\tilde{d}}{\tilde{u} - \tilde{d}}(x, Q^2)$$
$$= \frac{g_1^p - g_1^n}{F_1^p - F_1^n}(x, Q^2)$$

$h = \pi^\pm$, $K^\pm$, etc. and their sum $h^\pm$

Advantages:

- z is a passive observable
- no dependence on $\Delta\bar{q}$, $\Delta\bar{s}$, g and D^h
- only measurable quantities enter

$$\Delta q_3(x, Q^2) = (\Delta u + \Delta\bar{u}) - (\Delta d + \Delta\bar{d})$$

obtained directly through:

$$g_1^p(x, Q^2) - g_1^n(x, Q^7) = \frac{1}{6}\Delta q_3|_{LO}$$

Integrated:

$$\frac{\int dx \int dz [\Delta\sigma_p^{h+\bar{h}} - \Delta\sigma_n^{h+\bar{h}}]}{\int dx \int dz [\sigma_p^{h+\bar{h}} - \sigma_n^{h+\bar{h}}]} = \frac{g_A/g_V}{3S_G}$$

- used:

The Bjorken sum rule:

$$\begin{aligned} \int dx (g_1^p - g_1^n) &= (\Delta\tilde{u} - \Delta\tilde{d})|_{LO} = g_A/g_V \\ g_A/g_V &= 1.2670 \pm 0.0079 \end{aligned}$$

The Gottfried sum rule:

$$\begin{aligned} S_G = \int dx \frac{F_2^p - F_2^n}{x} &= e_u^2 - e_d^2 + \frac{2}{3} \int dx (\bar{u} - \bar{d}) \\ S_G &= 0.235 \pm 0.026 \end{aligned}$$

- remark

The Bjorken sum rule in NLO:

$$\begin{aligned} \int dx (g_1^p - g_1^n) &= \frac{1}{6} (\Delta\tilde{u} - \Delta\tilde{d}) \left(1 - \frac{\alpha_s(Q^0)}{\pi}\right) \\ &= \frac{1}{6} g_A/g_V \left(1 - \frac{\alpha_s(Q^2)}{\pi}\right) \end{aligned}$$

SIDIS and HT

Most generally:

$$\begin{aligned} \Delta\sigma_p^h &= \Delta\sigma_p^h(pQCD) + \Delta H_p^h(x,z) \\ \sigma_p^h &= \sigma_p^h(pQCD) + H_p^h(x,z) \end{aligned}$$

$\Rightarrow$ 4 new functions $\Delta H_{p,n}^h(x,z)$ & $H_{p,n}^h(x,z)$

How to simplify the problem in a phys. meaningful way?

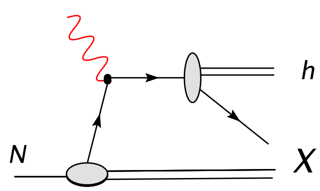
- We do not construct a full treatment of HT!

our strategy – consider partons as particles & split $\Delta H(x,z)$ into 2 indep. pieces: ΔH_q & H_D^h:

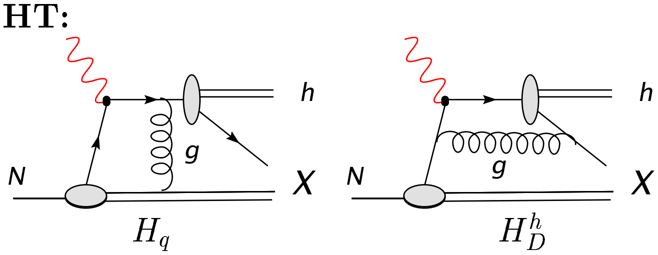
$$\Delta q \rightarrow \Delta q + \Delta H_q, \quad D_q^h \rightarrow D_q^h + H_{D_q}^h$$

- $\Delta H_q(x)$ & $H_D^h(z)$ = small corrs. to pQCD

LT:



HT:



HT in $\sigma_N^{\pi^+-\pi^-}$

,

first step: we suggest $\Delta H_q = \Delta H_q^{DIS}$

Recall DIS:

$$
\begin{aligned}
g_1^p &= g_1^p(pQCD) + \Delta H_p^{DIS} \\
g_1^n &= g_1^n(pQCD) + \Delta H_n^{DIS}
\end{aligned}
$$

where we define ΔH_q^{DIS} ($\Delta s \simeq 0$):

$$
\begin{aligned}
\Delta H_p^{DIS} &= 4\Delta H_u^{DIS} + \Delta H_d^{DIS} \\
\Delta H_n^{DIS} &= 4\Delta H_d^{DIS} + \Delta H_u^{DIS}
\end{aligned}
$$

$\Delta H_{p,n}^{DIS} =$ known, *Leader, Sidorov, Stamenov (2004)*

second step: $H_{D_u}^{\pi^+-\pi^-}$ = unknown, but the same in pol. and unpol. SIDIS and for p and n

$H_{D_u}^{\pi^+-\pi^-}$ from $e^+e^- \to \pi + X$?

Results:

LO:

$$
\begin{aligned}
\Delta\sigma_p^{\pi^+-\pi^-} &= (4\Delta u_V - \Delta d_V)(D_u + H_D)^{\pi^+-\pi^-} \\
&\quad + (4\Delta H_u^{DIS} - \Delta H_d^{DIS}) D_u^{\pi^+-\pi^-}
\end{aligned}
$$

$$
\sigma^{\pi^+-\pi^-} = (4u_V - d_V)(D_u + H_D) + (4H_u^{DIS} - H_d^{DIS})D_u
$$

- depends on $D_u^{\pi^+-\pi^-}$

NLO: $A_p^{\pi^+-\pi^-}, R_p^{\pi^+-\pi^-} \longrightarrow [D_u^{\pi^+-\pi^-} + H_D^{\pi^+-\pi^-}]$

CONCLUSIONS

We suggest a model independent approach to SIDIS
through the difference asymmetries
$A^{h-\bar{h}}$, $R^{h-\bar{h}}$ and $A^{h+\bar{h}}_{n-p}$

advantage : only measurable quantities are used
the price : precise measurements needed

• **SIDIS-$\pi^{\pm}$:** pol. and unpol. determine:
1) the valence quarks: Δu_V, Δd_V
2) SU(2) breaking for the pol. sea: $\Delta\bar{u} - \Delta\bar{d}$
3) $D_u^{\pi^+-\pi^-}$
$\longrightarrow$ LO & NLO
$\longrightarrow$ no assumptions about Δq_{sea}, ΔG and FFs
to be measured in JLab –

• tests for the reliability of LO – "passive" observable

• **SIDIS $K^{\pm}$:** $\Delta s - \Delta\bar{s} \neq 0$?

• break HTs into two indep. pieces:
$\Delta H_q \rightarrow \Delta H_q^{DIS}$; $\quad H_D^h$ = unknown