DIS 2001

Status of Spin Physics

$g_1(x, Q^2)$, $g_2(x, Q^2)$

$\downarrow$

$\Delta q(x, Q^2) \longrightarrow \Delta g(x, Q^2)$ (helicity)

L_q, L_g (orbital angular momentum)

$h_1(x, Q^2)$ (transversity)

$\hookrightarrow$ chiral-odd fragmentation f.

Azimuthal asymmetries ($\ell N^\uparrow \to \ell \pi X$)

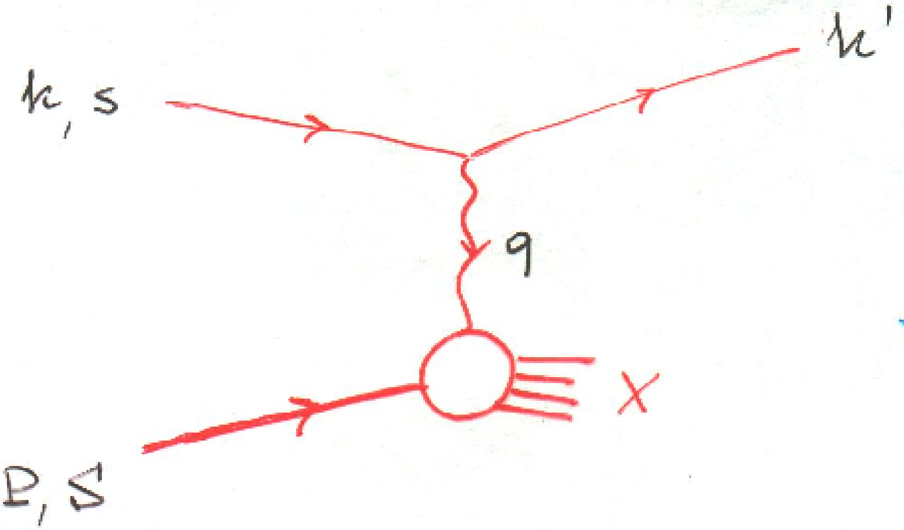
Λ polarization in DIS

$$\left.\begin{array}{l} g_1 \text{ and Bloom-Gilman duality} \\ F_2(Q^2)\, Q / F_1(Q^2) \end{array}\right\} \text{"small" } Q^2$$

e-Factory

Conclusions

Bologna, 27-4-01
M. ANSELMINO



$$-q^2 = Q^2$$

$$x = \frac{Q^2}{2P\cdot q}$$

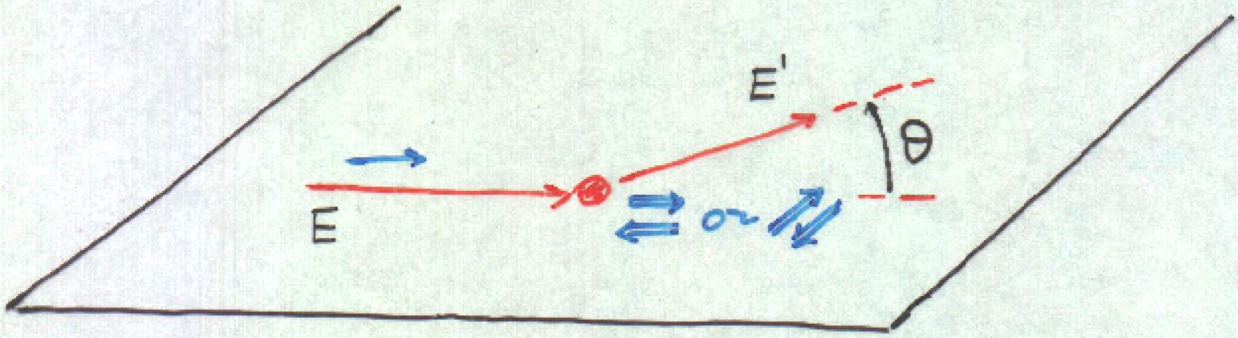
$$\frac{d\sigma}{d\Omega\, dE'} = \frac{\alpha^2}{2Mq^4}\,\frac{E'}{E}\,L_{\mu\nu}W^{\mu\nu}$$

$$L_{\mu\nu} = 2\left[k_\mu k'_\nu + k'_\mu k_\nu - g_{\mu\nu}(k\cdot k' - m^2)\right] + 2im\,\varepsilon_{\mu\nu\alpha\beta}\,s^\alpha (k-k')^\beta$$

$$W_{\mu\nu} = \left(-g_{\mu\nu} + \frac{q_\mu q_\nu}{q^2}\right)2F_1 + \left(P_\mu - \frac{P\cdot q}{q^2}q_\mu\right)\left(P_\nu - \frac{P\cdot q}{q^2}q_\nu\right)\frac{4x}{Q^2}F_2$$
$$+ 2i\frac{M}{P\cdot q}\,\varepsilon_{\mu\nu\alpha\beta}\,q^\alpha\left[S^\beta g_1 + \left(S^\beta - \frac{S\cdot q}{P\cdot q}P^\beta\right)g_2\right]$$

$\Rightarrow$ needs polarized lepton <u>and</u> nucleon to measure g_1, g_2

$-\ g_1(x, Q^2)$ and $g_2(x, Q^2)$



$$\frac{d\sigma^{\rightleftarrows}}{d\Omega\, dE'} - \frac{d\sigma^{\rightrightarrows}}{d\Omega\, dE'} = \frac{4\alpha^2 E'}{Q^2 E M \nu}\left[(E + E'\cos\vartheta)\, g_1 - 2Mx\, g_2\right]$$

$$\frac{d\sigma^{\rightarrow\Downarrow}}{d\Omega\, dE'} - \frac{d\sigma^{\rightarrow\Uparrow}}{d\Omega\, dE'} = \frac{4\alpha^2 E'^2}{Q^2 E M \nu}\sin\vartheta\left[g_1 + \frac{2E}{\nu}\, g_2\right]$$

$\nu = E - E' \qquad Q^2 = 4EE'\sin^2\frac{\vartheta}{2} \qquad x = \frac{Q^2}{2M\nu}$

Measure:

$$A_{\parallel} = \frac{d\sigma^{\rightleftarrows} - d\sigma^{\rightrightarrows}}{\underbrace{d\sigma^{\rightleftarrows} + d\sigma^{\rightrightarrows}}} \qquad A_{\perp} = \frac{d\sigma^{\rightarrow\Downarrow} - d\sigma^{\rightarrow\Uparrow}}{\underbrace{d\sigma^{\rightarrow\Downarrow} + d\sigma^{\rightarrow\Uparrow}}}$$

$= 2\, d\sigma^{unp}$

$$\frac{d\sigma^{unp}}{d\Omega\, dE'} = \frac{4\alpha^2 E'^2}{Q^4 M \nu}\left[2\nu F_1 \sin^2\frac{\vartheta}{2} + M F_2 \cos^2\frac{\vartheta}{2}\right]$$

$$A_{\parallel} = \frac{Q^2}{2EE'} \frac{(E+E'\cos\vartheta)\, g_1 - 2Mx\, g_2}{2\nu F_1 \sin^2\frac{\vartheta}{2} + M F_2 \cos^2\frac{\vartheta}{2}}$$

$$A_{\perp} = \frac{Q^2}{2E} \frac{g_1 + 2E/\nu\; g_2}{2\nu F_1 \sin^2\frac{\vartheta}{2} + M F_2 \cos^2\frac{\vartheta}{2}} \sin\vartheta$$

$$R = \frac{F_2}{2x F_1}\left(1 + \frac{4M^2x^2}{Q^2}\right) - 1$$

$\Longrightarrow$

$$g_1 = \frac{F_1}{D'}\left[A_{\parallel} + A_{\perp} \operatorname{tg}\frac{\vartheta}{2}\right]$$

$$g_2 = \frac{F_1}{D'} \frac{y}{2\sin\vartheta}\left(-A_{\parallel}\sin\vartheta + A_{\perp}\frac{E+E'\cos\vartheta}{E'}\right)$$

$$y' = \frac{\nu}{E} \qquad D' = \frac{(1-\varepsilon)(2-y)}{1+\varepsilon R}$$

$$\frac{1}{\varepsilon} = 1 + 2\left(1 + \frac{\nu^2}{Q^2}\right)\operatorname{tg}^2\frac{\vartheta}{2}$$

In QCD parton model (NLO)

$$g_1(x,Q^2) = \frac{1}{2}\sum_q e_q^2 \left\{ \Delta C_q \otimes \left[\Delta q + \Delta \bar{q}\right] + \frac{1}{N_f} \Delta C_g \otimes \Delta g \right\}$$

$$C \otimes q = \int_x^1 \frac{dy}{y} C(x,\alpha_s)\, q(y,Q^2)$$

Coefficient functions:

$$\Delta C_i(x,\alpha_s) = \Delta C_i^0(x) + \frac{\alpha_s(Q^2)}{2\pi} \Delta C_i^{(1)}(x) + \cdots$$

scheme dependent

LO: $\Delta C_q^0 = \delta(1-x) \quad [\Rightarrow \Delta C_q^0 \otimes \Delta q = \Delta q(x)]$

$\Delta C_g^0 = 0$ [no gluon contribution]

NLO($\overline{MS}$): $\int_0^1 \Delta C_g^{(1)} dx = 0 \qquad \int_0^1 \Delta C_q^{(1)} dx = -2$

$$\left[\Delta q(Q^2)_{\overline{MS}} = \Delta q_{AB} - \frac{\alpha_s(Q^2)}{4\pi} \Delta g(Q^2) \right]$$

$\Rightarrow$ NLO($\overline{MS}$)

$$\Gamma_1(Q^2) = \int_0^1 g_1(x,Q^2)\, dx$$

$$= \frac{1}{2}\sum_q e_q^2 \left[\Delta q(Q^2) + \Delta \bar{q}(Q^2)\right] \left(1 - \frac{\alpha_s(Q^2)}{\pi}\right)$$

Usual notations:

$$\Delta q_3 = \Delta u + \Delta \bar{u} - \Delta d - \Delta \bar{d}$$

$$\Delta q_8 = \Delta u + \Delta \bar{u} + \Delta d + \Delta \bar{d} - 2(\Delta s + \Delta \bar{s})$$

$$\Delta \Sigma = \sum_q [\Delta q + \Delta \bar{q}] = \Delta q_8 + 3(\Delta s + \Delta \bar{s})$$

$$\Delta q_{NS} = \Delta u + \Delta \bar{u} - \frac{1}{2}(\Delta d + \Delta \bar{d}) - \frac{1}{2}(\Delta s + \Delta \bar{s})$$

$$\Gamma_1^{p,n} = \left[\pm \frac{1}{12} \Delta q_3 + \frac{1}{36} \Delta q_8 + \frac{1}{9} \Delta \Sigma\right]\left(1 - \frac{\alpha_s}{\pi}\right)$$

Δq_3 and Δq_8 from $SU(3)_F$ hyperon β-decays

$$\Delta q_3 = F + D = 1.2670 \pm 0.0035$$

$$\Delta q_8 = 3F - D = 0.58 \pm 0.15$$

$$[\langle PS | \bar{q} \gamma^\mu \gamma_5 q | PS \rangle = \Delta q \, S^\mu]$$

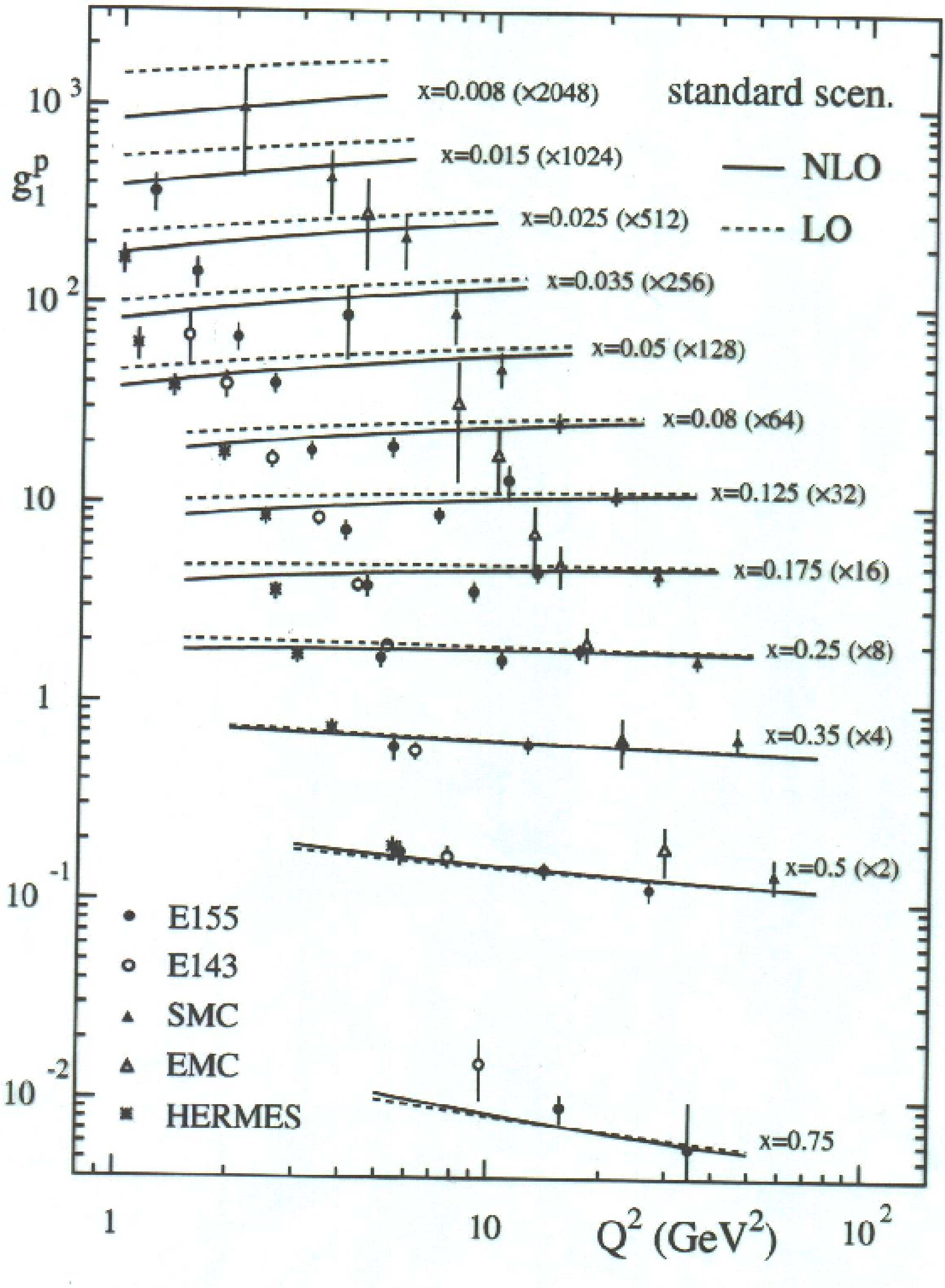
QCD evolution of Δq well known

$$\frac{d}{d \ln Q^2} \Delta q_{NS}(x, Q^2) = \frac{\alpha_s}{2\pi} \Delta P_{qq}^{NS} \otimes \Delta q_{NS}$$

$$\frac{d}{d \ln Q^2} \begin{pmatrix} \Delta \Sigma \\ \Delta g \end{pmatrix} = \frac{\alpha_s}{2\pi} \begin{pmatrix} \Delta P_{qq} & \Delta P_{qg} \\ \Delta P_{gq} & \Delta P_{gg} \end{pmatrix} \otimes \begin{pmatrix} \Delta \Sigma \\ \Delta g \end{pmatrix}$$

Glück, Reya, Stratmann, Vogelsang

$\Delta\bar{u} = \Delta u_{sea} = \Delta\bar{d} = \Delta\bar{d}_{sea} = \Delta s = \Delta\bar{s} = \Delta\bar{q}(x, Q^2)$

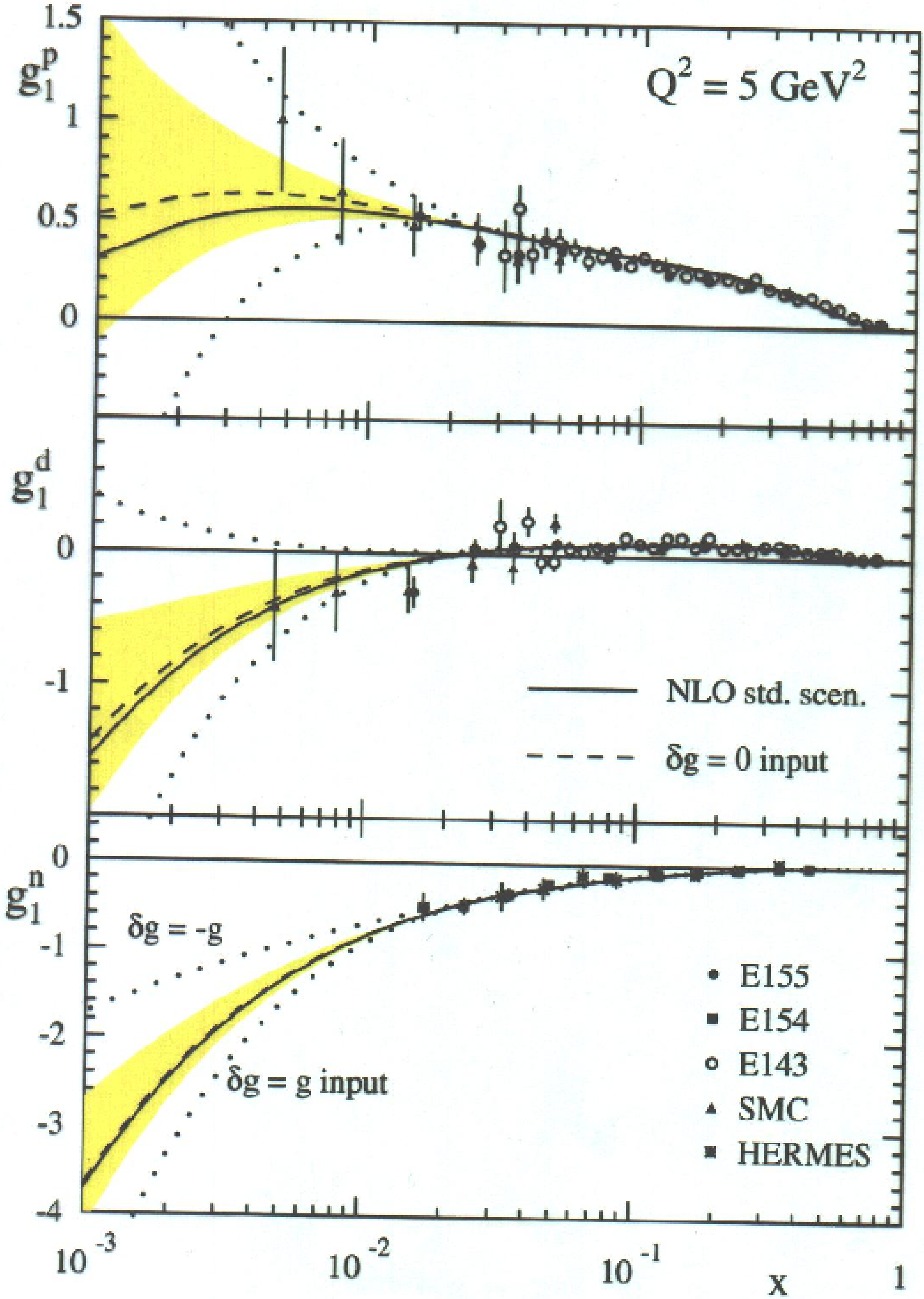


First moments: $\Delta u = 0.86$ $\Delta d = -0.41$

$\Delta \bar{q} = -0.06$ $\Delta g = 0.71$

$\Delta \Sigma = 0.197$

Shaded areas: $-0.81 \leq \Delta g \leq 1.73$



Direct measurement of $\Delta g(x, Q^2)$ needed

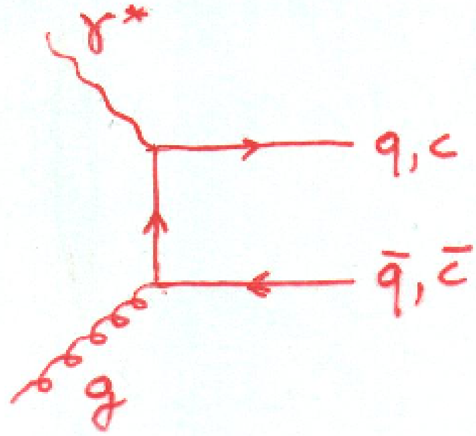
Look for processes involving <u>polarized gluons</u>

$\vec{\ell}\,\vec{N} \to \ell + 2\text{ jets}$

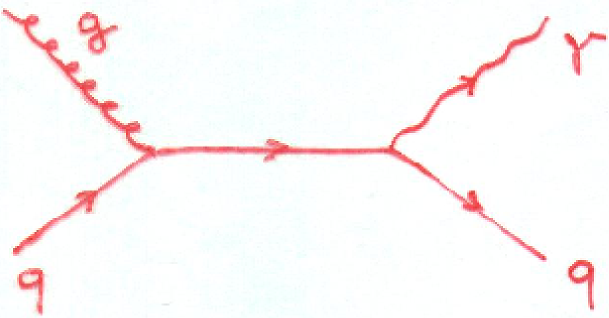
$\vec{\ell}\,\vec{N} \to \ell + h_1 + h_2 + X$

$\vec{\ell}\,\vec{N} \to \ell + c + \bar{c} + X$

(h_1, h_2 = large p_T h's)

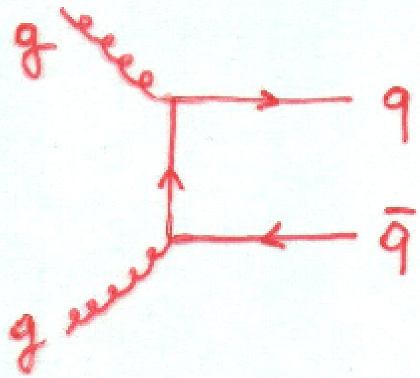


$\vec{p}\,\vec{N} \to \gamma X$



$\vec{p}\,\vec{N} \to 2\text{ jets} + X$

$\vec{p}\,\vec{N} \to h_1 + h_2 + X$



HERMES, COMPASS, RHIC

+ proposed new experiments

(HERA-$\vec{N}$, TESLA-$\vec{N}$, ELFE, EIC, ...)

$g_2(x, Q^2)$: no parton model interpretation

[higher-twist, $q\bar{q}g$ or ggg correlations]

$$g_2(x,Q^2) = \underbrace{-g_1(x,Q^2) + \int_x^1 \frac{dy}{y} g_1(y,Q^2)}_{g_2^{W-W} \ (\text{twist-2})} + g_2^{H-T}$$

New results (Braun, Korchemsky, Manashov)

$$g_2^{LL}(x,Q^2) = g_2^{W-W}(x,Q^2) + \frac{1}{2}\sum_q e_q^2 \int_x^1 \frac{dy}{y} \Delta q_T^+(y,Q^2)$$

Δq_T^+ and Δg_T (~ projections of $q\bar{q}g$ and ggg operators) have known 2-channel DGLAP-like Q^2 evolution

$$\int_0^1 g_2^{LL}(x,Q^2)\,dx = 0$$

[Burkhardt-Cottingham sum rule]

SLAC data

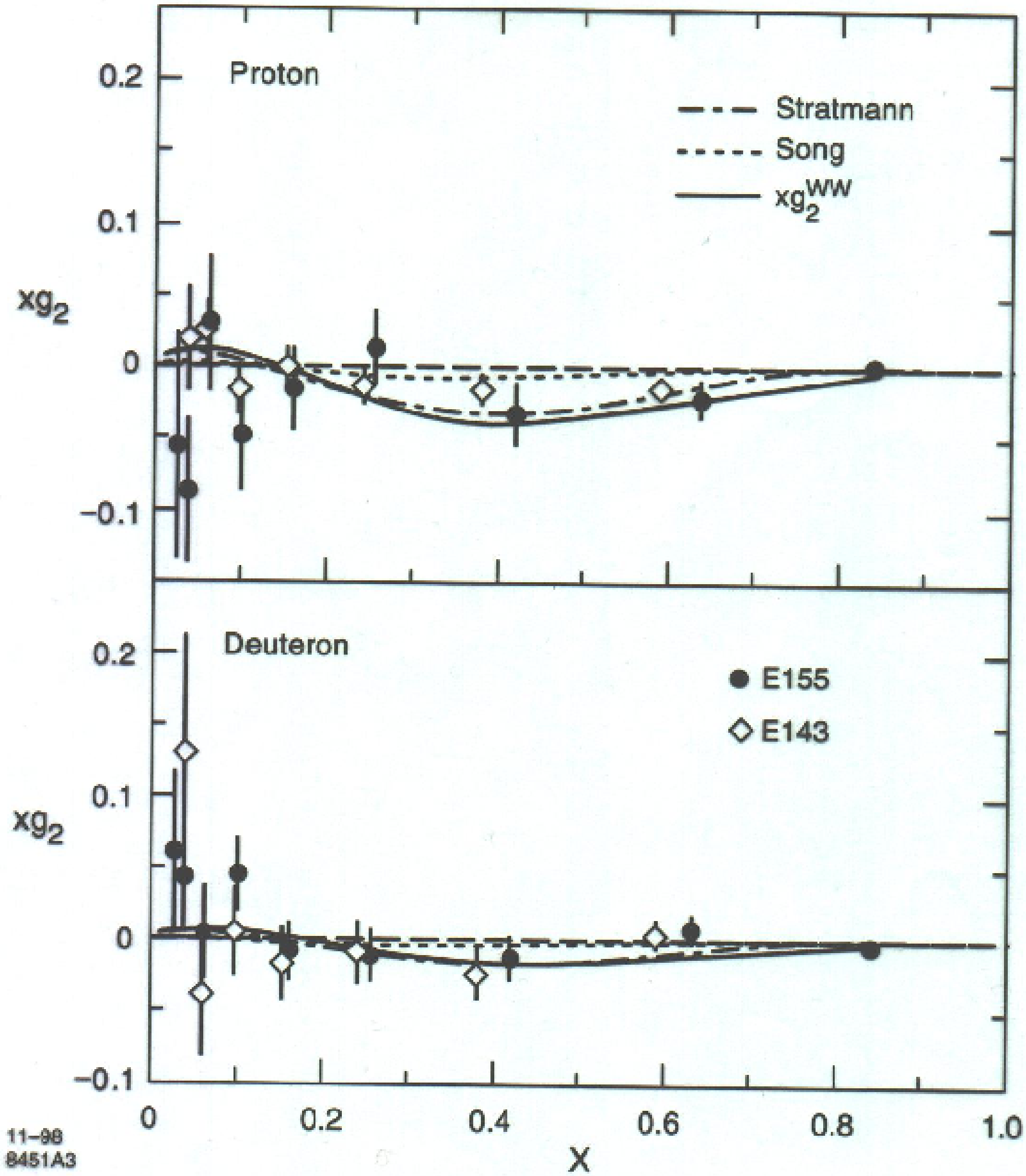
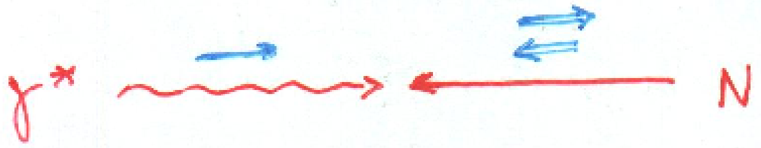


Figure 3: The structure function xg_2 for all spectrometers combined and data from E143[7]. The errors are statistical; the systematic errors are negligible. Also shown is our twist-2 g_2^{WW} at the average Q^2 of this experiment at each value of x and the calculations of Stratmann [23] and Song [12].

Flavour decomposition in SIDIS

Measure the γ^*-N asymmetry ($\vec{\ell}\vec{N} \to \ell h X$)



$$A_1^h = \frac{d\sigma^{\rightleftarrows} - d\sigma^{\rightrightarrows}}{d\sigma^{\rightleftarrows} + d\sigma^{\rightrightarrows}} = \frac{A_{\parallel}^h}{D} + O\left(\frac{Mx}{\sqrt{Q^2}}\right)$$

$$D = \frac{E - \varepsilon E'}{E(1+\varepsilon R)}$$

In inclusive DIS ($A_1 \simeq g_1/F_1$)

$$A_1(x,Q^2) = \frac{\sum_q e_q^2 [\Delta q(x,Q^2) + \Delta\bar{q}(x,Q^2)]}{\sum_q e_q^2 [q(x,Q^2) + \bar{q}(x,Q^2)]} [1 + R(x,Q^2)]$$

in SIDIS

$$A_1^h(x,Q^2) = \frac{\sum_q e_q^2 [\Delta q \, D_q^h + \Delta\bar{q} \, D_{\bar{q}}^h]}{\sum_q e_q^2 [q \, D_q^h + \bar{q} \, D_{\bar{q}}^h]} [1 + R]$$

$$A_1^h(x) = \sum_{i=f,\bar{f}} \underbrace{P_i^h(x)}_{\text{purities}} \frac{\Delta q_i(x)}{q_i(x)} [1+R]$$

$$P_i^h(x) = \frac{e_i^2\, q_i(x) \int D_{q_i}^h(z)\, dz}{\sum_{i'} e_{i'}^2\, q_{i'}(x) \int D_{q_{i'}}^h(z)\, dz}$$

- Assumptions on $\Delta\bar{u}, \Delta u_s, \Delta\bar{d}, \Delta d_s, \Delta s, \Delta\bar{s}$ (SU(3) symmetry of polarised sea)

- Measurements of $\left(A_1^{\pi, K, p \ldots}\right)_{p,n}$

- Flavour decomposition natural in $\nu N \to \ell X$ processes (ν-factory)

- Parity violating single-spin asymmetries at RHIC $[p^\pm p \to \ell \nu X,\ \ W \to \ell \nu]$

$$A_L^{W^+} = \frac{d\sigma^+ - d\sigma^-}{d\sigma^+ + d\sigma^-} = \frac{\Delta u(x_1)\, \bar{d}(x_2) - \Delta\bar{d}(x_1)\, u(x_2)}{u(x_1)\, \bar{d}(x_2) + \bar{d}(x_1)\, u(x_2)}$$

HERMES Coll.
hep-ex/9906035 V2

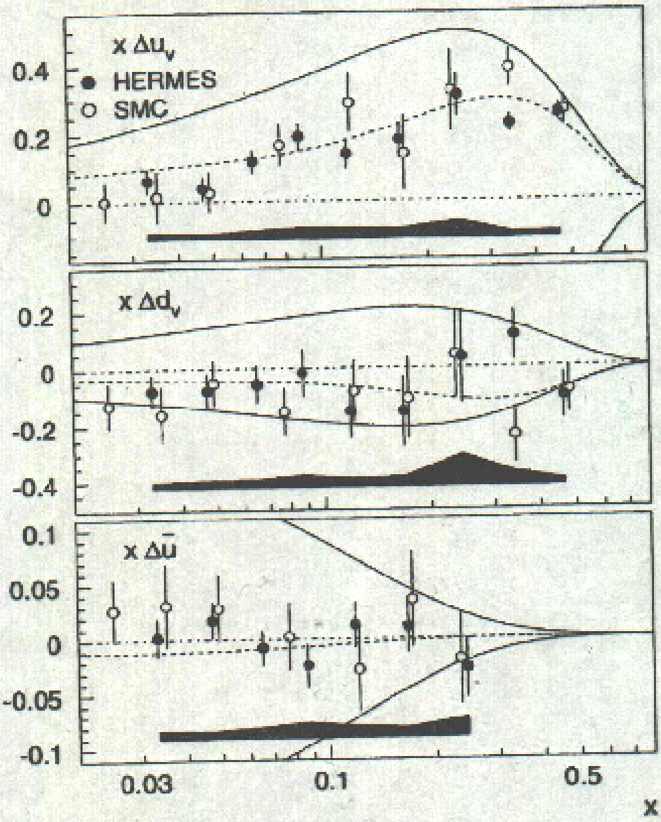


FIG. 4. The spin distributions at $Q^2 = 2.5$ GeV^2 separately for the valence quarks $x\Delta u_v(x)$, $x\Delta d_v(x)$ and the sea quarks $x\Delta\bar{u}(x)$ as a function of x. The error bars shown are the statistical and the bands the systematic uncertainties. The distributions are compared to results from SMC, extrapolated to $Q^2 = 2.5$ GeV^2. The error bars of the SMC result correspond to its total uncertainty. The solid lines indicate the positivity limit and the dashed lines are the parametrization from Gehrmann and Stirling ('Gluon A', LO) [46].

Orbital angular momentum

$$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + \Delta g + ??$$ (R. Jaffe)

$$\Delta\Sigma(Q^2) = \sum_q \left[\Delta q(Q^2) + \Delta\bar{q}(Q^2)\right]$$

$$\langle PS|\bar{q}\gamma^\mu\gamma_5 q|PS\rangle \frac{1}{S^\mu} \equiv \Delta q(Q^2)$$

$$= \int_0^1 dx \left[q_+(x,Q^2) + \bar{q}_+(x,Q^2) - q_-(x,Q^2) - \bar{q}_-(x,Q^2)\right]$$

Ideally:

$$\frac{1}{2} = L_q + \frac{1}{2}\Delta\Sigma + L_g + \Delta g = J_q + J_g$$

$$= \int_0^1 dx \left[L_q(x,Q^2) + \frac{1}{2}\Delta\Sigma(x,Q^2) + L_g(x,Q^2) + \Delta g(x,Q^2)\right]$$

L_q, L_g: gauge invariant, interaction independent, measurable, related to parton distrib.

$$J^i = \frac{1}{2}\varepsilon^{ijk}\int d^3x\, M^{0jk}$$ ← ang. mom. density

$$M^{\alpha\mu\nu} = T^{\alpha\nu}x^\mu - T^{\alpha\mu}x^\nu$$

Two ways: $J^3 = \int d^3x\, M^{012}$ or $\int d^3x\, M^{+12}$

$$M^{012} = \left\{ \frac{i}{2} q^\dagger (\vec{x} \times \vec{D}) q + \frac{1}{2} q^\dagger \vec{\sigma} q + 2 T_r E^j (\vec{x} \times \vec{D}) A^j + T_r (\vec{E} \times \vec{A}) \right\}_3$$

$\Longrightarrow$

$$\frac{1}{2} = \hat{L}_q + \frac{1}{2} \Delta\Sigma + \hat{L}_g + \Delta \hat{g}$$

with $\hat{L}_q$ measurable from DVCS and SPD

<u>However</u>: $\hat{L}_q$, $\hat{L}_g$ and $\Delta\hat{g}$ are interaction dependent and have no parton representation

Taking M^{+12} in the $A^+ = 0$ gauge

$$D^+ = \partial^+ - ig A^+ \longrightarrow \partial^+$$

gives free field expressions, so that, taking matrix elements in a nucleon state at rest:

$$\frac{1}{2} = L_q + \frac{1}{2} \Delta\Sigma + L_g + \Delta g$$

$$= \int_0^1 dx \left\{ L_q(x, Q^2) + \frac{1}{2} \Delta\Sigma(x, Q^2) + L_g(x, Q^2) + \Delta g(x, Q^2) \right\}$$

<u>However</u>: no known way of measuring L_q, L_g

Transversity, h_1

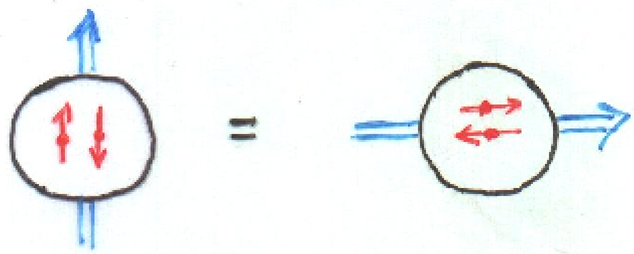
(D. Boer talk)

q, Δq and h_1 (or δq, $\Delta_T q$): fundamental leading-twist quark distributions

h_1 = quark transverse polarization in a transversely polarized nucleon

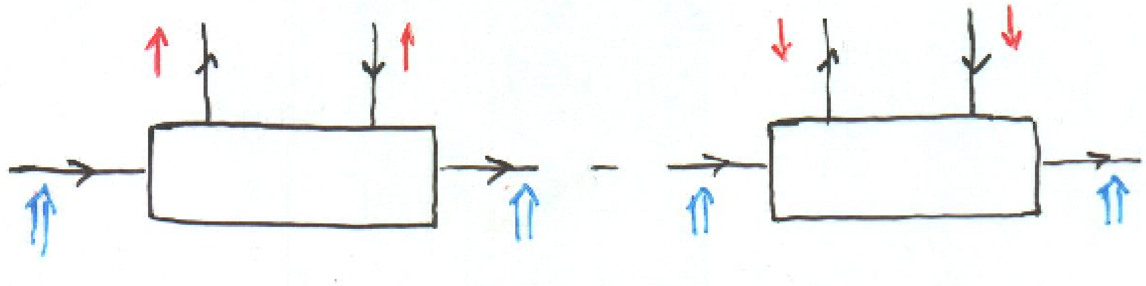
$\Delta q \sim \bar{q}\,\vec{\gamma}\,\gamma_5\, q$ (chiral-even)

$h_1 \sim \bar{q}\,\sigma^{0i}\gamma_5\, q$ (chiral-odd)

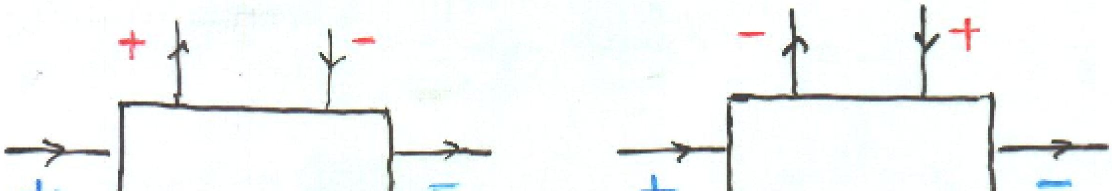


at rest only

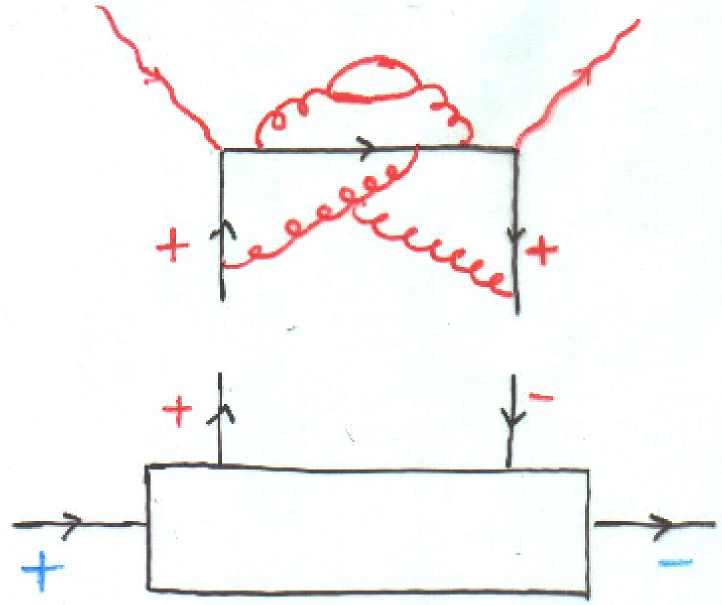
In inclusive DIS



$\Longrightarrow$ in hel. basis



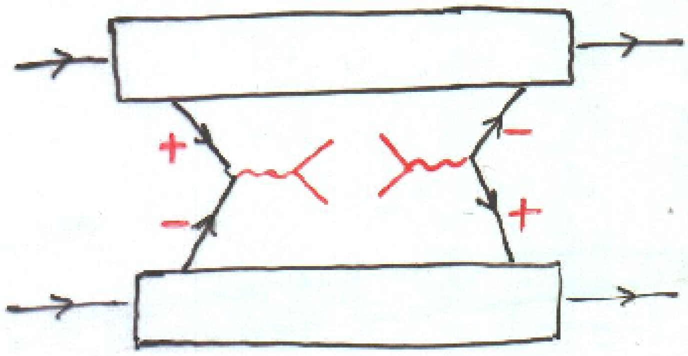
$\Longrightarrow$



h_1 decouples from QCD, SM dynamics

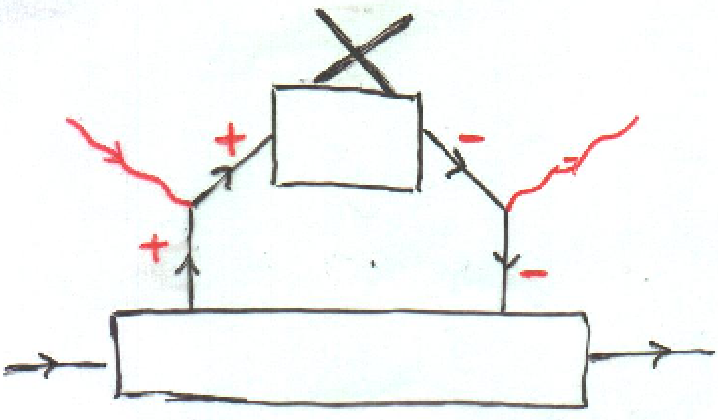
$\Rightarrow$ h_1 must couple to another chiral-odd function

Drell-Yan processes



$\sim h_1 \times h_1$

SIDIS

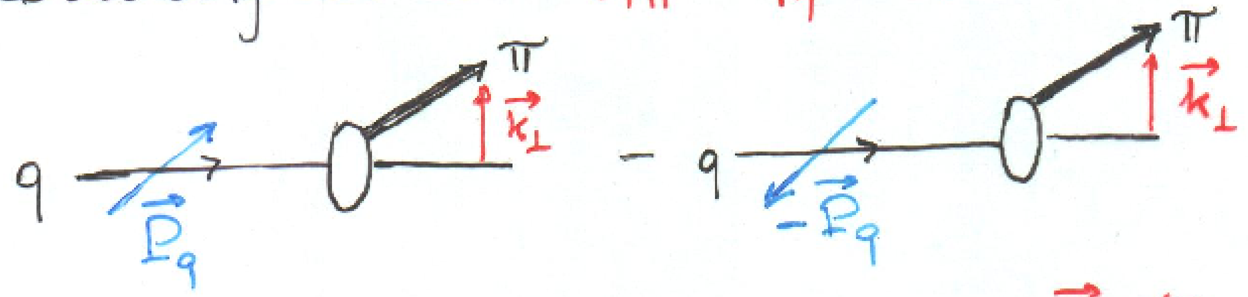


$\sim h_1 \times (\Delta D)_{c\text{-}o}$

New chiral-odd fragmentation functions

(filters to h_1)

Collins function $(\vec{p}_\pi = z\vec{p}_q + \vec{k}_\perp)$



$$D(\vec{p}_q, \vec{P}_q; z, \vec{k}_\perp) = D(z, k_\perp) + \frac{1}{2}\Delta^N D(z, k_\perp) \underbrace{\frac{\vec{P}_q \cdot (\vec{p}_q \times \vec{k}_\perp)}{|\vec{p}_q \times \vec{k}_\perp|}}_{\sin\phi_c}$$

$(\Delta^N D,\ H_1^T,\ c)$

$\Rightarrow$ azimuthal asymmetry in $\ell N^\uparrow \to \ell \pi X$

$$A_N^h = \frac{d\sigma(\vec{P}) - d\sigma(-\vec{P})}{d\sigma(\vec{P}) + d\sigma(-\vec{P})}$$

($\vec{P}$ = transv. nucleon pol.)

$$= \frac{\sum_q e_q^2\, h_{1q}\, \Delta^N D_q^h}{\sum_q e_q^2\, q\, D_q^h}\ \overbrace{\frac{2(1-y)}{1+(1-y)^2}}^{D_{NN}}\ P \sin\phi_c \quad (+\text{H-T})$$

$\Rightarrow A_N^{\pi^+} \simeq A_N^{\pi^0}$; upper bound on $|h_{1q}| \leq \frac{1}{2}(q + \Delta q)$

$\Rightarrow$ lower bound on $|\Delta^N D / D|$

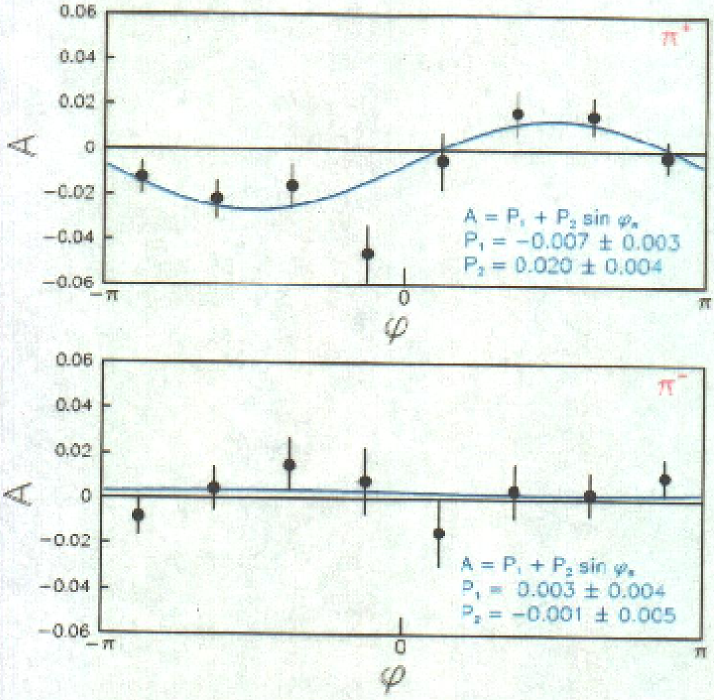


FIGURE 11. The Hermes azimuthal asymmetry.

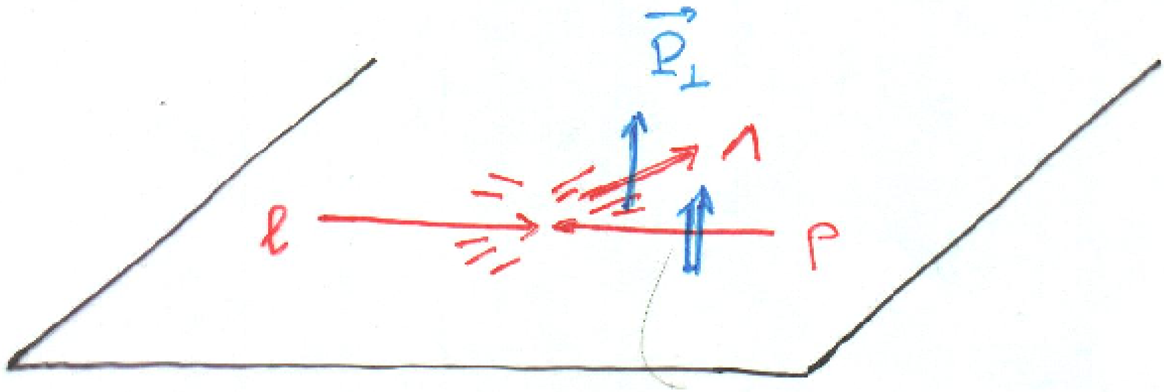
Talks by D. Hasch, K. Oganessyan

Transverse spin transfer in $q^\uparrow \to \Lambda^\uparrow$

$$\Delta_T D_q^\Lambda = H_1 = D_{q\uparrow}^{\Lambda\uparrow} - D_{q\downarrow}^{\Lambda\downarrow}$$

[analogue of h_1 for fragmentation]

$\Rightarrow$ measure transverse Λ polarization in $\ell N^\uparrow \to \ell \Lambda^\uparrow X$



$$P_\perp = \frac{\Sigma_q e_q^2 h_{1q}(x) \Delta_T D_q^\Lambda(z)}{\Sigma_q e_q^2 q(x) D_q^\Lambda(x)} \frac{2(1-y)}{1+(1-y)^2}$$

- h_1 can also be accessed via angular distribution of 2 pions in $\ell N^\uparrow \to \ell \pi\pi X$.

Λ polarization

$P(\Lambda)$ in

$$\ell N \to \ell \vec{\Lambda} X$$
$$\vec{\ell} N \to \ell \vec{\Lambda} X$$
$$\ell N \to \vec{\ell} \vec{\Lambda} X$$
$$\vec{\ell} N \to \vec{\ell} \vec{\Lambda} X$$

talks by
U. D'Alesio
O. Grebenyuk

(ℓ and N polarized or unpolarized)

$\Rightarrow$ test of known distribution function
" " elementary dynamics
new information on polarized f.f.

$P_\perp(\Lambda)$ in

$$\ell N \to \ell \Lambda^\uparrow X$$
$$p N \to \Lambda^\uparrow X$$

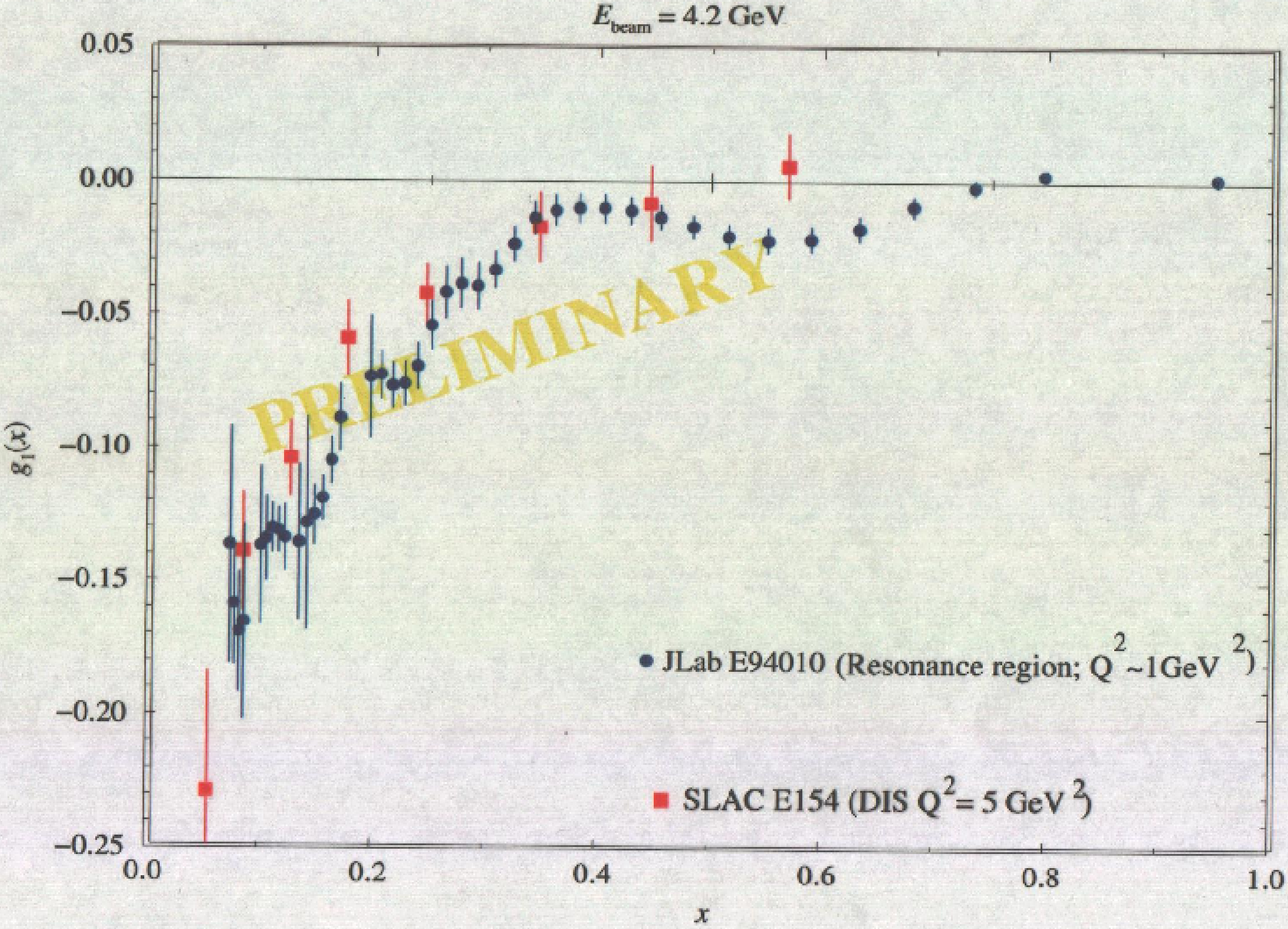
talk by
F. Murgia

(unpolarized ℓ and N)

$\Rightarrow$ New "polarizing fragmentation functions"

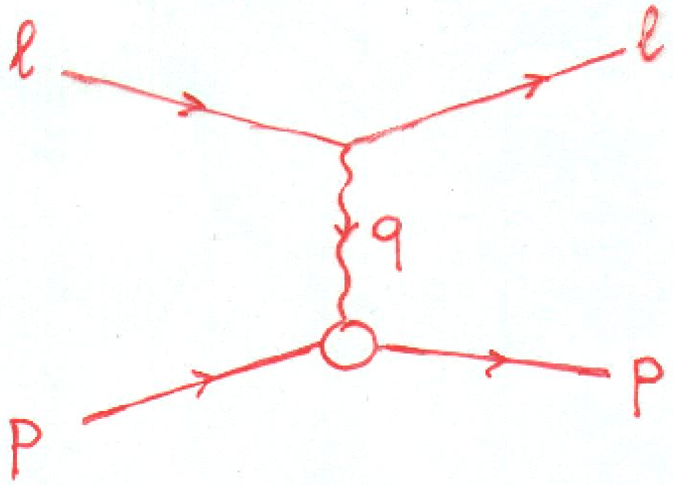
[M.A., D. Boer, U. D'Alesio, F. Murgia]

g_1 from JLab E94010



$g_1^n \rightarrow$ Talk
by W. Korsch

Proton elastic form factors



$$\Gamma^{\alpha}_{em} = F_1(q^2)\,\gamma^{\alpha} + \frac{\kappa}{2M} F_2(q^2)\, i\sigma^{\alpha\beta} q_{\beta}$$

$$G_E = F_1 + \frac{\kappa q^2}{4M^2} F_2 \qquad G_E(0) = 1$$

$$G_M = F_1 + \kappa F_2 \qquad G_M(0) = 1 + \kappa = \mu$$

Brodsky-Farrar, pQCD: $F_1 \sim \frac{1}{Q^4}$ $\quad F_2 \sim \frac{1}{Q^6}$
(at large Q^2)

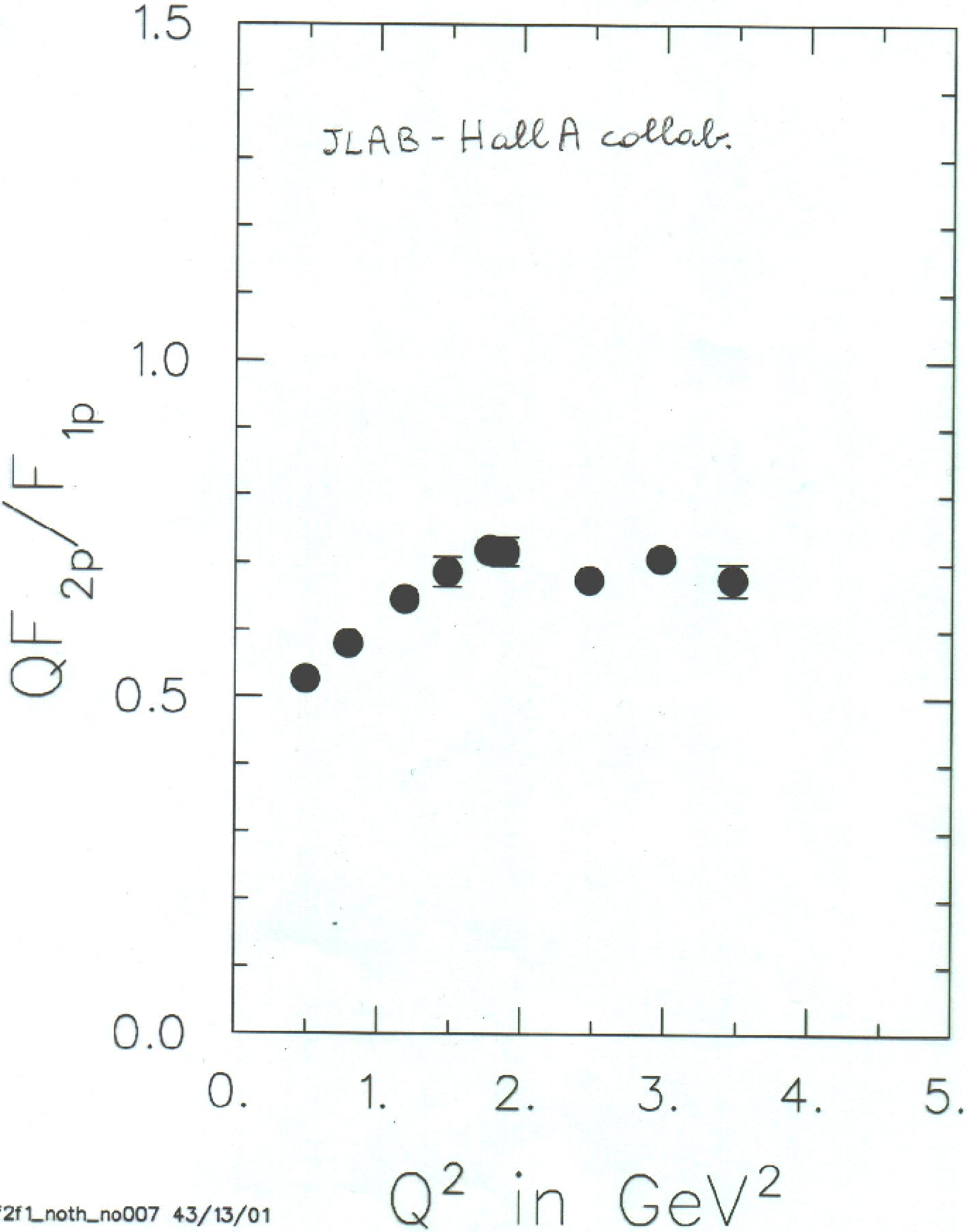
JLAB data: $Q F_2 \sim F_1$

F_2 associated with helicity flip
$\Rightarrow$ role of orbital angular momentum

If $|\psi_1| \sim |\psi_0| \Rightarrow Q F_2 \sim F_1$

[Talk by J. Ralston]

Preliminary data confirm the trend at higher Q^2



qf2f1_noth_no007 43/13/01

b - Factory (→ talk by J. Morfin)

Charged-current ($W^{\pm}$) DIS: access to new polarized structure functions (2 at L-T)

$$g_1^{W^+} = \Delta\bar{u} + \Delta d + \Delta\bar{c} + \Delta s$$

$$g_1^{W^-} = \Delta u + \Delta\bar{d} + \Delta c + \Delta\bar{s}$$

$$g_5^{W^+} = \Delta\bar{u} - \Delta d + \Delta\bar{c} - \Delta s$$

$$g_5^{W^-} = -\Delta u + \Delta\bar{d} - \Delta c + \Delta\bar{s}$$

[NLO study by S. Forte, M. Mangano, G. Ridolfi]

Special combinations:

$$\left(g_1^{W^+} - g_5^{W^+}\right)_{[n-p]} = 2\left(\Delta u - \Delta d\right)$$

$$\left(g_1^{W^-} + g_5^{W^-}\right)_{[n-p]} = 2\left(\Delta\bar{u} - \Delta\bar{d}\right)$$

$$\left(g_1^{W^-} - g_5^{W^-}\right)_{[p]} - \left(g_1^{W^+} - g_5^{W^+}\right)_{[n]} = 2\left(\Delta s - \Delta c\right)$$

$$\left(g_1^{W^-} + g_5^{W^-}\right)_{[p]} - \left(g_1^{W^+} + g_5^{W^+}\right)_{[n]} = 2\left(\Delta\bar{s} - \Delta\bar{c}\right)$$

$$\left(g_1^{W^+} - g_5^{W^+}\right)_{[p+n]} = 2\left(\Delta u + \Delta d + 2\Delta s\right)$$

$$\left(g_1^{W^-} + g_5^{W^-}\right)_{[p+n]} = 2\left(\Delta\bar{u} + \Delta\bar{d} + 2\Delta\bar{s}\right)$$

Recent and future results

Estimate of $\Delta g(x, Q^2)$ from QCD evolution

Measurement of $g_2(x, Q^2)$ [SLAC]

Fragmentation azimuthal asymmetry [HERMES]

Λ polarization in DIS [NOMAD, HERMES]

$QF_2(Q^2) / F_1(Q^2)$ [JLAB]

Theory and proposals of Δg measurements

Off-forward parton distributions [talk M. Diehl]

Theory and proposals of h_1 measurements

Phenomenology of new spin and $\vec{k}_\perp$ dependent distribution and fragmentation functions

Polarized structure functions of γ and γ^*

Direct measurement of $\Delta g(x, Q^2)$

First measurement of $h_1(x, Q^2)$

First measurement of polarized frag. f.

Flavour decomposition of spin distributions

$\Delta q(x, Q^2)$ at very large and small x

Higher-twists, exclusive reactions, transition from low to large Q^2, ...

Future machines ....