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(MAINZ)

DEEPLY VIRTUAL EXCLUSIVE SCATTERING & GENERALIZED PARTON DISTRIBUTIONS

OUTLINE

⇒ INTRODUCTION

WHAT ARE GPDs ?

WHAT IS THEIR 'NEW' PHYSICS CONTENT

⇒ MODELS / PARAMETRIZATIONS OF GPDs

⇒ DEEPLY VIRTUAL EXCLUSIVE SCATTERING PROCESSES

DEEPLY VIRTUAL COMPTON SCATTERING (DVCS)

DOUBLE DVCS

HARD ELECTROPRODUCTION OF MESONS

⇒ SUMMARY & OUTLOOK

(NON-FORWARD) DEEPLY VIRTUAL COMPTON SCATTERING (DVCS)

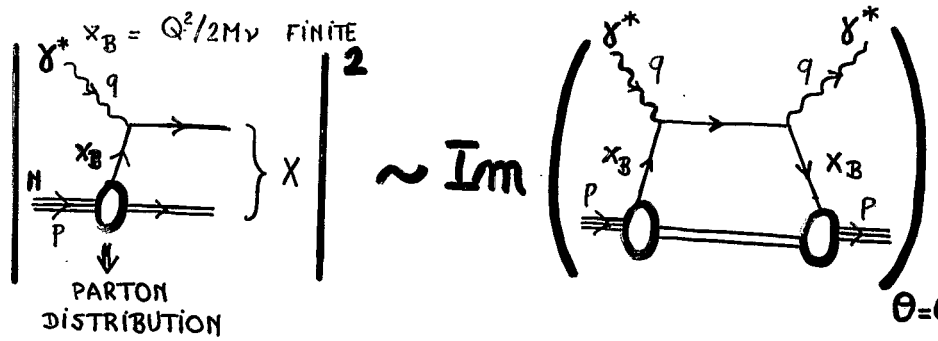
- **INCLUSIVE DIS $\longleftrightarrow$ FORWARD DVCS**

BJORKEN LIMIT

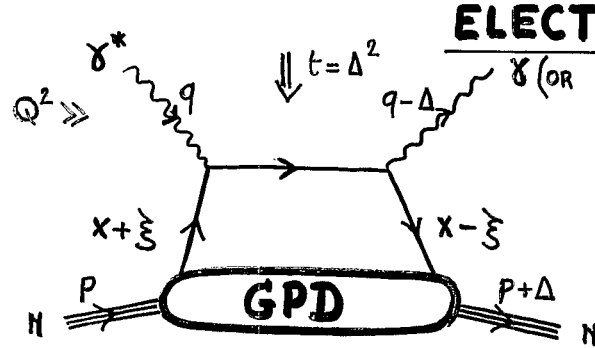
$Q^2 \gg$ HARD SCALE $\Rightarrow$ PQCD

$\nu \gg$

$x_B = Q^2/2M\nu$ FINITE



- **HARD EXCLUSIVE, NON-FORWARD ELECTROPRODUCTION**



Δ NON-ZERO BUT SMALL

$t \equiv \Delta^2 \quad (-t \lesssim 1\,\mathrm{GeV}^2)$

$$\mathrm{GPD}(x, \xi, t) \xrightarrow{Q^2 \gg} 4 \text{ LORENTZ} \begin{cases} H & (V) \\ E & (T) \\ \tilde{H} & (A) \\ \tilde{E} & (P) \end{cases}$$

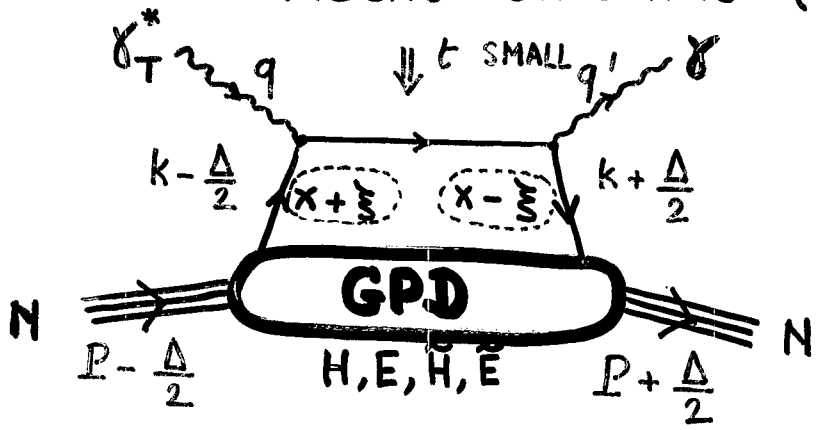
GENERALIZED PARTON DISTRIBUTION

DEEPLY VIRTUAL COMPTON SCATTERING

IN BJORKEN LIMIT ($Q^2 \gg$, $\nu_L \gg$, $x_B = \frac{Q^2}{2M\nu_L}$ FINITE)

$\Downarrow$

HANDBAG DIAGRAMS (VALENCE REGION)

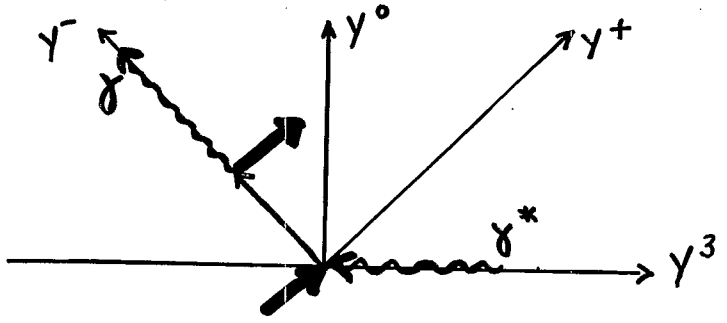


+ CROSSED DIAGRAM

$P \to$ LARGE P^+

$q \to$ LARGE q^-, q^+

$k^+ = x P^+$	$\Delta^+ = -2\xi P^+$	$\Delta^2 = t$



$$\xi = \frac{x_B/2}{1 - x_B/2}$$

$$P^\mu = P^+(1,0,0,1)$$

$$n^\mu = \frac{1}{2P^+}(1,0,0,-1)$$

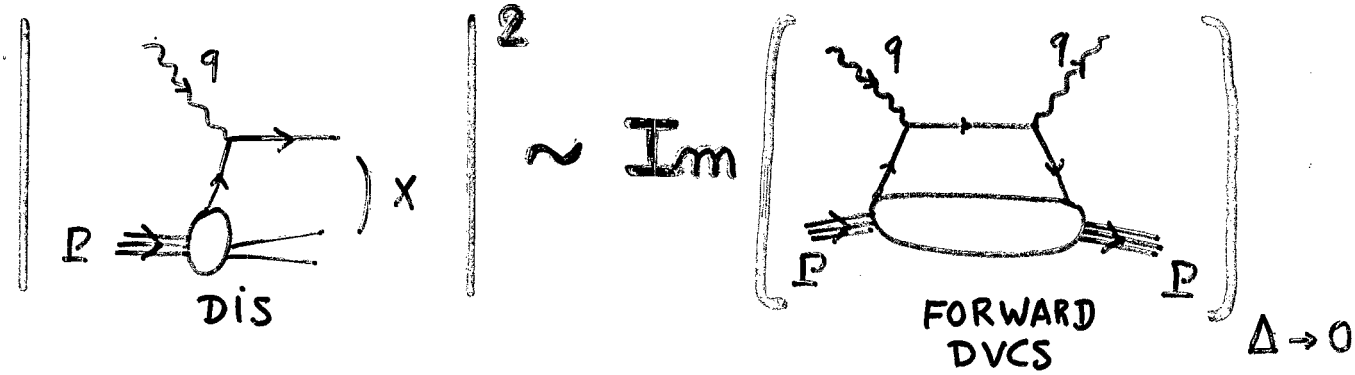
$$\frac{P^+}{2\pi}\int dy^- e^{ixP^+y^-} \langle P' | \bar{q}(-\tfrac{y}{2}) \not{n}\, q(\tfrac{y}{2}) | P \rangle_{\substack{y^+=0 \\ \bar{y}_\perp = 0}}$$

$$= \bar{N}(P')\left\{ H(x,\xi,t)\not{n} + E(x,\xi,t)\, i\sigma^{\nu\alpha}\frac{\Delta_\alpha}{2M} n_\nu \right\} N(P)$$

$$\frac{P^+}{2\pi}\int dy^- e^{ixP^+y^-} \langle P' | \bar{q}(-\tfrac{y}{2}) \not{n}\gamma_5\, q(\tfrac{y}{2}) | P \rangle_{y^+=0,\, \bar{y}_\perp=0}$$

$$= \bar{N}(P')\left\{ \tilde{H}(x,\xi,t)\not{n}\gamma_5 + \tilde{E}(x,\xi,t)\gamma_5 \frac{\Delta^\nu}{2M} n_\nu \right\} N(P)$$

- LINK BETWEEN GPD & 'ORDINARY' PARTON DISTRIBUTIONS

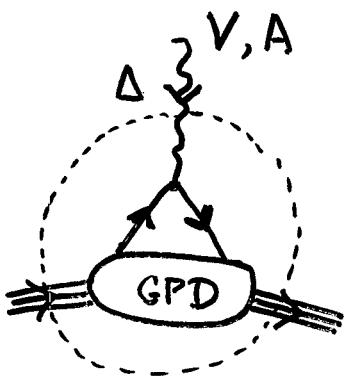


$$H(x, \xi=0, \Delta^2=0) = q(x) \quad \leftarrow \quad \text{QUARK DISTRIBUTION}$$

$$\tilde{H}(x, \xi=0, \Delta^2=0) = \Delta q(x) \quad \leftarrow \quad \text{QUARK HELICITY DISTR.}$$

! $E, \tilde{E}$ DO <u>NOT</u> APPEAR IN DIS $\Rightarrow$ NEW INFO !

- ELECTROWEAK FORM FACTOR SUM RULES



$$\int_{-1}^{1} dx\, \mathbf{H}(x, \xi, \Delta^2) = \mathbf{F_1}(\Delta^2)$$

$$\int_{-1}^{1} dx\, \mathbf{E}(x, \xi, \Delta^2) = \mathbf{F_2}(\Delta^2)$$

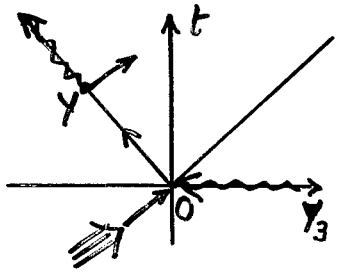
$$\int_{-1}^{1} dx\, \tilde{\mathbf{H}}(x, \xi, \Delta^2) = \mathbf{G_A}(\Delta^2)$$

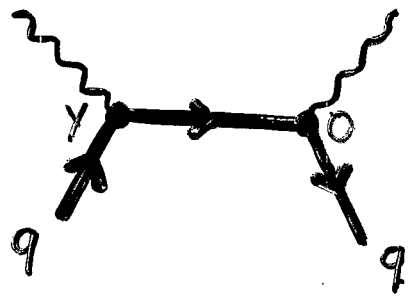
$$\int_{-1}^{1} dx\, \tilde{\mathbf{E}}(x, \xi, \Delta^2) = \mathbf{G_P}(\Delta^2)$$

π - POLE

ξ INDEPENDENCE (LORENTZ INV.)

HANDBAG (BILOCAL) OPERATOR PROVIDES NEW WAYS TO PROBE THE NUCLEON





"GENERALIZED" PROBE

$$\bar{q}(0)\left\{\begin{matrix}\gamma^\mu \\ \gamma^\mu\gamma_5\end{matrix}\right\} q(y)$$

$$\underset{y^-\simeq 0}{=} \bar{q}(0)\left\{\begin{matrix}\gamma^\mu \\ \gamma^\mu\gamma_5\end{matrix}\right\} q(0) + y^- \bar{q}(0)\left\{\begin{matrix}\gamma^\mu \\ \gamma^\mu\gamma_5\end{matrix}\right\} \partial^+ q(0) + \cdots$$

$(y^+=0, \bar{y}_\perp=0)$

$\Downarrow$ cfr. $\gamma, W^\pm, Z$ PROBE

$\Downarrow$ cfr. GRAVITON, PSEUDO-GRAVITON PROBE

$\langle N | \ldots | N \rangle$ $\Downarrow$ ELECTROWEAK FORM FACTORS

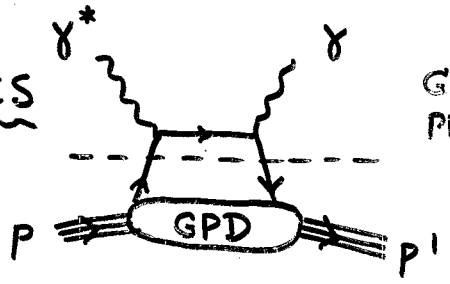
$\langle N | \ldots | N \rangle$ $\Downarrow$ ENERGY-MOMENTUM TENSOR FORM FACTORS

$\therefore$ HANDBAG OPERATOR MEASURES GENERALIZED FORM FACTORS

● MORE GENERAL SUM RULES / SPIN OF NUCLEON

(X. Ji)

⇒ DVCS

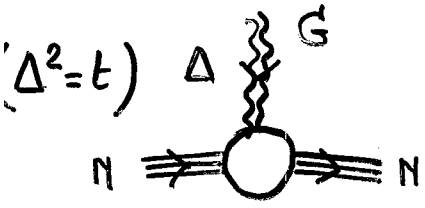


GENERAL PROBE

γ, W, Z PROBE ⇓

→ SPECIAL CASE $\int_{-1}^{1} dx\, GPD(x, \xi, t) = FF(t)$

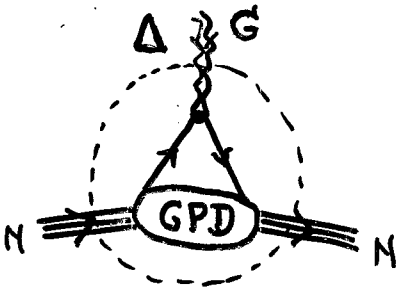
⇒ OTHER PROBE, e.g. NUCLEON IN EXTERNAL CLASSICAL GRAVITATIONAL FIELD



G COUPLES TO ENERGY-MOMENTUM TENSOR $T^{\mu\nu}$

$$\langle p' | T^{\mu\nu} | p \rangle \qquad P \equiv \tfrac{1}{2}(p + p')$$

$$= \bar{N}\Big\{ \underset{\text{"DIRAC"}}{A(t)}\, \gamma^{(\mu} P^{\nu)} + \underset{\text{"PAULI"}}{B(t)}\, P^{(\mu} i\sigma^{\nu)\alpha} \frac{\Delta_\alpha}{2M} + C(t)\left(\Delta^\mu \Delta^\nu - \Delta^2 g^{\mu\nu}\right)\frac{1}{M} \Big\} N$$



$$\int_{-1}^{1} dx\; x\; H(x, 0, t) = A(t)$$

(X. Ji)

$\xi = 0 \Rightarrow \Delta = \Delta_\perp$

$$\int_{-1}^{1} dx\; x\; E(x, 0, t) = B(t)$$

⇒ LINK WITH SPIN

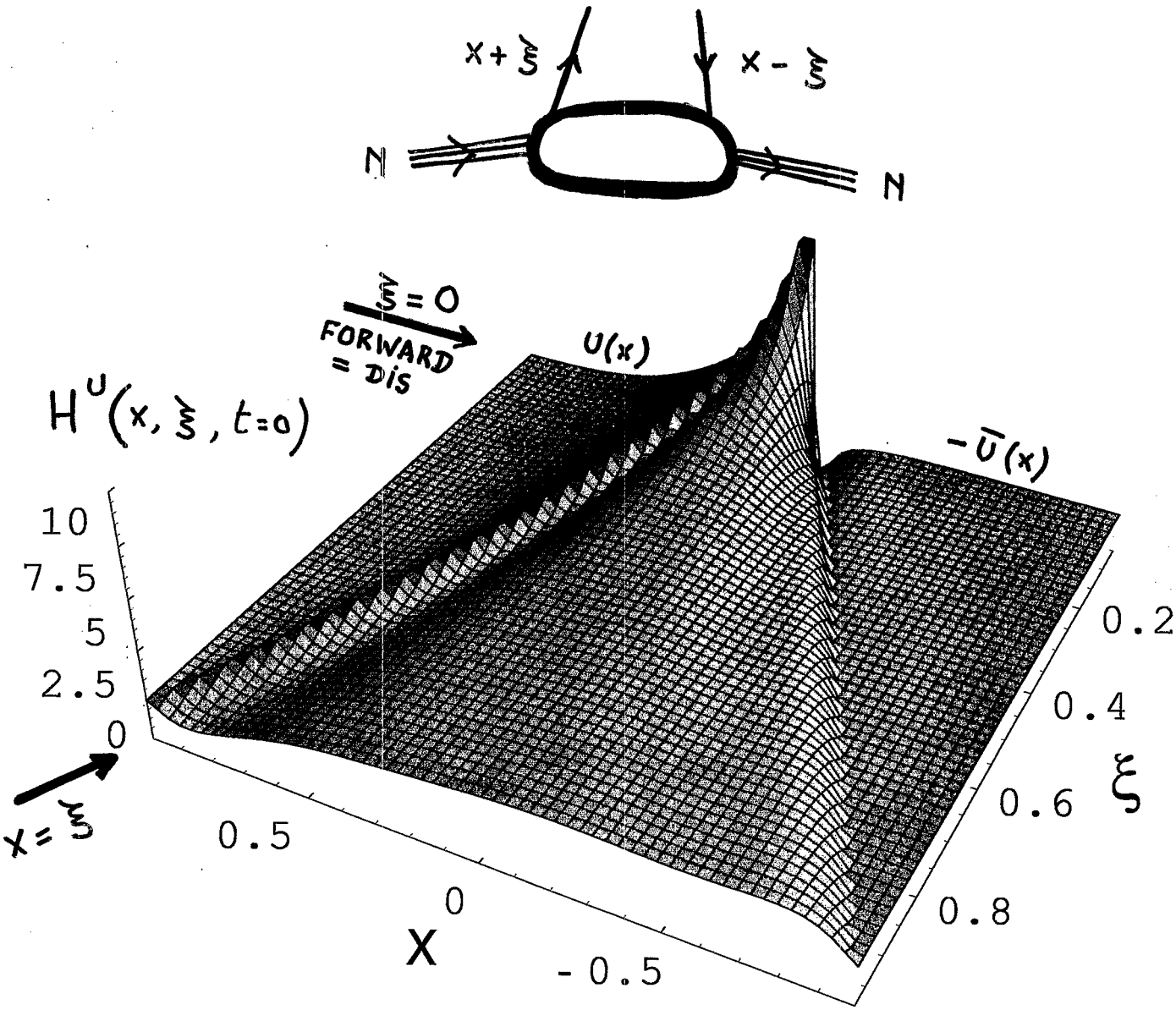
- GENERAL : TOTAL SYSTEM $\begin{cases} A(0) = 1 & \text{MOMENTUM CONS.} \\ B(0) = 0 & \text{ANGULAR MOM. CONS.} \end{cases}$

  TOTAL SPIN $J = \frac{1}{2}\left(A(0) + B(0)\right) = \frac{1}{2}$

- PHYSICAL INTERPRETATION IN TERMS OF QUARKS & GLUONS

$$J = J_q + J_g$$

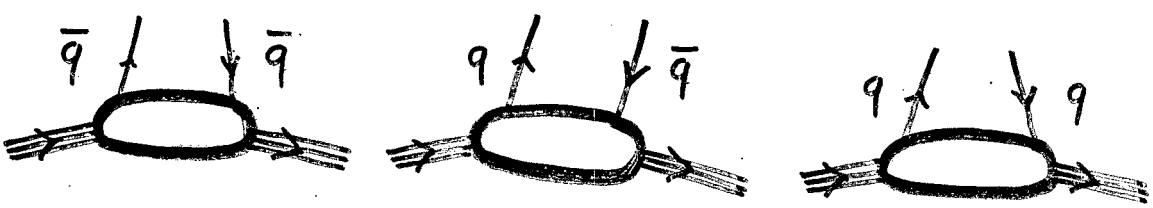
GENERALIZED PARTON DISTRIBUTION



$\bar{q}$ DISTRIBUTION FUNCTION

$q\bar{q}$ DISTRIBUTION AMPLITUDE

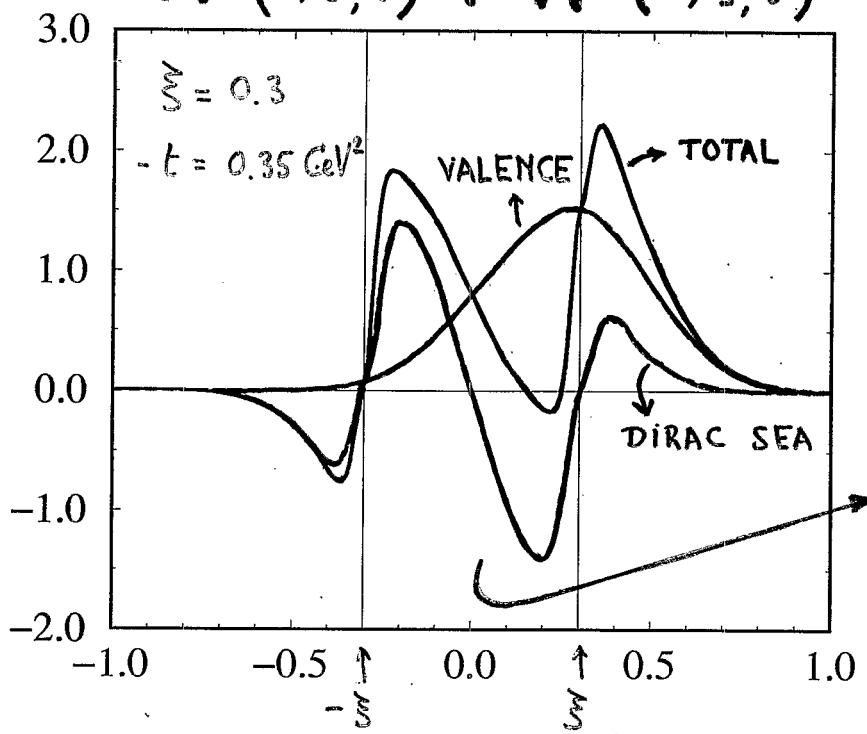
q DISTRIBUTION FUNCTION

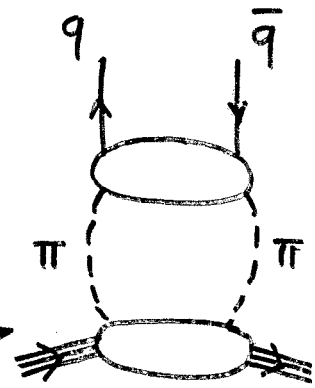


GPD calculation in the Chiral Quark Soliton Model

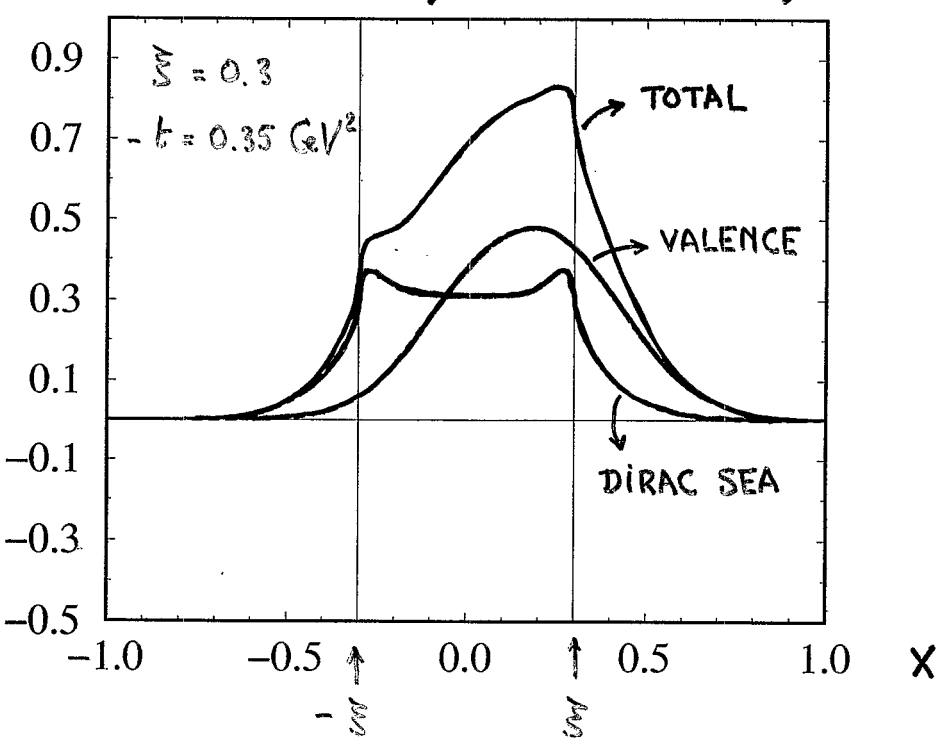
Petrov, Pobylitsa, Polyakov, Börnig, Goeke, Weiss (1998)

$N_c \gg$: ISOSINGLET $H^u(x,\xi,t) + H^d(x,\xi,t)$





$N_c \gg$: ISOVECTOR $E^u(x,\xi,t) - E^d(x,\xi,t)$



PARAMETRIZATION OF GPDs

II: POLYNOMIAL CONDITION, D-TERM

(JI, MELNITCHOUK, SONG / M. POLYAKOV, C. WEISS)

- POLYNOMIAL CONDITION

x^N MOMENT OF GPD

e.g. $N = 1$

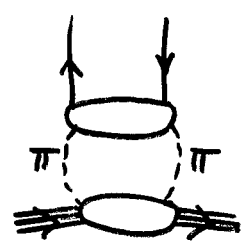
$$\int_{-1}^{1} dx \; x \, H^q(x, \xi, t) = A(t) \; + 4\xi^2 \, C(t)$$

$$\int_{-1}^{1} dx \; x \, E^q(x, \xi, t) = B(t) \; - 4\xi^2 \, C(t)$$

DOUBLE DISTRIBUTION | 'D-TERM' (POLYAKOV-WEISS)

$$J_q = \frac{1}{2}\left\{ A(0) + B(0) \right\}$$

(X. JI)



$I = J = 0$

- CONSISTENT PARAMETRIZATION OF GPD H, E

$$H^q(x, \xi, t) = H^q_{DD}(x, \xi, t) + \frac{1}{N_f} D\left(\frac{x}{\xi}, t\right)$$

$$E^q(x, \xi, t) = E^q_{DD}(x, \xi, t) - \frac{1}{N_f} D\left(\frac{x}{\xi}, t\right)$$

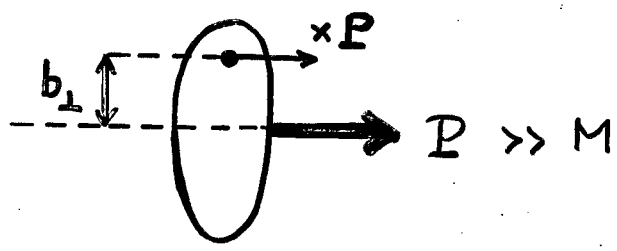
$\Uparrow$ DOUBLE DISTR. $\qquad$ $\Uparrow$ D-TERM

t - DEPENDENCE OF GPDs: GEOMETRIC INTERPRETATION

(M. BURKARDT)

$$\Rightarrow \quad H(x, \xi = 0, \underline{t = -\bar{\Delta}_\perp^2})$$

INFINITE MOMENTUM FRAME



$$\boxed{H(x, 0, -\bar{\Delta}_\perp^2) = \int d^2\bar{b}_\perp \, e^{-i\bar{\Delta}_\perp \cdot \bar{b}_\perp} \, q(x, b_\perp)}$$

$q(x, b_\perp)$ PROBABILITY DENSITY TO FIND QUARK WITH

$$\boxed{q(x) = \int d^2\bar{b}_\perp \, q(x, \bar{b}_\perp)}$$

→ MOMENTUM FRACTION x

→ AT $\perp$ DISTANCE $b_\perp$ FROM $\perp$ CM

" TRANSVERSE PROFILE "

- GEOMETRIC INTERPRETATION IN IMF NOT SPOILED BY RELATIVISTIC CORRECTIONS
- DENSITY → POSITIVITY $q(x, b_\perp) > 0$ → CONSTRAINT ON MODELS

LINK OF GPDs TO F.F.

$F_1^q(t) = \int_{-1}^{1} dx \; H^q(x,\xi,t)$	$F_2^q(t) = \int_{-1}^{1} dx \; E^q(x,\xi,t)$

→ TAKE $\xi = 0$

→ $$F_1^q(t) = \int_0^1 dx \; \left\{ H^q(x,0,t) - H^{\bar{q}}(x,0,t) \right\}$$

∴ MODEL $H^q(x,0,t)$, $E^q(x,0,t)$

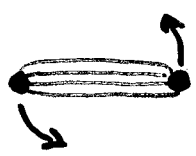
✱ SMALL $-t$ ($< 1\,\mathrm{GeV}^2$) : REGGE FORM

GOEKE, POLYAKOV, VDH ('01)

- $t=0$: $$H^q(x,0,0) = q(x) \underset{x\to 0}{\sim} \frac{1}{x^{\alpha(0)}}$$

$$H^q(x,0,0) - H^{\bar{q}}(x,0,0) = q_v(x) \sim \frac{1}{x^{0.5}}$$

- $t \neq 0$: $$H^q(x,0,t) - H^{\bar{q}}(x,0,t) \sim \frac{1}{x^{\alpha(t)}}$$



$\alpha(t) = \alpha(0) + \alpha' t$: REGGE TRAJ. $\alpha' \simeq 0.9\,\mathrm{GeV}^{-2}$

→ $$\boxed{H^q(x,0,t) - H^{\bar{q}}(x,0,t) = q_v(x) \cdot \frac{1}{x^{\alpha' t}}}$$

- $$\boxed{F_1^q(t) = \int_0^1 dx \; q_v(x) \frac{1}{x^{\alpha_1' t}}} \qquad \boxed{F_2^q(t) = \int_0^1 dx \; K^q q_v(x) \frac{1}{x^{\alpha_2' t}}}$$

⇒ 2 PARAMETERS

PROTON and NEUTRON electric charge radii

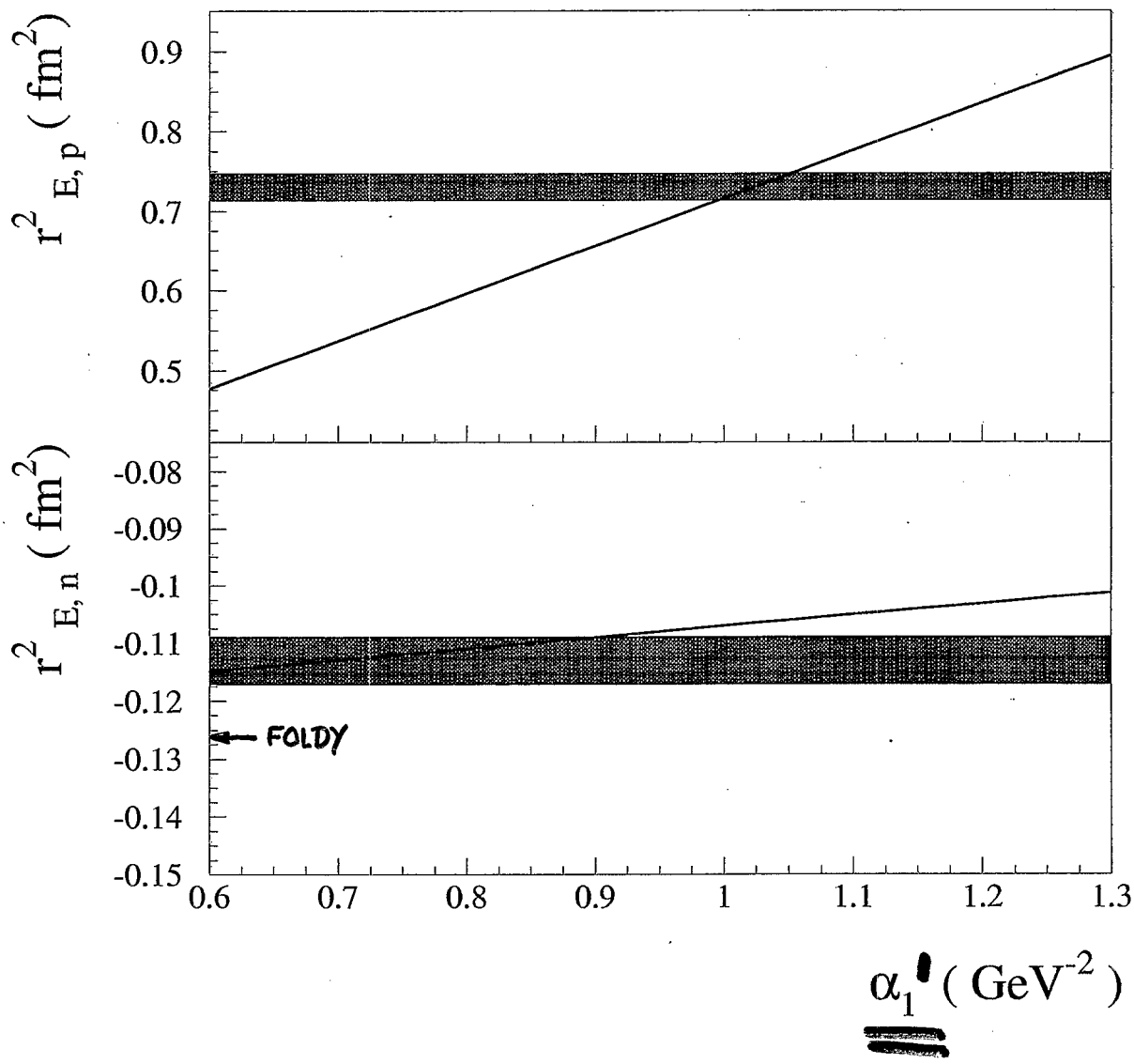
$$F_1^q(t) = \int_0^1 dx \; q_v(x) \; \frac{1}{x^{\alpha' t}}$$

$q_v(x)$ FROM MRST 01

$$r^2_{1,p} = -6\,\alpha_1' \int_0^1 dx \, \ln x \left\{ e_u \, u_v + e_d \, d_v \right\}$$

$u_v \leftrightarrow d_v$ FOR n

$$r^2_{E,N} = r^2_{1,N} + \frac{3}{2} K_N / M_N^2$$

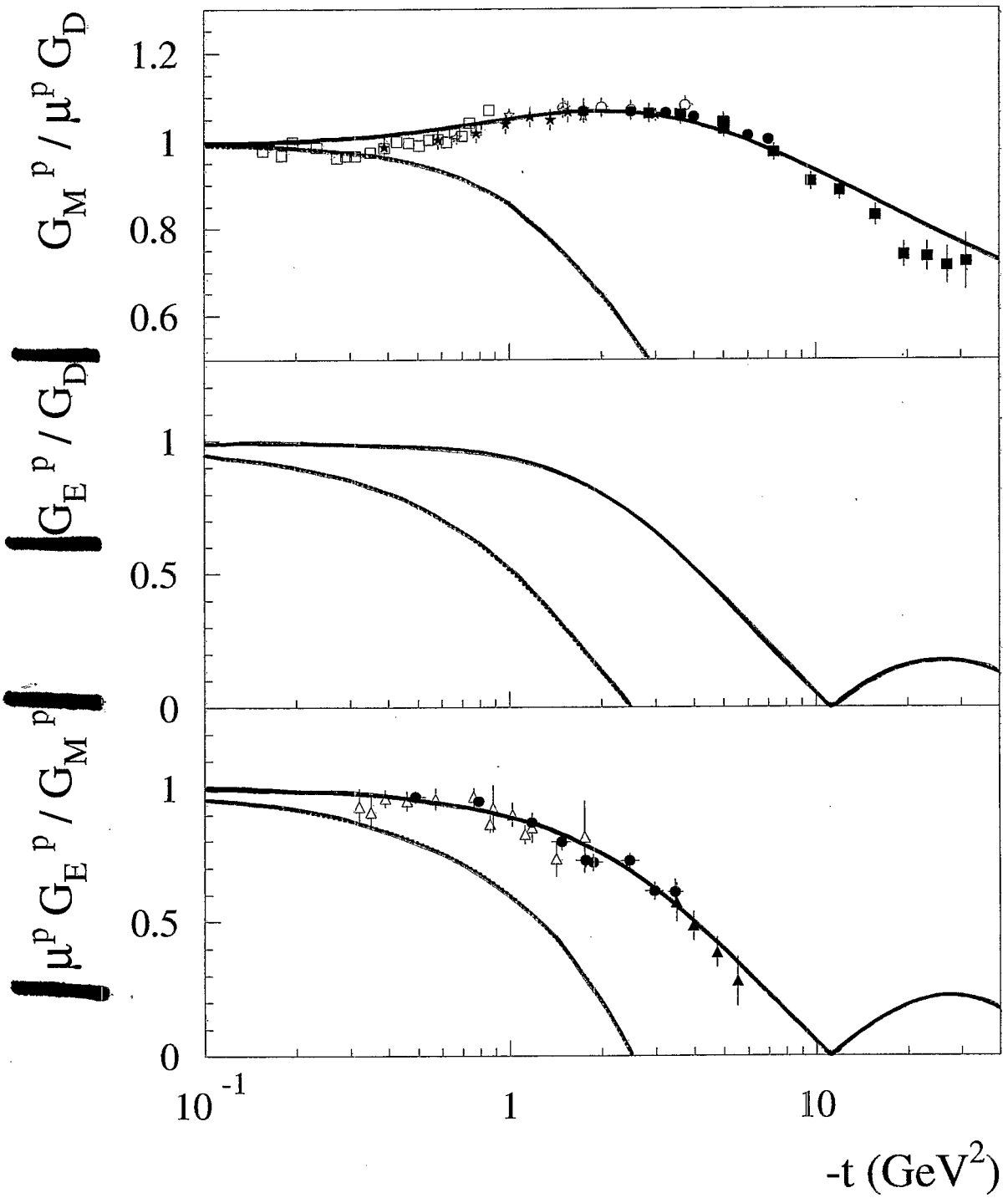


$\alpha_1' \sim 1.0 \; \text{GeV}^{-2}$

cfr. REGGE SLOPES FOR MESON TRAJ.

PROTON electric and magnetic form factors

WORK IN PROGRESS : M. GUIDAL, M. TOLYAKOV, M. VDH



—— REGGE $\sim \frac{1}{x^{\alpha' t}}$

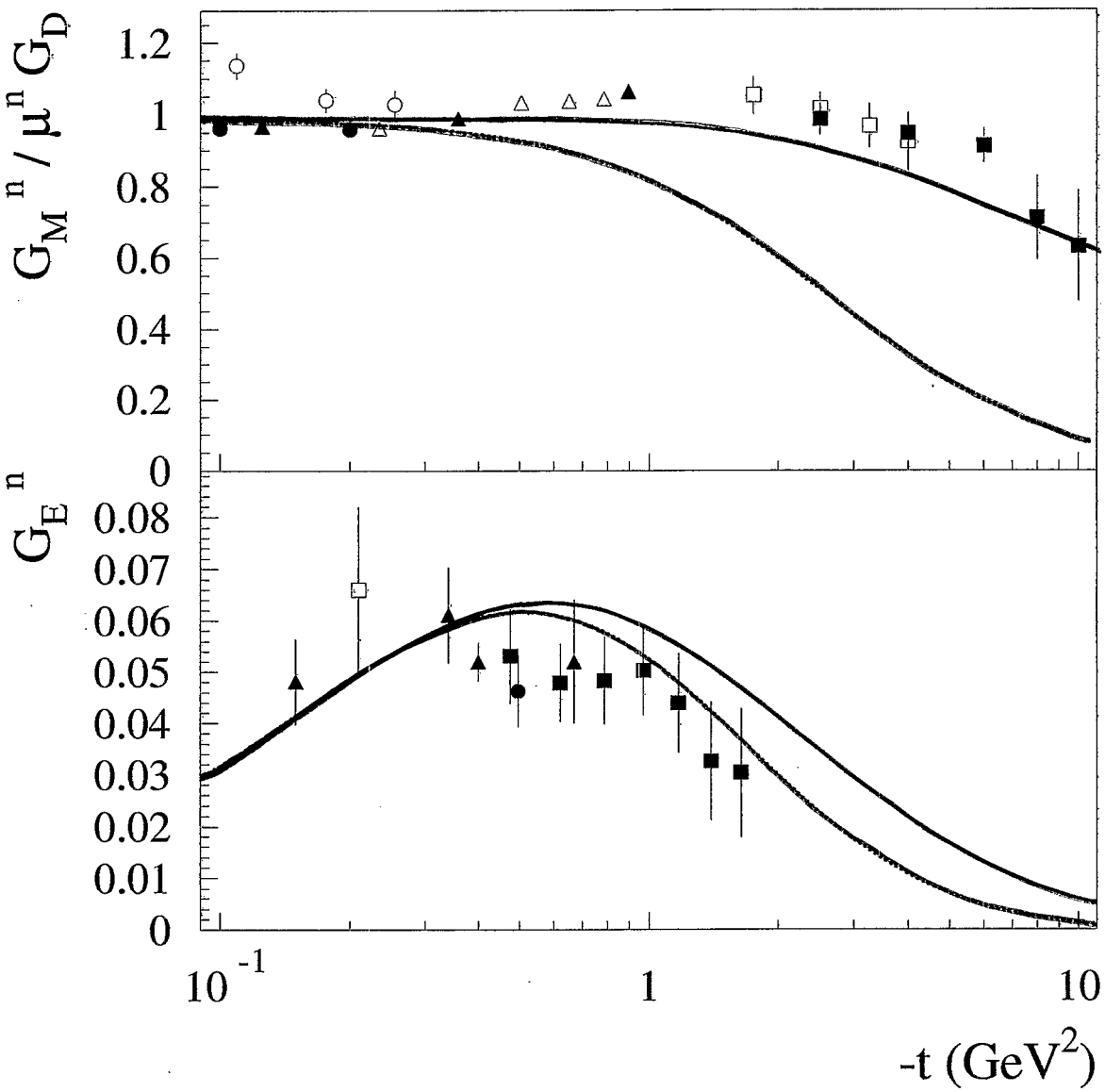
—— REGGE (NON-LINEAR TRAJ.) : 6 PARAMETERS

α'_1, α'_2

$\eta_e^0, \eta_e^d, T_1, T_2$

NEUTRON electric and magnetic form factors

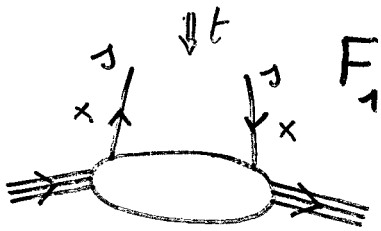
WORK IN PROGRESS : M. GUIDAL, M. POLYAKOV, M. VDH



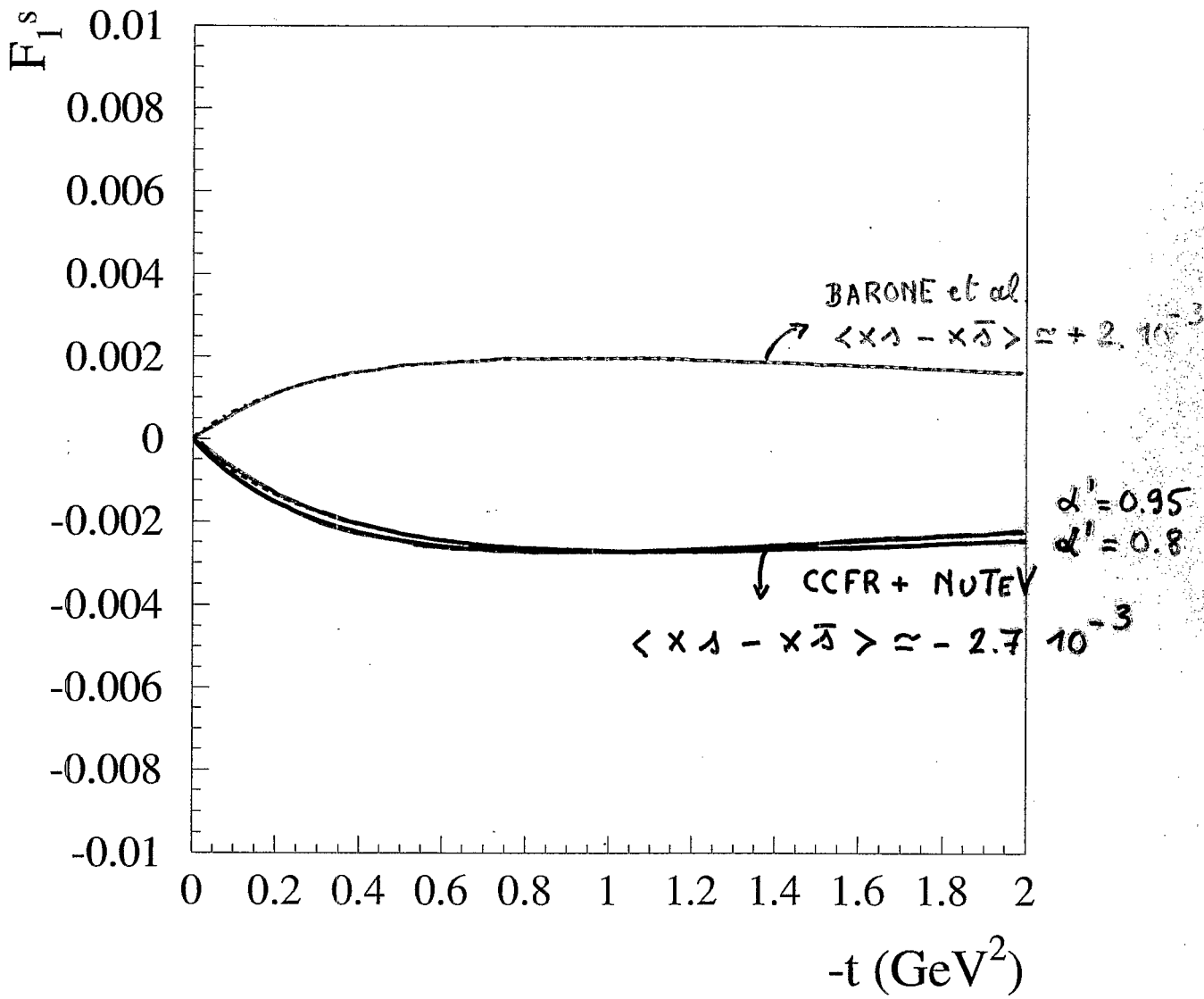
—— REGGE $\sim \frac{1}{x^{\alpha' t}}$

—— REGGE (NON-LINEAR TRAJ.)

NUCLEON STRANGENESS F_1 form factor



$$F_1^s(t) = \int_0^1 dx \left[s(x) - \bar{s}(x) \right] \frac{1}{x^{\alpha' t}}$$

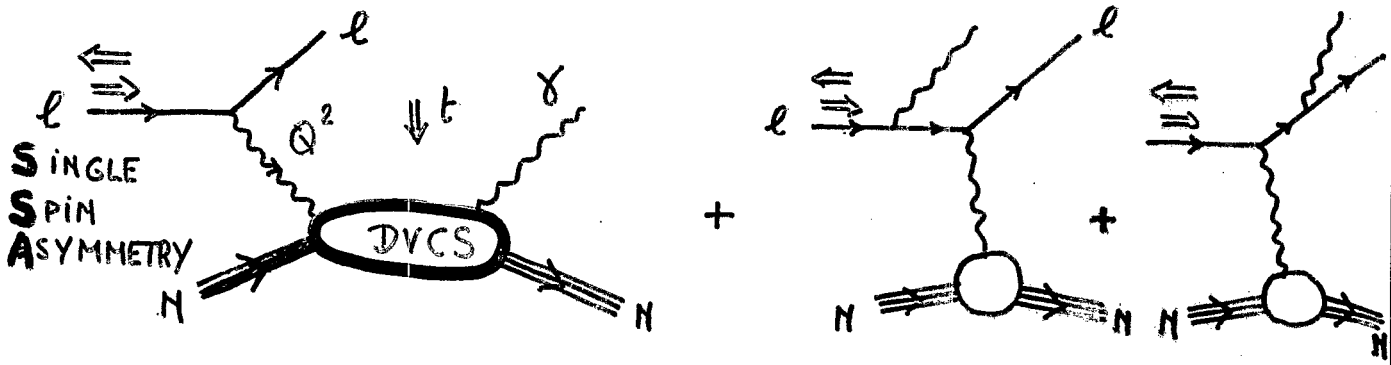


PRECISE DATA (UPPER LIMIT) FOR F_1^s

$\Downarrow$

CONSTRAIN $s(x) - \bar{s}(x)$

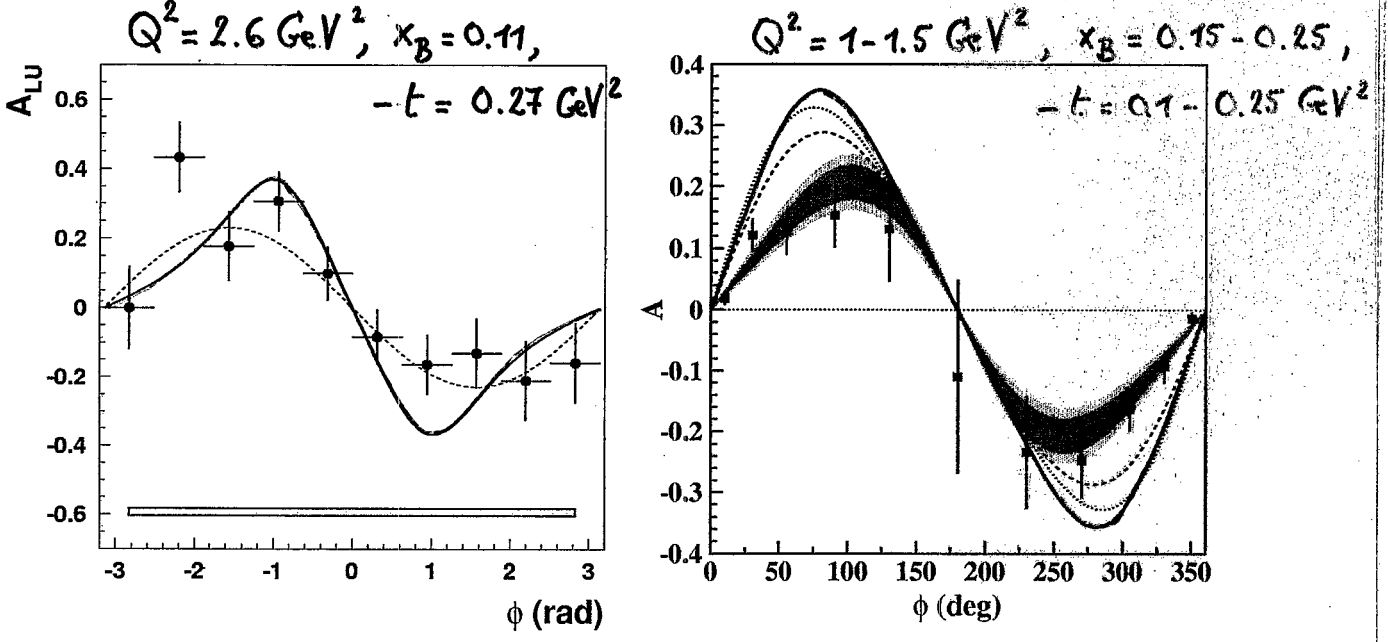
DVCS SSA @ HERMES and CLAS



$$\sigma_{\Rightarrow} - \sigma_{\Leftarrow} \sim (\mathrm{BH}) \cdot \mathrm{Im}(\mathrm{DVCS}) \cdot \sin\phi$$

ANGLE BETWEEN 2 PLANES

HERMES (2001) **JLAB/CLAS**



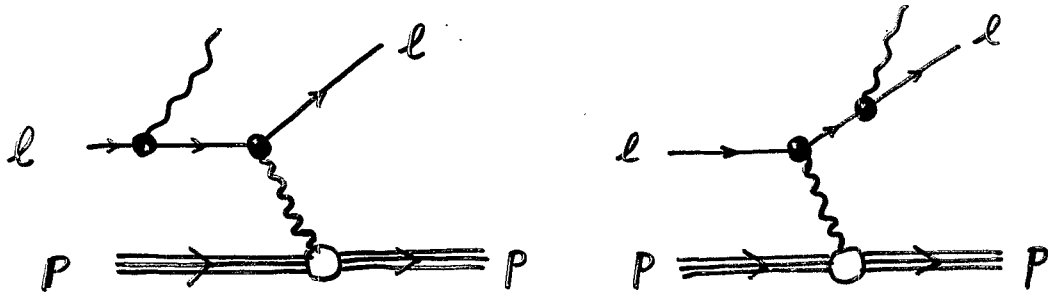
—— DVCS TWIST-2 + TWIST-3 CALCULATION

KIVEL, POLYAKOV, VDH (2000)

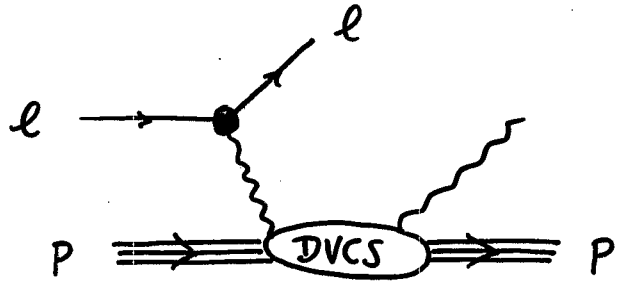
DVCS SSA : measures GPD(x, ξ, t) at $x = \xi$

$$\xi = \frac{x_B/2}{1 - x_B/2}$$

e^+/e^- OR BEAM-CHARGE ASYMMETRY IN $e^\pm p \to e^\pm p \gamma$



↳ BETHE - HEITLER $\sim (q_\ell)^2$



↳ DVCS $\sim q_\ell$

∴ IN $\sigma_{e^+} - \sigma_{e^-}$: $|BH|^2$ AND $|DVCS|^2$ DROP OUT

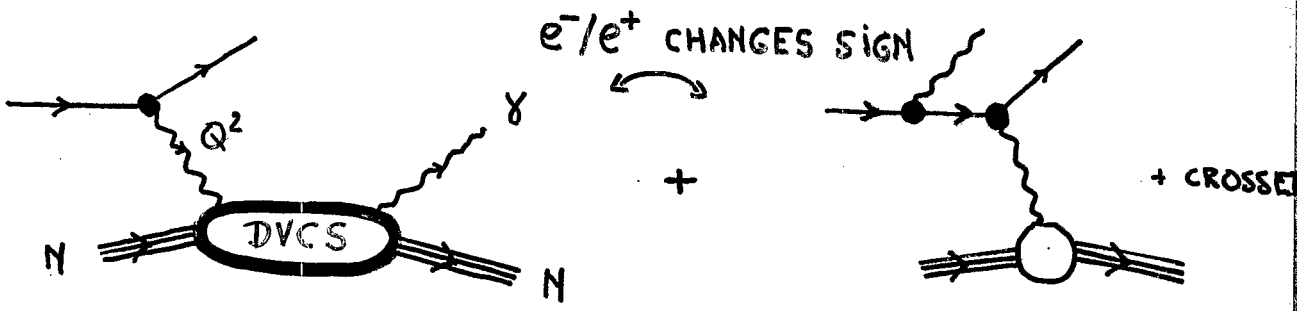
$$\boxed{\sigma_{e^+} - \sigma_{e^-} \sim \mathrm{Re}\,(BH \cdot DVCS^*)}$$

INTERFERENCE

$$\sigma_{e^+} - \sigma_{e^-} \sim \frac{1}{\mathcal{P}_1(\phi)\mathcal{P}_2(\phi)} \left\{ \underbrace{P_1 + P_2 \cos\phi}_{\text{TWIST-2}} + \underbrace{P_3 \cos 2\phi}_{\text{TWIST-3}} + \underbrace{P_4 \cos 3\phi}_{\text{ONLY FOR GLUON GPD WITH DOUBLE HEL. FLIP}} \right\}$$

DENOM. OF BH PROPAGATORS

Signature of $q\bar{q}$ correlations in DVCS beam-charge asymmetry



$\Longrightarrow$ Accesses REAL PART of DVCS amplitude

$$e^-/e^+ + p \rightarrow e^-/e^+ + p + \gamma$$

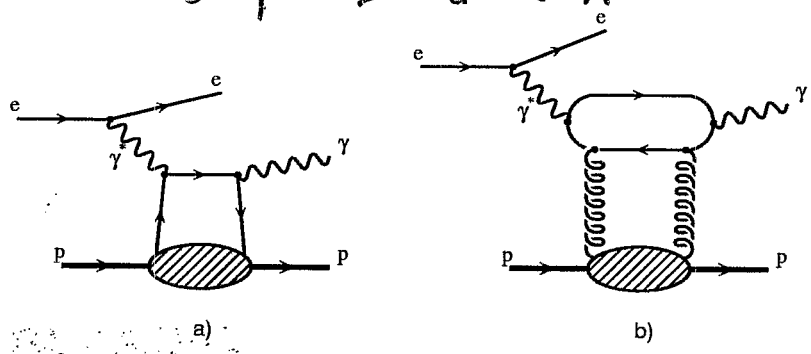
$E_e = 27\ GeV,\ Q^2 = 2.5\ GeV^2,\ x_B = 0.11,\ t = -0.25\ GeV^2$

Accesses $q\bar{q}$ content of mesonic correlations in nucleon

DVCS @ HERA (H1/ZEUS)

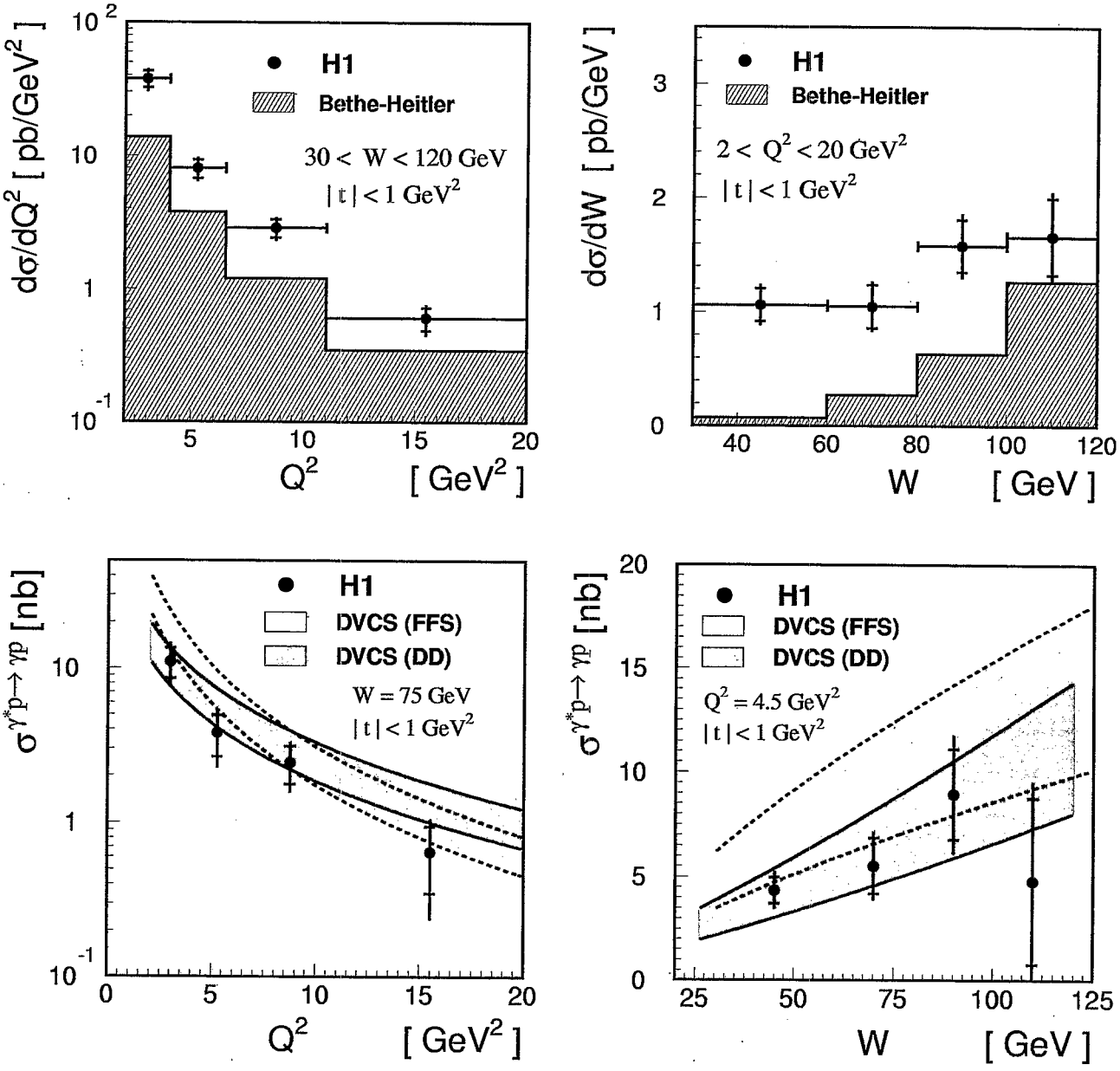
PLB 517 (2001)

$e^+ p \to e^+ \gamma X$



⇒ SMALL x ($\lesssim 10^{-2}$)
LARGE W

$2 < Q^2 < 20$ GeV^2, $30 < W < 120$ GeV, $|t| < 1$ GeV^2



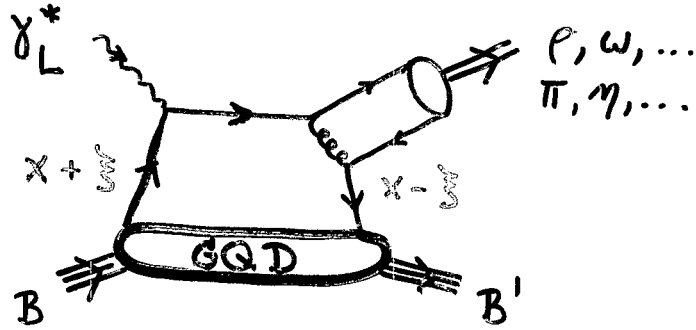
TWIST-2 DVCS : FRANKFURT, FREUND, STRIKMAN (1998)

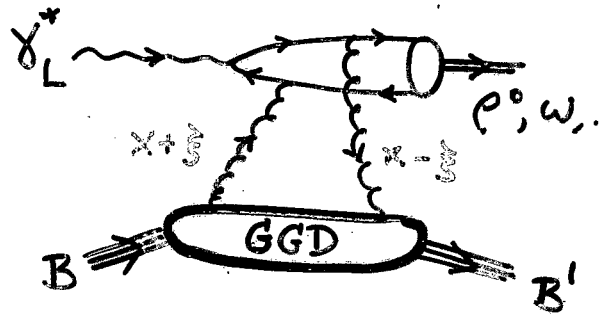
DIPOLE MODEL OF DIFFRACTION : DONNACHIE, DOSCH (2001)

HARD ELECTROPRODUCTION OF MESONS ($\pi, \rho, \omega, \ldots$)

- QCD FACTORIZATION PROOF

COLLINS, FRANKFURT, STRIKMAN (1997); RADYUSHKIN (1997)

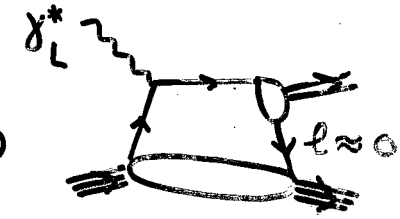




$$\Rightarrow \mathcal{M}_{\gamma_L^* B \to M B'} \sim \frac{1}{Q} \quad \Rightarrow \quad \frac{d\sigma}{dt} \sim \frac{1}{Q^6}$$

$\Rightarrow$ FOR γ_L^* : LEADING ORDER

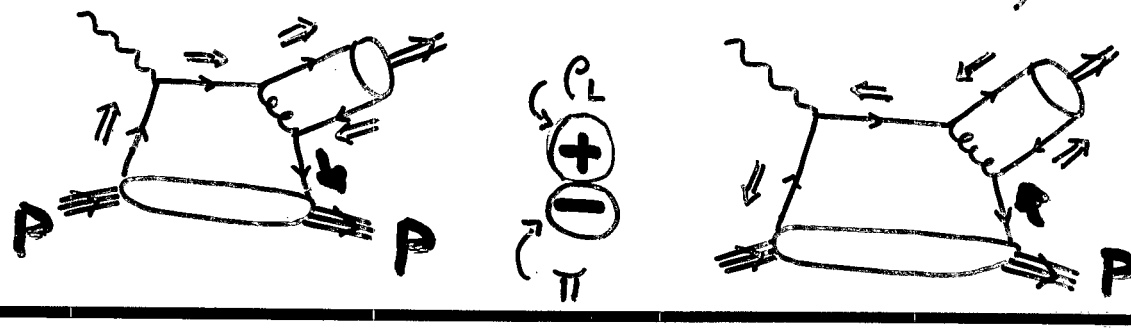
e.g. SOFT OVERLAP SUPPRESSED



- **MESON : HELICITY FILTER**

$$|\rho_L\rangle = \frac{1}{\sqrt{2}} \left(|\uparrow\downarrow\rangle + |\downarrow\uparrow\rangle \right)$$

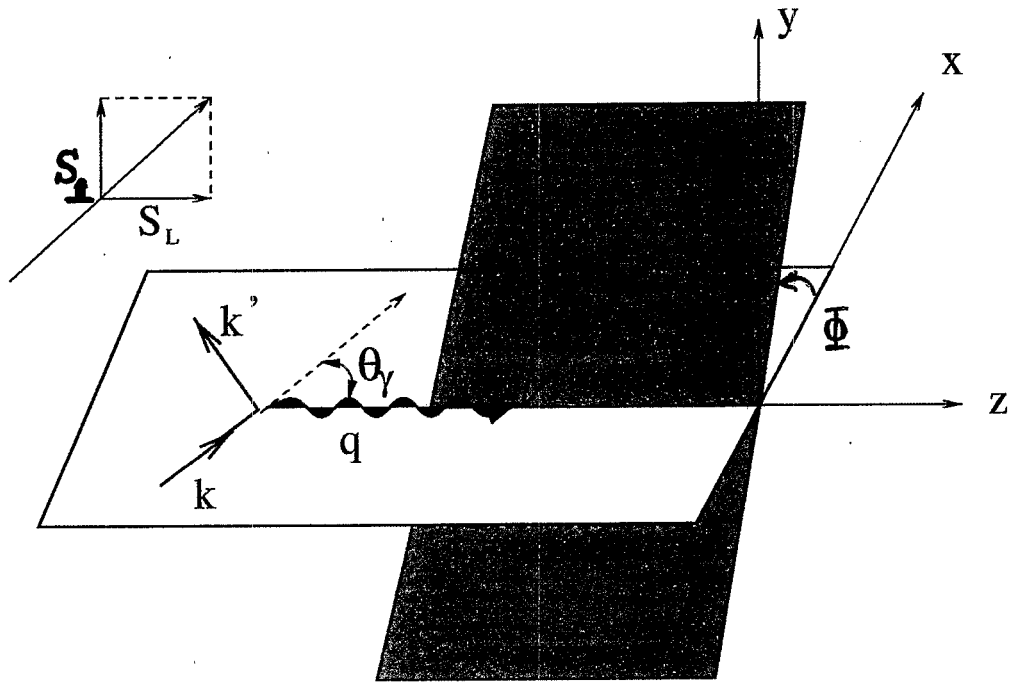
$$|\pi\rangle = \frac{1}{\sqrt{2}} \left(|\uparrow\downarrow\rangle - |\downarrow\uparrow\rangle \right)$$



V : $\rho, \omega, \ldots$	$\Rightarrow$ 'UNPOLARIZED' GPDs	H, E
PS : $\pi, \eta, \ldots$	$\Rightarrow$ 'POLARIZED' GPDs	$\tilde{H}, \tilde{E}$

Transverse spin asymmetry in hard meson electroproduction

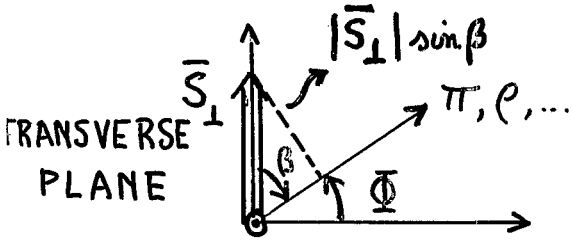
ASYMMETRY for a TRANSVERSELY polarized target



in LEADING ORDER (in Q) $\Rightarrow$ 2 OBSERVABLES

$$\sigma = \sigma_L + P_n \, \sigma_L^n$$

$$P_n = |\vec{S}_\perp| \, \sin\beta$$



$(\beta = 90 - \Phi)$

$$\mathcal{A} = \frac{1}{|S_\perp|} \frac{\int_0^\pi d\beta \, \sigma(\beta) - \int_\pi^{2\pi} d\beta \, \sigma(\beta)}{\int_0^{2\pi} d\beta \, \sigma(\beta)} = \frac{2 \, \sigma_L^n}{\pi \, \sigma_L}$$

Transverse spin asymmetry in longitudinal vector meson electroproduction

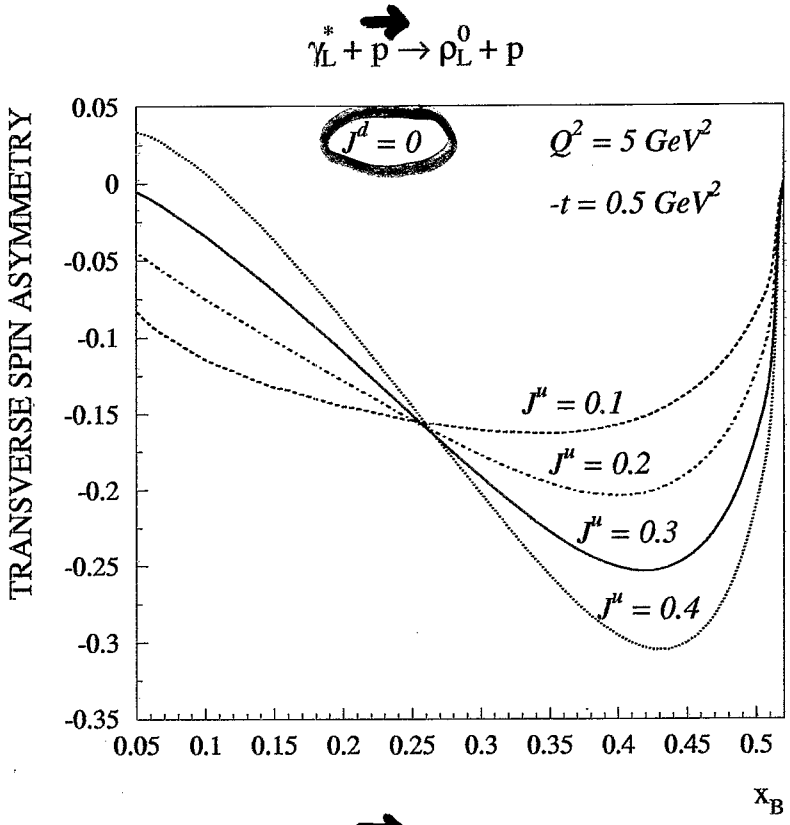
$$\mathcal{A}_{V_L N} = -\frac{2\,|\Delta_\perp|}{\pi} \times \frac{\mathrm{Im}(AB^*)\,/\,m_N}{|A|^2\,(1-\xi^2) - |B|^2\,(\xi^2 + t/(4m_N^2)) - \mathrm{Re}(AB^*)\,2\,\xi^2}$$

GOEKE, POLYAKOV, VDH (2001)

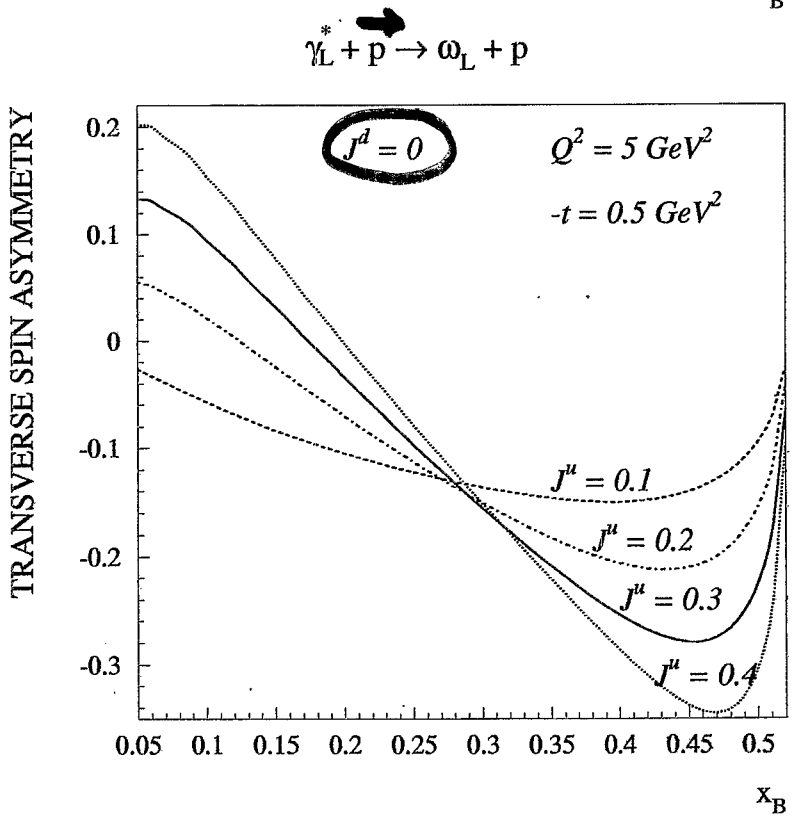
- $A \quad \Rightarrow \quad$ GPD $\quad H$
- $B \quad \Rightarrow \quad$ GPD $\quad E$
- LINEAR dependence on the GPD $\quad E$
  $\leftrightarrow$ unpolarized cross sections
- Ratio $\Rightarrow$ LESS sensitive to NLO and higher twist effects
- sensitivity to J^u, J^d

$\mathcal{A}_{V_L N} \quad \Rightarrow$ "measure" of the TOTAL quark angular momentum contributions to the proton spin !

Transverse spin asymmetry in ρ_L^0 and ω_L production



ρ_L^0 SENSITIVE TO $(2J^u + J^d)$



ω_L SENSITIVE TO $(2J^u - J^d)$

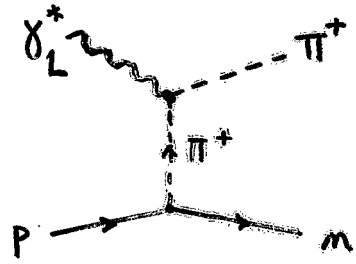
(GOEKE, POLYAKOV, VDH (2001))

Transverse spin asymmetry in pseudoscalar meson electroproduction

$$\mathcal{A}_{\pi N} = \frac{2\,|\Delta_\perp|}{\pi} \times \frac{\mathrm{Im}(AB^*)\,\xi\,/\,m_N}{|A|^2\,(1-\xi^2) - |B|^2\,\xi^2\,t\,/\,(4\,m_N^2) - \mathrm{Re}\,(AB^*)\,2\,\xi^2}$$

FRANKFURT, POBYLITSA, TOLYAKOV, STRIKMAN (1999)

- $A \Rightarrow$ GPD $\widetilde{H}$
- $B \Rightarrow$ GPD $\widetilde{E}$

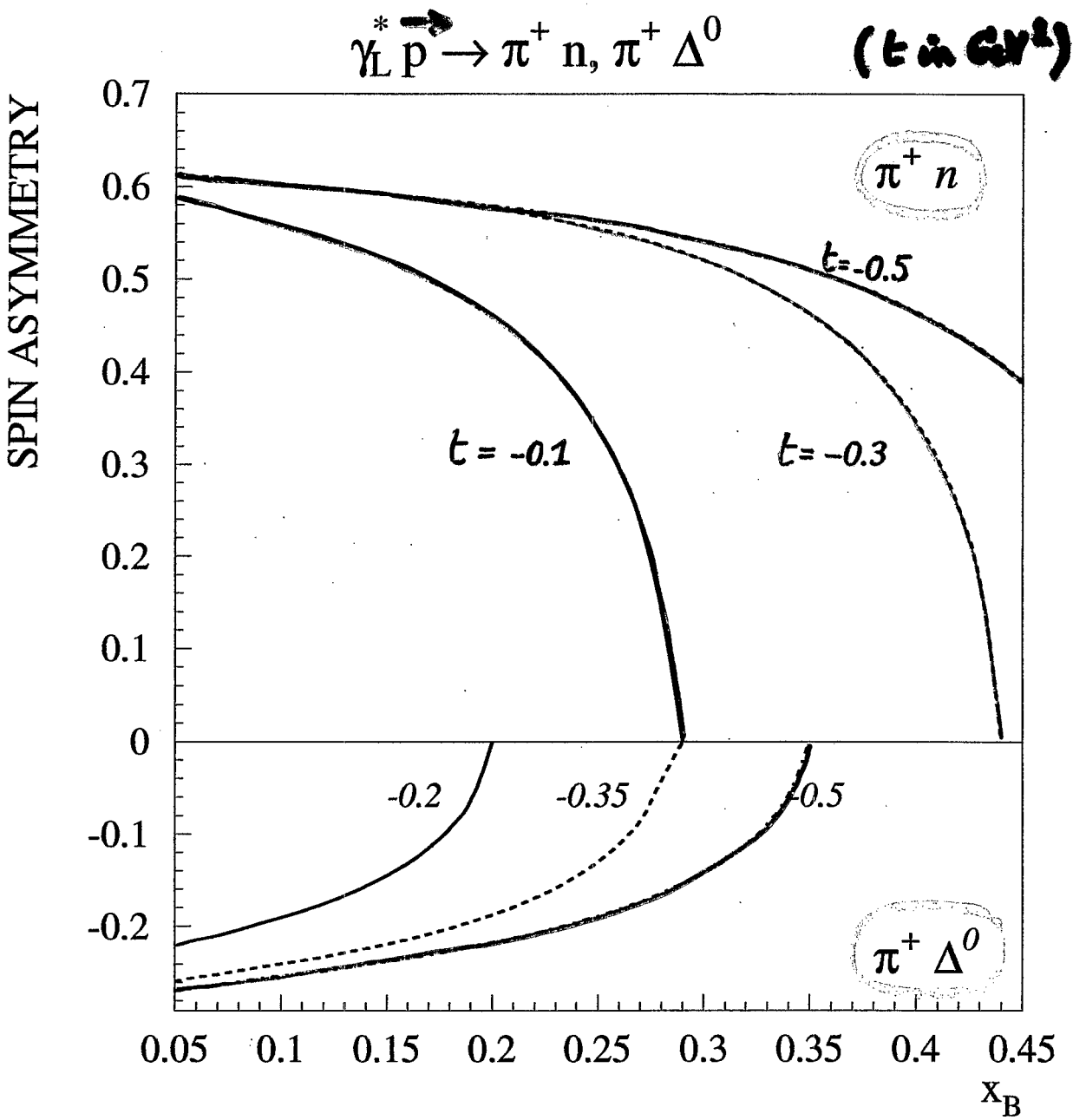


- linear dependence on the GPD $\widetilde{E}$ for π^+ :
  B is dominated by a LARGE π-pole contribution
- Ratio $\Rightarrow$ LESS sensitive to NLO and higher twist effects (EARLY scaling)
- purely real contribution to amplitude
  $\Rightarrow$ does not give an asymmetry

LARGE $\mathcal{A}_{\pi N}$ $\Rightarrow$ predicted by the chiral dynamics of QCD

Transverse spin asymmetry in pion electroproduction

Leading order PQCD result

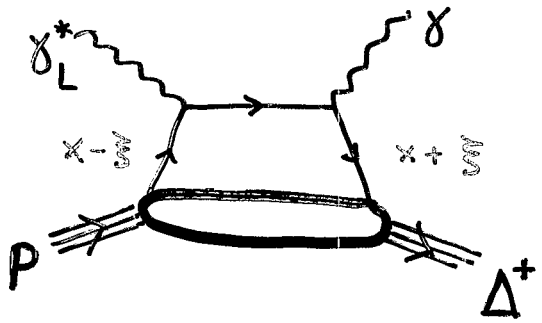


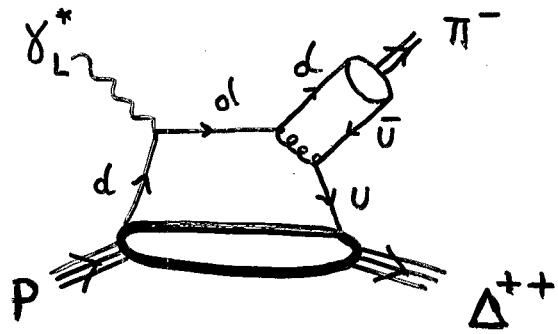
FRANKFURT, POLYAKOV, STRIKMAN, VDH (2000)

GPD's $N \to \Delta$, $N \to Y$, ...

"NEW SPECTROSCOPY"

- **$N \to \Delta$**





LARGE N_c L. FRANKFURT, M. POLYAKOV, M. STRIKMAN, M. VDH (2000)

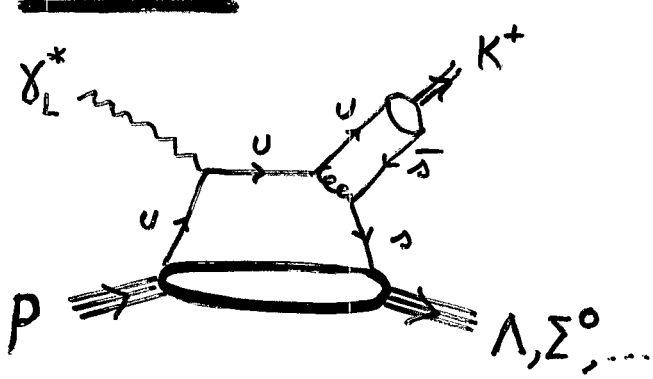
$\Rightarrow$ $N \to \Delta$ VECTOR TRANSITION

- $$H^{N\to\Delta}(x,\xi,t) = \frac{2}{\sqrt{3}}\left\{ E^{(u)}(x,\xi,t) - E^{(d)}(x,\xi,t)\right\}$$

$\Rightarrow$ $N \to \Delta$ AXIAL TRANSITION

- $$C_1^{N\to\Delta}(x,\xi,t) = \sqrt{3}\left\{ \tilde{H}^{(u)}(x,\xi,t) - \tilde{H}^{(d)}(x,\xi,t)\right\}$$
- $$C_2^{N\to\Delta}(x,\xi,t) = \frac{\sqrt{3}}{4}\left\{ \tilde{E}^{(u)}(x,\xi,t) - \tilde{E}^{(d)}(x,\xi,t)\right\}$$

- **$N \to Y$**



$N \to Y \Longleftrightarrow N \to N$

SU(3)

SUMMARY

⇒ GPDs NEW NUCLEON STRUCTURE FUNCTIONS

WHICH INTERPOLATE $\left.\begin{matrix} q(x) \\ \Delta q(x) \end{matrix}\right\} \Leftrightarrow \left\{\begin{matrix} F_1(t) \\ G_A(t) \end{matrix}\right.$

DIS ⋮ ELECTROWEAK FF ⋮

HIGHER MOMENTS ⟺ GENERALIZED FF.
(e.g. ENERGY-MOMENTUM TENSOR)

⇒ DVCS : SSA $\sim -i\pi\, H(\xi,\xi,t)$

- THEORY: UNDER CONTROL TO NLO, TWIST-3 (WW), ...
- t-DEPENDENCE : MAP OUT TRANSVERSE PROFILE
  GEOMETRICAL PICTURE

⇒ DVCS : e^+/e^- ASYMM CROSS SECTION $\sim \mathcal{P}\int_{-1}^{1} dx\, \frac{H(x,\xi,t)}{x-\xi}$

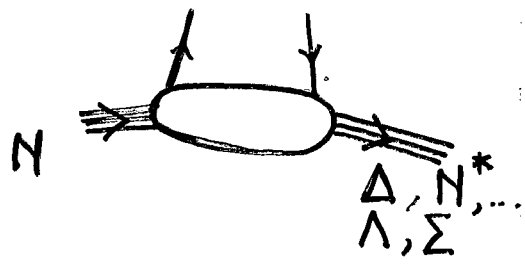
- $q\bar{q}$ COMPONENTS IN NUCLEON
  "D-TERM" (CONSEQUENCE OF SPONT. BREAKING OF χ SYMM)

⇒ 2 NEW LEADING TWIST GPDs :

TENSOR $E \Leftrightarrow F_2(t), J_q(t)$: $\rho_L^0, \omega_L, \rho_L^+ \sim \mathrm{Im}(\text{'}H\text{''}E)$ TRANSVERSE TARGET SPIN ASYMM

PS $\tilde{E} \Leftrightarrow G_p(t)$: $\pi, K, \ldots \sim \mathrm{Im}(\text{'}\tilde{H}\text{''}\tilde{E}\text{'})$

⇒ NEW INFORMATION ON RESONANCE STRUCTURE ⇒ NEW SPECTROSCOPY



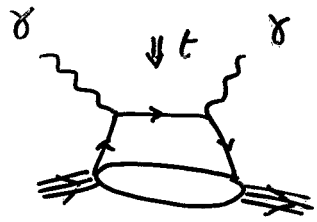
⇒ STRANGENESS DISTR.
SU(3)

⇒ OTHER APPLICATIONS

* WIDE ANGLE COMPTON SCATTERING

  RADYUSHKIN ('98)

  DIEHL et al. ('99)



$\frac{1}{x}$ MOMENT OF GPDs

* $\gamma\gamma \to p\bar{p}$, $p\bar{p} \to \gamma\gamma$

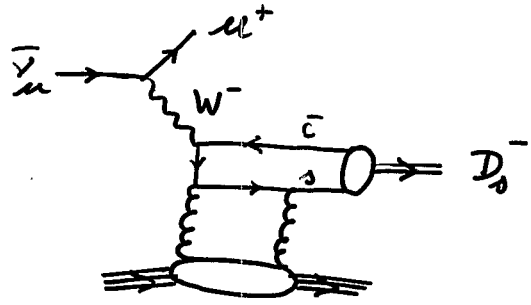
  FREUND et al. ('02)

* DVCS ON NEUTRON ⇒ FLAVOR SEPARATIONS

* DVCS ON d CANO et al ('01)

  NUCLEI ELLINGHAUS (HERMES)

* ν - INDUCED REACTIONS LEHMANN - DRONKE, SCHÄFER ('01)



⇒ GENERALIZED GLUON DISTR.

⇒ EXISTING FACILITIES

JLAB @ 6 GeV (CLAS, HALL A)

HERMES (TRANSVERSE TARGET POL., RECOIL DETECTION)

COMPASS (2° PHASE)

⇒ FUTURE PLANS : HIGH LUMINOSITY + GOOD RESOLUTION

JLAB @ 12 GeV

EVELIN (50 GeV), EIC, ...