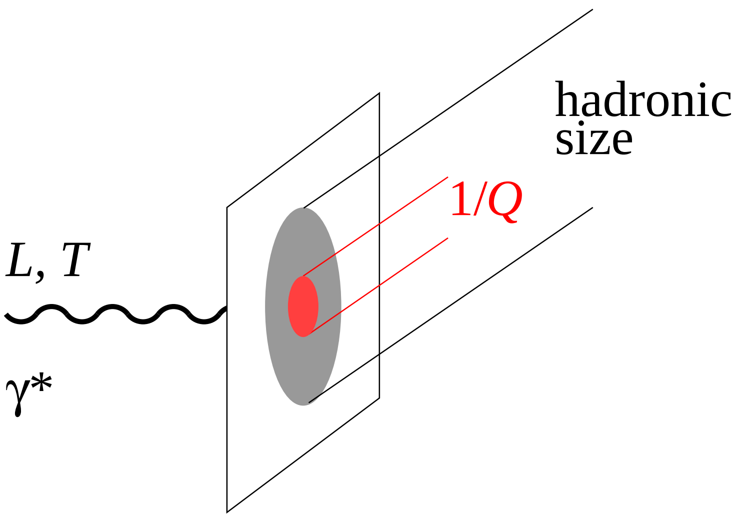
Probing the two–component structure of the virtual photon in exclusive π^0 photo/electroproduction at JLab

Ch. Weiss (JLab) GPD/Exclusive Processes WG, JLab, Feb. 27, 2007



Aim: "Disentangle" components of virtual photon:

hadronic size	VDM, Regge
size $1/Q$	GPDs

$\rightarrow$ Energy dependence

$\rightarrow$ t–slopes, dip structure

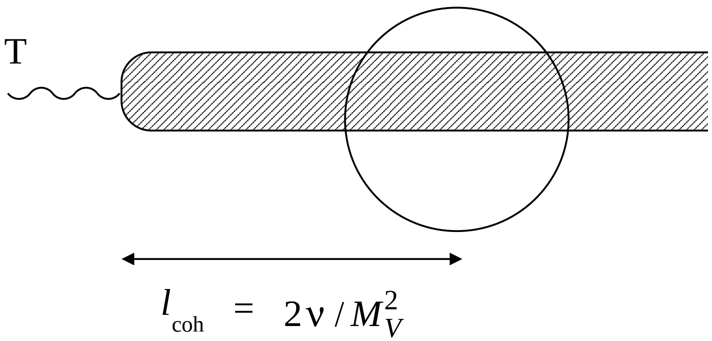
$\rightarrow$ Azimuthal dependence

How do they change with Q^2?

. . . No "explicit" L/T separation!

Space–time picture of photo/electroproduction at $W \gg 1$ GeV

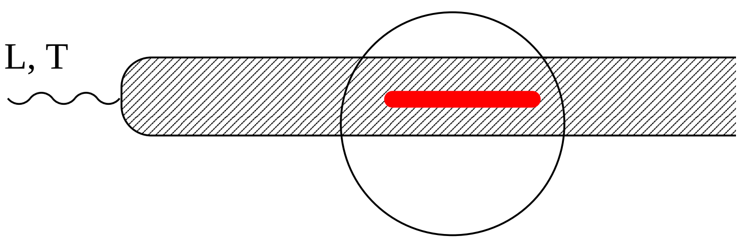
$Q^2 = 0$



hadronic
size

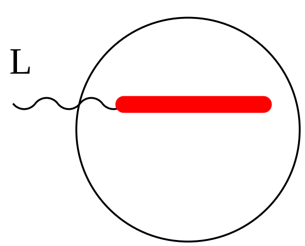
Vector dominance
Regge phenomenology

$Q^2 >> M_V^2$



size $1/Q$

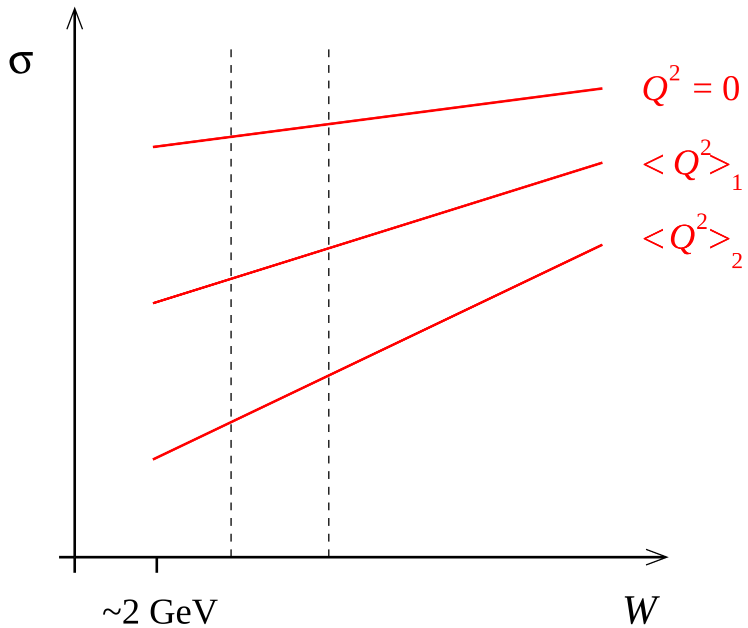
Q^2 –> Infinity



size $1/Q$

GPDs
"Hard scattering"

W dependence — How does it change with Q^2



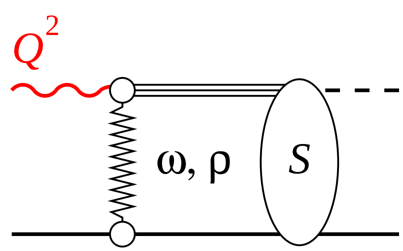
W–dependence in Q^2 bins

- Change of W dependence with Q^2 indicates presence of L components

- Vector dominance at $Q^2 > 0$:
  No change in W–dependence of σ_T
  $\rightarrow$ Change due to σ_L + interf.

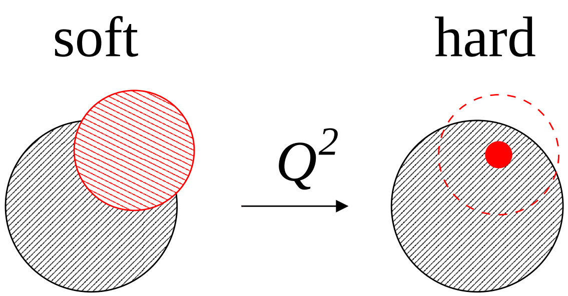
- Regge exchange at $Q^2 > 0$

Poles only:	No change
Poles + absorption:	Change



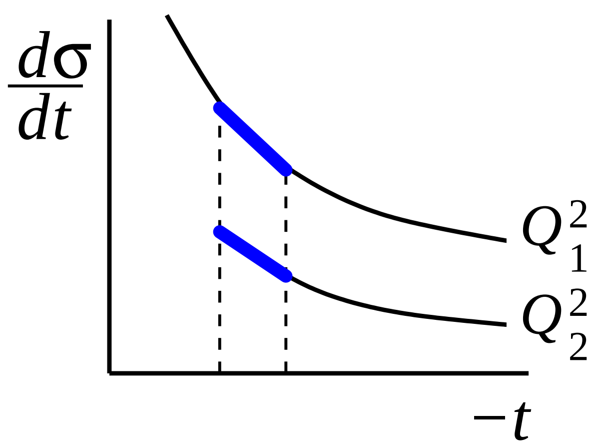
cf. “color transparency”

t–dependence in forward peak — How does it change with Q^2?



- $\Delta_\perp$–dependence of cross section (fixed x) reflects transverse size of interaction region

  $\underbrace{\text{Probe size}}_{Q^2\text{-dep.!}}$ + Target size



- $Q^2 \to \infty$: Pointlike probe
  $\to \Delta_\perp$ slope becomes Q^2–independent

- Important: $t_{\min}$ depends on x, Q^2
  t–slope $\neq$ $\Delta_\perp^2$–slope

- $x \to 1$: Shrinkage of target size

Dip in t–dependence — How does it evolve with Q^2?

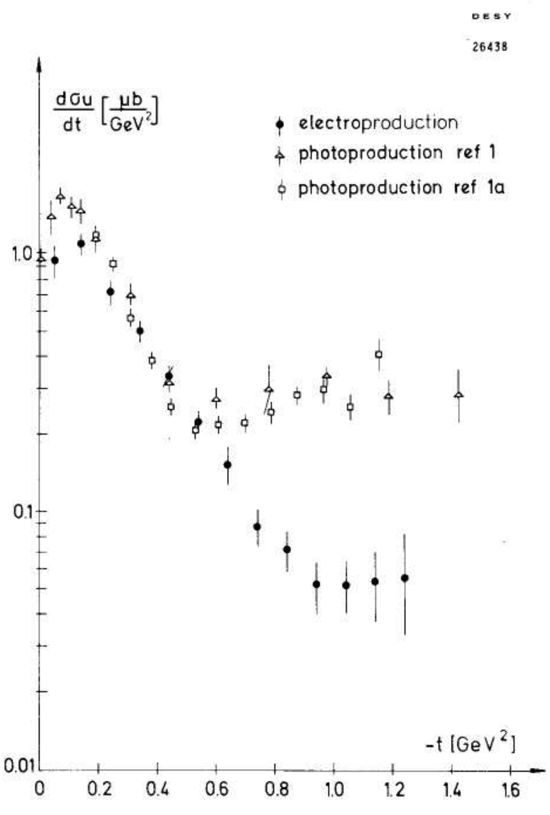


Fig.11

$1.8 < W < 2.7$ GeV,
$0.1 < Q^2 < 0.7$ GeV
[DESY: Berger et al. 77]

- Regge phenomenology for $Q^2 = 0$:
  Two competing explanations for dip
  - Zeroes of residues (NWSZ) — No Q^2–dep.
  - Pole + absorption — Q^2–dep.

- DESY data: Large–t shoulder disappears at $\langle Q^2 \rangle \sim 0.28$ GeV^2

  . . . very strange! [Collins, Wilkie 81]
  . . . Can we confirm these measurements?

- u–channel effect?

Azimuthal dependence — How does it change with Q^2?

$$\sigma \;=\; \sigma_T \;+\; \epsilon\cos 2\phi\,\sigma_{TT} \;+\; \epsilon\,\sigma_L \;+\; \sqrt{2\epsilon(\epsilon+1)}\,\cos\phi\,\sigma_{LT}$$

Unpolarized beam/target

alt.: $\sigma_T = \frac{1}{2}\left(\sigma_{\|} + \sigma_{\perp}\right), \;\; \sigma_{TT} = \frac{1}{2}\left(\sigma_{\|} - \sigma_{\perp}\right)$

- $Q^2 = 0$: $\sigma_{\perp} \gg \sigma_{\|}$, $\sigma_{TT} \approx -\sigma_T$ (natural parity exchange ω, ρ^0)
  Azimuthal dependence $\sigma \sim 1 - \epsilon\cos 2\phi$

- $Q^2 \to \infty$: σ_L dominates, no azimuthal dependence!

- Beam polarization: $h\sqrt{2\epsilon(\epsilon+1)}\,\sin\phi\,\sigma_{LT}$

- Target polarization (longitudinal): $P_l\sqrt{2\epsilon(\epsilon+1)}\,\sin 2\phi\,\sigma_{TT'}$
  Regge phenomenology: Interference of ω and ρ exchange
  . . . How does it evolve with Q^2?

Summary

- Many interesting tests of two–component structure of virtual photon in π^0 production without explicit L/T separation

- Need to develop truly interpolating model for meson electroproduction

- What happens between $Q^2 = 0$ and $1\,\mathrm{GeV}^2$ is key to understanding approach to the hard regime and relating meson electroproduction data to GPDs!