Summary: Impressions and Directions, followed by discussion

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Open Questions in Parton Hadron Duality

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UVA

WILLIAM & MARY

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Too simple famous theorem

- If we use Nachtmann variable, and
- if we believe duality is perfect,

$$\int_0^1 d\xi\, \xi^n F(\xi, Q^2) = a_n = \text{const.},$$

- then the structure function is zero,

$$\boxed{F(\xi, Q^2) = 0\,.}$$

- (See Gross, Treiman, Wilczek, 1977.)

Data

- Duality context here e+A -> e+X
- Relation between scaling function seen at high Q^2 and resonances at lower Q^2.
- Seen in A = p, n, d, other nuclei, both F_T and F_L, and in polarized cases (Thia, Simona, Eric, Donal, Ionna, Xiaochao, Oscar, Victor, Nilanga)
- ∃ violations for Δ at various Q^2 in polarized case.

Definitions

- Local W ranges
- Moments and truncated moments
- Perturbative expansion (Poggio, Quinn, Weinberg; see Shifman talk, 2003),
  - Exact structure function/cross section, suitably averaged ≈ Perturbative calculation to some order, similarly averaged, at high energy
  - Easier context, $e^+ e^- \rightarrow$ *hadrons*

Theory

- Fewer theory talks than experimental talks!
- Modeling: Veneziano (Tim), Harmonic osc. (Wally)
- Effects on PDF fits (Alberto)
- Utility for finding PDFs as $x \rightarrow 1$ (Eric, Alberto)
- Utility for $\boldsymbol{\alpha}_s$ determination (Simonetta)

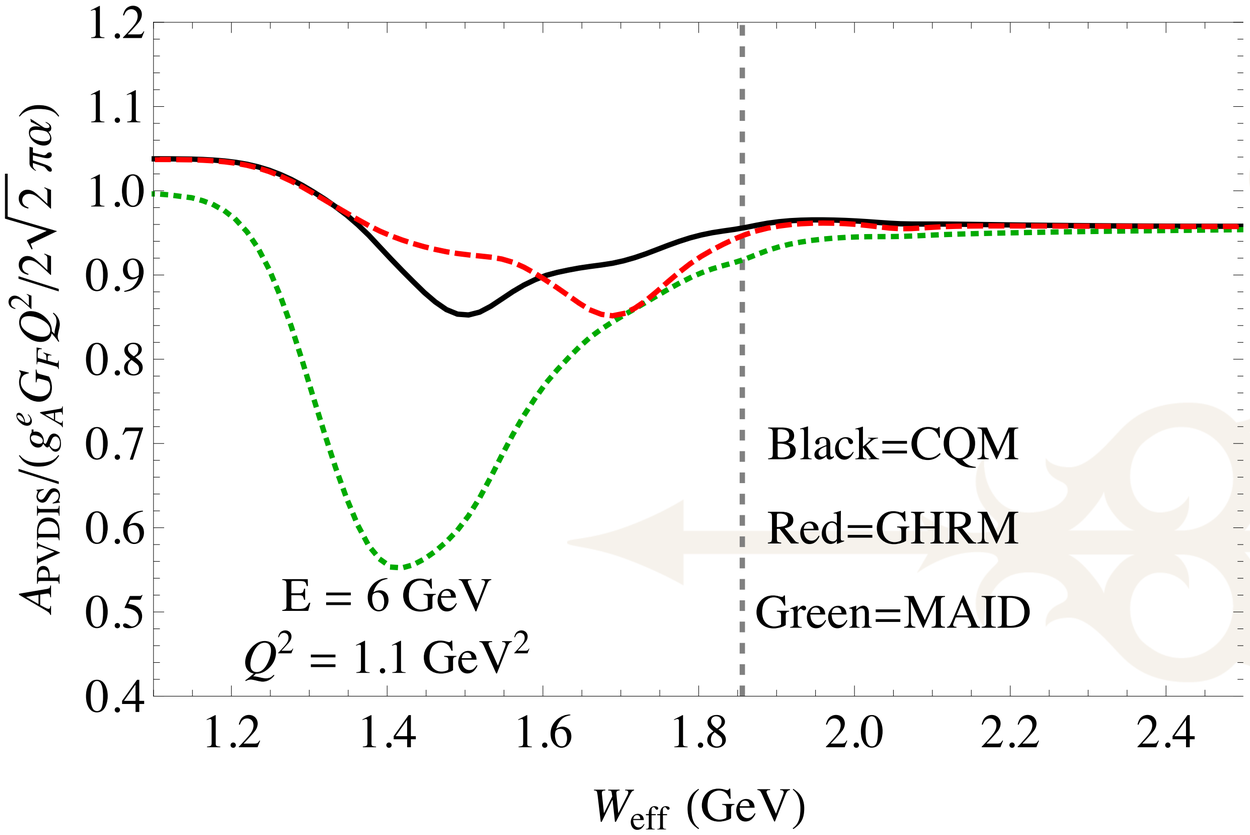
Summary of Summary

- Duality has an exciting future
- Especially if we understand what it tells us about QCD
- Not enough teleology understood
  - Workings of definitions
  - Modeling: Venezano, Harmonic Oscillator models
- Useful application: structure functions in limit $x \rightarrow 1$.

Discussion

- What should we do next?
  - Experiment
  - Theory
    - Basic theory
    - Fitting data/extrapolating scaling curves

Extra slide


1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
$A_{PVDIS}/(g_A^e G_F Q^2/2\sqrt{2}\,\pi\alpha)$
1.2
1.4
1.6
1.8
2.0
2.2
2.4
W_{eff} (GeV)
Black=CQM
Red=GHRM
Green=MAID
E = 6 GeV
Q^2 = 1.1 GeV^2