What do we learn from measuring sum rules at $0<Q^2<\sim1$ GeV^2?

Data interpretation: Many approaches available, with different degrees of connection with QCD:

- Lattice QCD
- Chiral Effective field theory (χEFT)
- Light-Front holographic QCD
- Schwinger-Dyson equations
- "Improved pQCD" methods
- Models (too wide spectrum to discuss here)

Lattice QCD:

- Closest nonperturbative approach to QCD. Many of its approximations are now under control.
- Can provide moments if well-defined matrix element exists (ex. d_2).
- Until recently, no near prospect of prediction for most sum rules. **But it is changing!**
  - Two groups (Adelaide, Kentucky) can now compute 4-point correlation functions. Those are connected to measured moments of SF via sum rules. **Very exciting development!!!**
  - SF (and thus moments) may now be accessible via pseudo/quasi PDFs. Longer prospect.

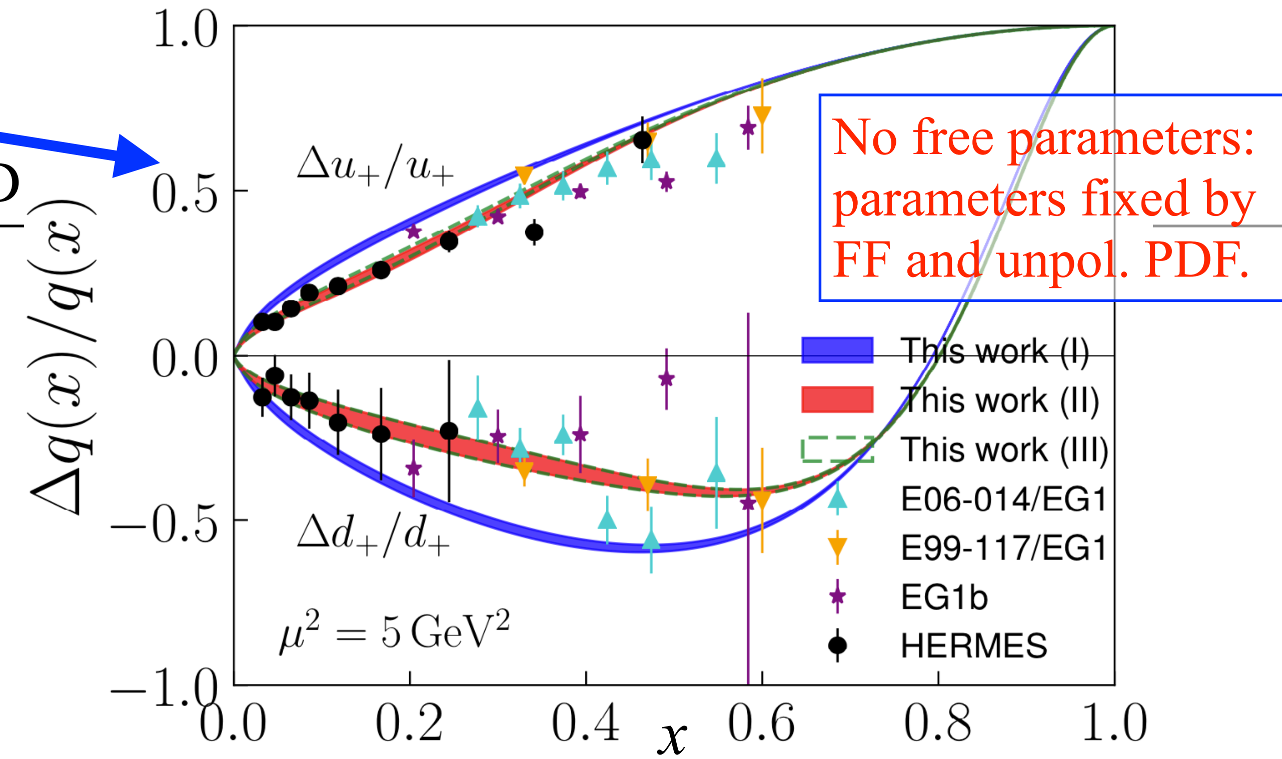
⟹Exciting news for sum rule experimentalists.

χEFT:

- Implement QCD's symmetries in Lagrangian using the d.o.f relevant at low Q^2. ⟹ Rightful approach.
- Offspring of Current Algebra. (We all know how useful it was.)
- **Very important**: EFTs are what must be used for phenomena emerging from complexity: atomic physics, chemistry (try doing biology with partons, electrons & photons). Missing χEFT = missing a rung in complexity ladder.
- Understanding interface between EFT and fundamental theory is required for full understanding of Nature.
- Teach about parent theory (here QCD). Ex: Chemists (use effective approach) told physicists (more fundamental approach) about atomic structure of matter.
- Like for lattice QCD, sum rules links measured moments to calculated amplitudes.

LFHQCD: Brodsky, de Teramond *et al*. other equally important AdS/QCD works exist, e.g. top-down approach.

- Semi-classical approximation of QCD. Bottom-up approach.
- Implement QCD's approximate conformal symmetry. Link with chiral symmetry.
- AdS_5 gravity $\Longleftrightarrow$ 4D QCD: Mathematical maneuver justified by isomorphism between AdS_5 and QCD relevant groups.
- QCD bound problem formulated exactly, starting from QCD's Action. Require semiclassical confinement potential.
- Potential can be determined by several independent methods. Consistent answers $\Longrightarrow$ unique potential.
- Handful of parameters enough for large number of successful predictions:
  - Nucleon and meson form factors.
  - Baryon and meson mass spectroscopy (Regge trajectories): Analytical result. Only Λ_s as free parameter.
  - QCD running coupling. $\Longrightarrow$ Bjorken sum rule.
  - GPDs, s and c quark sea, PDFs, **polarized PDFs**
- Analytical, intuitive approach to non-perturbative QCD



Liu, Sufian, de Téramond, Dosch, Brodsky, AD. arXiv:1909.13818

SDE: Not aware of work re: low Q^2 SR.

Improved QCD:

- Typically IF safe use effective coupling expand domain of applicability of pQCD.
  - Use SDE results and concepts.
  - Fold-in non-perturbative effects into pQCD formalism.
- Successful predictions of moments and SF down to $Q^2 \sim 0$.