JAM PDFs, structure functions at large x

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Motivations

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- **JLab 12 brings new challenges**
  - **Quantitative** limits of x, Q^2 where factorization theorems are applicable
  - What is the relevant variable that shows **scaling**?
  - What properties of partonic dof can we infer? e.g intrinsic transverse momentum
  - Universality of nonperturbative objects $\rightarrow$ **predictive power**
  - QCD analysis framework that extend to **semi-inclusive** observables

Motivations

- **Understanding target mass corrections** (see T. Rogers talk)
  - There are a variety TMC
  - In particular Georgi-Politzer (GP) has **assumptions** on partonic dof
  - Ellis, Furmanski, Petronzio noted that GP implies

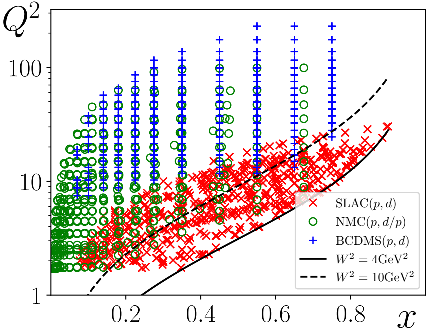
$$f(x, k_{\rm T}) = \frac{1}{\pi M^2} \Phi \left(x + \frac{k_{\rm T}^2}{x M^2} \right) \theta(x(1-x)M^2 - k_{\rm T}^2)$$

  - If intrinsic transverse momentum is bounded $\rightarrow$ sets constraints on TMDs (ask J. Collins)

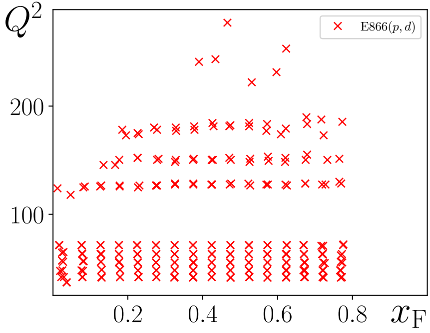
PDFs at high x

High-x analysis setup

- **Data sets**
  - DIS: SLAC(p, d), NMC$(p, d/p)$, BCDMS(p, d)
  - DY: E866(p, d)



DIS



DY

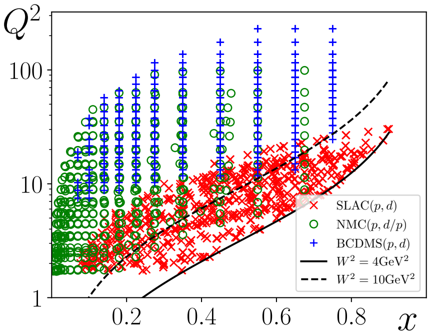
High-x analysis setup

- **Theory setup**
  - Observables computed at **NLO in pQCD**
  - DIS structure functions only at **leading twist** $(W^2 > 10\ \mathrm{GeV}^2)$
  - No nuclear corrections for d data

- **Target Mass Corrections (see T. Rogers talk)**
  - Massless target approximation (MTA)
  - $x \to x_{\mathrm{N}}$
  - Aivazis-Olness-Tung (AOT)
  - Georgi-Politzer (GP)

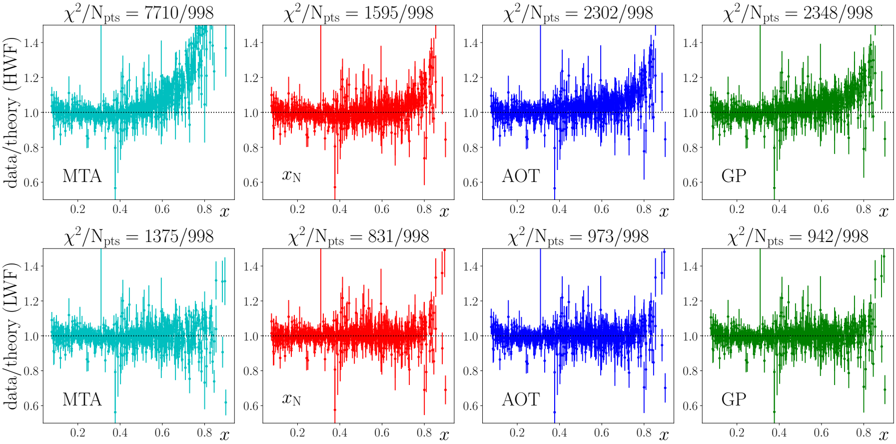
High-x analysis setup

- **Two likelihood analyzes**
  - **HWF** $\equiv$ High W fit : $W^2 > 10\text{GeV}^2$
  - **LWF** $\equiv$ Low W fit : $W^2 > 4\text{GeV}^2$



Results: Data vs. theory

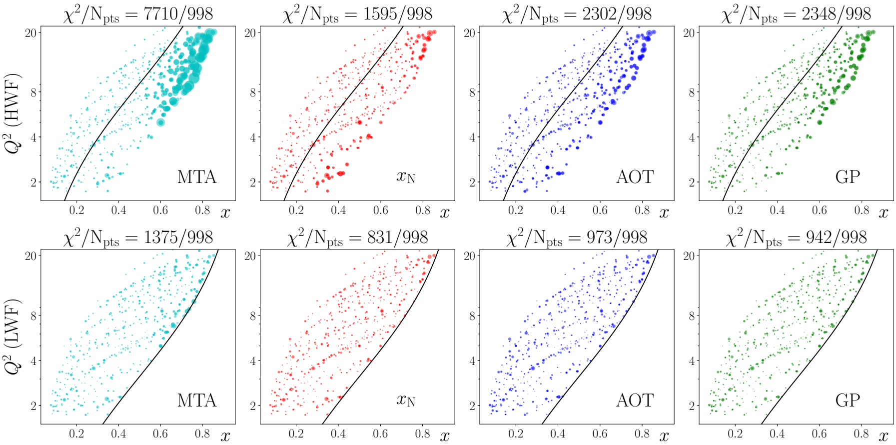
SLAC (p, d)



- Predictions of HWF fail even with any TMC
- The LWF give a good description for any TMC

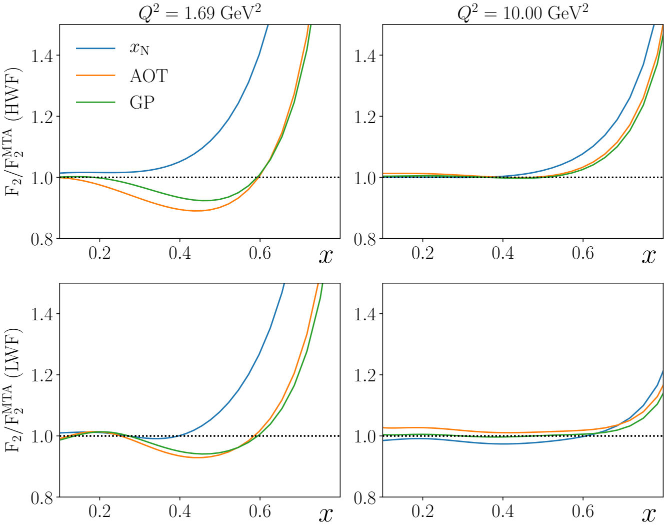
Results: Data vs. theory

SLAC (p, d)



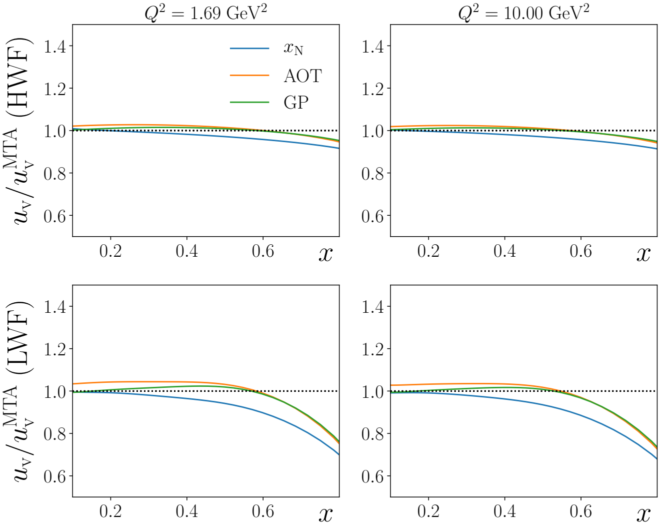
- Sizes of the blobs are proportional to χ^2
- TMC improves the description at large x and $Q^2 \sim 8\ \mathrm{GeV}^2$

Results: F_2



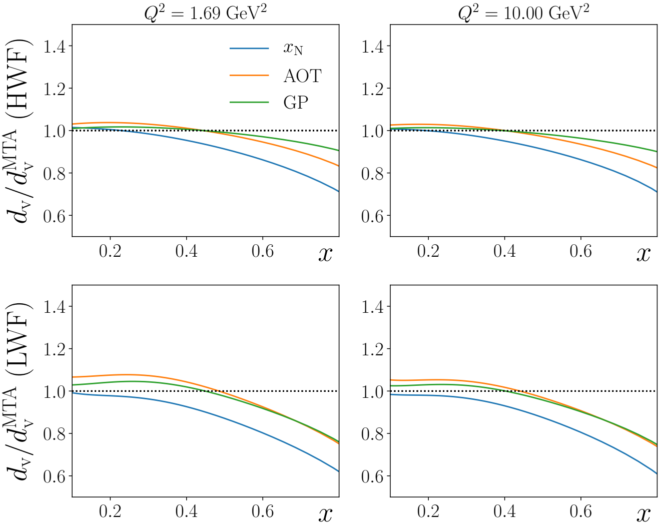
- AOT and GP gives similar results
- x_N differs from AOT and MTA

Results: u_V PDF



- TMC with HWF are basically compatible
- Inclusion of high-x data do change PDFs

Results: d_v PDF



- The change in d_v relative to u_v indicates onset of nuclear effects

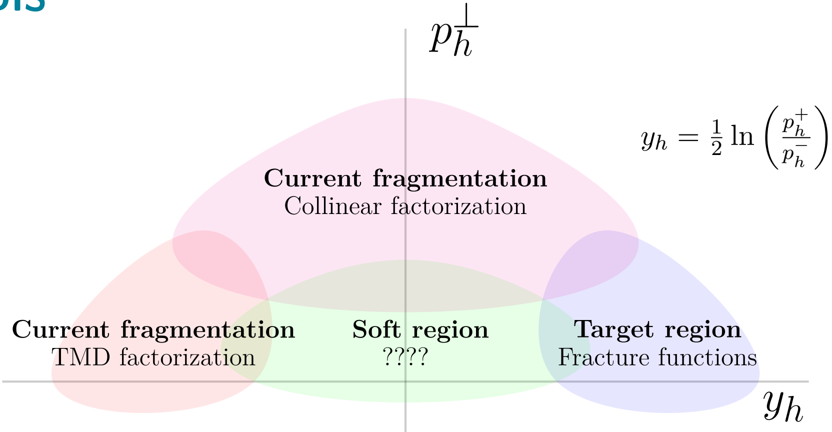
Discussion

Discussion

- **What do we leaned?**
  - TMCs(x_{N}, AOT, GP) improves the data/theory agreement at large-x
  - TMCs(AOT, GP) at **LWF** give same PDFs/F2
  - Are the PDFs at high-x universal? or just curve fitting?
    $\rightarrow$ need to validate high-x PDFs in other observables

- **High-x sensitive observables**
  - Lattice QCD: quasi-PDFs, pseudo-PDFs
  - Collider data: W lepton asymmetry, ...
  - Large p_{T} spectrum in SIDIS

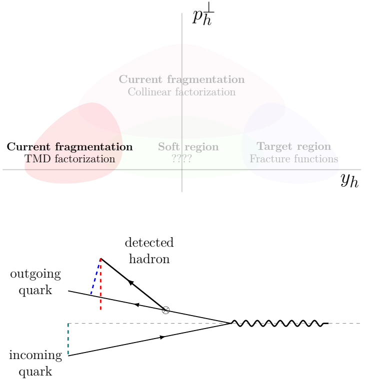
SIDIS



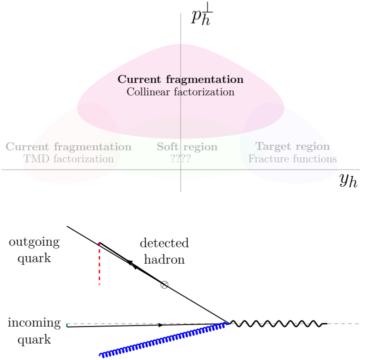
- **Different regions** are sensitive to distinct physical mechanisms

Theory framework for current fragmentation

small transverse momentum W



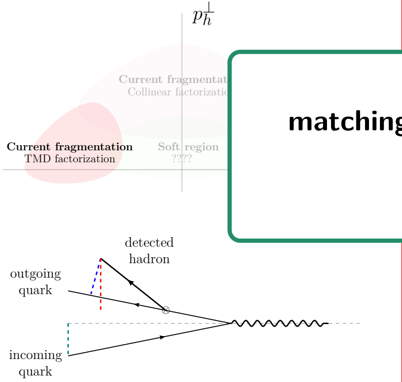
large transverse momentum FO



Theory framework for current fragmentation

small transverse momentum

W

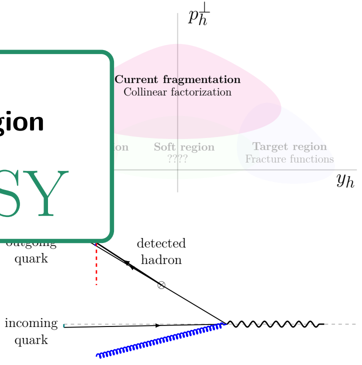


matching region

ASY

large transverse momentum

FO



The large p_{T} SIDIS

- **The p_{T} cross section @ LO**

$$\frac{d\sigma}{dx dQ^2 dz dp_{\mathrm{T}}} \sim \sum_q e_q^2 \int_{\frac{q_{\mathrm{T}}^2}{Q^2}\frac{xz}{1-z}+x}^{1} \frac{d\xi}{\xi - x} f_q(\xi,\mu)\ d_q(\zeta(\xi),\mu)\ H(\xi)$$

- **Comments**:
  - $\xi_{\min}$ is q_{T} dependent $\rightarrow$ SIDIS can constrain high-x
  - It offers flavor separation by looking at π and K
  - gluon initiated subprocess enters at LO $\rightarrow$ constraints on high-x gluons

Summary and outlook

- **Challenges at high-x**
  + Establish a TMC theory consistent with factorization
  + What can we learn from data and TMCs?
  + High-x PDF validation $\rightarrow$ predictive power