Complementarity of EIC and LHC: TMDs and GPDs

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July 30, 2021, Hadron 2021

TMDs

- **Unpolarised quark TMDs**:
  - **LHC data** for *Z/W* production extremely important for quark TMD **PDFs**,
  - large lever arm in Q allows to probe **non-perturbative evolution**,
  - it is very important to characterise **theoretical uncertainties**:
    - **N³LL(‘)** accurate calculations at low q_T vs. **sub-percent** experimental uncertainties.
    - Fundamental for a faithful extraction of M_W.
  - Can TMD flavour dependence play a role?
  - Can other observables, such as φ^*, be used to constrain TMD PDFs?
  - The LHC tells us nothing on **TMD FFs**.
  - Here the **EIC** comes to rescue:
    - **SIDIS** does depend on FFs (better to measure cross sections or multiplicities?),
    - wide **kinematic coverage** (complementary to HERMES, COMPASS, and JLab),
    - Also TMD PDFs are probed in a kinematic region complementary to the LHC (lower x).

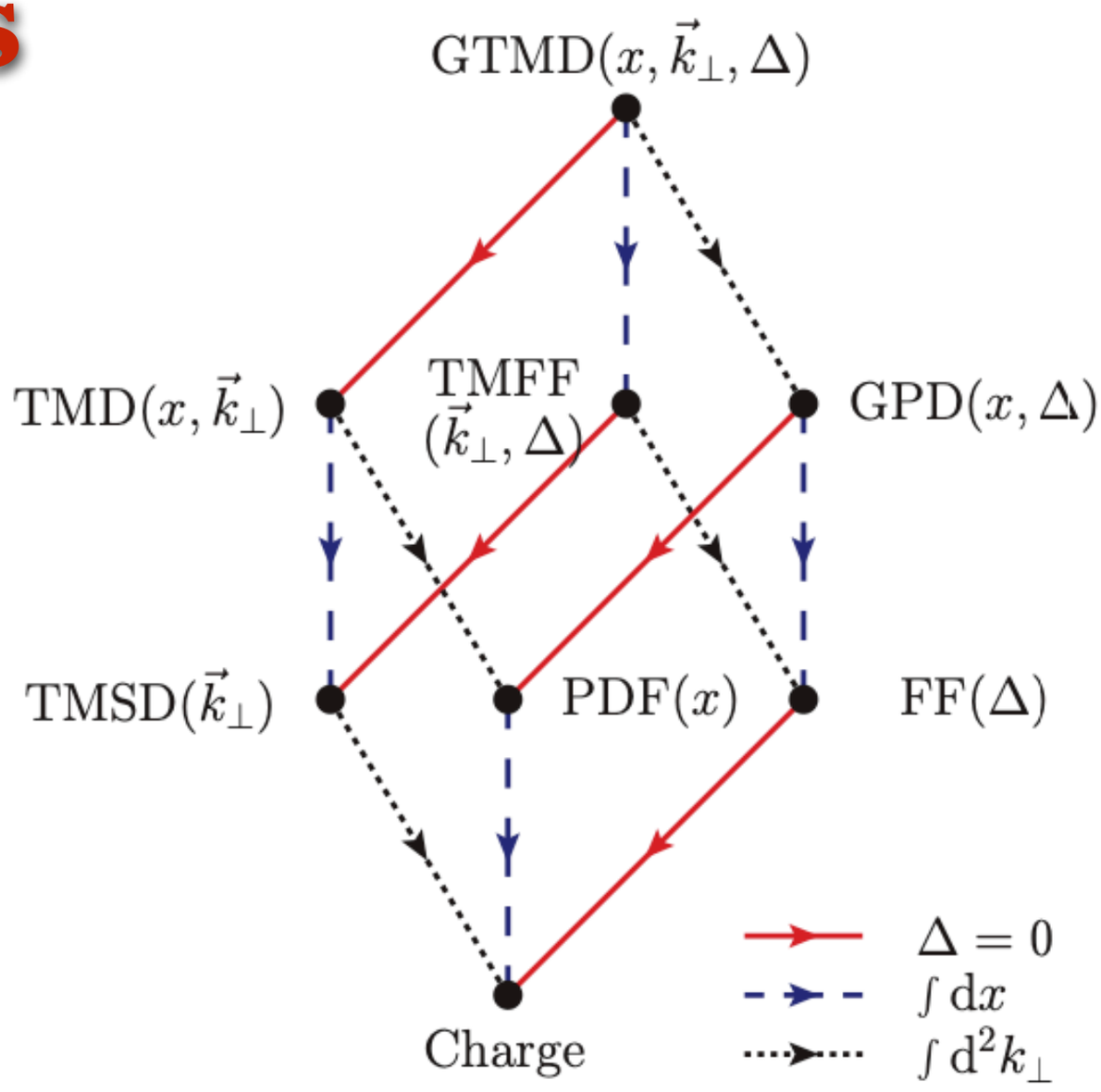
TMDs

- **Unpolarised gluon TMD**:
  - very little is known so far.
  - Hard to probe at the **LHC**:
    - data for **Higgs production in gluon fusion** can say something:
      - how about the impact of the Boer-Mulders (linearly polarised) gluon TMD?
    - **quarkonium** or **jet** production? Factorisation issues at low q_T.
  - As a consequence the **EIC** is expected to give a dramatic contribution:
    - **quarkonium** and **jet** production at low q_T are promising channels.
    - The theoretical understanding of quarkonium production in DIS has recently seen a boost.
- **Sivers TMDs**:
  - the LHC has very little to say here.
  - a handful of datapoint for TSSA from COMPASS/HERMES/Jlab/STAR,
  - match onto the **Qiu-Sterman** (twist-3) distributions mostly unknown.
  - Again, the **EIC** is expected to have a tremendous impact on the Sivers TMDs.

GPDs

- The **LHC** does not have a prominent exclusive-physics program:
  - exclusive forward J/ψ and Υ production from LHCb sensitive to the gluon GPD,
  - elastic photon production in heavy-ion collisions?
- The **EIC** is thus crucial to advance our understanding of GPDs.
- Phenomenological extractions of GPDs at the EIC require:
  - **evolution** effects be included,
  - "classical" DVSC does uniquely disentangle GPDs (deconvolution problem).
  - A **multichannel** analysis is required, possibly including data for:
    - timelike Compton scattering,
    - exclusive vector meson-production (how about DAs?),
    - double DVCS (hard to measure experimentally),
    - anything else?

GTMDs



[Lorcé, Pasquini, Vanderhaegen, arXiv:1102.4704]

- GTMDs are the mother distributions of all one-body distributions:
  - no direct experimental access (?), only through their projections.
  - Reduce to TMDs in the forward limit $\Delta \to 0$,
  - reduce to GPDs upon integration over k_T (divergent → collinear evolution).
  - Any information on these projections can be translated into information on GTMDs:
    - This requires a model,
    - approaches like the LCWF overlap representation exist to model them.