INT 18-3 program

Week II - TMDs and Transverse Spin

H. Avakian
A. Bacchetta
D. Boer
Z. Kang

Main Goal

Update and extend TMD section of “Yellow Report” arXiv:1108.1713 and “White Paper” arXiv:1212.1701

Main Goal

Update and extend TMD section of "Yellow Report" arXiv:1108.1713 and "White Paper" arXiv:1212.1701

arXiv:1108.1713

Main Goal

Update and extend TMD section of “Yellow Report” arXiv:1108.1713 and “White Paper” arXiv:1212.1701

arXiv:1108.1713

arXiv:1212.1701

TMD "science matrix"

Deliverables	Observables	What we learn
Sivers & unpolarized TMD quarks and gluon	SIDIS with transverse polarization; di-hadron (di-jet)	Quantum interference & spin-orbital correlations 3D Imaging of quark's motion: valence + sea 3D Imaging of gluon's motion QCD dynamics in an unprecedented Q^2 (P_{hT}) range
Chiral-odd functions: transversity; Boer-Mulders	SIDIS with transverse polarization	3rd basic quark PDF: valence + sea, tensor charge Novel spin-dependent hadronization effect QCD dynamics in a chiral-odd sector with a wide Q^2 (P_{hT}) coverage

p. 94 of arXiv:1108.1713 and p. 41 of arXiv:1212.1701

TMD motivation from "White Paper"

- *3D-imaging.* The TMDs represent the intrinsic motion of partons inside the nucleon (confined motion!) and allow reconstruction of the nucleon structure in momentum space. Such information, when combined with the analogous information on the parton spatial distribution from GPDs, leads to a 3-dimensional imaging of the nucleon.

- *Orbital motion.* Most TMDs would vanish in the absence of parton orbital angular momentum, and thus enable us to quantify the amount of orbital motion.

- *Spin-orbit correlations.* Most TMDs and related observables are due to couplings of the transverse momentum of quarks with the spin of the nucleon (or the quark). Spin-orbit correlations in QCD, akin to those in hydrogen atoms and topological insulators, can therefore be studied.

- *Gauge invariance and universality.* The origin of some TMDs and related spin asymmetries, at the partonic level, depend on fundamental properties of QCD, such as its color gauge invariance. This leads to clear differences between TMDs in different processes, which can be experimentally tested.

TMD motivation from "White Paper"

- *3D-imaging.* The TMDs represent the intrinsic motion of partons inside the nucleon (confined motion!) and allow reconstruction of the nucleon structure in momentum space. Such information, when combined with the analogous information on the parton spatial distribution from GPDs, leads to a 3-dimensional imaging of the nucleon.

- *Orbital motion.* Most TMDs would vanish in the absence of parton orbital angular momentum, and thus enable us to quantify the amount of orbital motion.

- *Spin-orbit correlations.* Most TMDs and related observables are due to couplings of the transverse momentum of quarks with the spin of the nucleon (or the quark). Spin-orbit correlations in QCD, akin to those in hydrogen atoms and topological insulators, can therefore be studied.

- *Gauge invariance and universality.* The origin of some TMDs and related spin asymmetries, at the partonic level, depend on fundamental properties of QCD, such as its color gauge invariance. This leads to clear differences between TMDs in different processes, which can be experimentally tested.

Can we make it even more appealing?

Main topics of this week

Main topics of this week

- Unpolarized quark TMD phenomenology

Main topics of this week

- Unpolarized quark TMD phenomenology
- Sivers TMD phenomenology

Main topics of this week

- Unpolarized quark TMD phenomenology
- Sivers TMD phenomenology
- Transversity and Collins function phenomenology

Main topics of this week

- Unpolarized quark TMD phenomenology
- Sivers TMD phenomenology
- Transversity and Collins function phenomenology
- Gluon TMDs unpolarized + polarised

Main topics of this week

- Unpolarized quark TMD phenomenology
- Sivers TMD phenomenology
- Transversity and Collins function phenomenology
- Gluon TMDs unpolarized + polarised
- Jet TMDs (hadron-in-jet, photon-jet, jet-jet…)

Main topics of this week

- Unpolarized quark TMD phenomenology
- Sivers TMD phenomenology
- Transversity and Collins function phenomenology
- Gluon TMDs unpolarized + polarised
- Jet TMDs (hadron-in-jet, photon-jet, jet-jet…)
- Higher twist

Connections with other weeks

- GPDs
- Low-x physics
- Nuclear modifications

Connections with other topics

- Lattice QCD
- Precision computations in jet physics
- Search for physics Beyond the Standard Model

Open questions

- Where can we trust the formalism?
- How much do we need to know about TMD Fragmentation Functions?
- How much do we need from other experiments?
- How good is the status of gluon TMD theoretical framework?
- …

Suggestions/requests

- Talks should be 30 min. + 10 min. discussion
- Please, keep focus on EIC physics
- Feel free to ask questions during the talk
- “Brainstorming” is encouraged
- At some point, let’s be as concrete as possible
- We will collect proceedings from all of you