

TMD and collinear factorization: some points for discussion

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Pre-POETIC focus meeting, Berkeley, 16 September 2019

HELMHOLTZ RESEARCH FOR
GRAND CHALLENGES



A few slides as discussion starter on:

- ▶ the q_T spectrum in SIDIS and in Drell-Yan
- ▶ the $\cos \varphi$ and $\cos 2\varphi$ asymmetries
- ▶ TMD matching to twist-three collinear distributions

Disclaimer: references will be only indicative, to most recent work,
and **by no means** complete

The q_T spectrum in SIDIS and in Drell-Yan

- ▶ theory: TMD factorization at low q_T and collinear factorization at high q_T match
- ▶ seems to work well for Z or W production at LHC
- ▶ but: serious problems reported in regime $q_T \sim Q$ for
 - Drell-Yan (talk by Werner Vogelsang in this session)
 - SIDIS (O Gonzalez-Fernandez et al, arXiv:1808.04396)

culprit(s)? \sqrt{s} , Q , q_T ? power corrections, ... ?? PDFs and FFs ???

- ▶ TMD factorization from the 'intrinsic k_T ' to the 'matched' q_T regime
Bertone, Scimemi, Vladimirov, arXiv:1902.08474
how well does it work? what are next steps?
- ▶ interpolating between TMD and (fixed-order) collinear descriptions
Collins et al, arXiv:1605.00671
where do we stand?

The $\cos \varphi$ and $\cos 2\varphi$ asymmetries in SIDIS and Drell-Yan

▶ $\cos 2\varphi$

- TMDs: Boer-Mulders (and Collins) functions
collinear regime: 'straightforward twist-two effect'
- twist-2 TMD and collinear descriptions do not match at intermediate q_T but extend to power-suppressed terms in the other regime
- Drell-Yan analysis of [Lambertsen, Vogelsang, arXiv:1605.02625](#) leaves little space for Boer-Mulders effect

▶ $\cos \varphi$

- in TMD regime is a twist-three effect (including Cahn effect)
- matching with collinear description requires control over twist-three TMD factorization
does it even hold?
- recent work by [Bacchetta et al, arXiv:1906.07037](#) and previous attempts
where do we stand?

TMD matching to twist-three collinear distributions

- ▶ several TMDs (including Sivers, Boer-Mulders) match to twist-three collinear distributions at high k_T
- ▶ matching at NLO ($\mathcal{O}(\alpha_s)$, one-loop): [talk by Andrey Tarasov in this session](#)
- ▶ twist-three distributions (fcts of **two** momentum fractions) poorly known
can we envisage a 'global twist-three' phenomenology?
what would be needed?
- ▶ matching TMD and collinear factorization: verified at lowest order
[Ji, Qiu, Vogelsang, Yuan 2016](#)
can we go to NLO? can we envisage interpolation and phenomenology?