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Editorial

Transverse Momentum Dependent Observables from Low to High Energy: Factorization, Evolution, and Global Analyses

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Transverse momentum dependent (TMD) observables in high-energy particle collisions allow one to study the motion of hadron constituents (partons) in three dimensions. The intense theoretical, phenomenological, and experimental work over the last several decades has seen great progress in modeling and extracting TMD parton distribution functions (PDFs) and fragmentation functions (FFs) [1, 2]. The wealth of experimental data, both current and future [3–6], across various reactions and energy ranges, along with substantial progress in other approaches, such as Lattice QCD [7], has increased the demand to rigorously study the intrinsic transverse motion of hadrons. Such issues currently being addressed include factorization, evolution, and operator definitions of TMD distributions, as well as how they influence phenomenological and Lattice QCD studies.

Therefore, in this special issue we attempt to further the effort of understanding TMD structure through a series of review articles that address some of the significant areas of ongoing research.

I. Scimemi provided an overview of the tools and concepts which are behind TMD factorization and evolution. He considered both theoretical and phenomenological aspects and the importance of future collider data on further developments.

G. Bozzi and A. Signori focused on the possible flavor dependence of quark intrinsic transverse momentum. They studied the transverse momentum spectrum of electroweak gauge bosons produced in proton-proton collisions at the Large Hadron Collider and showed that flavor-dependent TMD effects are comparable in size to other nonperturbative effects.

X. Wang and Z. Lu presented the current understanding of the pion-nucleon Drell-Yan process from the point of view of TMD factorization. They studied the unpolarized cross-section, the Sivers asymmetry, and the double Boer-Mulders effects.

J. Gaunt and T. Kasemets described the status of transverse momentum dependence in double parton scattering (DPS). They emphasized the differences and similarities to TMD single parton scattering as well as the status of the factorization of double color-singlet production in DPS.

H. Xing and S. Yoshida introduced the techniques for next-to-leading order (NLO) calculations of TMD-weighted single-spin asymmetries, which can serve as a useful tool to derive the QCD evolution equations for twist-3 functions and to verify the QCD collinear factorization for twist-3 observables at NLO.

K. Cichy and M. Constantinou gave an extensive, detailed review of Lattice QCD analyses of quasi-PDFs, including theoretical and practical developments and future challenges. They also reviewed numerical results and the theoretical validation of the approach as well as alternative strategies for analyzing PDFs on the lattice.

This special issue gives a nice overview of the various avenues of research currently explored within the community. The papers do well to synthesize and elucidate the

state-of-the-art theoretical, phenomenological, and Lattice QCD frameworks of TMD distributions and TMD observables. We hope that the reader will not only gain knowledge from the breadth and depth of this work but also be motivated to engage in their own studies that are required in order to meet the demands of ongoing and future measurements.

Conflicts of Interest

The editors declare that they have no conflicts of interest regarding the publication of this special issue.

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References

[1] M. Grosse Perdekamp and F. Yuan, "Transverse spin structure of the nucleon," *Annual Review of Nuclear and Particle Science*, vol. 65, artilce no. 429, 2015.

[2] A. Bacchetta, "Where do we stand with a 3-D picture of the proton?" *The European Physical Journal A*, vol. 52, no. 6, article no. 163, 2016.

[3] J. Dudek, R. Ent, R. Essig et al., "Physics opportunities with the 12 GeV upgrade at jefferson lab," *The European Physical Journal A*, vol. 48, article no. 187, 2012.

[4] D. Boer, M. Diehl, R. Milner et al., "Gluons and the quark sea at high energies: distributions, polarization, tomography," *Nuclear Theory*, 547 pages, 2011, https://arxiv.org/abs/1108.1713v2.

[5] A. Accardi, J. L. Albacete, M. Anselmino et al., "Electron ion collider: the next qcd frontier - understanding the glue that binds us all," *The European Physical Journal A*, vol. 52, no. 9, article no. 268, 164 pages, 2016.

[6] E. C. Aschenauer, C. Aidala, A. Bazilevsky et al., "The RHIC cold QCD plan for 2017 to 2023: a portal to the EIC," https://arxiv.org/abs/1602.03922.

[7] H. W. Lin, E. R. Nocera, F. Olness et al., "Parton distributions and lattice QCD calculations: a community white paper," *High Energy Physics*, vol. 100, article no. 107, 80 pages, 2018.