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Stress-testing factorization techniques: quantitative results in scalar Yukawa field theory

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Factorization theorems have long been a successful and elegant tool to describe and interpret hadronic structure. The early parton model picture, first developed by Feynman, has now been generalized past the leading power description of inclusive processes like deep inelastic scattering (DIS) to semi-inclusive ones like SIDIS and much more. However, a consistent description of both collinear and TMD distribution functions is still not agreed upon along with the limits of the factorization program. The inherent complexity of QCD prohibits a direct test of factorization but any other simpler renormalizable theory can be adopted to stress-test its validity and the schemes regularly used to describe physical observables like cross sections and structure functions.

A scalar Yukawa model, free of gauge degrees of freedom, can be studied as toy-model to quantitatively tackle issues such as the positivity of collinear PDFs (and FFs) and their possible definitions as the integrated versions of TMD distributions. The performance of the well known b_* prescription can also be compared directly along with quantitative results on the role of the W and Y term in the description of TMD observables.

The information obtained by studying a simpler model that still retains some of the features of QCD could shed light onto many of the standard schemes employed in regular QCD and cast some doubts on the various assumptions that are made.

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