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First Determination of the Collins–Soper Kernel using Lattice QCD in a Neural Network TMD fit

We present the first proof of concept extraction using neural networks (NNs) of the unpolarized transverse-momentum distributions (TMDs) at next-to-next-to-next-to-leading logarithmic (N^3LL) accuracy. By offering a more flexible and adaptable approach, NNs overcome some of the limitations of traditional functional forms, providing a better description of data.
Moreover, we present the first joint study of the Collins–Soper kernel combining inputs from lattice QCD and TMD phenomenology. Using recent continuum-extrapolated lattice calculations of the kernel at 3 values of the lattice spacing, we assess their impact on a recent phenomenological extraction based on Neural Network parametrizations. We perform both Bayesian reweighing and, for the first time, a direct global fit including the 21 lattice data alongside about 500 experimental measurements. We
find that the inclusion of the lattice points shifts the central value of the non-perturbative parameter by 5\% and reduces its uncertainty by 30\%, highlighting the potential of lattice inputs to improve TMD extractions.

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