

The NNPDF4.0 aN³LO Parton Distributions

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We extend the existing next-to-next-to-leading order (NNLO) NNPDF4.0 sets of parton distribution functions (PDFs) to approximate next-to-next-to-next-to-leading order (aN³LO).

We construct an approximation to the N³LO splitting functions that includes all available partial information from both fixed-order computations and from small and large x resummation, and estimate the uncertainty on this approximation by varying the set of basis functions used to construct the approximation. We include known N³LO corrections to deep-inelastic scattering structure functions and extend the FONLL general-mass scheme to $\mathcal{O}(\alpha_s^3)$ accuracy.

We determine a set of aN³LO PDFs by accounting both for the uncertainty on splitting functions due to the incomplete knowledge of N³LO terms, and to the uncertainty related to missing higher corrections (MHOU), estimated by scale variation, through a theory covariance matrix formalism. We assess the perturbative stability of the resulting PDFs, we study the impact of MHOUs on them, and we compare our results to the aN³LO PDFs from the MSHT group. We examine the phenomenological impact of aN³LO corrections on parton luminosities at the LHC, and give a first assessment of the impact of aN³LO PDFs on the Higgs and Drell-Yan total production cross-sections.

We find that the aN³LO NNPDF4.0 PDFs are consistent within uncertainties with their NNLO counterparts, that they improve the description of the global dataset and the perturbative convergence of Higgs and Drell-Yan cross-sections, and that MHOUs on PDFs decrease substantially with the increase of perturbative order.

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