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Higher-order corrections for hadronic processes. — In order to fully exploit the physics potential of the LHC, quantum chromodynamics (QCD) must be understood as best as possible. Our research focuses on one particular aspect of this challenge, namely the evaluation of exact higher-order perturbative corrections to physical observables. Although straightforward in principle, computing perturbative results beyond leading order runs into a host of technical difficulties. One such issue is the presence of infrared (IR) divergences in intermediate steps of the calculation. These divergences must be consistently treated before any numerical predictions can be computed. A conceptually appealing approach to handling IR singularities is the construction of a subtraction scheme, the goal of which is to reshuffle divergences between various pieces of the calculation to obtain finite blocks that can be evaluated numerically.

One practical realization of a subtraction scheme at next-to-next-to-leading order (NNLO) accuracy is the CoLoRFulNNLO scheme. Recently, we have extended this method to deal with the production of color-singlet final states in hadronic processes. Such an extension involves the definition of so-called local subtraction terms [1], as well as the computation of the integrals of these terms over the momenta of unresolved partons [2]. In order to be able to perform the integrations analytically, it was necessary to develop new computer algebra tools for the fast partial fraction decomposition of complicated symbolic expressions. Our method and implementation, dubbed LinApart [3], publicly available at <https://github.com/fekeshazy/LinApart>, offers up to 4-5 orders of magnitude speed-up on complicated cases compared to standard tools such as the Apart routine in Mathematica, as shown in Figure 1.

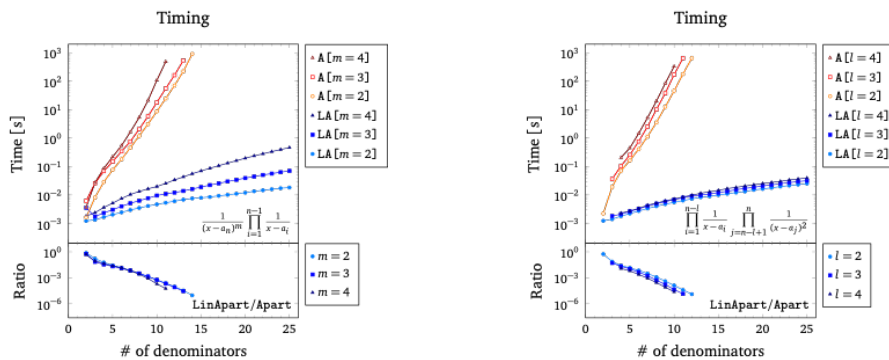


Figure 1. Timings of the native Mathematica routine Apart (A) and LinApart (LA) on rational functions of two different forms with n denominators. Figures taken from ref. [3].

The NNLOCAL code. — We have implemented the CoLoRFulNNLO method, described above, in the proof-of-concept parton-level Monte Carlo code NNLOCAL [4]. Our code provides the first public implementation of a fully local and analytic subtraction scheme at NNLO accuracy. It can be used to compute any infrared and collinear-safe observable via a user-defined analysis routine. The current public version of the code, available at <https://github.com/nnlocal/nnlocal.git>, deals with Higgs boson production in hadron collisions in the Higgs effective field theory (HEFT) with no light quarks. By way of illustration,

in Figure 2 we present the rapidity distribution of a Higgs boson of mass $m_H = 125$ GeV at the 13 TeV LHC.

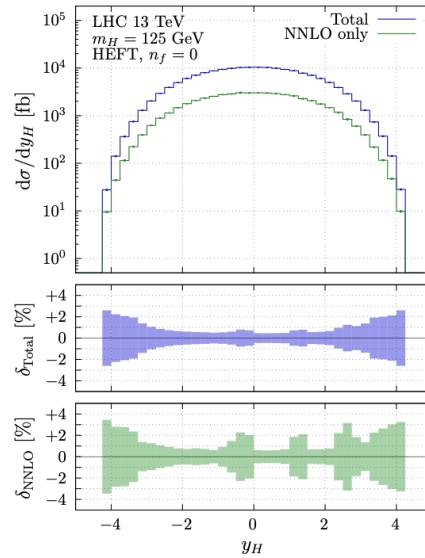


Figure 2. The rapidity distribution of the Higgs boson at NNLO in HEFT without light quarks at the 13 TeV LHC. Figure taken from ref. [4].

Currently, we are working on including all partonic channels for Higgs boson production as well as other processes, such as vector boson production in hadron collisions, in NNLOCAL. These developments will turn our code into a useful tool for computing NNLO QCD corrections to a plethora of important LHC processes.

References:

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