

NNLO QCD corrections to unpolarized and polarized SIDIS

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The semi-inclusive deep-inelastic scattering (SIDIS) process requires the presence of an identified hadron H' in the final state, which arises from the scattering of a lepton with an initial hadron P . By employing factorization in quantum chromodynamics (QCD), SIDIS provides essential knowledge on the hadron structure, enabling the exploration of parton distribution functions (PDFs) and fragmentation functions (FFs). The coefficient functions for SIDIS can be calculated in perturbative QCD and are currently known to the next-to-next-to-leading order (NNLO) for the cases, where the incoming lepton and the hadron P are either both polarized or unpolarized. We present a detailed description of these NNLO computations, including a thorough discussion of all the partonic channels, the calculation of the amplitudes and master integrals for the phase-space integration as well as the renormalization of ultraviolet divergences and mass factorization of infrared divergences in dimensional regularization through NNLO. We provide an extensive phenomenological analysis of the effects of NNLO corrections on SIDIS cross sections for different PDFs and FFs and various kinematics, including those of the future Electron-Ion Collider (EIC). We find that these corrections are not only significant but also crucial for reducing the dependence on the renormalization and factorization scales μ_R and μ_F to obtain stable predictions.

Presenter: PATHAK, Vaibhav (The Institute of Mathematical Sciences, Chennai)

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