SNAIL: Scattering Neutrinos on Atoms In the LHC

Abstract: *The Standard Model of Particle Physics remains a successful description of nature at small distances and high energies. Despite this, aspects of the model are still elusive, such as a precise understanding of how neutrinos interact with other types of matter, or a precise determination of the parity-violating structure of the proton and heavy nuclei. The 2023 observation of high-energy neutrinos emerging from proton collisions at CERN's Large Hadron Collider (LHC), however, establishes the LHC as a new neutrino deep-inelastic scattering (nuDIS) facility capable of reaching TeV scattering scales. Inspired by this and the 2021 publication of the anticipated neutrino fluxes for "forward physics" experiments, the "Scattering Neutrinos on Atoms In the LHC" (SNAIL) project aims to develop theoretical and computational frameworks to enable, for the first time, the simulation of arbitrary nuDIS processes with LHC neutrinos, up to next-to-leading order in quantum chromodynamics. By implementing these into the simulation tool MadGraph5aMC@NLO, SNAIL will explore the sensitivity to hadronic structure, nuclear structure, and new physics at nuDIS experiments using LHC neutrinos.*