Nuclear Parton Distributions with LHC Data

PhD Project
VU Amsterdam and Nikhef Theory group

Project description The understanding of the dynamics that determine the energy distribution of quarks and gluons inside protons, the *parton distribution functions* (PDFs), has experienced a series of dramatic breakthroughs in the recent years. A plethora of measurements from proton-proton collisions at the Large Hadron Collider (LHC) have been used to constrain the internal structure of protons, leading to improved theoretical predictions of direct relevance for many crucial areas of the scientific program of the LHC. A prime example here is the exploration of the properties of the recently discovered Higgs boson, which requires that the accuracy of experimental measurements is matched with that of the corresponding theory calculations.

In addition to proton-proton, the LHC also operates a heavy ion program with both lead-lead and proton-lead collisions. An important requirement for the characterization of the hot and dense medium created in these collisions, the Quark-Gluon Plasma, are the *nuclear parton distributions*, which encode how the energy distributions of quarks and gluons in free nucleons are modified when these are bound inside nuclei. Unfortunately, the determination of nuclear PDFs is currently in a less advanced stage than their proton counterparts, with available fits being based on limited datasets and affected by model-dependent assumptions.

The goal of this PhD project is to bridge this gap and achieve a state-of-the-art determination of nuclear PDFs by exploiting the information from proton-lead collisions at the LHC. These nuclear PDFs will be extracted from data by means of the NNPDF framework, a statistically robust fitting methodology based on Machine Learning methods such as Artificial Neural Networks and Genetic Algorithms. These studies will provide a unique window into cold nuclear matter and the inner workings of the strong interactions in a extreme regime, and provide an essential input for the heavy ion program of the LHC.

Practical information The PhD student will join the (astro)-particle physics group of the *Vrije Universiteit* (VU) of Amsterdam, which is embedded into the Nikhef theory group. Nikhef is the national institute for subatomic physics in The Netherlands, where approximately 175 physicists and 75 technical staff members work together in an open and international scientific environment. Together, they perform theoretical and experimental research in the fields of particle and astroparticle physics. The activities of the theory group include higher order calculations and jet physics in perturbative Quantum Chromodynamics, parton distribution functions, 3D imaging of the proton, flavour physics, gravity, and cosmology, among others. The Nikhef theory group and Nikhef as a laboratory provides a stimulating environment with many seminars, colloquia, and journal clubs meetings.

The duration of a PhD position in the Netherlands is four years. The PhD student will be member of the Dutch Research School of Theoretical Physics (DRSTP), offering a wide spectrum of activities and training opportunities. This position includes teaching duties, of up to 0.1FTE integrated along the duration of the project.

The starting date of the appointment is **Autumn 2017** or immediately thereafter.

Requirements The applicants should have a Master degree (or equivalent) in physics and good knowledge of Quantum Field Theory and the Standard Model. Applicants with excellent software skills, in particular in C++ and Python, are strongly encouraged.

Funding This PhD project is funded by a *Projectruimte* subsidy from the NWO, the Netherlands Organisation for Scientific Research, https://www.nwo.nl/en/.

Contact For more information about this project, please contact Dr. Juan Rojo at j.rojo@vu.nl. General information about the group can be found in www.juanrojo.com. Please submit your application materials using the link that can be found in:

https://www.nikhef.nl/jobs/vacatures/

which should include a cover letter, curriculum vitae, grade transcript and a brief motivational statement of your research interests. Moreover, the applicants should arrange for two letters of recommendation to be submitted on her/his behalf.

There is no deadline for applications to this position, which will remain open until the vacancy is filled.