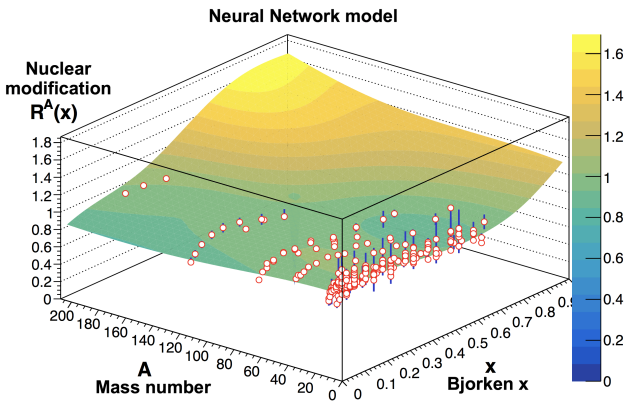
First Artificial Neural Network determination of nuclear parton distributions

Master project, Theoretical Physics & GRAPPA tracks, MSc Physics and Astronomy

Supervisors: PhD. Rabah Abdul Khalek and Dr. Juan Rojo.

A precise knowledge of the Parton Distribution Functions (PDFs) of the proton is essential in order to make predictions for the Standard Model and beyond the Standard Model processes at hadron colliders. The parton density function $f_i(x, Q^2)$ gives the probability of finding in the proton a parton of flavour i (quarks or gluon) carrying a fraction x of the proton momentum with Q being the energy scale of the hard interaction. Cross sections are calculated by convoluting the parton level cross section with the PDFs [1].



The presence of nuclear medium and collective phenomena which involve several nucleons modify the parton distribution functions of nuclei (nPDFs) compared to those of a free nucleon (PDFs). These modifications have been investigated by different groups using global analyses of high energy nuclear reaction world data resulting in modern nPDF parametrizations with error estimates, such as EPS09(s), HKN07 and nDS [2]. Although the PDFs in the nucleon are now known rather accurately, their nuclear modifications are not well determined. It is important to determine the NPDFs not only for establishing QCD in nuclei but also for applications to heavy-ion physics and neutrino reactions [3].

The student will join the ongoing effort in the determination of the first data-drive model of nPDFs, and will learn how to build his own Artificial Neural Networks (ANNs). Applications of ANNs range from pattern recognition (used by Google, Facebook, etc.) to the prediction of financial markets (DeepMind, Craftinity, etc.). In particular, ANN are now a well established technique in high energy physics [4], where they are used for event reconstruction in particle detectors (ATLAS, LHCb, etc.).

For more information about this project, please contact Dr. Juan Rojo at j.rojo@vu.nl.

References

[1] R. Placakyte, arXiv:1111.5452 [hep-ph].

[2] H. Honkanen, M. Strikman and V. Guzey, arXiv:1310.5879 [hep-ph].

[3] M. Hirai, S. Kumano and T.-H. Nagai, hep-ph/0408023.

[4] S. Forte, L. Garrido, J. I. Latorre and A. Piccione, JHEP 0205, 062 (2002) doi:10.1088/1126-6708/2002/05/062 [hep-ph/0204232].