Precise Phenomenology for Hadron Tomography in the Era of New Experiments

Despite the great success of the description of strong interactions within the framework of the quantum chromodynamics, it is still not clear how the quarks and gluons are bound inside the hadrons, even in the case of the proton and neutron, the fundamental building blocks of the atomic nucleus. In particular, it is not understood how the spin of the nucleons emerges out of complicated interactions of the quarks and gluons. During the past few decades the main effort to solve that problem focused mostly on the inclusive scattering, in which properties of only some of the final particles are measured. Lately, experiments with exclusive scattering, where all of the final state particles are identified, attracted a lot of attention. Their description in terms of Generalized Parton Distribution allows hadron tomography, *i.e.* the three-dimensional imaging of their structure.

After exploratory experiments on Deeply Virtual Compton Scattering and Deeply Virtual Meson Production in JLab, DESY and CERN, and almost 20 years of theoretical effort, the effectiveness of the GPD formalism has been proved. Nowadays, the measurements of exclusive processes are among the main goals of the experimental programmes carried out by the new generation of experiments - those already running, like Hall-A with CLAS at JLab upgraded to 12 GeV and COMPASS-II at CERN, and those foreseen in the future, like Electron Ion Collider (EIC) and Large Hardron Electron Collider (LHeC) . All those new experiments aim to provide very precise data for various exclusive channels and therefore also much detailed theoretical description is needed.

The main goal of the proposed programme is the creation of a precise description of exclusive processes and an extraction of GPD information from the experimental data. Four main goals that we want to accomplish are: analysis of many channels, improved precision through inclusion of the effects not accounted for in the earlier studies, development of new GPD models respecting all theoretical constraints, extraction of GPD information through fits to the experimental data.

All elements of the proposed research programme require both use and development of the PARTONS software platform. PARTONS (PARtonic Tomography Of Nucleon Software) is a C++ framework dedicated to the theory and phenomenology of GPDs, providing a necessary bridge between models of GPDs and experimental data measured in various exclusive processes. We plan also to use several modern computing algorithms. The most important are artificial neural networks, with the ability of parameterizing the most complex problems in an almost unbiased way, and genetic algorithm, which mimics the process of natural selection known from Nature to solve even the most convoluted problems.