Quantum chromodynamics (QCD) provides a commonly accepted description of hadrons. In this theory quarks and gluons appear as fundamental building blocks of hadronic structures. Attributes of partons are therefore the basic degrees of freedom of which macroscopic properties of hadrons, like charge and spin, emerge. The questions that arise are: how distributions of longitudinal and transverse momenta of partons look like? How partons are spatially distributed in hadrons? What are the pressure and the shear stress in partonic media at a given point in space? Finally, how all those properties change when a hadron is polarised, e.g. how an external transverse magnetic field deforms spatial distributions of partons? Despite a very active progress towards understanding of hadronic structures, in particular that of proton, finding answers to those questions still remains among the main challenges faced by nuclear and high energy physics.

QCD factorisation theorems provide us with tools to answer all of the afore-mentioned questions. In particular, generalised parton distributions (GPDs) offer a rigorous theoretical framework that can be used to study 3D structure of nucleons. Those objects can be used to obtain tomographic pictures of the nucleon, where spatial distributions of partons carrying a fraction of nucleon's momentum are projected in the plane perpendicular to the direction of nucleon's motion. Those pictures reveal a true nature of the nucleon, as in the framework of GPDs hadrons are depicted as extended objects made out of quarks and gluons. Another exciting feature of GPDs is their relation to QCD energy-momentum tensor, which otherwise would be accessible only via graviton scattering. This unique relation allows one to evaluate total angular momentum carried by gluons or quarks of a given flavour, which is essential to solve the long-standing problem of nucleon's spin decomposition that has emerged 30 years ago with the measurements of EMC experiment. The relation between GPDs and energy-momentum tensor can be also used to access information on ”mechanical” properties of partonic systems, like a distribution of pressure inside the nucleon. This may help to understand properties of partonic media and shed some light upon the stability of proton.

The proposed research program aims in the exploration of hadron structures in the formalism of GPDs. The proposed research tasks are: i) analysis of amplitudes for exclusive meson production, ii) study of nuclear effects and initial stages, iii) development of a new Monte Carlo generator for exclusive reactions, and iv) development of re-weighing methods. Those four tasks compose a coherent research program that will significantly improve our understanding of nucleon and nuclear structures. Theory and phenomenology of GPDs, as well as novel computing tools will be developed. The proposed project will be useful for all current and foreseen experiments exploring hadron structures via exclusive reactions. In particular, it will be of great importance for building the physics case for measuring GPDs at electron-ion collider (EIC) that will be build in USA.