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Generalized Parton Distributions and their covariant extension

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The internal structure of hadrons (which are bound-states of quarks and gluons, such as the proton or pion) is difficult to map due to the non-perturbative QCD regime in which the constituents interact. Decades of experiments in the field have allowed us to learn a lot about the distribution of momentum (through what is called parton distribution functions, PDFs) or transverse plane position (through Form Factors). We can generalize these two concepts into Generalized Parton Distributions (GPDs), which encode the correlations between longitudinal momentum and transverse position of partons.

The goal of this work is to model nucleon GPDs ab initio. We can mention for example the Dyson-Schwinger framework, one of such possibilities for calculations as close as possible to QCD. The path to GPDs can then go through Light-cone wave-functions, which allow to fulfil one important property of GPDs, called positivity. The issue is that the information is often limited in terms of physical region. But, taking advantage of another property of GPDs, called polynomiality, related to Lorentz invariance of the theory, we can extend the GPD to the complete domain. This is done through the inversion of a Radon transform (which is a mathematical tool often used in computerized tomography). This is the first systematic procedure yielding consistent GPD models fulfilling a priori all theoretical constrains.

Auteur principal: M. CHOUIKA, Nabil (Irfu/SPhN - CEA Saclay)

Orateur: M. CHOUIKA, Nabil (Irfu/SPhN - CEA Saclay)

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