Abstract

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Title of the thesis: EXPANDING THE ACCESSIBLE KINEMATIC DOMAIN OF GENERALIZED PARTON DISTRIBUTIONS

Quantum Chromodynamics (QCD) is the theoretical framework to study hadrons by means of their fundamental degrees of freedom, i.e. quarks and gluons, collectively referred to as partons. QCD defines many types of distributions describing a given nucleon in terms of partons. In this doctoral dissertation, we are interested in the so-called generalized parton distributions (GPDs). GPDs are off-forward matrix elements of quark and gluon operators that serve as a window to the total angular momentum of partons and their transverse imaging (nucleon tomography).

GPDs arise from the factorization that takes place in scattering amplitudes when a particle probing the hadron, typically a virtual photon, is considered in the limit of infinite virtuality. This is known as the kinematic leading twist (LT). GPDs are accessed in exclusive process where the states of all incoming and outgoing particles are measured. Three such processes, which are prominent for current and near-future experimental programmes, are: deeply virtual Compton scattering (DVCS), timelike Compton scattering (TCS) and double deeply virtual Compton scattering (DDVCS). Current and future data can not be considered as a practical realization of the aforementioned LT approximation, suggesting the need for corrections inversely proportional to the photon virtuality. In QCD, these ones are referred to as kinematic and genuine higher-twist corrections.

At the lowest approximation, DVCS and TCS grant access to GPDs in a particular region of the partonic kinematics. Such a limitation is not present in DDVCS, which serves as the main motivation for this doctoral project. Since DVCS and TCS are special limits of DDVCS, this project also provides a consistent framework for the description of the three processes. Therefore, as a first task, we consider DDVCS at leading order (LO) in the strong coupling constant and LT, and address the feasibility of measuring it at current and future experiments. As indicated above, since these experiments do not fulfill the conditions for a correct LT description, our next task is to calculate the kinematic twist corrections for DDVCS at LO. From the formulation of DDVCS, we can obtain the corresponding corrections for DVCS and TCS and finally provide numerical estimates of these effects, leaving aside the genuine higher-twist corrections which are a difficult and separate subject.