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Transverse proton structure via double parton scattering in photon-induced interactions

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In this contribution, we discuss the possibilities and advantages of observing double parton scattering (DPS) in photon-proton interactions. In general, DPS measurements give access to double parton distribution functions of the protons. These distributions represent a novel and promising tool, to access the 3D partonic structure of the proton, complementary to TMDs and GPDs. In fact, dPDFs encode double parton correlations in hadrons which cannot be accessed through, e.g., GPDs. Up to date, however, dPDFs are almost unknown, in particular, their dependence on the transverse distance of partons which is critical in DPS estimates.

In our previous analyses we discussed the impact of both perturbative and non perturbative double parton correlations in dPDFs. In addition, our collaboration also investigated how these effects affect an experimental observable called effective cross section, σ_{eff}. However, in proton-proton collisions, the information on the partonic proton structure are quite limited due to the lack of information on dPDFs and their relative first moment called effective form factor (eff), the latter entering the definition of σ_{eff}.

Therefore we propose to look for DPS in processes initiated by quasireal photon. In such photoproduction processes, the offshellness of the photons is controlled by measuring leptons, proton, or ions from the impinging beam scattered at low angle. At such low virtualities, the photon will fluctuate hadronically or electromagnetically in a $q\bar{q}$ pair which will then initiate a double parton scattering interacting on the proton.

The key idea is that measuring the virtuality of the quasi real photon
one is effectively controlling its transverse size and therefore appreciate
its interaction rate in the DPS mechanism offering information on the transverse
proton structure. In our analysis we prove that the dependence of
$\sigma_{eff}^{\gamma p}$ on the photon virtuality Q^2 could be quasi-directly
related to the mean transverse distance between two partons in the proton active
in the DPS process. Moreover, different models of the photon and proton effs
have been used to calculate, for the first time, $\sigma_{eff}^{\gamma p}(Q^2)$.

These results have been then used to estimate the DPS cross section for the
four jets production via DPS in HERA kinematics, since in this channel
collaborations reported significant MPI effects on the four jets cross section,
and exposed in their analyses possible contamination of the DPS processes.
By estimating the expected number of events
at integrated luminosity within reach at future facilities,
we conclude that DPS processes in photoproduction
gives a significant fraction of the four jet production cross sections,
if cuts on transverse momenta of the jets are low enough.
Moreover, the DPS peculiar dependence on Q^2 could be tested against models
of the photon and proton transverse structure, with the possibility to consider
even more exotic final states, involving, for example, single or double quarkonia.

Author: CECCOPIERI, Federico Alberto

Co-authors: Mr TRAINI, Marco; SCOPETTA, Sergio; VENTO, Vicente

Presenter: RINALDI, Matteo (Perugia University and INFN, Perugia)

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