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Deeply Virtual Compton Scattering at HERMES

Jennifer Bowles[*†]
School of Physics and Astronomy, University of Glasgow, Glasgow G12 8QQ, United Kingdom
E-mail: j.bowles@physics.gla.ac.uk

The HERMES experiment at DESY, Hamburg used the HERA 27.6GeV electron/positron polarised beam to study the structure of the nucleon. Deeply Virtual Compton Scattering (DVCS) provides access to Generalised Parton Distributions (GPDs) via measured azimuthal asymmetries. Data was collected from 1995 to 2007 with both longitudinally and transversely polarised gas targets(H, D or heavier nuclei), which has been analysed to provide the most diverse set of DVCS azimuthal asymmetries. A Recoil Detector was installed in 2005-2006, which has provided improved exclusivity of the beam spin asymmetry measurement. The latest DVCS results from HERMES will be presented including the first result from the Recoil Detector.

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[*]Speaker.
[†]On behalf of the HERMES Collaboration

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1. Introduction

At present the theoretically cleanest way of accessing Generalised Parton Distributions is via the hard exclusive leptoproduction of real photons on nucleons, Deeply Virtual Compton Scattering (DVCS). The framework of GPDS provide a wealth of information on the nucleon structure encompassing parton distribution functions and form factors as limiting cases and moments of GPDs, respectively. They also include correlated information on the transverse spatial distribution of the partons and the fraction of the longitudinal momentum of the nucleon carried by that parton [1] and a way to access the total angular momentum of the constituent partons [2].

For the proton there are four chiral-even GPDs at leading twist $H, E, \tilde{H}$ and $\tilde{E}$. They depend on three kinematic variables: the squared four-momentum transfer to the nucleon, t, the average longitudinal momentum fraction of the nucleon carried by the active quark x and ξ which is half the difference of the longitudinal momentum fraction carried by the quark. The DVCS process is experimentally indistinguishable from the Bethe-Heitler (BH) process as they have an identical final state.

The cross section of exclusive leptoproduction of a real photon can be written as [3]

$$\frac{d\sigma}{dx_B Q^2 dt d\phi} = \frac{\alpha^3 x_B y}{16\pi^2 Q^2 e^3} \frac{2\pi y}{Q^2} \frac{|T_{DVCS}|^2 + |T_{BH}|^2 + I}{\sqrt{1+4x_B^2 M_N^2/Q^2}} \tag{1.1}$$

where T_{DVCS} (T_{BH}) is the DVCS (BH) amplitude, I is the interference term, x_B is the Bjorken scaling variable and Q^2 is the negative squared four-momentum transferred by the virtual photon. The BH amplitude is completely calculable from QED. The BH process dominates at HERMES kinematics. The extraction of different asymmetries with respect to the beam charge and/or beam and target helicities allows us to access the suppressed terms. The asymmetries depend on the azimuthal angle ϕ which is the angle between the lepton scattering and the photon production planes. In the case for transversely polarised target spin asymmetries an additional dependence on the angle ϕ_s arises, where ϕ_s is the angle between the lepton plane and the component of the target polarisation vector orthogonal to the momentum of the virtual photon.

2. Data Analysis

In order to extract these asymmetries form data, events were selected which contained one photon and one scattered lepton track. Photons were identified by their energy deposition in the calorimeter and preshower. The requirements imposed on the lepton track were $Q^2 > 1GeV^2$ and $W > 3GeV$.

Before 2006 the recoiling nucleon was not detected, and exclusive DVCS events were selected by imposing an additional constraint on the missing mass M_x.

The most recent result obtained using the recoil detector also took events with a recoiling proton. Kinematic event fitting was performed for every DVCS event candidate by using the measured four-momentum of the particles under the hypothesis of the process $ep \to ep\gamma$. Applying a cut on the probability that a particular event satisfied the hypothesis. It was demonstrated in Monte Carlo studies that the contamination of the background processes is below 0.1%. The background from semi-inclusive and exlusive π^0 production is estimated to be negligible. This sample is referred to as the " pure elastic" sample.

In order to compare results under similar kinematic conditions a "reference" sample was created. Where for the reference sample, in addition o the requirements for an analysis without using the recoil detector, a hypothetical proton with 4-momenta calculated from the kinematics of the electron and the photon were required to be within the acceptance of the Recoil detector.

The systematic uncertainties for all results were obtained from a Monte Carlo simulation estimating the effects of limited acceptance, smearing and finite bin width.

3. Results

In Figure 1 an overview of all azimuthal amplitudes integrated over the entire HERMES kinematic range using the data taken from 1997 to 2007. This includes data on the unpolarised hydrogen [4] and deuterium targets, the longitudinally polarised hydrogen [6] and deuterium [7] targets and the transversely polarised hydrogen target [8, 9]. The amplitudes are sensitive to different combinations of the real and imaginary parts of CFFs corresponding to the GPDs.

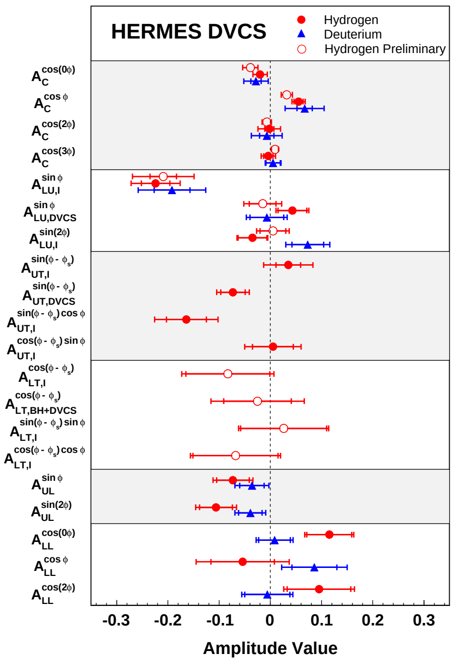

Figure 1: Overview of all DVCS azimuthal asymmetry amplitudes measured at HERMES experiment.

In Figure 2 the amplitudes of the single charge beam helicity asymmetry extracted from 2006 and 2007 hydrogen data and a fully operational Recoil detector. The results are projected versus $-t\, x_B$ and Q^2 and also integrated over the entire acceptance. Results are shown for the pure elastic sample, a reference and the traditional sample analysed without using the additional information from the recoil detector.

There is no dependence on the leading twist sinϕ amplitude on x_B and Q^2, however there is an indication of a dependence versus $-t$. For low values of $-t$ the pure elastic and reference samples agree, and for higher values of $-t$ the elastic sample shows a slightly higher magnitude of the reference sample. The sub-leading twist amplitude, $\sin(2\phi)$ is compatible for with zero across all kinematic projections.

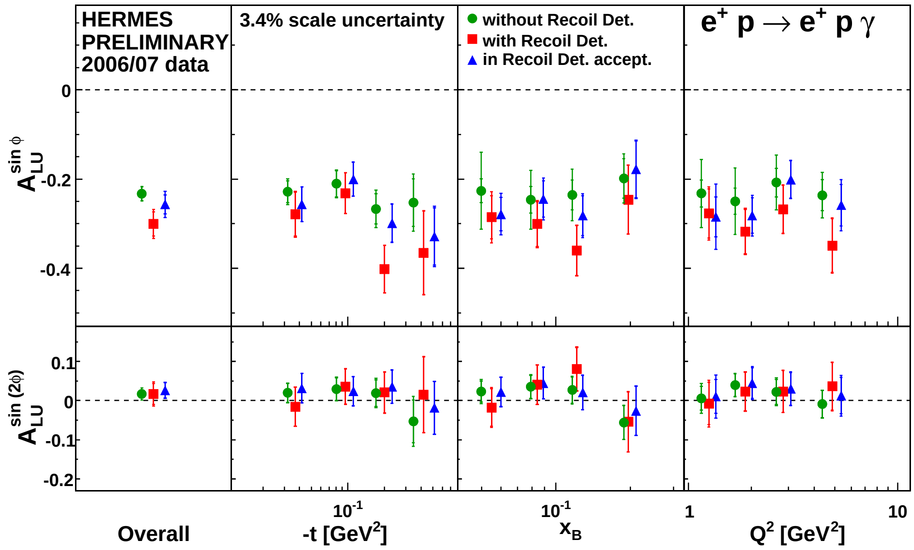

Figure 2: The sin $(n\phi)$ asymmetry amplitudes of the DVCS single-charge beam helicity asymmetry of the pure elastic (red squares), reference (blue triangles) and traditional (green circles) samples extracted form 2006 and 2007 hydrogen data taken with a positron beam and fully operational Recoil detector. The inner error bars denote the statistical uncertainties and the total error bars the quadratic sum of the statistical and systematic uncertainties.

References

[1] M. Burkardt, Phys. Rev. **D66** (2002) 114005. [hep-ph/0209179].

[2] X. -D. Ji, Phys. Rev. Lett. **78** (1997) 610-613. [hep-ph/9603249].

[3] A. V. Belitsky, D. Mueller, A. Kirchner, Nucl. Phys. **B629** (2002) 323-392. [hep-ph/0112108].

[4] A. Airapetian *et al.* [HERMES Collaboration], JHEP **0911** (2009) 083. [arXiv:0909.3587 [hep-ex]].

[5] J. R. T. Burns, *Deeply virtual Compton scattering off an unpolarised hydrogen target at HERMES,* Ph.D Thesis, University of Glasgow (2010).

[6] A. Airapetian *et al.* [HERMES Collaboration], JHEP **1006** (2010) 019. [arXiv:1004.0177 [hep-ex]].

[7] A. Airapetian *et al.* [HERMES Collaboration], Nucl. Phys. **B842** (2011) 265-298. [arXiv:1008.3996 [hep-ex]].

[8] A. Airapetian *et al.* [HERMES Collaboration], JHEP **0806** (2008) 066. [arXiv:0802.2499 [hep-ex]].

[9] A. Airapetian , *et al.* [The HERMES Collaboration], Phys. Lett. **B704** (2011) 15-23. [arXiv:1106.2990 [hep-ex]].

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