## 2.3 The handbag approach to wide-angle Compton Scattering

Peter Kroll[1]
*Universität Wuppertal*
*Fachbereich Physik*
*D-42097, Wuppertal, Germany*

**Abstract**

In this talk I reviewed briefly the present status of the handbag approach to wide-angle Compton scattering (WACS).

1. **Introduction** In [1] the WACS amplitudes have been derived for Mandelstam variables $s, -t$ and $-u$ that are large as compared to $\Lambda^2$ where $\Lambda$ is a typical hadronic scale of order $1\ \mathrm{GeV}$. Under the assumption that the soft hadronic wave function occurring in the Fock decomposition of the proton state, is dominated by parton virtualities $|k_i^2| \lesssim \Lambda^2$ and by intrinsic transverse momenta that satisfy $k_{\perp i}^2/x_i \lesssim \Lambda^2$, the light-cone helicity amplitudes for WACS, $\mathcal{M}$, factorize in amplitudes, $\mathcal{H}$, for Compton scattering off massless quarks and in form factors which represent $1/x$-moments of zero-skewness generalized parton distributions (GPDs)

$$R_V^a(t) = \int_{-1}^{1} \frac{dx}{x} H^a(x,0,t) \tag{1}$$

where $a$ denotes the quark flavor. The full form factor is

$$R_V = \sum_a e_a^2 R_V^a(t) \tag{2}$$

The GPD $\widetilde{H}(E)$ is related to the axial (tensor) form factor $R_A(R_T)$ in an analogous fashion. The WACS amplitudes read [1, 2]

$$\begin{aligned} \mathcal{M}_{\mu'+,\mu+}(s,t) = {} & 2\pi\alpha_{\rm em}\Big[\mathcal{H}_{\mu'+,\mu+}(\hat{s},)\big(R_V(t)+R_A(t)\big) \\ & +\mathcal{H}_{\mu'-,\mu-}(\hat{s},)\big(R_V(t)-R_A(t)\big) \\ \mathcal{M}_{\mu'-,\mu+}(s,t) = {} & \pi\alpha_{\rm em}\frac{\sqrt{-t}}{m}\Big[\mathcal{H}_{\mu'+,\mu+}(\hat{s},)+\mathcal{H}_{\mu'+,\mu+}(\hat{s},)\Big]\,R_T(t)\,. \end{aligned} \tag{3}$$

The subprocess amplitudes have been calculated to order $\alpha_s$ [2]. The large $-t$ GPDs at zero skewness have been extracted in an analysis of the nucleon form factors exploiting the sum rules [3, 4]. The Compton form factors can be evaluated from these GPDs and, hence, the WACS cross section can be predicted free of parameters. The results agree reasonably well with experiment.

Predictions for spin-dependent observables have also been given [2]. Some care is however necessary, in particular for a kinematical region where the Mandelstam variables are not much larger than $\Lambda^2$. Various corrections have to be considered and a quality assessment of the Compton form factors is necessary:

[1]Email: pkroll@uni-wuppertal.de

- The amplitudes (3) are given for light-cone helicities. For a comparison with experiment standard helicities are more convenient. In [5] the transformation from one basis to the other one is given. The admixtures of amplitudes with opposite proton helicity is under control of the parameter $\eta = 2m\sqrt{-t}/(s+\sqrt{-us})$. For the massless photons both light-cone and standard helicities fall together.
- The matching of the variables $s, t, u$ with the corresponding ones for the subprocess, $\hat{s}, , \hat{u}$, is another source of uncertainty [6]. For $s$ less than $10\ \mathrm{GeV}^2$ these uncertainties are large.
- The vector form factor $R_V$ is rather well determined due to the precise data on the magnetic form factor of the proton measured in a large range of $t$ which dominate $R_V$ at large $-t$. The tensor form factor is less accurately known since it is sensitive to all four electromagnetic form factors of the nucleon [4]. The neutron form factors are only measured up to $4\ \mathrm{GeV}^2$ as yet. The available experimental information on the axial form factor, $F_A$, at large $-t$ from which in principle $\widetilde{H}$ is determined, is very limited. There are only dipole parametrizations of $F_A$. This poor information prevents an analysis of $\widetilde{H}$ like that one performed for $H$ and $E$. Several examples of parametrizations for $\widetilde{H}$ have been presented which all agree with the data on $F_A$ within errors but lead to substantially different results for $R_A$ and, hence, for different predictions for the spin correlation parameter $K_{LL} = A_{LL}$. In turn from a measurement of $K_{LL}$ or $A_{LL}$ at sufficiently large $-t$ and $-u$ one may extract $R_A(t)$ and use these results as an additional constraint in the analysis of $\widetilde{H}$ at large $-t$. Even if we would have new and better data on $F_A$, e.g. from the FNAL MINERVA experiment, additional data on $R_A$ will help in the flavor decomposition of $\widetilde{H}$. Knowledge of the large $-t$ behavior of $\widetilde{H}$ is of interest for investigating the transverse distribution of longitudinally polarized quarks in the proton.

# References


[1] M. Diehl, T. Feldmann, R. Jakob and P. Kroll, Eur. Phys. J. C **8**, 409 (1999).

[2] H. W. Huang, P. Kroll and T. Morii, Eur. Phys. J. C **23**, 301 (2002) Erratum: [Eur. Phys. J. C **31**, 279 (2003)].

[3] M. Diehl, T. Feldmann, R. Jakob and P. Kroll, Eur. Phys. J. C **39**, 1 (2005).

[4] M. Diehl and P. Kroll, Eur. Phys. J. C **73**, no. 4, 2397 (2013).

[5] M. Diehl, Eur. Phys. J. C **19**, 485 (2001).

[6] M. Diehl, T. Feldmann, H. W. Huang and P. Kroll, Phys. Rev. D **67**, 037502 (2003).