Hadron Optics: Diffraction Patterns in Deeply Virtual Compton Scattering

S. J. Brodsky[a], **D. Chakrabarti**[b], **A. Harindranath**[c], **A. Mukherjee**[d], **J. P. Vary**[e,a,f]

[a] Stanford Linear Accelerator Center, Stanford University, Stanford, California 94309, USA.

[b] Department of Physics, University of Florida, Gainesville, FL-32611-8440, USA.

[c] Saha Institute of Nuclear Physics, 1/AF Bidhannagar, Kolkata 700064, India.

[d] Department of Physics, Indian Institute of Technology, Powai, Mumbai 400076, India.

[e] Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011, USA.

[f] Lawrence Livermore National Laboratory,
L-414, 7000 East Avenue, Livermore, California, 94551, USA.

abstract

We show that the Fourier transform of the Deeply Virtual Compton Scattering (DVCS) amplitude with respect to the skewness variable ζ provides a unique way to visualize the structure of the target hadron in the boost-invariant longitudinal coordinate space variable ($\sigma = \frac{P^+ y^-}{2}$). The results are analogous to the diffractive scattering of a wave in optics in which the dependence of the amplitude on σ measures the physical size of the scattering center of a one-dimensional system. If one combines this longitudinal transform with the Fourier transform of the DVCS amplitude with respect to the transverse momentum transfer $\Delta^\perp$, one can obtain a complete three-dimensional description of hadron optics at fixed light-front time $\tau = t + z/c$. As a specific example, we utilize the quantum fluctuations of a spin-1/2 state at one loop in QED to obtain the behavior of the helicity flip and non-flip DVCS amplitudes for electron-photon scattering. We then simulate the wavefunctions for a hadron by differentiating the above LFWFs with respect to M^2 and study the corresponding DVCS amplitudes in σ space.