GPDs for non zero skewness in longitudinal position space

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Introduction

The Compton scattering of coherent light on an object is one of the most elementary processes of physics. In a general way, by measuring the angular and energy distributions of the scattered light information on the structure and the shape of the probed object can be accessed. The wavelength of incident light must match the size of the probed object in order to be able to probe its internal structure.

With the advent of intense multi-GeV lepton beam facilities, it has become possible to experimentally study the Compton scattering at the smallest dimensions of matter: the nucleon at quark and gluon level. Here it is called the Deep Virtual Compton scattering (DVCS), where the term virtual here has meaning that the incoming photon is radiated from a lepton beam. DVCS process $\gamma^*(q) + p(P) \to \gamma(q') + p(P')$, where the virtuality of the initial photon $q^2 = -Q^2$ is much large compared to the squared momentum transfer $t = -(P - P')^2$, provides a valuable probe to the structure of the proton near the light cone. In this paper, we are using a model of light front wavefunctions (LFWFs) to calculate the Generalized Parton Distributionss (GPDs) [1]. We have generalized the framework of QED by assigning a mass M to external electrons in the compton scattering process, but a different mass m to the internal electron line and a mass λ to the internal photon line. Thus, we represent a spin 1/2 system as a composite of a spin 1/2 fermion and spin 1 vector boson, with arbitrary masses. This one loop model is self consistent since it has correct correlation of different fock components of the state as given by light-front eigen value equation. In Ref. [1], a simulated model has been derived from the LFWFs by taking derivative w.r.t bound state mass M^2 which improves the behavior of wavefunctions near the end points of x. There are three distinct regions in x. In the domain where $\zeta < x < 1$, there are diagonal $2 \to 2$ overlap contributions for both helicity non flip $H_{2\to2}(x, \zeta, t)$ and helicity flip $E_{2\to2}(x, \zeta, t)$. The GPDs $H_{2\to2}(x, \zeta, t)$ and $E_{2\to2}(x, \zeta, t)$ vanish in domain $\zeta - 1 < x < 0$. It was shown that the DVCS amplitude expressed in terms of the variable σ show diffraction pattern analogous to diffractive scattering of a wave in optics where the distribution in σ measures the physical size of the scattering center in a 1-D system. It was concluded that the finite size of the ζ integration of the Fourier transform acts as a slit width and produces the diffraction pattern. Hence it becomes interesting to calculate the GPDs for non zero skewness in the domain $\zeta < x < 1$.

1. Kinematics of DVCS and Generalized Parton Distributions

We specify the frame by choosing a convenient parametrization of the light-cone coordinates for the initial and final proton. The contribution to the spin flip conserving and non conserving part of GPDs in the domain $\zeta < x < 1$ are expressed in Ref. [2].

2. Simulated Model Calculations

The GPD in this model for helicity non-flip and for helicity flip is given in Ref. [4]. In Fig. 1 we have plotted the helicity non-flip GPD $H(x, \zeta, t)$ and helicity flip GPD $E(x, \zeta, t)$ as a function of x with fixed value of ζ. From the Fig. 1 one can see that the behaviour of the GPDs are the same. They increase with

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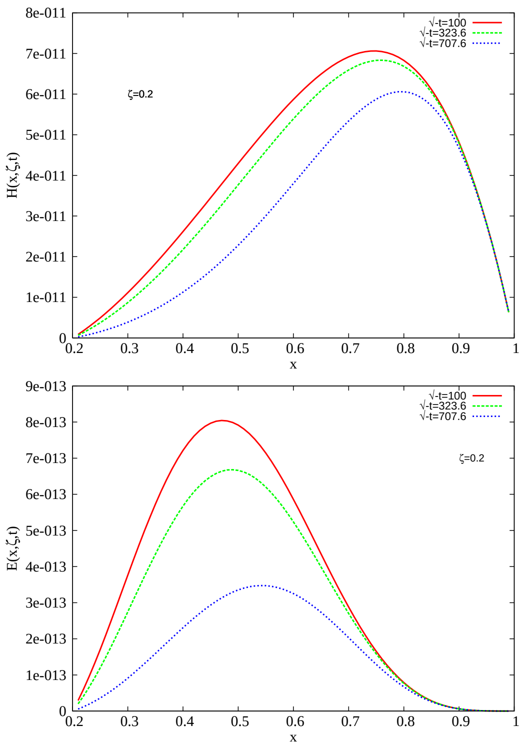

FIG. 1: Plot of GPD H vs x for a fixed value of $-t$ with different value of ζ and plot of GPD E vs x for a fixed value of ζ with different values of $-t$. Parameter t is in MeV^2.

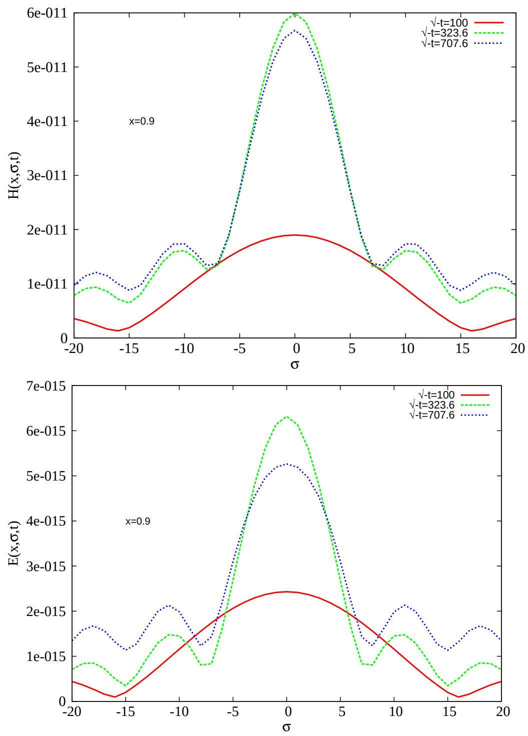

FIG. 2: Plot of GPD H vs σ for a fixed value of x with different value of $-t$ and plot of GPD E vs σ for a fixed value of x with different values of $-t$. Parameter t is in MeV^2.

x, reach maximum and then decrease. Since x is the momentum fraction of the active quark and at $x = 1$, the active quark carries all the momentum. The peak of H occurs at higher value of x as $|t|$ increases, it means that quark have large momentum fraction. In $E(x, \zeta, t)$, the peak occurs at lower value of x, but again shifts toward higher value of x as $|t|$ increases. In Ref. [3] a longitudinal boost invariant impact parameter σ has been introduced which is conjugate to longitudinal momentum transfer ζ. Diffraction pattern has been obtained for both $H(x, \sigma, t)$ and $E(x, \sigma, t)$.

3. Summary and Conclusions

We have investigated the GPDs H and E for non zero skewness. By taking Fourier transform with respect to ζ we get the GPDs in longitudinal position space. Both H and E show the diffraction pattern in σ space. However, in order to get the full lorentz invariant picture in longitudinal space, one has to study the GPDs in $x < \zeta$ region as well.

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