TJNAF Letter of Intent

A Test of Factorization in $N(e, e'\pi^{\pm})N$ with 6 GeV Beam

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Abstract

We propose a measurement of the Q^2 dependence of the separated $N(e, e'\pi^{\pm})N$ cross sections to test for the Q^{-6} dependence predicted when factorization applies. The longitudinal and transverse responses will be unambiguously separated. The $N(e, e'\pi^{\pm})N$ channel is of interest because at large $-t$ a single GPD should dominate, $H^{\sim}$. The measurements would be done at fixed x_b and a fixed $-t$ far from the pion pole, and the maximum Q^2 would be $\simeq 4$. These measurements are a logical complement to the Hall B experiment PR99-105, "Deeply Virtual Electroproduction of Vector Mesons". Both experiments have important implications for the JLab 12 GeV GPD program: if factorization cannot be at least approximately established in meson electroproduction by $Q^2 \simeq 4$, then the outlook for a comprehensive GPD program is uncertain. At best, a small x_b range would remain accessible to high luminosity apparatus.

1 Introduction

There is optimism that DVCS measurements will be consistent with factorization at modest Q^2 and that this will give access to the GPD's. The reason for this optimism is the close relationship of DVCS to DIS, which is known to behave perturbatively at relatively modest Q^2. However, since DVCS is a function of all 4 GPD's (E, H, $E^{\sim}$, and $H^{\sim}$, only 2-3 of which may dominate in a given kinematics [1]) it is unlikely that all 4 GPD's will be separated using DVCS data alone. It is even more unlikely that the quark flavor dependence of the GPD's will be untangled from DVCS data alone.[1] A comprehensive program to determine the GPD's will require data in different sectors than DVCS.

While DVCS is a function of 4 GPD's, longitudinal meson electroproduction is less complex: vector meson electroproduction like $N(e,e'\rho)N$ depends only on E and H, while pseudoscalar meson electroproduction like $N(e,e'\pi)N)$ depends only on $E^{\sim}$ and $H^{\sim}$. (Figure 1) The H and $H^{\sim}$ terms normally dominate since the E and $E^{\sim}$ terms are kinematically suppressed. However, in the presence of a pole, the E and $E^{\sim}$ terms can also be large. This means that for the case of $N(e,e'\pi^{\pm})N$, the $E^{\sim}$ term dominates at small $-t$ due to the pion pole, but at larger $-t$, the GPD $H^{\sim}$ is dominant. Thus, one possible scenario for separating the GPD's is to begin by using longitudinal $N(e,e'\pi)N$ cross sections to determine $H^{\sim}$. Similarly, longitudinal $N(e,e'\rho)N$ cross sections could be used to determine H. These results could then be combined with DVCS measurements to see if an overall consistent picture emerges.

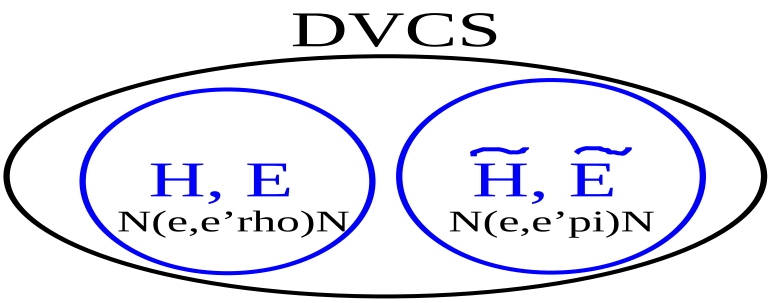

Figure 1: Meson electroproduction depends only 2 of the 4 GPD's of which DVCS is a function.

However, before $H^{\sim}$ or H can be extracted, the factorization theorem must apply

[1]except in the approximation of u-quark dominance

to the longitudinal response of the appropriate meson electroproduction channel at the measured Q^2. The necessary condition to be met is that

$$d\sigma_L/dt \propto \frac{1}{Q^6}$$

Unlike most of the meson electroproduction channels under discussion for GPD's, charged pion electroproduction is accessible to a pair of relatively small solid angle, focusing magnetic spectrometers. The Rosenbluth technique permits an unambiguous isolation of the longitudinal cross section. Hall C acquired significant experience doing L-T separations with charged pions during the successful F_π experiment.

2 The Experiment

In the factorization test proposed here, the Q^2 dependence of the longitudinal cross section will be examined at fixed $x_b = Q^2/(2M\nu)$ and fixed, relatively large, $-t$. The data will be taken in near-parallel kinematics, so that the separation of the response functions can be made. [2]

An overview of the kinematics is shown in Table 1. This choice of kinematics yields a relatively large range of Q^2 above the resonance region.

Table 1: Kinematics for the proposed HMS-SOS measurement with $x_B = 0.5$ and $-t_{min} = .38$. An L-T separation is assumed and the ϵ range is given.

Kinematic Setting	Q^2	W	$\Delta\epsilon$
1	2.5	1.84	.40
2	3.0	1.97	.29
3	3.5	2.09	.24
4	4.0	2.21	.18

To demonstrate the potential discrimination power of the experiment, projected errors of 10% are shown in Figure 2.[3] Using only the data between $Q^2 = 3$ and 4,

[2] Although it is perhaps not obvious, it is possible to keep $-t_{min}$ relatively constant during the Q^2 scan at fixed x_b. The price one pays is that x_b and $-t_{min}$ become correlated.

[3] These errors are approximately what is expected for the case of 2% uncorrelated errors and an L/T ratio of 2. While the lever arm in ϵ decreases with increasing Q^2, this effect is offset by an increase in the L/T ratio.

the fitted exponent in the Q^2 dependence will be determined at roughly the ± 0.5 level, assuming it is constant.

The total error budget will be looked at more carefully in a full proposal.

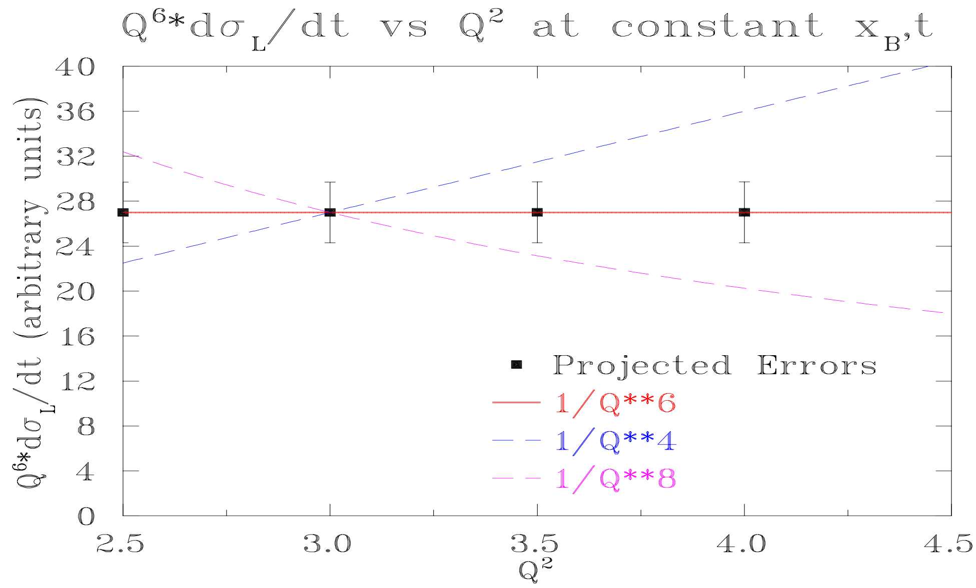

Figure 2:

3 Collaboration

The F_π collaboration, which has the most relevent experience, will be invited to participate. However, an important purpose of submitting this LOI is to bring this experiment to the attention of a broader community which has greater interest in (and knowledge of) the subject of GPD's.

4 Summary

We think the proposed experiment has important implications for the JLab 12 GeV GPD program. If the PAC response is encouraging, we will submit a full proposal.

References

[1] M. Vanderhaeghen *et al.*, PRD **60** 094017 (1999).