Remarks on $\pi^- p \to l^- l^+ n$

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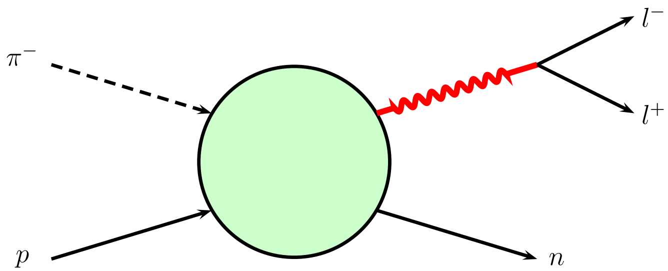


the exclusive limit of the Drell-Yan process
directly related to leptoproduction of pions
- same GPDs
- $\hat{s} - \hat{u}$ crossed subprocess

$$\mathcal{H}^{\pi^- \to \gamma^*}(\hat{u}, \hat{s}) \,=\, -\mathcal{H}^{\gamma^* \to \pi^+}(\hat{s}, \hat{u})$$

or for hard scattering kernel $\mathcal{F}^{t.l.*}(x, \xi, \mathbf{k}_\perp^2, \bar{z}) \,=\, \mathcal{F}^{s.l.}(x, \xi, -\mathbf{k}_\perp^2, z)$
equivalent to $Q^2 \to -Q'^2$

Berger-Diehl-Pire (01): leading-twist, LO analysis of long. cross(i.e. exploiting asymp. factorization formula)

we know that leading-twist analysis of π^+ production fails with HERMES data by order of magnitude

Therefore a reanalyis of the exclusive Drell-Yan process seems appropriate
making use of what we have learned from analysis of pion production

- retaining quark transverse momenta in the subprocess (the MPA)
- treating pion-pole contribution as an OPE term
- take into account transverse photons and transversity GPDs

What do we know about the GPDs?

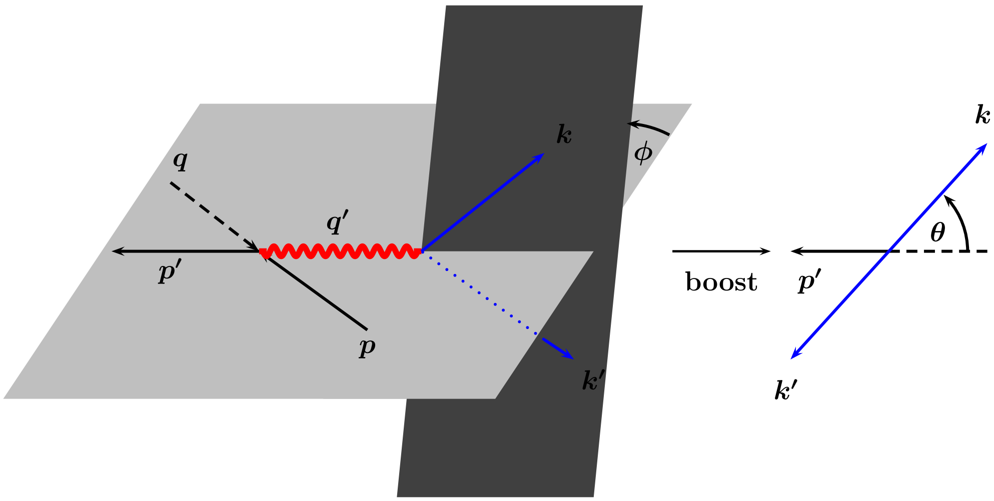
- $\widetilde{H}$: known from form factor analysis Diehl-K(13) and probed in π leptonproduction, spin asymmetries in DVCS, SDME in DVMP

- $\widetilde{E}$: contribution from pion pole, no clear signal for a non-pole contribution

- H_T: not well-known, information from π^+ leptoproduction, spin asymmetries in vector-meson leptoproduction, moments from lattice QCD

- $\bar{E}_T$: not well-known, information from SDMEs in vector-meson leptoproduction, moments from lattice QCD

Cross section



k momentum of l^-

$\tau = Q'^2/(s-m^2)$

$$\begin{aligned}\frac{d\sigma}{dt\,dQ'^2\,d\cos\theta\,d\phi} &= \frac{3}{8\pi}\left\{\sin^2\theta\,\frac{d\sigma_L}{dt\,dQ'^2}+\frac{1+\cos^2\theta}{2}\,\frac{d\sigma_T}{dt\,dQ'^2}\right.\\ &+ \left.\frac{1}{\sqrt{2}}\sin(2\theta)\cos\phi\,\frac{d\sigma_{LT}}{dt\,dQ'^2}+\sin^2\theta\cos(2\phi)\,\frac{d\sigma_{TT}}{dt\,dQ'^2}\right\}\end{aligned}$$

$$\frac{d\sigma_L}{dtdQ'^2} = \frac{\alpha_{\rm elm}}{48\pi^2}\frac{\tau^2}{Q'^6}\sum_{\nu'}|\mathcal{M}_{0\nu',0+}|^2 \qquad \frac{d\sigma_T}{dtdQ'^2} = \frac{\alpha_{\rm elm}}{48\pi^2}\frac{\tau^2}{Q'^6}\sum_{\mu=\pm1,\nu'}|\mathcal{M}_{\mu\nu',0+}|^2$$

$$\frac{d\sigma_{LT}}{dtdQ'^2} = \frac{\alpha_{\rm elm}}{48\pi^2}\frac{\tau^2}{Q'^2}\,{\rm Re}\sum_{\nu'}\mathcal{M}^*_{0\nu'0+}(\mathcal{M}_{+\nu'0+}-\mathcal{M}_{-\nu'0+})$$

$$\frac{d\sigma_{TT}}{dtdQ'^2} = \frac{\alpha_{\rm elm}}{48\pi^2}\frac{\tau^2}{Q'^2}\,{\rm Re}\sum_{\nu'}\mathcal{M}^*_{+\nu'0+}\mathcal{M}_{-\nu'0+}$$

ϕ integration

$$\frac{d\sigma}{dtdQ'^2d\cos\theta} = \frac{3}{4}\sin^2\theta\,\frac{d\sigma_L}{dtdQ'^2} + \frac{3}{8}(1+\cos^2\theta)\frac{d\sigma_T}{dtdQ'^2}$$

θ integration

$$\frac{d\sigma}{dtdQ'^2} = \frac{d\sigma_T}{dtdQ'^2} + \frac{d\sigma_T}{dtdQ'^2}$$

What do we learn on the GPDs (or convolutions) from the Drell-Yan process:

- $d\sigma_L$: $\langle \widetilde{H} \rangle$ and $\langle \widetilde{E} \rangle$ (essentially the pion pole)
- $d\sigma_T$: $\langle H_T \rangle$ ($\langle \bar{E}_T \rangle$ small)
- $\sin 2\theta \cos\phi$: $\mathrm{Re}\Big(\langle \widetilde{E} \rangle^* \langle H_T \rangle\Big)$
- $\sin^2\theta \cos 2\phi$: $|\langle \bar{E}_T \rangle|^2$ (small)

can exclusive Drell-Yan help to fix these GPDs better?
measurements at which values of s, Q'^2, t?

Polarization?