

Diffractive exclusive two meson production

Wim Cosyn

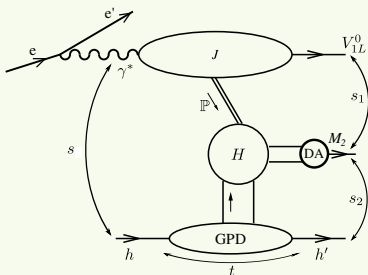
Florida International University

Yellow Report Exclusive WG

In collaboration w B. Pire, L. Szymanowski



Diffractive electroproduction of two mesons



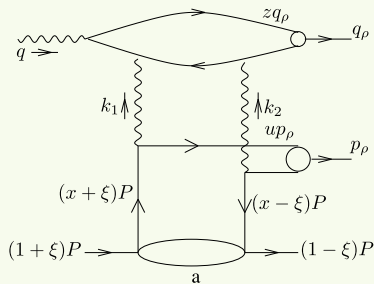
- Two vector mesons are separated by large rapidity gap
- Ordering of scales:
 $s_1 \gg s_2 \sim \mathbf{q}_{\rho T}^2$ (\mathbb{P} virt.) $\gg \Lambda_{\text{QCD}}^2$
- **Hard Pomeron** → two gluon exch.
 Its virtuality ($\approx \mathbf{q}_{\rho T}^2$) gives
 i) the **hard scale** (bottom)
 ii) small-sized $q\bar{q}$ (top)

- No gluon GPD contribution (Hard Pomeron is C-even)
- $\xi \approx \frac{s_1/s}{2-s_1/s}$, large ξ possible at large s_1/s .
- cross section **independent** of s
- All the hard work already done for $\rho^0\rho^+$ production on the nucleon in
 D.Yu. Ivanov, B. Pire, L. Szymanowski, PLB550 '02
 R. Enberg, B. Pire, L. Szymanowski, EPJC47 '06
 Focus on transversity (transverse polarization for second meson)

This study

- Revisit in EIC context; progress in GPD phenomenology
- Additional channels:
 - ▶ $\rho^0 + \rho_{L/T}^0 + N'$: chiral even(L)/odd(T), isovector
 - ▶ $\rho^0 + \omega_{L/T}^0 + N'$: chiral even(L)/odd(T), isoscalar
 - ▶ $\rho^0 + \pi^0 + N'$: chiral even (axial), isovector
- Extension for **coherent** deuteron straightforward:
 - ▶ $\rho^0 + \omega_{L/T}^0 + D'$: chiral even(L)/odd(T), isoscalar
- ϕ also possible but should be small if symmetric strange sea..

Calculation of the hard part



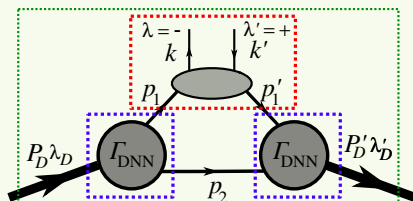
D.Yu. Ivanov, B. Pire, L. Szymanowski, PLB550 '02

- 6 diagrams contributing at LO
- Collinear approximation and leading twist contributions
- Factorization **OK** for LO, no endpoint singularities
No general factorization theorem!
- GPDs probed in the **ERBL** $-\xi < x < \xi$ region
- C -odd H^-, H_T^- and C -even \tilde{H}^+ enter (all have $H(x) + H(-x)$)

- Total amplitude can be written as a convolution of **Impact factor** ($\gamma_{L/T} \rightarrow \rho_L^0$) \otimes $[\rho_{L/T}^0; \omega_{L/T}; \pi]$ **DA** \otimes **GPD** factor (chiral **even/odd**) \otimes **Hard part**

Deuteron quark GPDs: convolution calculation

- Approach based on Cano, Pire, EPJA19 ('04); Cosyn, Pire, PRD ('18)



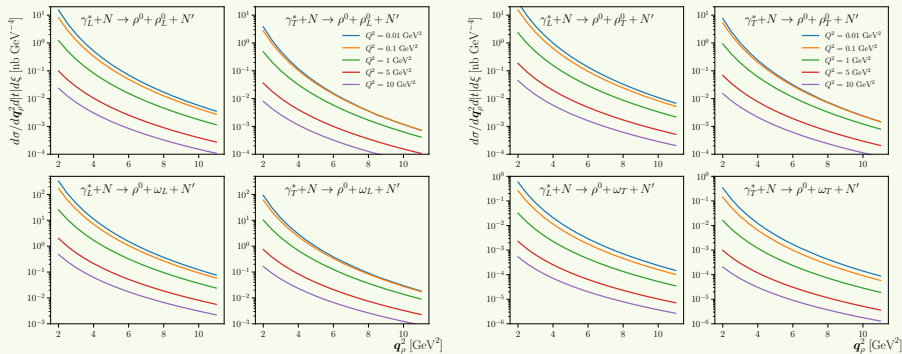
- **Deuteron helicity amplitudes** written as convolution of **nucleon helicity amplitudes** \otimes **deuteron LF wave function**
- Nucleon chiral even/odd helicity amplitudes \rightarrow nucleon chiral even/odd GPDs
- Deuteron helicity amplitudes \rightarrow deuteron GPDs
- Does **not** obey polynomiality constraints

- Nucleon GPDs (also enter in deuteron convolution)
 - ▶ chiral even: linked to PARTONS [GK16, MMS13, VGG99]
B. Berthou et al., EPJC78 '18; MMS13 PRD88 014001
 - ▶ chiral odd: parametrization based on GK
Goloskokov, Kroll, EPJA47 112 ('11)

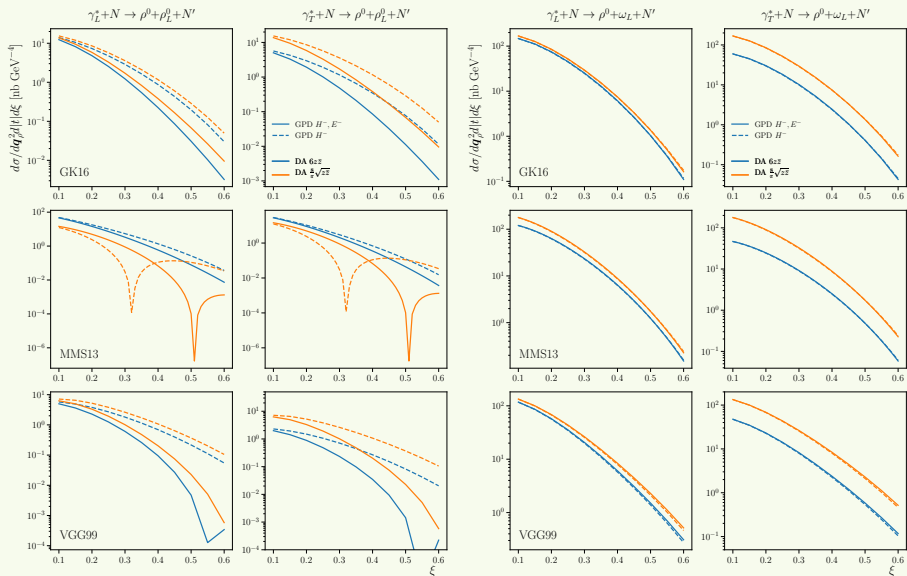
- Meson distribution amplitudes
 - ▶ Asymptotic form $\phi(z) = 6z\bar{z}$
 - ▶ Holographic form $\phi(z) = \frac{8}{\pi}\sqrt{z\bar{z}}$
 - ▶ Normalization (decay constants) from pheno
Bharucha, Straub, Zwicky, JHEP ('15)

$$\gamma_{L/T}^* + N \rightarrow \rho_L^0 + (\rho_{L/T}^0 / \omega_{L/T}) + N'$$

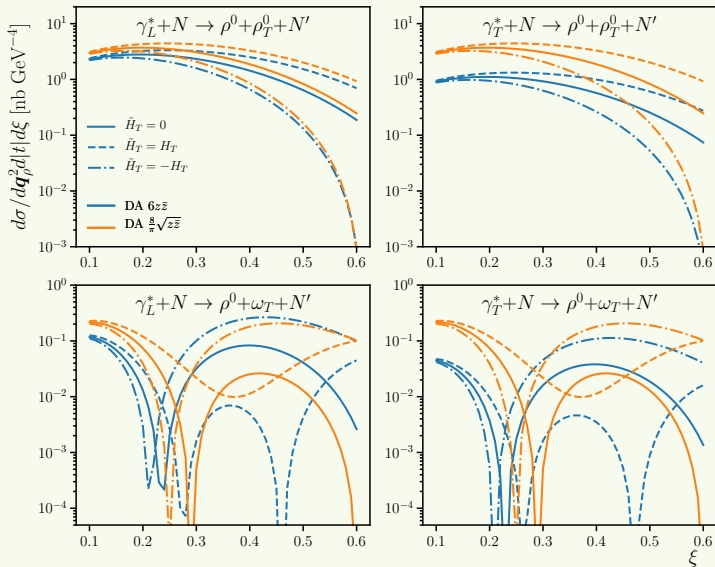
- Chiral even(L) / odd(T) vector GPD; isovector (ρ^0), isoscalar (ω)
- Calculation at $\xi_N = 0.3$, $t = t_{\min} = -0.33 \text{ GeV}^2$
- q_T^2 corresponds to Pomeron virtuality (hard scale)



$\gamma_{L/T}^* + N \rightarrow \rho_L^0 + (\rho_L^0/\omega_L) + N'$: Model input

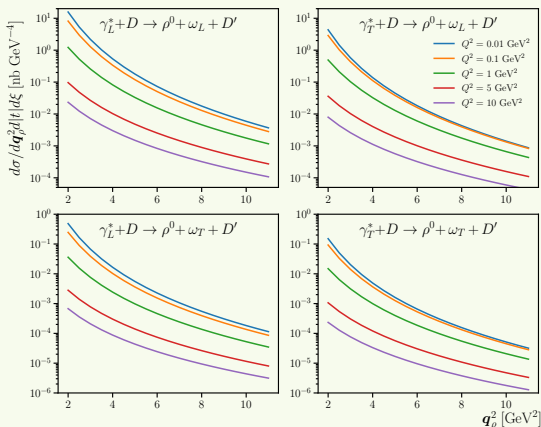


$\gamma_{L/T}^* + N \rightarrow \rho_L^0 + (\rho_T^0/\omega_T) + N'$: Model input



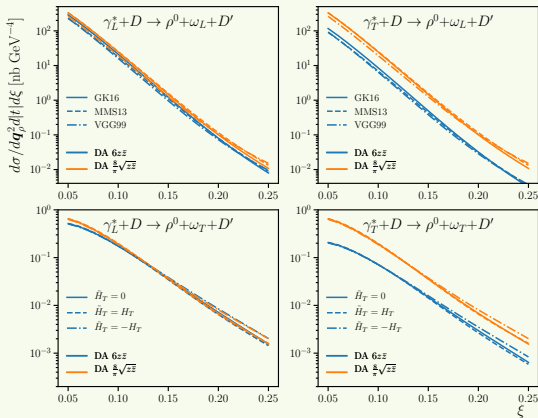
$$\gamma_{L/T}^* + D \rightarrow \rho_L^0 + \omega_{L/T} + D'$$

- Chiral even(L) / odd(T) vector GPD; isoscalar (ω)
- Calculation at $\xi_D = 0.15$, $t \approx t_{\min} = -0.33 \text{ GeV}^2$
- $q_{T\rho}^2$ corresponds to Pomeron virtuality (hard scale)
- Cross sections smaller than N counterparts (\sim order of magnitude)



$\gamma_{L/T}^* + D \rightarrow \rho_L^0 + \omega_{L/T} + D'$: Model input

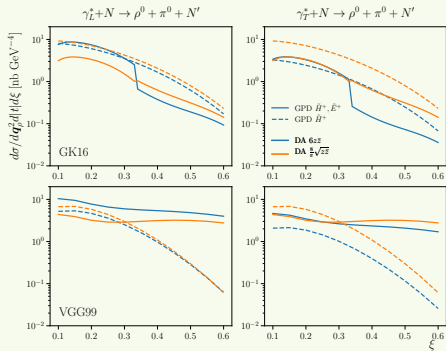
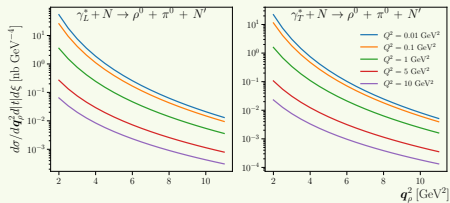
- Steeper drop with ξ_D but $\xi_N \approx 2\xi_D$!
- Convolution averages out differences compared to N case



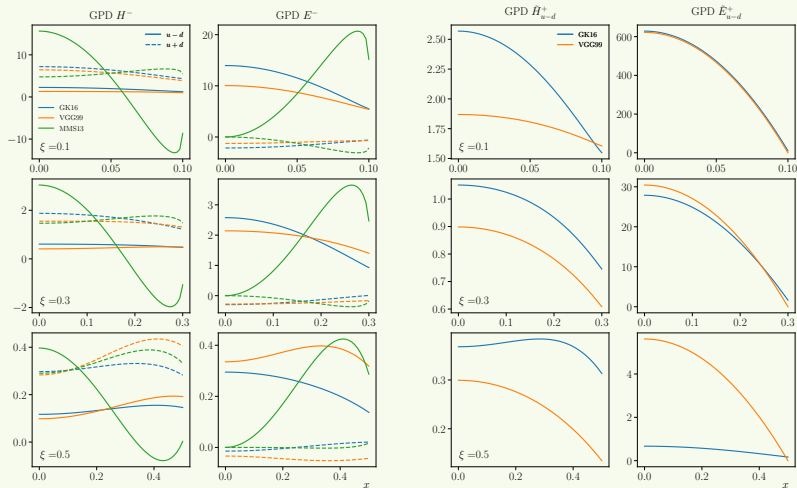
EIC - Detector requirements / Outlook

- Scattered electron: small angle electrons at low Q^2 ?
- ρ^0 from photon \rightarrow similar to diffractive VM production
- Second meson + scattered nucleon/deuteron: similar to DVMP
Polarization from decay products?
- Issues for coherent deuteron? [Complementarity discussion on Wed]
- L/T separation? Leverage in ϵ ; azimuthal modulations?
- Code is quite fast (even for D); can generate cross section tables
 \rightarrow **if anyone wants to collaborate for exp. simulations contact us!**
- Outlook
 - ▶ Add photon flux factors for electroproduction cross sections
 - ▶ Other channels: $\rho\eta$, $\rho\phi$
 - ▶ Theory: beyond LO/LT [BFKL pomeron ; Hard process]
 - ▶ Improved deuteron convolution that respects polynomiality

$$\gamma_{L/T}^* + N \rightarrow \rho_L^0 + \pi^0 + N'$$



Nucleon GPD input



Nucleon GPD input

