

Colour transparency in hard exclusive reactions

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GiBUU
The Giessen Boltzmann-Uehling-Uhlenbeck Project

Color Transparency (CT)

Our primary interest is the CT effect in $A(e, e'\pi^+)$ off nuclei

- CT: in QCD \implies suppression of the interaction of small size color singlets with hadrons
- CT: longitudinal γ_L or transverse γ_T photons
- In nuclear reactions CT: a reduction of FSI of transmitted π^+ as a function of Q^2

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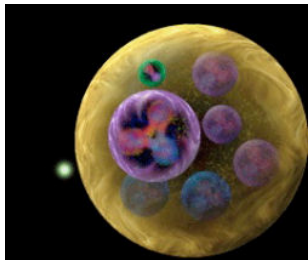
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An onset of CT at JLAB@5

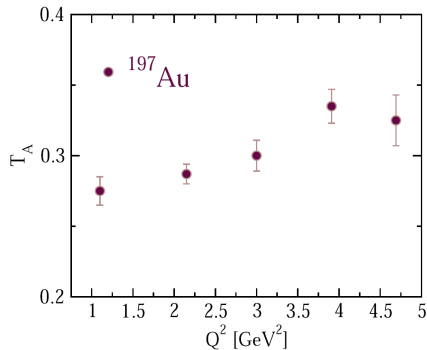


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$$T_A = \sigma_A / A\sigma_N$$

$$\sigma(FSI) \propto d_{\perp}^2 \sim 1/Q^2$$

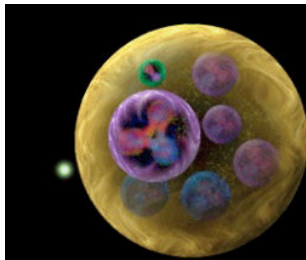
- JLAB: B. Clasie *et al.*, Phys. Rev. Lett. **99**, 242502 (2007)



- W. Cosyn, M. C. Martinez, J. Ryckebusch and B. Van Overmeire, Phys. Rev. C **74**, 062201 (2006)
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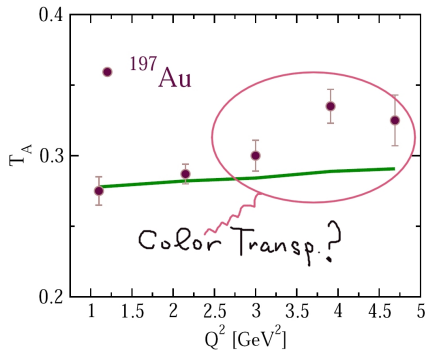


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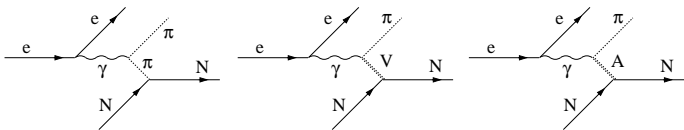
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π^+ electroproduction: Regge-pole model

■ Regge – pole model



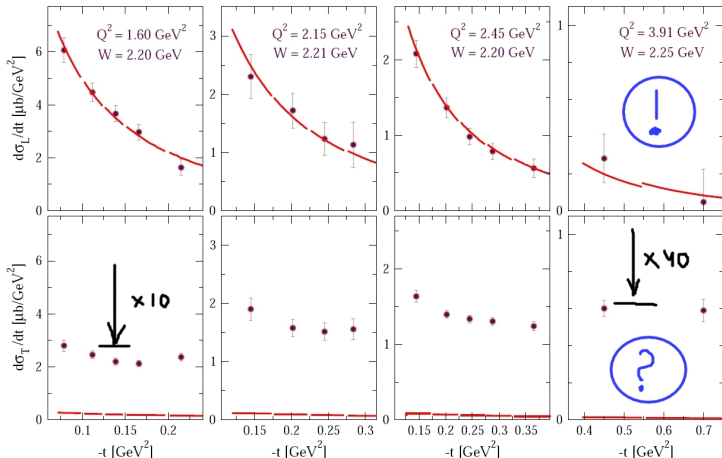
■ $\pi/b_1(1235)$, $\rho(770)/a_2(1300)$, $a_1(1260)$ trajectories

$$\mathcal{R}(s, t) = -\alpha' \left[\frac{1 + (-)^\tau e^{-i\pi\alpha(t)}}{2} \right] \Gamma(\tau - \alpha(t)) \left(\frac{s}{s_0} \right)^{\alpha(t) - \tau}$$

$$\text{where } \alpha(t) = \alpha_0 + \alpha' t = \tau + \alpha'(t - m^2)$$

Regge - pole model at high Q^2

- JLAB F_{π^2}
- JLAB π CT



V, A -exchanges are marginal

σ_T is grossly underestimated

σ_T problem

- Meson-exchange models cannot explain the transverse cross section σ_T
- The σ_T problem at even higher values of Q^2 (Cornell data)
- GPD based models:
 - σ_T is power suppressed by $1/Q^2$ compared with σ_L : $\sigma_L \gg \sigma_T$.

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Scattering off partons

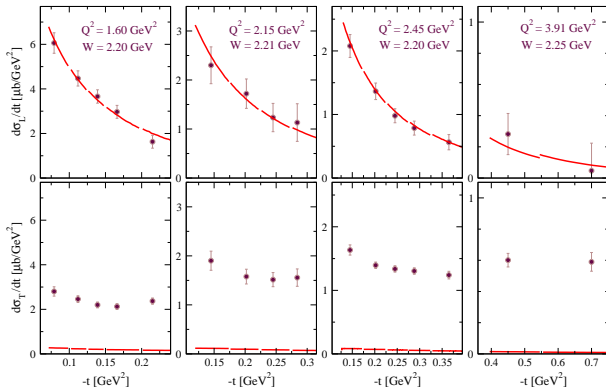
- At $W > 2$ GeV many resonances can contribute to 1π
- How to model the contribution from resonances
- Direct hard interaction of virtual photons with partons (DIS) since DIS involves all possible transitions of the nucleon from its ground state to any excited state
- The idea followed here is complement the soft hadron-like interaction types which dominate in photoproduction and low Q^2 electroproduction by direct hard interaction of virtual photons with partons followed by the hadronization process into $\pi^+ n$
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$p(e, e'\pi^+)n$: soft and hard contributions

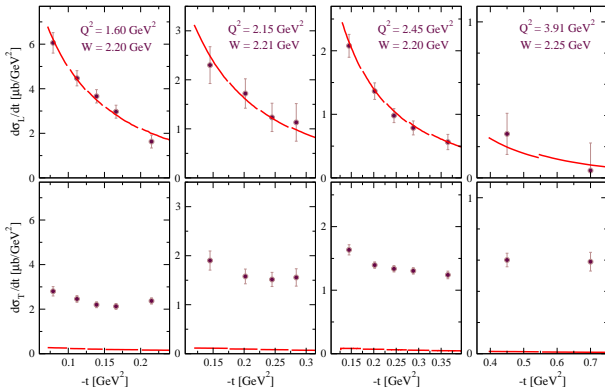
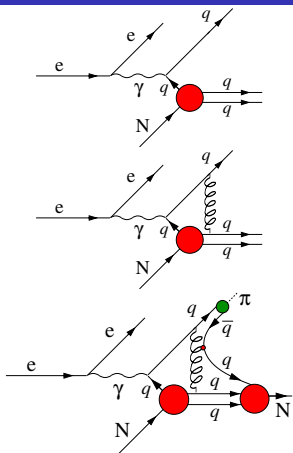
M. M. K., K. Gallmeister and U. Mosel, Phys. Rev. D **78**, 114022 (2008)



Transverse momentum $\sqrt{\langle k_T^2 \rangle} = 1.2$ GeV

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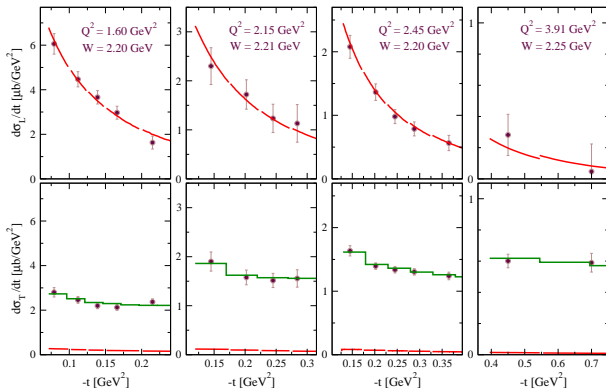
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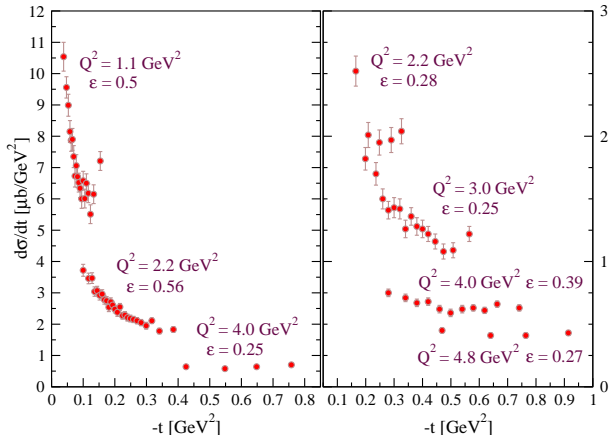
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Q^2 dependence at fixed $W \simeq 2.2$ GeV

$$\frac{d\sigma_e}{dQ^2 d\nu dt} = \frac{\pi \Phi}{E_e(E_e - \nu)} \left[\frac{d\sigma_T}{dt} + \varepsilon \frac{d\sigma_L}{dt} \right]$$

$\sigma_L \rightarrow$ hadronic (π -pole)

$\sigma_T \rightarrow$ partonic



X. Qian *et al.*, to be submitted to Phys. Rev. C.

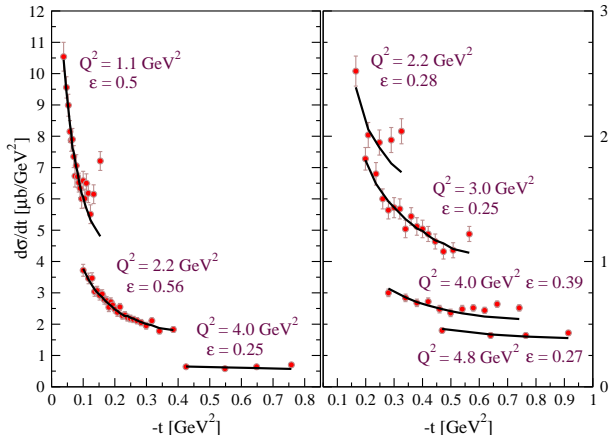


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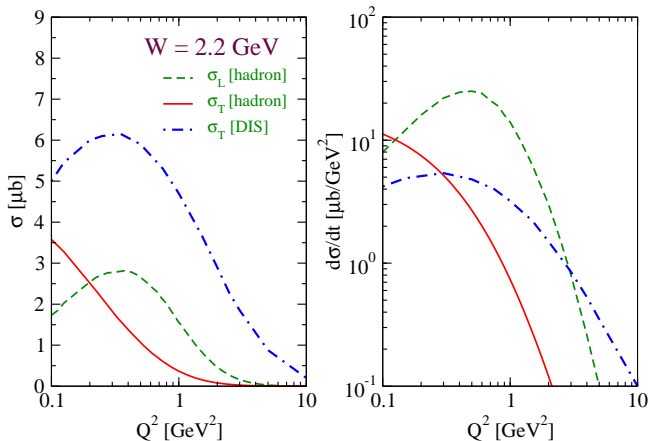
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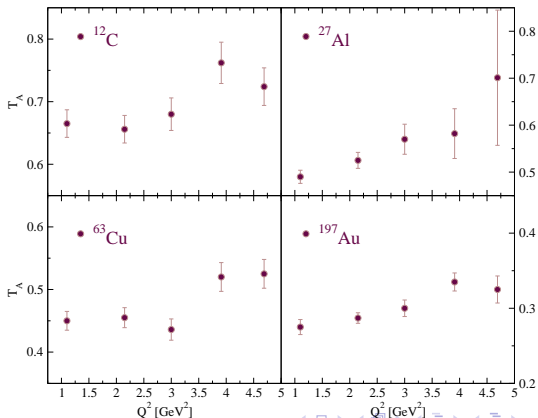
Forward π^+ production and CT effect



Color Transparency in $A(e, e'\pi^+)A^*$

M. M. K., K. Gallmeister and U. Mosel, Phys. Rev. C **79**, 015207 (2009)

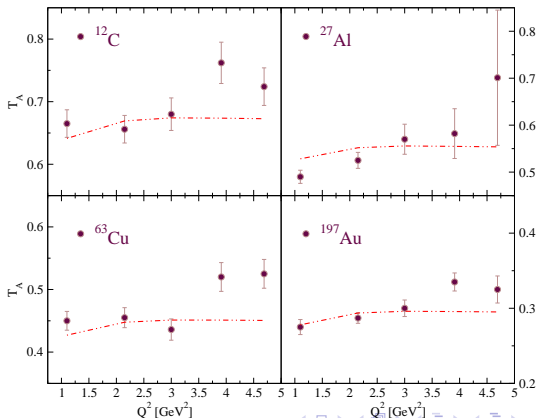
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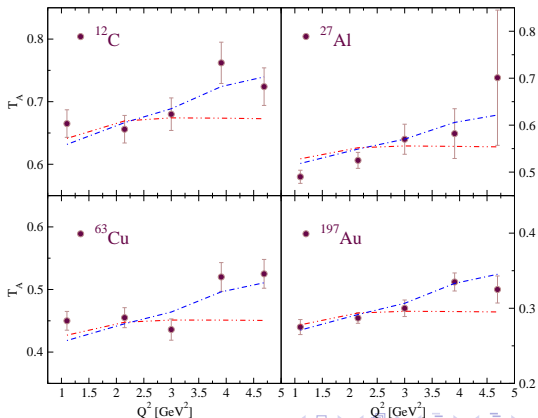
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Summary

- We have proposed a phenomenological model for $p(e, e'\pi^+)n$
- We have seen that such process involves a delicate interplay between hard (partonic) and soft (hadronic) interactions.
- Our results support an early onset of CT at JLAB in the transverse channel.
- L/T separation of the nuclear cross section is needed to make definite conclusions

Outlook

- Exclusive reactions $p(e, e'K)\Lambda/\Sigma$
- CT effect in $(e, e'K)$ off nuclei
- References
 - M. M. Kaskulov, K. Gallmeister and U. Mosel, Phys. Rev. D **78**, 114022 (2008)
 - M. M. Kaskulov, K. Gallmeister and U. Mosel, Phys. Rev. C **79**, 015207 (2009)