Inclusive prompt photon+dijet production in e+A DIS at small x as a probe of gluon saturation

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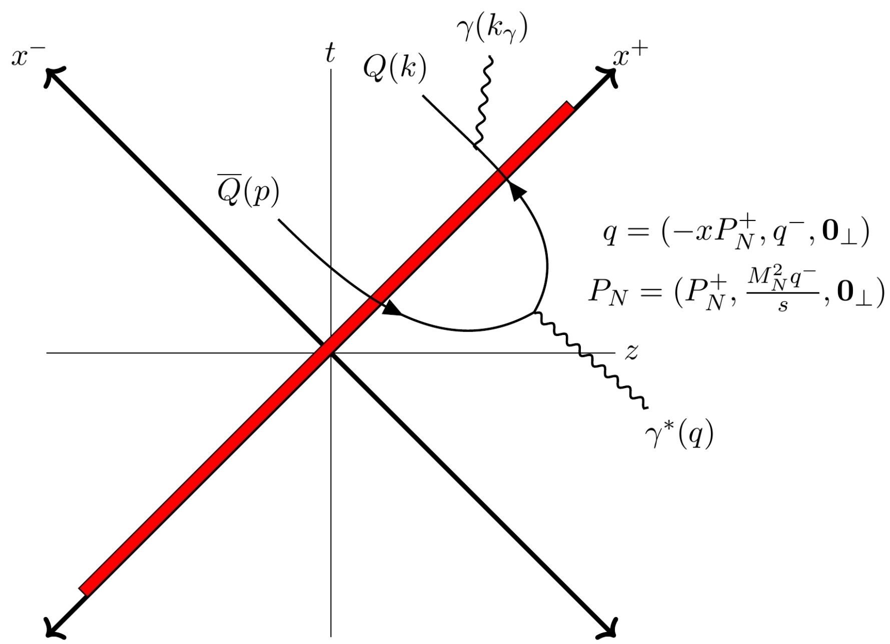
KR, Venugopalan, JHEP 1805 (2018) 013 [arXiv:1802.09550]; and work in preparation

Inclusive photon production in small x DIS at LO

- Cleanest process after fully inclusive DIS
- Can be measured at the luminosities provided by a future **E**lectron **I**on **C**ollider (**EIC**)

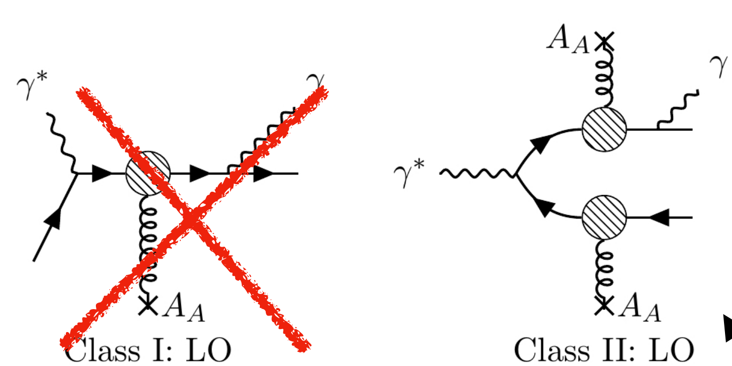


The right moving nucleus with large P_N^+ has its x^- extent Lorentz contracted

Compliments similar computations for pA collisions

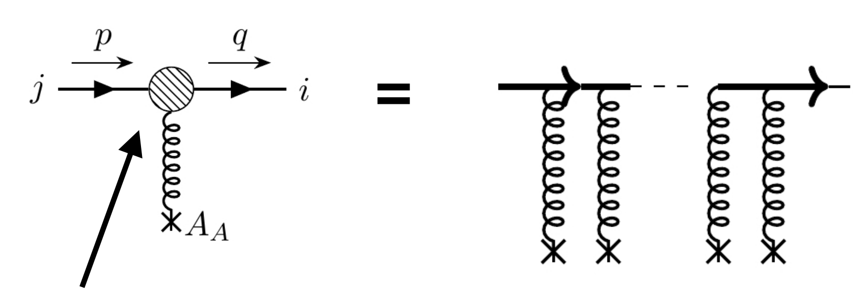
Gelis, Jalilian-Marian, hep-ph/0205037; Dominguez, Marquet, Xiao, Yuan, arXiv:1101.0715
Benic, Fukushima, arXiv:1602.01989;
Benic, Fukushima, Garcia-Montero, Venugopalan, arXiv:1609.09424, 1807.03806

Light cone coordinate convention: $V^{\pm} = \frac{V^0 \pm V^3}{\sqrt{2}}$



Suppressed at small x
Cross-section accompanied by valence quark distribution
$xf(x,Q^2) \ll xG(x,Q^2)$ at small x

Consider processes of this class



Quark must scatter off of the ``shock wave"

CGC inputs:

Working gauge: $\partial_\mu A^\mu = 0$ (Lorenz gauge)

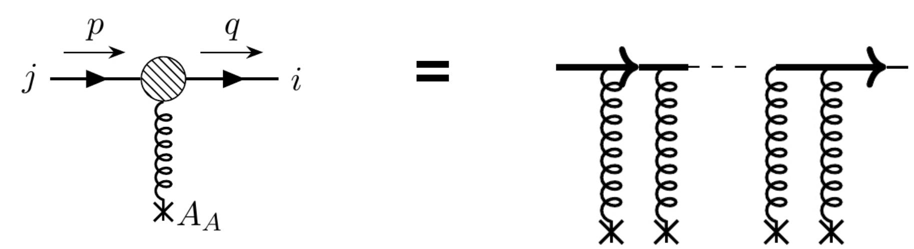
Background classical field: $A^{-,a} = A^{i,a} = 0, \quad A^{+,a} = \int \mathrm{d}^2\boldsymbol{y}_\perp \langle \boldsymbol{x}_\perp | \frac{1}{-\nabla_\perp^2} | \boldsymbol{y}_\perp \rangle \, \rho_A^a(x^-, \boldsymbol{x}_\perp)$

Momentum space fermion propagator in this background field has a simple form

$$S_{Lor.}(q,p) = (2\pi)^4 \delta^{(4)}(q-p) S_0(p) + S_0(q) \mathcal{T}(q,p) S_0(p)$$

McLerran, Venugopalan, hep-ph/9402335, hep-ph/9809427

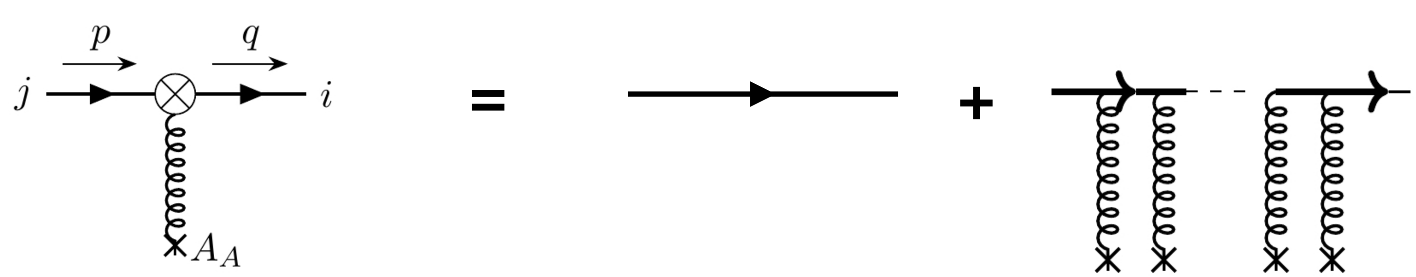
Diagrammatically represented by an effective vertex



Vertex factor $\mathcal{T}_{ij}(q,p) = 2\pi\delta(q^- - p^-)\,\mathrm{sign}(p^-)\gamma^- \int \mathrm{d}^2\boldsymbol{z}_\perp e^{-i(\boldsymbol{q}_\perp - \boldsymbol{p}_\perp).\boldsymbol{z}_\perp} [\tilde{U}^{\mathrm{sign}(p^-)}(\boldsymbol{z}_\perp) - \mathbb{1}]_{ij}$

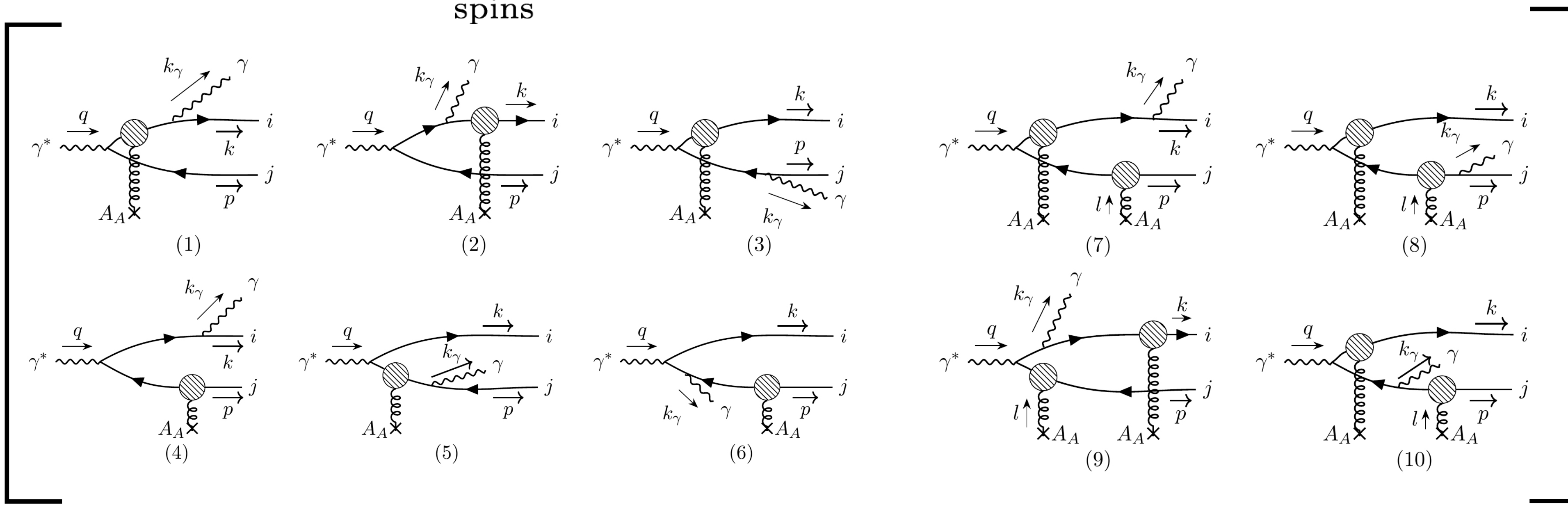
Fundamental Wilson line $\tilde{U}(\mathbf{x}_\perp) = \mathcal{P}_- \exp\left[-ig \int_{-\infty}^{+\infty} \mathrm{d}z^- \frac{1}{\nabla_\perp^2} \rho_A^a(z^-, \mathbf{x}_\perp) t^a\right]$

What we show and utilize: **Use modified vertices (same as above modulo identity)**
Subtract "no-scattering" contribution at the end. Simple and equivalent



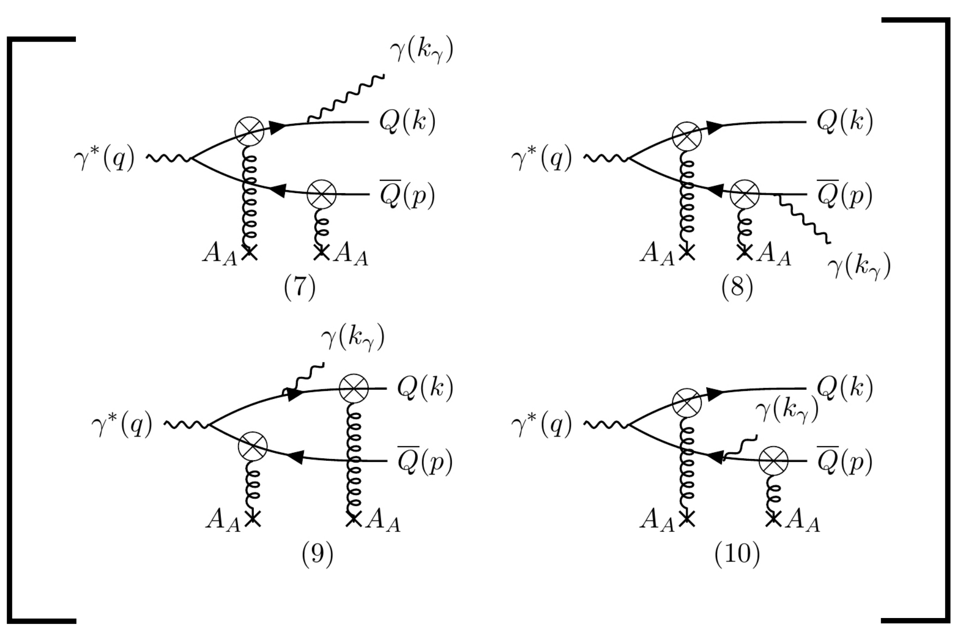
Hadron tensor: $X_{\mu\nu} = -\sum_{\text{spins}} \mathcal{M}^{*}_{\mu\alpha}(\boldsymbol{q},\boldsymbol{k},\boldsymbol{p},\boldsymbol{k}_\gamma)\mathcal{M}_{\nu}{}^{\alpha}(\boldsymbol{q},\boldsymbol{k},\boldsymbol{p},\boldsymbol{k}_\gamma)$

$\mathcal{M}_{\mu\alpha}(\boldsymbol{q},\boldsymbol{k},\boldsymbol{p},\boldsymbol{k}_\gamma) = \sum$



Equivalent results with vertex definitions modified slightly

$\mathcal{M}_{\mu\alpha}(\boldsymbol{q},\boldsymbol{k},\boldsymbol{p},\boldsymbol{k}_\gamma) = \sum$



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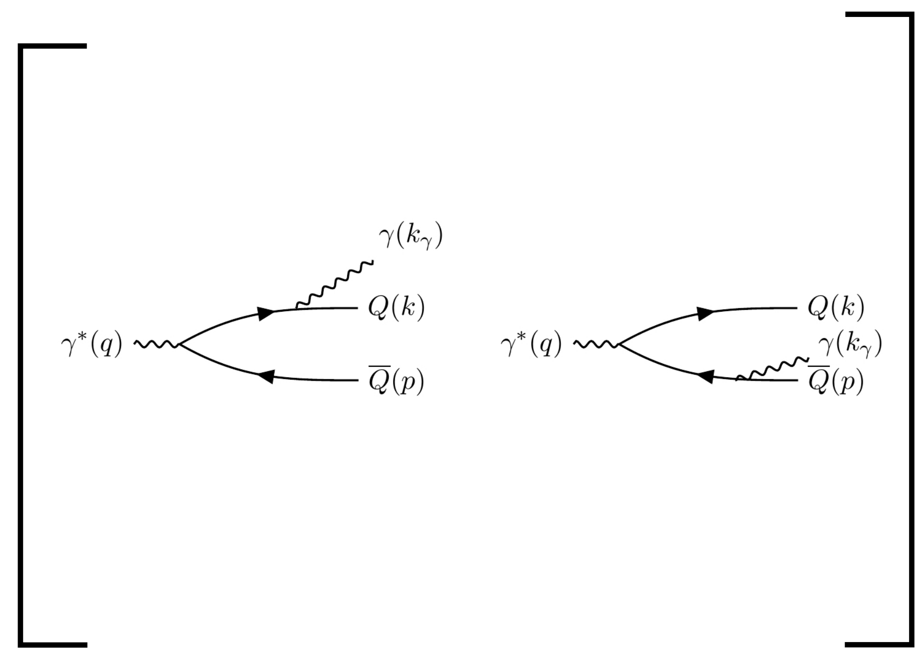


Offers significant advantage for NLO computation

Key analytical results:

Triple differential cross-section

$$\frac{\mathrm{d}\sigma}{\mathrm{d}x\mathrm{d}Q^2\mathrm{d}^6K_\perp\mathrm{d}^3\eta_K} = \frac{\alpha^2 q_f^4 y^2 N_c}{512\pi^5 Q^2}\frac{1}{(2\pi)^4}\frac{1}{2q^-}L^{\mu\nu}\widetilde{X}_{\mu\nu}(2\pi)\delta(P^- - q^-)$$

Lepton tensor

$$L^{\mu\nu} = \frac{2e^2}{Q^4}\left[(\tilde{l}^\mu\tilde{l}'^\nu + \tilde{l}^\nu\tilde{l}'^\mu) - \frac{Q^2}{2}g^{\mu\nu}\right]$$

Hadron tensor

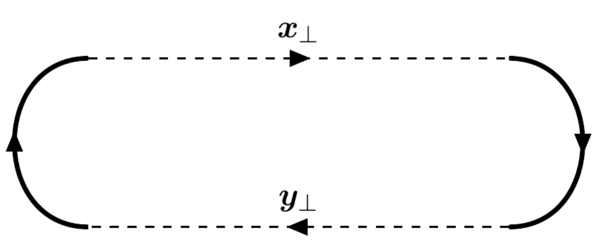
Complicated trace over gamma matrices

$$\widetilde{X}_{\mu\nu} = \int_{\boldsymbol{x}_\perp,\boldsymbol{y}_\perp,\boldsymbol{x}'_\perp,\boldsymbol{y}'_\perp}\int_{\boldsymbol{l}_\perp,\boldsymbol{l}'_\perp} e^{-i(\boldsymbol{P}_\perp-\boldsymbol{l}_\perp).\boldsymbol{x}_\perp - i\boldsymbol{l}_\perp.\boldsymbol{y}_\perp + i(\boldsymbol{P}_\perp-\boldsymbol{l}'_\perp).\boldsymbol{x}'_\perp + i\boldsymbol{l}'_\perp.\boldsymbol{y}'_\perp}\ \tau_{\mu\nu}{}^{q\bar{q},q\bar{q}}(\boldsymbol{l}_\perp,\boldsymbol{l}'_\perp|\boldsymbol{P}_\perp)\times\Xi(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp;\boldsymbol{x}'_\perp,\boldsymbol{y}'_\perp)$$

Non-perturbative input about strongly correlated gluons is contained in

$$\Xi(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp;\boldsymbol{x}'_\perp,\boldsymbol{y}'_\perp) = 1 - D(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp) - D(\boldsymbol{y}'_\perp,\boldsymbol{x}'_\perp) + Q(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp;\boldsymbol{y}'_\perp,\boldsymbol{x}'_\perp)$$

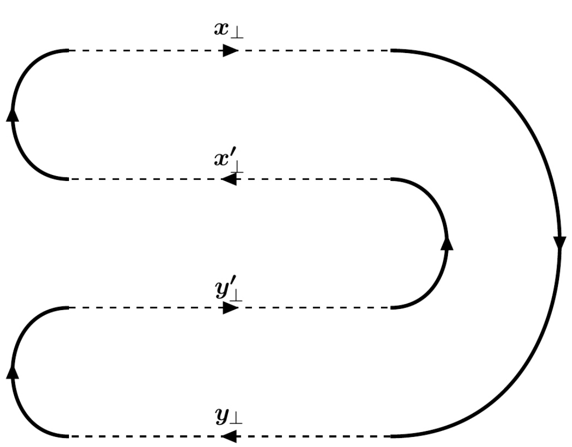
Dipole Wilson line correlator $D(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp) = \frac{1}{N_c}\langle\mathrm{Tr}\left(\tilde{U}(\boldsymbol{x}_\perp)\tilde{U}^\dagger(\boldsymbol{y}_\perp)\right)\rangle_{Y_A}$



Quadrupole Wilson line correlator

$$Q(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp;\boldsymbol{y}'_\perp,\boldsymbol{x}'_\perp) = \frac{1}{N_c}\langle\mathrm{Tr}\left(\tilde{U}(\boldsymbol{y}'_\perp)\tilde{U}^\dagger(\boldsymbol{x}'_\perp)\tilde{U}(\boldsymbol{x}_\perp)\tilde{U}^\dagger(\boldsymbol{y}_\perp)\right)\rangle_{Y_A}$$

$$\langle\mathcal{O}\rangle_{\Lambda^+(Y_A)} = \int[\mathcal{D}\rho_A]\,W_{\Lambda^+(Y_A)}[\rho_A]\,\mathcal{O}[\rho_A]$$



Ubiquitous building blocks of high energy QCD

KR, Venugopalan, arXiv: 1802.09550

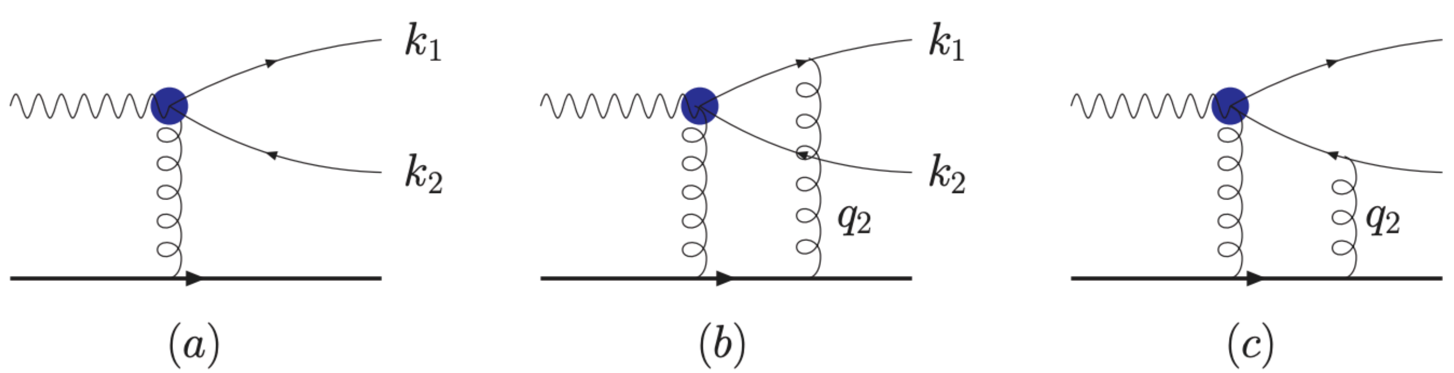
Interesting limit:

KR, Venugopalan, arXiv: 1802.09550

In the soft photon limit of $k_\gamma \to 0$ the amplitude satisfies the Low-Burnett-Kroll theorem

$$\mathcal{M}_\mu(\boldsymbol{q},\boldsymbol{k},\boldsymbol{p},\boldsymbol{k}_\gamma) \to -(eq_f)\epsilon^*_\alpha(\boldsymbol{k}_\gamma,\lambda)\left(\frac{p^\alpha}{p.k_\gamma} - \frac{k^\alpha}{k.k_\gamma}\right)\mathcal{M}^{NR}_\mu(\boldsymbol{q},\boldsymbol{k},\boldsymbol{p})$$

Polarization vector **x** Vectorial structure depending only on momenta of emitted particles **x** Non-radiative DIS amplitude



Recover existing results on inclusive dijet production in DIS

$$\frac{d\sigma^{L,T}}{d^3k d^3p} = \alpha\, q_f^2 N_c \delta(q^- - p^- - k^-) \int \frac{d^2\boldsymbol{x}_\perp}{(2\pi)^2}\frac{d^2\boldsymbol{x}'_\perp}{(2\pi)^2}\frac{d^2\boldsymbol{y}_\perp}{(2\pi)^2}\frac{d^2\boldsymbol{y}'_\perp}{(2\pi)^2}\; e^{-i\boldsymbol{k}_\perp.(\boldsymbol{x}_\perp-\boldsymbol{x}'_\perp)}e^{-i\boldsymbol{p}_\perp.(\boldsymbol{y}_\perp-\boldsymbol{y}'_\perp)}$$
$$\times \sum_{\alpha,\beta} \psi^{L,T}_{\alpha\beta}(q^-,z,|\boldsymbol{x}_\perp-\boldsymbol{y}_\perp|)\; \psi^{L,T*}_{\alpha\beta}(q^-,z,|\boldsymbol{x}'_\perp-\boldsymbol{y}'_\perp|) \times \Xi(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp;\boldsymbol{x}'_\perp,\boldsymbol{y}'_\perp)$$

Dominguez, Marquet, Xiao, Yuan, arXiv:1101.0715

Important check because it is sensitive to the Weizsäcker-Williams UGD in the back-to-back correlation limit $|\boldsymbol{k}_\perp + \boldsymbol{p}_\perp| \ll |\boldsymbol{k}_\perp - \boldsymbol{p}_\perp|/2$.

Golden channel for probing and understanding the WW distribution at a future EIC or LHeC!!

KR, Venugopalan, arXiv: 1802.09550

Structure of higher order computations

CGC inputs: Shockwave gluon propagator

- Convenient to work in the “wrong” light-cone gauge $A^- = 0$ for the kinematics of this problem. (Gauge links appearing in PDF definitions are unity in the conventional LC gauge $A^+ = 0$.)

- Resulting momentum space expression is simple and similar to the shockwave fermion propagator.

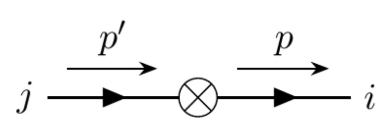
McLerran, Venugopalan, hep-ph/9402335
Ayala, Jalilian-Marian, McLerran, Venugopalan, hep-ph/9501324
Balitsky, Belitsky, hep-ph/0110158

$$G^{\mu\nu;ab}(p,p') = (2\pi)^4\delta^{(4)}(p-p')G_0^{\mu\nu;ab}(p) + G_0^{\mu\rho;ac}(p)\mathcal{T}_{\rho\sigma;cd}(p,p')G_0^{\sigma\nu;db}(p')$$

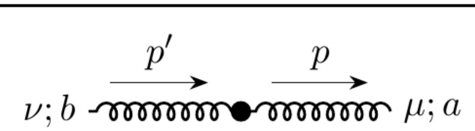
$G_0^{\mu\nu;ab}$ **: Free gluon propagator in** $A^- = 0$ **gauge**

Vertex structures identical to quark-quark-reggeon and gluon-gluon-reggeon in Lipatov’s Reggeon EFT

Bondarenko, Lipatov, Pozdnyakov, Prygarin , arXiv: 1708.05183
Hentschinski, arXiv: 1802.06755



$$\mathcal{T}_{ij}(p,p') = (2\pi)\delta(p^- - p'^-)\gamma^-\mathrm{sign}(p^-)\int \mathrm{d}^2\boldsymbol{z}_\perp e^{-i(\boldsymbol{p}_\perp - \boldsymbol{p}'_\perp).\boldsymbol{z}_\perp}\ \tilde{U}_{ij}^{\mathrm{sign}(p^-)}(\boldsymbol{z}_\perp)$$

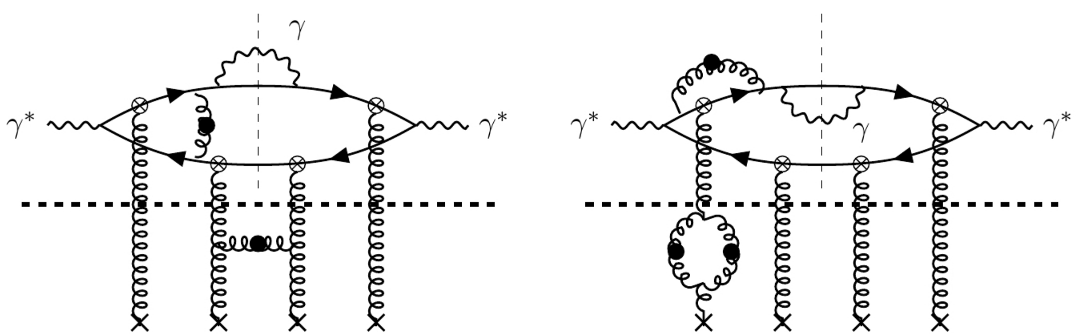


$$\mathcal{T}_{\mu\nu;ab}(p,p') = -2\pi\delta(p^- - p'^-) \times (2p^-)g_{\mu\nu}\ \ \mathrm{sign}(p^-)\int \mathrm{d}^2\boldsymbol{z}_\perp e^{-i(\boldsymbol{p}_\perp - \boldsymbol{p}'_\perp).\boldsymbol{z}_\perp}\ U_{ab}^{\mathrm{sign}(p^-)}(\boldsymbol{z}_\perp)$$

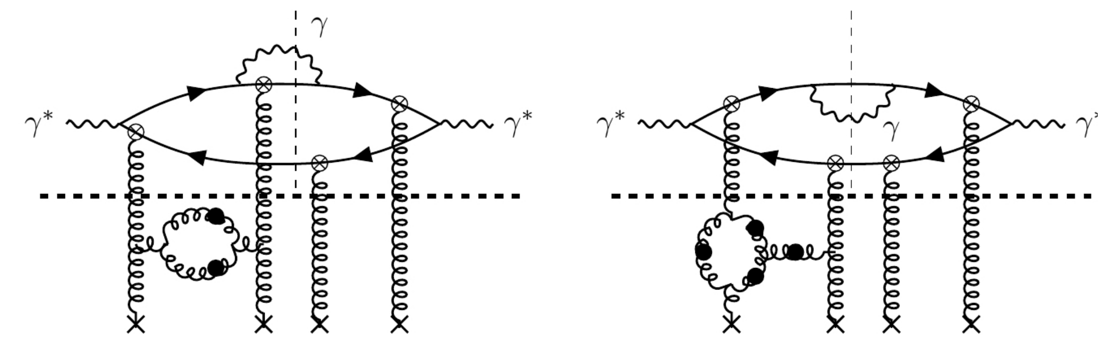
DIS dijet+photon at NLO+NLLx

KR, Venugopalan, in preparation

NNLO:1



NNLO:2



Formally NNLO(=O((α_S)^2) in CGC power counting

Collect leading log in x (LLx) pieces $\sim \alpha_S \ln(\Lambda_1^-/\Lambda_0^-)$
+
NLO pieces~α_S **in the photon+dijet impact factor**

Collect next-to-leading-log (NLLx) pieces $\sim \alpha_S^2 \ln(\Lambda_1^-/\Lambda_0^-)$
+
LO pieces~ α_S^0 **in the photon+dijet impact factor**

$$\langle \mathrm{d}\sigma_{NLO+NLLx} \rangle = \int [\mathcal{D}\rho_A] \left\{ W^{NLLx}_{\Lambda_0^-}[\rho_A]\, \mathrm{d}\hat{\sigma}_{LO}[\rho_A] + W^{LLx}_{\Lambda_0^-}[\rho_A]\, \mathrm{d}\hat{\sigma}_{NLO}[\rho_A] \right\}$$
$$= \int [\mathcal{D}\rho_A] \left(W^{NLLx}_{\Lambda_0^-}[\rho_A] \left\{ \mathrm{d}\hat{\sigma}_{LO}[\rho_A] + \boxed{\mathrm{d}\hat{\sigma}_{NLO}[\rho_A]} \right\} + O(\alpha_S^3 \ln(\Lambda_1^-/\Lambda_0^-)) \right)$$

NLLx resummed weight functional

$$W^{NLLx}_{\Lambda_0^-}[\rho_A] = \left\{ 1 + \ln(\Lambda_1^-/\Lambda_0^-)(\mathcal{H}_{LO} + \mathcal{H}_{NLO}) \right\}$$

$\mathcal{H}_{NLO}$ **= NLO JIMWLK Hamiltonian**

NLO photon+dijet impact factor

Correction terms are higher order compared to the relevant accuracy of the problem

NLO BK
- Balitsky, Chirilli, arXiv:0710.4330
- Kovchegov, Weigert, hep-ph/0609090

NLO JIMWLK
- Kovner, Lublinsky, Mulian, arXiv:1310.0378
- Grabovsky, arXiv:1307.5414
- Caron-Huot, arXiv:1309.6521
- Lublinksy, Mulian, arXiv: 1610.03453

NLO impact factor for photon+dijet in eA DIS

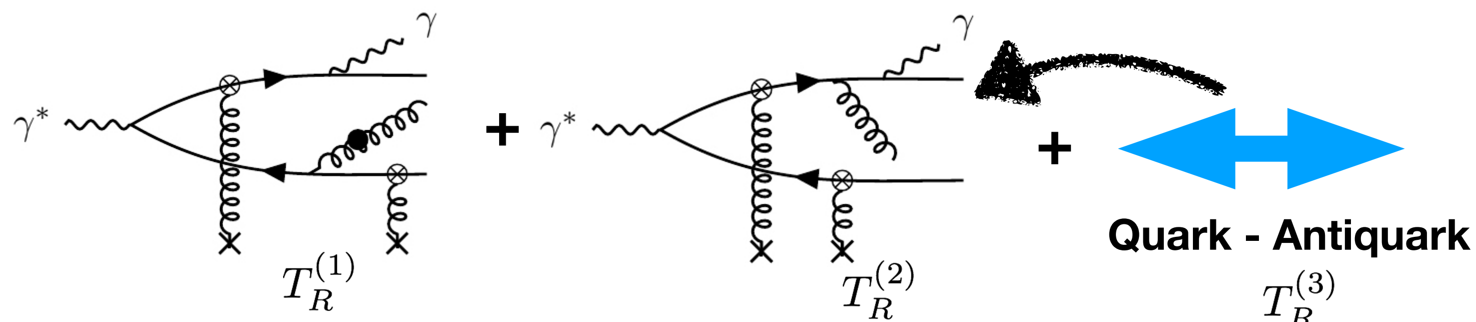
Extant NLO results in literature

Fully Inclusive DIS
- Balitsky, Chirilli, arXiv: 1009.4729
- Beuf, arXiv: 1606.00777, 1708.06557
- Hanninen, Lappi, Paatelainen, arXiv: 1711.08207

Diffractive DIS dijet → Boussarie, Grabovsky, Szymanowski, Wallon, arXiv:1606.00419

First computation of photon+dijet in eA DIS at small x

Real gluon emission:



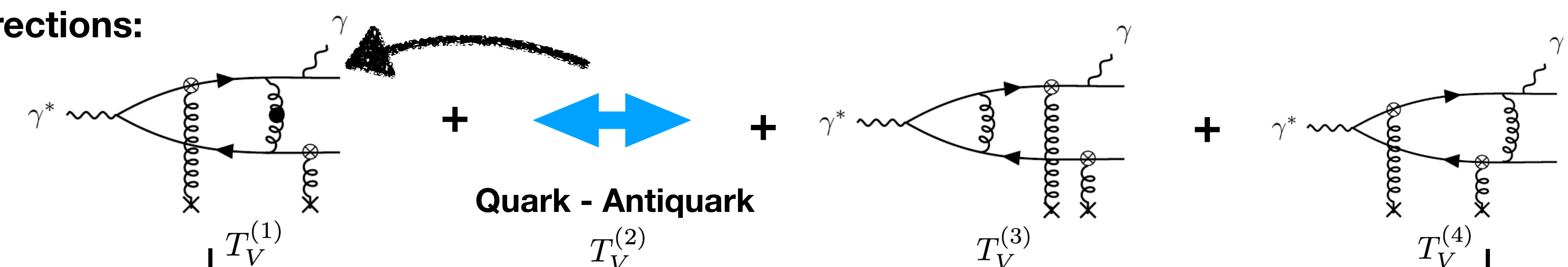
Gluon can possibly cross the "shock wave"

Gluon does not cross the "shock wave"

20x20=400 contributions in the squared amplitude

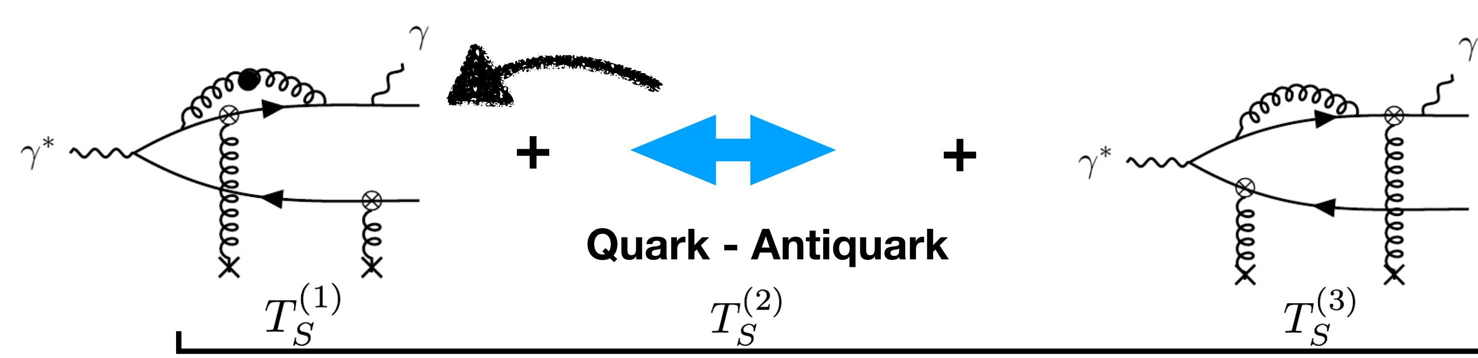
Virtual emission:

a. Vertex corrections:



6x4=24 diagrams in total interfering with LO processes

b. Self-energy corrections:



(6x2=12)+24=36 diagrams in total interfering with LO processes

Assembling different contributions in the amplitude squared:

KR, Venugopalan, in preparation

- **Novel and rich structure in terms of 2-point and 4-point Wilson line correlators obtained.**

$|\mathcal{M}^R|^2$ $\qquad$ $\mathcal{M}_{NLO}\mathcal{M}^*_{LO} + c.c$

Wilson line factor	Real emission	Virtual: Vertex	Virtual: Self-energy
$\frac{N_c^2}{2}\left(1 - D_{xz}D_{zy} - D_{y'z}D_{zx'} + D_{y'y}D_{xx'}\right) - \frac{1}{2}\Xi(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp;\boldsymbol{y}'_\perp,\boldsymbol{x}'_\perp)$	$T_R^{(1)*}T_R^{(1)}$		
$C_F N_c \Xi(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp;\boldsymbol{y}'_\perp,\boldsymbol{x}'_\perp)$	$T_R^{(2)*}T_R^{(2)} + T_R^{(3)*}T_R^{(3)}$	$T^*_{LO}T_V^{(3)} + c.c$	$T^*_{LO}T_S^{(3)} + c.c$
$\frac{N_c^2}{2}[(1 - D_{xy})(1 - D_{y'x'})] - \frac{1}{2}\Xi(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp;\boldsymbol{y}'_\perp,\boldsymbol{x}'_\perp)$	$T_R^{(2)*}T_R^{(3)} + c.c$	$T^*_{LO}T_V^{(4)} + c.c$	
$\frac{N_c^2}{2}\left(1 + (Q_{zy;y'x'} - D_{zy})D_{xz} - D_{y'x'}\right) - \frac{1}{2}\Xi(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp;\boldsymbol{y}'_\perp,\boldsymbol{x}'_\perp)$	$T_R^{(2)*}T_R^{(1)}$	$T^*_{LO}T_V^{(1)}$	$T^*_{LO}T_S^{(1)}$
$\frac{N_c^2}{2}\left(1 + (Q_{y'x';xz} - D_{xz})D_{zy} - D_{y'x'}\right) - \frac{1}{2}\Xi(\boldsymbol{x}_\perp,\boldsymbol{y}_\perp;\boldsymbol{y}'_\perp,\boldsymbol{x}'_\perp)$	$T_R^{(3)*}T_R^{(1)}$	$T^*_{LO}T_V^{(2)}$	$T^*_{LO}T_S^{(2)}$

+conjugates of last two rows
Wilson line factors obtained by permutations of coordinates

Collinear divergences cancel between real and interference contributions

No collinear singularities due to transverse momentum kicks from nucleus

Rapidity and UV divergent pieces: absorb into the NLLx JIMWLK expressions using a suitable subtraction scheme.

KR, Venugopalan, in preparation

Deriving the JIMWLK evolution from the projectile side for a non-trivial process

Non-linear RG evolution equation, governs rapidity evolution of many-body gluon correlators

Hadron tensor at LO:

$$X^{\rm LO}_{\mu\nu} = \mathcal{C}^{\rm LO}_{\mu\nu} \otimes \Xi(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp; \boldsymbol{y}'_\perp, \boldsymbol{x}'_\perp | \Lambda_0^-)$$

$$\Xi(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp; \boldsymbol{x}'_\perp, \boldsymbol{y}'_\perp) = 1 - D(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp) - D(\boldsymbol{y}'_\perp, \boldsymbol{x}'_\perp) + Q(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp; \boldsymbol{y}'_\perp, \boldsymbol{x}'_\perp)$$

Hard coefficient

In the soft gluon limit which generates logarithms in x, we obtain the following for our hadron tensor at NLO

$$X^{\rm NLO}_{\mu\nu;LLx} = C^{\rm LO}_{\mu\nu} \otimes \ln(\Lambda_1^-/\Lambda_0^-) \Bigg[\frac{\alpha_S N_c}{2\pi^2} \Big\{ \mathcal{K}_B(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp; \boldsymbol{z}_\perp) D_{xy} + \begin{pmatrix} \boldsymbol{x}_\perp \to \boldsymbol{y}'_\perp \\ \boldsymbol{y}_\perp \to \boldsymbol{x}'_\perp \end{pmatrix} \Big\} - \frac{\alpha_S N_c}{(2\pi)^2} \mathcal{K}_1(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp, \boldsymbol{y}'_\perp, \boldsymbol{x}'_\perp; \boldsymbol{z}_\perp) Q_{xy}$$

$$- \frac{\alpha_S N_c}{2\pi^2} \Big\{ \mathcal{K}_B(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp; \boldsymbol{z}_\perp) D_{xz} D_{zy} + \begin{pmatrix} \boldsymbol{x}_\perp \to \boldsymbol{y}'_\perp \\ \boldsymbol{y}_\perp \to \boldsymbol{x}'_\perp \end{pmatrix} \Big\} + \frac{\alpha_S N_c}{(2\pi)^2} \Bigg(\Big\{ \mathcal{A}(\boldsymbol{x}_\perp, \boldsymbol{y}'_\perp, \boldsymbol{y}_\perp, \boldsymbol{x}'_\perp; \boldsymbol{z}_\perp) D_{xx'} D_{y'y} + \boldsymbol{x}_\perp \leftrightarrow \boldsymbol{y}'_\perp$$

$$+ \Big\{ \mathcal{K}_2(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp, \boldsymbol{x}'_\perp; \boldsymbol{z}_\perp) D_{xz} Q_{zy;y'x'} + \begin{pmatrix} \boldsymbol{x}_\perp \to \boldsymbol{y}'_\perp \\ \boldsymbol{y}_\perp \to \boldsymbol{x}'_\perp \end{pmatrix} \Big\} + \Big\{ \mathcal{K}_2(\boldsymbol{x}'_\perp, \boldsymbol{x}_\perp, \boldsymbol{y}'_\perp; \boldsymbol{z}_\perp) D_{zx'} Q_{y'z;xy'} + \begin{pmatrix} \boldsymbol{x}_\perp \to \boldsymbol{y}'_\perp \\ \boldsymbol{y}_\perp \to \boldsymbol{x}'_\perp \end{pmatrix} \Big\} \Bigg)$$

Building blocks: Non-trivial combinations of dipole and quadrupole Wilson line correlators

Dominguez, Mueller, Munier, Xiao, arXiv: 1108.1752

$\mathscr{A}, \mathscr{K}_{1,2}$ **are evolution kernels composed of several BFKL kernels** $\mathcal{K}_B = \dfrac{(\boldsymbol{x}_\perp - \boldsymbol{y}_\perp)^2}{(\boldsymbol{x}_\perp - \boldsymbol{z}_\perp)^2 (\boldsymbol{y}_\perp - \boldsymbol{z}_\perp)^2}$

Remarkably, this whole thing can be simply written as

$$X^{\rm NLO}_{\mu\nu;LLx} = C^{\rm LO}_{\mu\nu} \otimes \ln\left(\frac{\Lambda_1^-}{\Lambda_0^-}\right) H^{\rm LO}_{\rm JIMWLK}\, \Xi(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp; \boldsymbol{y}'_\perp, \boldsymbol{x}'_\perp | \Lambda_0^-)$$

Leads immediately to the JIMWLK evolution equation:

$$W_{\Lambda_1^-}[\rho_A] = \left(1 + \ln\left(\frac{\Lambda_1^-}{\Lambda_0^-}\right) H^{\rm LO}_{\rm JIMWLK}\right) W_{\Lambda_0^-}[\rho_A]$$

$$\frac{\partial}{\partial\,(\ln \Lambda^-)} (\mathrm{d}\sigma^{LO}) = \langle H_{\rm JIMWLK}\, (\mathrm{d}\sigma^{LO}) \rangle$$

Summary

- We present a first computation of inclusive photon production in deeply inelastic electron-nuclear scattering at small x in the CGC framework. Clean way of studying the emergent regime of saturation physics that has aspects of both weak and strong interactions.
- The LO result is proportional to universal 2-point and 4-point Wilson line correlators in the nucleus. Extant results on fully inclusive DIS dijet are obtained in the soft photon limit.
- The simple structure of the dressed quark and gluon propagators in the “wrong” light cone gauge enables higher order computations in momentum space using otherwise standard covariant perturbation theory (pQCD) techniques.
- The techniques employed in NLO calculation are also discussed, with emphasis on the high energy JIMWLK factorization.
- The computation of the NLO impact factor is the missing non-trivial piece and **COMING SOON** ON arXiv..

We thank Ian Balitsky, Renaud Boussarie, Al Mueller and Yair Mulian for useful discussions

Thank you…