RG improved JIMWLK Hamiltonian: running coupling and DGLAP resummation

Michael Lublinsky

Ben-Gurion University of the Negev, Israel

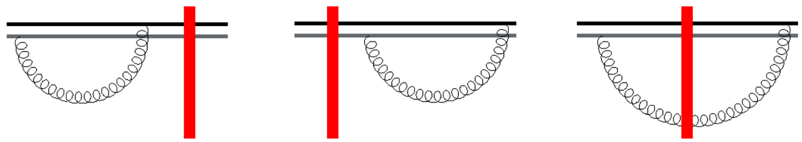
A. Kovner, M. Lublinsky, V. V. Skokov and Z. Zhao, arXiv:2308.15545 [hep-ph].

T. Altinoluk, G. Beuf, M. Lublinsky and V. V. Skokov, arXiv:2310.10738 [hep-ph]

LO JIMWLK Hamiltonian

$$\mathcal{H}^{\rm JIMWLK}_{\rm LO} = \int_{x,y,z} K_{\rm LO} \left\{ J^a_L(x) J^a_L(y) + J^a_R(x) J^a_R(y) - 2 J^a_L(x) S^{ab}_A(z) J^b_R(y) \right\}$$

$$K_{\rm LO}(x,y,z) = \frac{\alpha_s}{2\,\pi^2} \frac{(x-z)_i (y-z)_i}{(x-z)^2 (y-z)^2} \equiv \frac{\alpha_s}{2\,\pi^2} \frac{X_i Y_i}{X^2 Y^2}$$



Here J_L and J_R are left and right SU(N) generators:

$$J^a_L(x) S^{ij}_A(z) = \left(T^a S_A(z)\right)^{ij} \delta^2(x-z) \qquad J^a_R(x) S^{ij}_A(z) = \left(S_A(z) T^a\right)^{ij} \delta^2(x-z)$$

$$\mathcal{H}_{\rm LO} = \frac{\alpha_s}{2} \int_z Q^a_i(z) Q^a_i(z)\,, \qquad Q^a_i(z) = \frac{1}{\pi} \int_x \frac{X_i}{X^2} \left[S_A(x) - S_A(z)\right]^{ab} J^b_R(x).$$

JIMWLK is valid for dilute-on-dense collisions only ($Q_s^P \ll Q_s^T$)

Stochastic formulation/Langevin

The rapidity evolution operator from η_0 to η_1 is

$$\mathcal{U}(\eta_0,\eta_1) = \mathcal{P}\mathbf{e}^{-\int_{\eta_0}^{\eta_1} \mathrm{d}\eta \mathcal{H}_{\mathrm{LO}}} = \int \mathbf{D}\xi \, \mathcal{U}_\xi(\eta_0,\eta_1)\, \mathbf{e}^{-\int_{\eta_0}^{\eta_1} \mathrm{d}\eta \int_{\mathbf{z}} \frac{1}{2}\vec{\xi}^{\,2}(\eta,\mathbf{z})}$$

$$\mathcal{U}_\xi(\eta_0,\eta_1) \;=\; \mathcal{P}_\eta \,\exp\left\{-\mathbf{i}\int_{\eta_0}^{\eta_1} \mathrm{d}\eta \,\int_{\mathbf{z}} \sqrt{\alpha_s}\,\mathbf{Q}^{\mathbf{a}}_{\mathbf{i}}(\mathbf{z})\xi^{\mathbf{a}}_{\mathbf{i}}(\eta,\mathbf{z})\right\}$$

for an infinitesimally small rapidity interval Δ

$$\mathcal{U}_\xi \equiv \mathcal{U}_\xi(\eta,\eta+\mathbf{\Delta}) \;=\; \exp\left\{-\mathbf{i}\mathbf{\Delta}\int_{\mathbf{z}} \sqrt{\alpha_s}\mathbf{Q}^{\mathbf{a}}_{\mathbf{i}}(\mathbf{z})\xi^{\mathbf{a}}_{\mathbf{i}}(\eta,\mathbf{z})\right\}$$

Rapidity evolution of any operator that is built out of Wilson lines, such as a color dipole, is performed in two steps: first one computes evolution of the Wilson lines on a fixed configuration of the noise and then averages the operator over the noise.

The success of the Langevin reformulation lies in the observation that $\mathcal{H}_{\mathrm{LO}}$ is quadratic in the operator Q. The Hamiltonian $\mathcal{H}_{LO}$ has all its eigenvalues non-negative.

LO JIMWLK kernel beyond LO

$$\mathcal{H} = \int_{x,y,z} \mathbf{K}(\mathbf{x},\mathbf{y};\mathbf{z}) \left[\mathbf{J}^a_L(\mathbf{x})\,\mathbf{J}^a_L(\mathbf{y}) \;+\; \mathbf{J}^a_R(\mathbf{x})\mathbf{J}^a_R(\mathbf{y}) \;-\; 2\mathbf{J}^a_L(\mathbf{x})\,\mathbf{S}^{ab}_A(\mathbf{z})\,\mathbf{J}^b_R(\mathbf{y}) \right]$$

An effective kernel $\mathbf{K} \;=\; \mathbf{K_{LO}} \;+\; \mathbf{K_{NLO}} \;+\; \ldots. \sim\; \alpha_s(\# \;+\; \alpha_s\,(\# + \mathbf{Logs}) \;+\; \cdots)$

Large transverse logarithms emerge at NLO. There are various types of large Logs - all have to be identified, clearly separated, and independently resummed.
Proper resummation requires understanding of physics beyond NLO!

- Running coupling effects (UV divergent) – rcJIMWLK:

$$\mathbf{K_{LO}} \;=\; \frac{\alpha_s}{2\pi^2}\frac{\mathbf{XY}}{\mathbf{X^2Y^2}} \;\to\; \mathbf{K_{rc}} \;=\; \frac{\alpha_s[\mathbf{running}]}{2\pi^2}\frac{\mathbf{XY}}{\mathbf{X^2Y^2}}$$

- DGLAP logs: Large transverse logs of the $\log(Q^T_s/Q^P_s)$ type (dilute-on-dense).

rcJIMWLK kernel?

Action on a dipole $\mathbf{S(u,v)}$ (BK equation):

$$\mathcal{H}\,\mathbf{S(u,v)} \;=\; \mathbf{N_c}\int_{\mathbf{z}} \mathbf{K_{dipole}(u,v,z)}\;[\mathbf{S(u,z)\,S(z,v)} \;-\; \mathbf{S(u,v)}]$$

$$\mathbf{K_{dipole}(u,v,z)} \;=\; \mathbf{K(u,u,z)} \;+\; \mathbf{K(v,v,z)} \;-\; \mathbf{K(u,v,z)} \;-\; \mathbf{K(v,u,z)}$$

$\mathbf{K_{rc}} \;\leftrightarrow\;$ rcBK (parent dipole or minimal daughter dipole, etc, not consistent with NLO)

$$\mathbf{K^{Bal}} = \frac{\alpha_s(\mathbf{X-Y})}{2\pi^2}\frac{\mathbf{X\cdot Y}}{\mathbf{X^2Y^2}} + \frac{\alpha_s(\mathbf{X})}{4\pi^2}\frac{\mathbf{1}}{\mathbf{X^2}}\left(\mathbf{1} - \frac{\alpha_s(\mathbf{X-Y})}{\alpha_s(\mathbf{Y})}\right) + \frac{\alpha_s(\mathbf{Y})}{4\pi^2}\frac{\mathbf{1}}{\mathbf{Y^2}}\left(\mathbf{1} - \frac{\alpha_s(\mathbf{X-Y})}{\alpha_s(\mathbf{X})}\right)$$

$$\mathbf{K^{KW}} \;=\; \frac{\alpha_s(\mathbf{X})\alpha_s(\mathbf{Y})}{\alpha_s(\mathbf{R(X,Y)})}\,\frac{\mathbf{1}}{\mathbf{2\pi^2}}\frac{\mathbf{X\cdot Y}}{\mathbf{X^2Y^2}}\,, \qquad\qquad \mathbf{R} \;=\; \mathbf{R(X,Y)}$$

These results are problematic: what α_s is doing in the denominators? why is the charge renormalization of the emitter at position x sensitive to position of another emitter at y?

Any constraints on K?

Positive semi-definiteness of the JIMWLK kernel

The Hamiltonian $\mathcal{H}$ must have all its eigenvalues non-negative.

This is equivalent to the positive semi-definiteness of the kernel K.

$$\int \mathbf{d^2X\, d^2Y\, f(X)\, K(X,Y)\, f(Y) \;\geq\; 0} \qquad \text{for } \mathbf{any\ f}$$

$$\mathbf{A_1^2\, K(X_1,X_1) \;+\; A_2^2\, K(X_2,X_2) \;+\; 2A_1A_2\, K(X_1,X_2) \;\geq\; 0} \quad \text{for any } \mathbf{A_1} \text{ and } \mathbf{A_2}.$$

$$\mathbf{K(X,X) \;+\; K(Y,Y) \;-\; 2K(X,Y) \;\geq\; 0} \qquad \rightarrow \qquad \mathbf{K_{dipole}(X,Y) \;\geq\; 0}$$

$$\mathbf{K(X,X) \;+\; K(Y,Y) \;-\; K^2(X,Y) \;\geq\; 0}$$

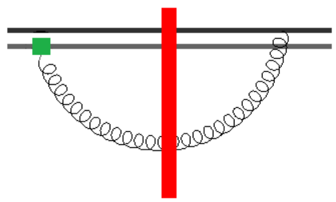
For any positive semidefinite kernel, it is possible to define a “square root” Ψ

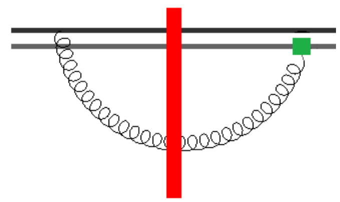
$$\int_{\mathbf{V}} \mathbf{\Psi_i(X,V)\Psi_i(Y,V) = K(X,Y)}\,.$$

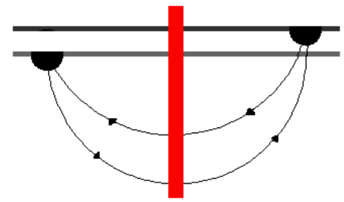
None of the rcJIMWLK prescriptions satisfy positive semi-definiteness!

JIMWLK Hamiltonian @ NLO

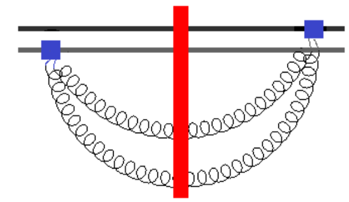
Kovner, ML & Mulian (2013) based on Balitsky & Chirilli (2007), Grabovsky (2013); ML & Mulian (2016)







(a)



(b)

$$\mathcal{H}^{NLO\ JIMWLK} = \int_{x,y,z} K_{JSJ}(x,y;z)\left[J_L^a(x)J_L^a(y) + J_R^a(x)J_R^a(y) - 2J_L^a(x)S_A^{ab}(z)J_R^b(y)\right]$$

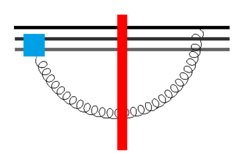
$$+\int_{x\,y\,z\,z'} K_{JSSJ}(x,y;z,z')\left[f^{abc}f^{def}J_L^a(x)S_A^{be}(z)S_A^{cf}(z')J_R^d(y) - N_c J_L^a(x)S_A^{ab}(z)J_R^b(y)\right]$$

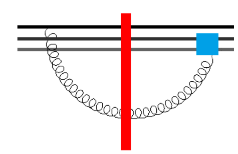
$$+\int_{x,y,z,z'} K_{q\bar{q}}(x,y;z,z')\left[2\,J_L^a(x)\,tr[S_F^\dagger(z)\,t^a\,S_F(z')t^b]\,J_R^b(y)\;-\;J_L^a(x)\,S_A^{ab}(z)\,J_R^b(y)\right]$$

$$+\int_{w,x,y,z,z'} K_{JJSSJ}(w;x,y;z,z')f^{acb}\left[J_L^d(x)\,J_L^e(y)\,S_A^{dc}(z)\,S_A^{eb}(z')\,J_R^a(w) - J_L^a(w)\,S_A^{cd}(z)\,S_A^{be}(z')\,J_R^d(x)\,J_R^e(y)\right]$$

$$+\int_{w,x,y,z} K_{JJSJ}(w;x,y;z)\,f^{bde}\left[J_L^d(x)\,J_L^e(y)\,S_A^{ba}(z)\,J_R^a(w)\;-\;J_L^a(w)\,S_A^{ab}(z)\,J_R^d(x)\,J_R^e(y)\right]$$

$$+\int_{w,x,y} K_{JJJ}(w;x,y)f^{deb}\left[J_L^d(x)\,J_L^e(y)\,J_L^b(w)\;-\;J_R^d(x)\,J_R^e(y)\,J_R^b(w)\right].$$





NLO Kernels (Large UV Logs only)

$$\mathbf{X} = \mathbf{x} - \mathbf{z}$$
$$Y = y - z$$

$$\mathbf{K_{JSJ}}(\mathrm{b\,terms}) = \frac{\alpha_s^2}{16\pi^3}\left\{-\mathbf{b}\frac{(\mathbf{x}-\mathbf{y})^2}{\mathbf{X}^2\mathbf{Y}^2}\ln(\mathbf{x}-\mathbf{y})^2\mu^2 + \frac{\mathbf{b}}{\mathbf{X}^2}\ln\mathbf{Y}^2\mu^2 + \frac{\mathbf{b}}{\mathbf{Y}^2}\ln\mathbf{X}^2\mu^2\right\} + \cdots$$

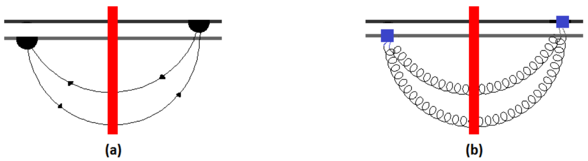
Here μ is the normalization point, $\mathbf{b} = \frac{11}{3}\mathrm{N_c} - \frac{2}{3}\mathrm{n_f}$ **,** $\mathbf{b}\ \ln\mathbf{Q}^2/\mu^2 \to \alpha_s(\mathbf{Q}^2)$

Huge ambiguity in identifying Q. K_{JSJ} is not positive semi-definite

Resumm large Logs into an effective kernel $\mathbf{K} = \mathbf{K_{LO}} + \mathbf{K_{JSJ}} + \ldots.$

$$\int_{\mathrm{x\,y\,z,z'}} \mathbf{K_{JSSJ}}(\mathbf{x},\mathbf{y};\mathbf{z},\mathbf{z}')\,\mathbf{J_L^a}(\mathbf{x})\mathbf{J_R^b}(\mathbf{y})\,\left[\mathbf{D^{ab}}(\mathbf{z},\mathbf{z}')\right] \sim \mathbf{b} \times (\mathrm{UV\ divergent\ Log})$$

$$\mathbf{D^{ab}}(\mathbf{z},\mathbf{z}') \equiv \mathbf{Tr}[\mathbf{T^aS_A}(\mathbf{z})\mathbf{T^bS_A^+}(\mathbf{z}')]$$



The UV divergence in $JSSJ$ is trivial: when the two gluons are too close to each other ($z \sim z'$), they cannot be resolved by the target and hence should be counted as a single gluon scattering. We are thus prompted to introduce a "resolution scale" Q

Dressed Wilson line

Within the finite resolution Q bare gluons $\rightarrow$ dressed gluons,
bare Wilson lines $\rightarrow$ *dressed Wilson lines*, $\mathbf{S} \rightarrow \mathbf{S_Q}$

$$\mathbf{S^{ab}_Q(z)} = \mathbf{S^{ab}_A(z)} + \frac{\alpha_s}{2\pi^2}\int_0^1 \mathbf{d}\xi\,\sigma(\xi)\int^{\mathbf{Q^{-1}}} \frac{\mathbf{d^2Z}}{\mathbf{Z^2}}\Big(\mathbf{D^{ab}}(\mathbf{z} + (\mathbf{1}-\xi)\mathbf{Z}, \mathbf{z} - \xi\mathbf{Z}) - \mathbf{N_c}\,\mathbf{S^{ab}_A(z)}\Big)$$

ξ is the fraction of longitudinal momentum carried by one of the gluons.

$$\sigma(\xi) = \left[\frac{\mathbf{1}}{\xi(\mathbf{1}-\xi)}\Big(\xi^2 + (\mathbf{1}-\xi)^2 + \xi^2(\mathbf{1}-\xi)^2\Big)\right]_+ ;\quad \mathbf{2N_c}\int_0^1 \mathbf{d}\xi\sigma(\xi) = -\frac{\mathbf{11N_c}}{\mathbf{3}} \rightarrow -\,\mathrm{b}$$

This is a P_{gg} splitting function except that we introduce the "+" prescription both for $\xi = 1$ and $\xi = 0$ poles The "+" prescription emerges from the $1/\xi$ subtraction absorbed into (LO)^2 part of the evolution.

The sign is negative – correcting for the over-subtraction in the LO.

We go beyond the usual DGLAP: we allow simultaneous scattering of all gluons.

For $\mathbf{Q} > \mathbf{Q_s^T}$, $\mathbf{S_Q} \simeq \mathbf{S_A}$ - the target does not resolve gluon splitting at distances smaller than $1/\mathbf{Q_s^T}$.

Resolution scale and the running coupling

Express S in terms of S_Q and substitute it into the LO+NLO JIMWLK Hamiltonian. $\mathcal{H}[S] \to \mathcal{H}[S_Q]$. The Hamiltonian will feature $\ln Q^2$ terms such as $\ln(Q^2X^2)$.

$$\mathbf{K} \;=\; \mathbf{K_{LO}} \left(\mathbf{1} + \frac{\alpha_s}{\mathbf{4}\pi}\mathrm{b}\,(\ln \mathbf{X}^2\mu^2 + \ln \mathbf{Y}^2\mu^2 - \ln \mathbf{Q}^{-2}\mu^2)\right) \;+\; \text{other } O(\alpha_s^2) \text{ terms}$$

We assume existence of a typical scale $Q_s^P \ll Q_s^T$ associated with the projectile, such that $\ln(Q_s^P X^2)$ are small. The UV finite parts of the Hamiltonian proportional to b do not have any large Logs

$$\mathbf{K_{in}} \;=\; \mathbf{K}(\mathbf{Q} = \mathbf{Q_s^P}) \;=\; \frac{\sqrt{\alpha_s(\mathbf{X})\,\alpha_s(\mathbf{Y})}}{\mathbf{2}\pi^2}\,\frac{\mathbf{XY}}{\mathbf{X^2Y^2}}\,\left[\mathbf{1} + \frac{\alpha_s}{\mathbf{8}\pi}\mathrm{b}\,(\text{small logs})\right]$$

$\sqrt{\alpha_s(\mathbf{X})\,\alpha_s(\mathbf{Y})}$ is a positive semi-definite prescription for rcJIMWLK.
Has been already used in Langevin

However, at $Q = Q_s^P$, $\mathbf{S_Q}$ is very different from $\mathbf{S_A}$, $\mathbf{S_Q} \sim \mathbf{S_A}\,[\mathbf{1} + \alpha_s\,\#\,\mathbf{Log}(\mathbf{Q^2}/\mathbf{Q_s^T})]$. This large Log has to be resummed via inclusion of multiple consecutive DGLAP splittings:

$$\frac{\partial \mathbf{S_Q(z)}}{\partial \ln \mathbf{Q}} = -\frac{\alpha_s}{\mathbf{2}\pi^2} \int_\xi \sigma(\xi) \int_{\phi_\mathbf{Q}} [\mathbf{D_Q(z)} - \mathbf{N_c}\,\mathbf{S_Q(z)}]$$

$$\mathbf{D_Q(z_1, z_2)} \equiv \mathbf{Tr}[\mathbf{T^a S_Q(z_1) T^b S_Q^+(z_2)}]$$

If we were to take $\mathbf{Q} = \mathbf{Q_s^T}$ then $\mathbf{S_Q} \simeq \mathbf{S_A}$ but the $\ln \mathbf{Q^2}$ terms in the Hamiltonian would be large and have to be resummed.

Either way, we have to resum large logs of the order $\log Q_s^T/Q_s^P$.

Functional RG

The resummed Hamiltonian should be Q-independent:

$$\frac{\mathbf{d}\mathcal{H}}{\mathbf{d}\ln\mathbf{Q}} = \frac{\partial\mathcal{H}}{\partial\ln\mathbf{Q}} + \int_{\mathbf{u}}\left[\frac{\delta\mathcal{H}}{\delta\mathbf{S}_{\mathbf{Q}}(\mathbf{u})}\frac{\partial\mathbf{S}_{\mathbf{Q}}(\mathbf{u})}{\partial\ln\mathbf{Q}}\right] = \mathbf{0}$$

DGLAP-like evolution for the Hamiltonian (evolution in the space of Hamiltonians):

$$\mathcal{H}[\mathbf{Q}_{\mathbf{s}}^{\mathbf{P}}] \;=\; \mathbf{Exp}\left[\int_{\mathbf{Q}_{\mathbf{s}}^{\mathbf{P}}}^{\mathbf{Q}_{\mathbf{s}}^{\mathbf{T}}}\frac{\mathbf{dQ}}{\mathbf{Q}}\mathbf{H}_{\mathbf{DGLAP}}\right]\mathcal{H}_{\mathbf{in}}$$

$$\mathbf{H}_{\mathbf{DGLAP}} \;=\; \frac{\alpha_{\mathbf{s}}}{\mathbf{2}\pi^{\mathbf{2}}}\int_{\mathbf{u}}\int_{\xi}\sigma(\xi)\int_{\phi_{\mathbf{Q}}}\mathbf{Tr}\left([\mathbf{D}_{\mathbf{Q}}(\mathbf{u}) \;-\; \mathbf{N}_{\mathbf{c}}\,\mathbf{S}_{\mathbf{Q}}(\mathbf{u})]\,\frac{\delta}{\delta\mathbf{S}_{\mathbf{Q}}(\mathbf{u})}\right)$$

$\mathbf{Q}_{\mathbf{s}}^{\mathbf{P}} = \mathbf{Q}_{\mathbf{s}}^{\mathbf{P}}(\eta)$ **– Q_s^P is dynamical (rapidity dependent);**
hence the resummed Hamiltonian is too.

Weak target field approximation – linearization

$$\mathbf{S^{ab}_Q = \delta^{ab} + f^{abc}\alpha^c_Q\,;} \qquad\qquad \mathbf{D^{ab}_Q(z_1,z_2) = N_c\left(\delta^{ab} + \frac{1}{2}f^{abc}\left[\alpha^c_Q(z_1) + (\alpha^c_Q(z_2))^*\right]\right)}$$

Expand the Hamiltonian (BFKL-like)

$$\mathcal{H} \;=\; \int_{x,y,z,z'} \mathbf{K_Q(x,y,z,z')\;\left(\alpha_Q(x) - \alpha_Q(z)\right)^a\;\left(\alpha_Q(y) - \alpha_Q(z')\right)^b \frac{\delta}{\delta\alpha^a_Q(x)}\,\frac{\delta}{\delta\alpha^b_Q(y)}}$$

$$\mathcal{H} \;=\; \int_{q_1,q_2,p_1,p_2} \mathbf{K_Q(p_1,p_2,q_1,q_2)\;\alpha^a_Q(q_1)\;\alpha^b_Q(q_2)\,\frac{\delta}{\delta\alpha^a_Q(p_1)}\,\frac{\delta}{\delta\alpha^b_Q(p_2)}}$$

$$\mathbf{H_{DGLAP}} \sim \;\alpha_Q\,\frac{\delta}{\delta\alpha_Q}$$

$\mathbf{H_{DGLAP}}$ **is homogeneous**

The DGLAP-like RG evolution becomes a closed equation for the kernel K_Q.

$$\mathbf{K_Q(p_1, p_2, q_1, q_2) \;=\; Exp\left(\int_{Q_s^P}^{Q_s^T} \frac{dQ}{Q}(R(q_1, Q) + R(q_2, Q))\right) K_{in}(p_1, p_2, q_1, q_2)}$$

Here $\mathbf{K_{in}}$ is the non-forward BFKL kernel, which is multiplicatively "renormalized"

$$\mathbf{R(q, Q) \;=\; \frac{\alpha_s N_c}{2\pi^2}\int d\xi\sigma(\xi)\int d\phi\left(e^{i(1-\xi)Q^{-1}\vec{q}\cdot\vec{e}_\phi} - 1\right)}$$

Alternatively,

$$\mathbf{\alpha_Q(z) \approx \left(\frac{Q_T}{Q}\right)^{\frac{\alpha_s b}{2\pi}}\alpha(z) + \int_{1/Q_T<|x-z|<1/Q} d^2x\frac{\alpha_s b}{4\pi}\frac{Q^2}{\pi}\left[1 - \left(\frac{1}{Q^2(x-z)^2}\right)^{1+\frac{\alpha_s b}{4\pi}}\right]\alpha(x)}$$

For small distances, the WW fields get smeared

Saturation region

$$\mathbf{H_{DGLAP}} = \frac{\alpha_s}{2\pi^2} \int_{\mathbf{u}} \int_\xi \sigma(\xi) \int_{\phi_{\mathbf{Q}}} \mathbf{Tr} \left([\mathbf{D_Q(u)} - \mathbf{N_c}\, \mathbf{S_Q(u)}] \frac{\delta}{\delta \mathbf{S_Q(u)}} \right)$$

Since $|\mathbf{z_1} - \mathbf{z_2}| = 1/\mathbf{Q} > 1/\mathbf{Q_s^T}$, the two gluons are well separated and outside the correlation region in the target (in the sense of averaging over the target).

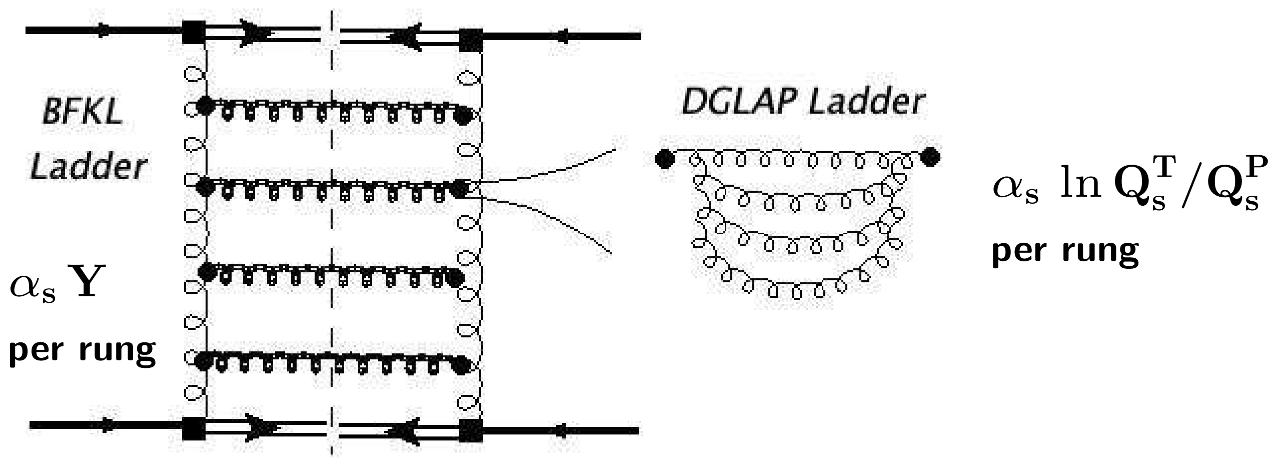
$$\mathbf{D_Q} \ll \mathbf{N_c}\, \mathbf{S_Q} \quad \rightarrow \quad \mathbf{H_{DGLAP}} \text{ is again homogeneous}$$

$$\frac{\partial S_Q(z)}{\partial \ln Q^2} = \frac{\alpha_s N_c}{\pi} \int_\xi \sigma(\xi)\, S_Q(z)$$

$$\mathbf{S_Q} = \left[\frac{\mathbf{Q_s^T}}{\mathbf{Q}} \right]^{\frac{\alpha_s}{2\pi}\mathbf{b}} \mathbf{S}$$

Summary/Outlook

- **DGLAP-like resummation inside the JIMWLK Hamiltonian has been performed. These DGLAP corrections are large whenever there is a large disparity between the correlation lengths (or saturation momenta) in the projectile and the target. This is precisely JIMWLK's regime of validity.**
  The result is a smearing of the WW fields within the $1/Q_s^T$ distance



- **rcJIMWLK emerges with the scale choice for the running coupling:**
  $K \sim \sqrt{\alpha_s(X)\alpha_s(Y)}$

"High energy QCD: from the LHC to the EIC"

When: 2025, Aug 4 - Aug 15

Where: Centro de Ciencias de Benasque Pedro Pascual

Organizers:

T. Altinoluk (National Centre for Nuclear Research, Poland),
N. Armesto (Universidade de Santiago de Compostela, Spain),
J. Jalilian-Marian (City University of New York, USA),
A. Kovner (University of Connecticut, USA),
M. Lublinsky (Ben Gurion University of the Negev, Israel),
C. Marquet (CNRS and Ecole Polytechnique, France)