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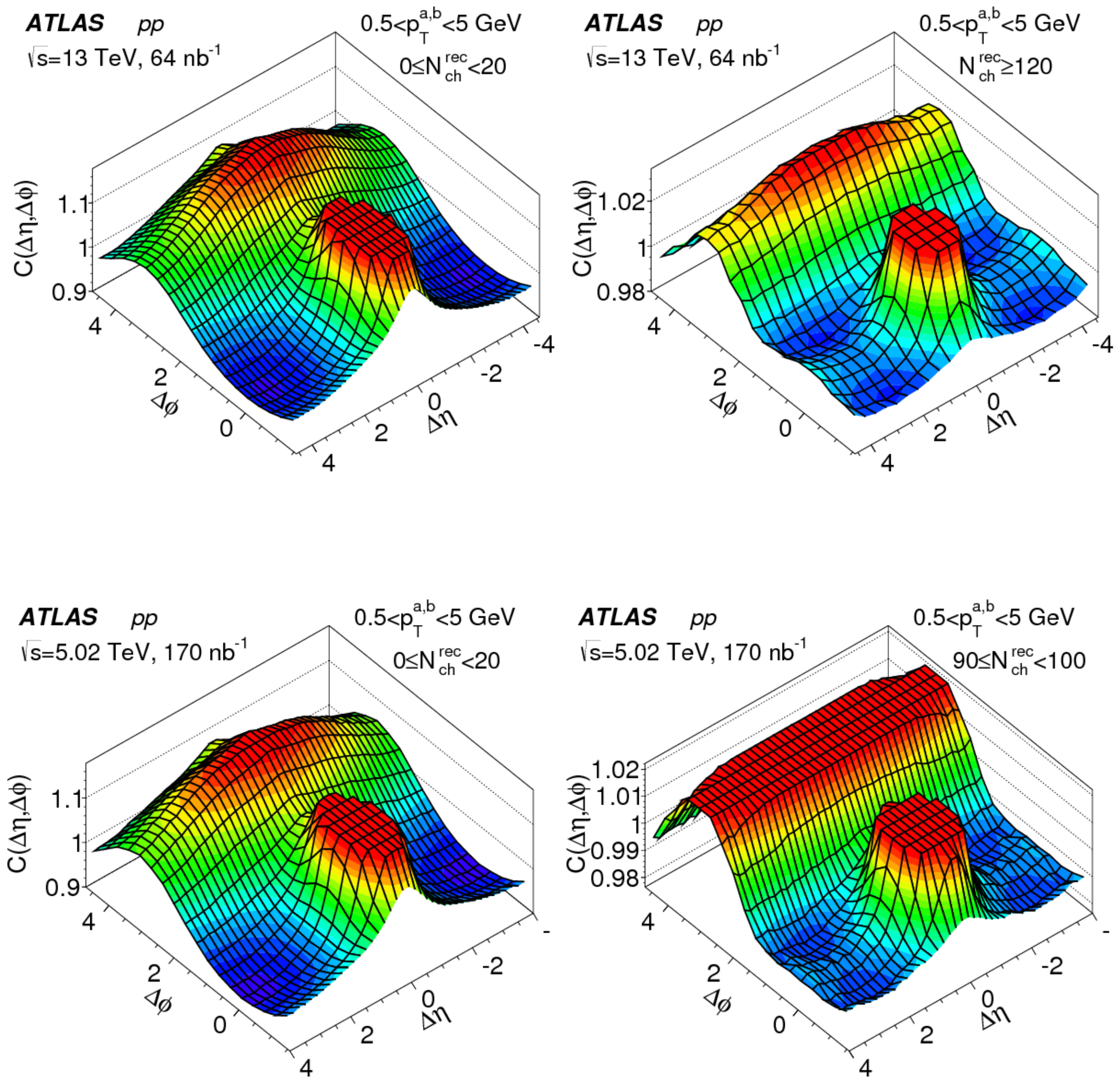
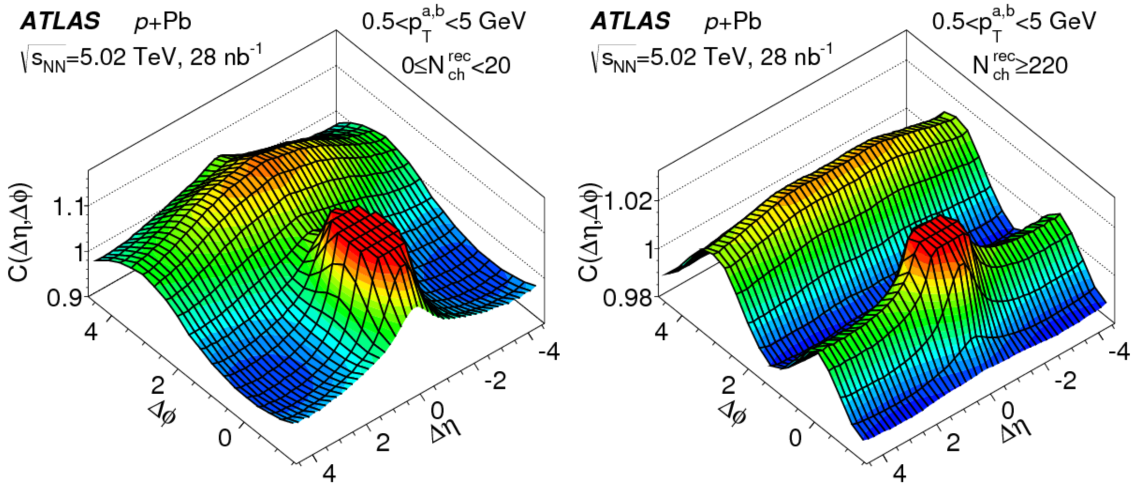
SURFACING ODD HARMONICS IN TWO PARTICLE CORRELATIONS WITHIN THE COLOR GLASS CONDENSATE APPROACH

Víctor Vila

[in collaboration with Cyrille Marquet and Anderson Kendi]

13th International Workshop on Multiple Partonic Interactions at the LHC, 14-18 November 2022





ATLAS Collaboration, "Measurements of long-range azimuthal anisotropies and associated Fourier coefficients for *pp* collisions at $s^{1/2}$=*5.02* and *13 TeV* and *p+Pb* collisions at $s_{NN}^{1/2}$=*5.02 TeV* with the ATLAS detector", ATLAS-CONF-2016-026 [arXiv:1609.06213 [nucl-ex]].

- One of the main unveilings of the CMS collaboration.
- First noticed in relativistic heavy-ion data from RHIC.
- An incentive to seek the origin of particle correlations.

Mechanisms behind the ridge in *pp*, *pA* and *AA* collisions:

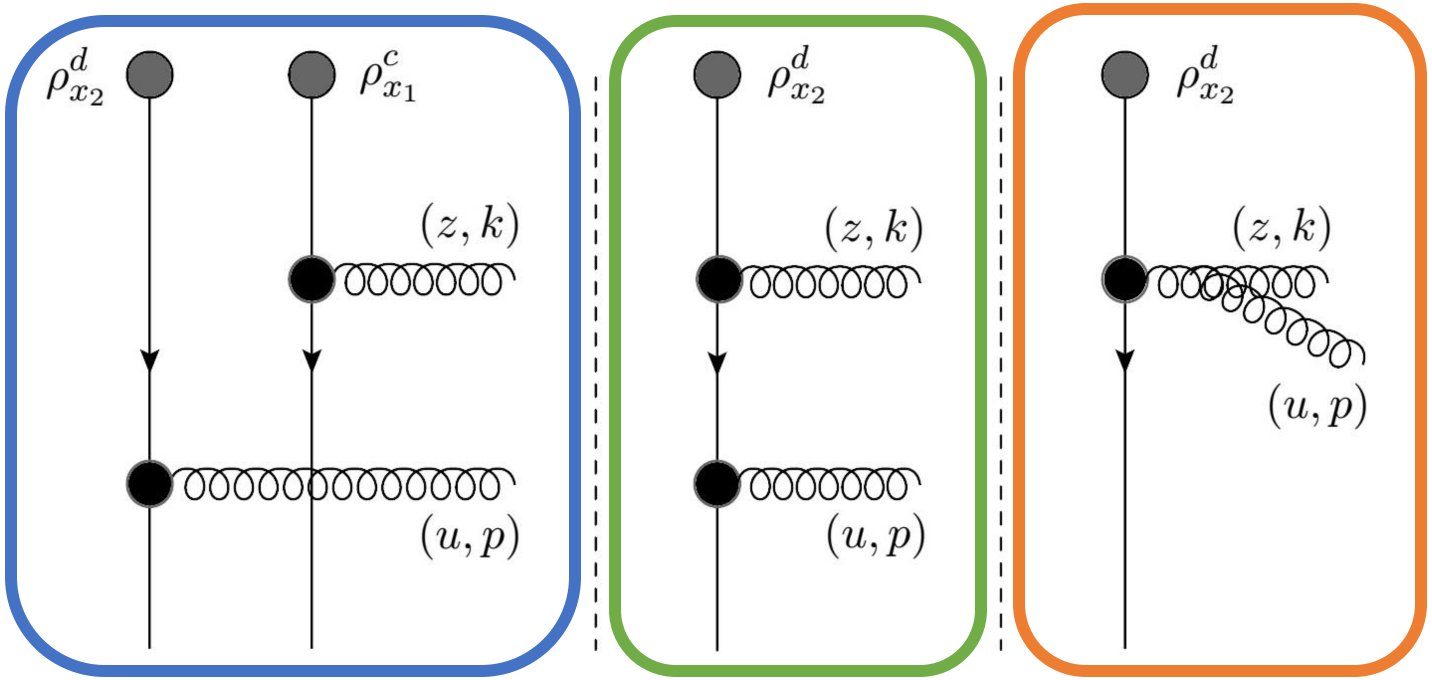
- HICs: collective behaviour of the gluons cloud's final state.
- Small systems: hydrodynamical evolution logic consistent with data.
- **Particle correlations: roots in the very early stages of the collision.**
- **Glasma graph approximation — Dilute-dilute limit of the CGC framework:**
  - Extremely effective.
  - Anisotropic distribution of particles motivates decomposition in Fourier harmonics with the corresponding coefficients v_n:
    - Rise of even Fourier harmonics.
    - **ABSENCE OF ODD AZIMUTHAL HARMONICS.**

$$A^{ab}_{ij}(k,p) = \int_{u,z} e^{ik\cdot z+ip\cdot u}\Bigg\{\int_{x_1,x_2}\Big\{f_i(z-x_1)[S_z-S_{x_1}]^{ac}\rho^c_{x_1}\Big\}\Big\{f_j(u-x_2)[S_u-S_{x_2}]^{bd}\rho^d_{x_2}\Big\}$$

$$-\frac{1}{2}\int_{x_1} f_i(z-x_1)f_j(u-x_1)\Big\{[S_z-S_{x_1}]\bar{\rho}_{x_1}[S^\dagger_u+S^\dagger_{x_1}]\Big\}^{ab}$$

$$+\int_{x_1} f_i(z-u)f_j(u-x_1)\Big\{[S_z-S_u]\bar{\rho}_{x_1}S^\dagger_u\Big\}^{ab}\Bigg\},$$

A. Kovner and M. Lublinsky, "Angular Correlations in Gluon Production at High Energy", Phys.Rev. D**83** (2011) 034017 [arXiv:1012.3398 [hep-ph]].



$$\frac{dN}{d^2p\,d^2k\,d\eta\,d\xi} = \langle \sigma^4 + \sigma^3 + \sigma^2 \rangle_{P,T}$$

A. Kovner and M. Lublinsky, "Angular Correlations in Gluon Production at High Energy", Phys.Rev. D**83** (2011) 034017 [arXiv:1012.3398 [hep-ph]].

$$\sigma^4 = \int_{u,z,\bar{u},\bar{z}} e^{ik\cdot(z-\bar{z})+ip\cdot(u-\bar{u})} \int_{x_1,x_2,\bar{x}_1,\bar{x}_2} f(\bar{z}-\bar{x}_1)\cdot f(z-x_1)\; f(\bar{u}-\bar{x}_2)\cdot f(u-x_2)$$
$$\times \left\{\rho_{x_1}[S^\dagger_z - S^\dagger_{x_1}][S_{\bar{z}} - S_{\bar{x}_1}]\rho_{\bar{x}_1}\right\}\left\{\rho_{x_2}[S^\dagger_u - S^\dagger_{x_2}][S_{\bar{u}} - S_{\bar{x}_2}]\rho_{\bar{x}_2}\right\}$$

$$\sigma^3 = \int_{u,z,\bar{u},\bar{z}} e^{ik\cdot(z-\bar{z})+ip\cdot(u-\bar{u})} \int_{x_1,\bar{x}_1,x_2(\bar{x}_2)}$$
$$-\frac{1}{2} f(\bar{z}-\bar{x}_1)\cdot f(z-x_1) f(\bar{u}-\bar{x}_1)\cdot f(u-x_2)$$
$$\times \mathrm{Tr}\left\{\bar{\rho}_{x_1}[S^\dagger_z - S^\dagger_{x_1}][S_{\bar{z}} - S_{\bar{x}_1}]\bar{\rho}_{\bar{x}_1}[S^\dagger_{\bar{u}} + S^\dagger_{\bar{x}_1}][S_u - S_{x_2}]\bar{\rho}_{x_2}\right\}$$
$$+\frac{1}{2} f(\bar{z}-\bar{x}_1)\cdot f(z-x_1) f(\bar{u}-\bar{x}_2)\cdot f(u-x_1)$$
$$\times \mathrm{Tr}\left\{\bar{\rho}_{\bar{x}_2}[S^\dagger_{\bar{u}} - S^\dagger_{\bar{x}_2}][S_u + S_{x_1}]\bar{\rho}_{x_1}[S^\dagger_z - S^\dagger_{x_1}][S_{\bar{z}} - S_{\bar{x}_1}]\bar{\rho}_{\bar{x}_1}\right\}$$
$$+ f(\bar{z}-\bar{u})\cdot f(z-x_1) f(\bar{u}-\bar{x}_1)\cdot f(u-x_2)$$
$$\times \mathrm{Tr}\left\{\bar{\rho}_{x_1}[S^\dagger_z - S^\dagger_{x_1}][S_{\bar{z}} - S_{\bar{u}}]\bar{\rho}_{\bar{x}_1} S^\dagger_{\bar{u}}[S_u - S_{x_2}]\bar{\rho}_{x_2}\right\}$$
$$- f(\bar{z}-\bar{x}_1)\cdot f(z-u) f(\bar{u}-\bar{x}_2)\cdot f(u-x_1)$$
$$\times \mathrm{Tr}\left\{\bar{\rho}_{\bar{x}_2}[S^\dagger_{\bar{u}} - S^\dagger_{\bar{x}_2}] S_u \bar{\rho}_{x_1}[S^\dagger_z - S^\dagger_u][S_{\bar{z}} - S_{\bar{x}_1}]\bar{\rho}_{\bar{x}_1}\right\}$$

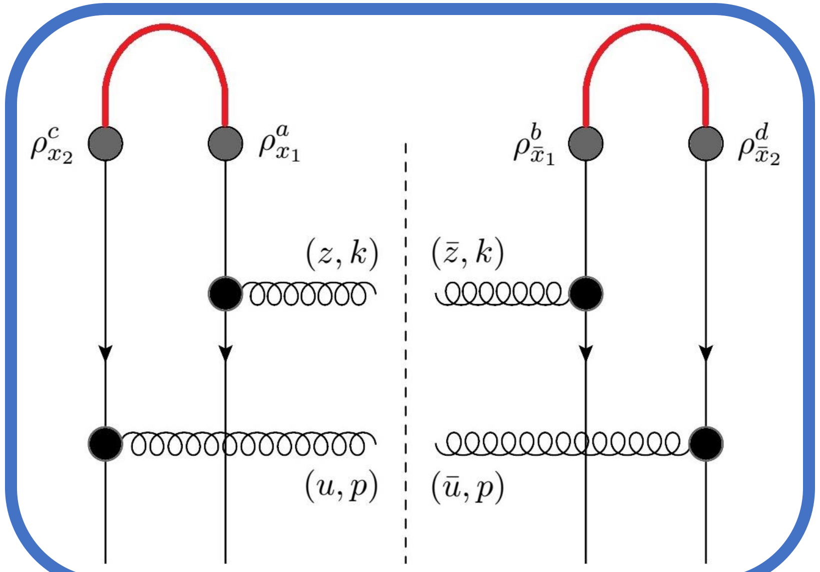
$$\sigma^2 = \int_{u,z,\bar{u},\bar{z}} e^{ik\cdot(z-\bar{z})+ip\cdot(u-\bar{u})} \int_{x_1,\bar{x}_1}$$
$$\frac{1}{4} f(\bar{z}-\bar{x}_1)\cdot f(z-x_1) f(\bar{u}-\bar{x}_1)\cdot f(u-x_1)$$
$$\times \mathrm{Tr}\left\{[S_u + S_{x_1}]\bar{\rho}_{x_1}[S^\dagger_z - S^\dagger_{x_1}][S_{\bar{z}} - S_{\bar{x}_1}]\bar{\rho}_{\bar{x}_1}[S^\dagger_{\bar{u}} + S^\dagger_{\bar{x}_1}]\right\}$$
$$+ f(\bar{z}-\bar{u})\cdot f(z-u) f(\bar{u}-\bar{x}_1)\cdot f(u-x_1)$$
$$\times \mathrm{Tr}\left\{S_u \bar{\rho}_{x_1}[S^\dagger_z - S^\dagger_u][S_{\bar{z}} - S_{\bar{u}}]\bar{\rho}_{\bar{x}_1} S^\dagger_{\bar{u}}\right\}$$
$$-\frac{1}{2} f(\bar{z}-\bar{x}_1)\cdot f(z-u) f(\bar{u}-\bar{x}_1)\cdot f(u-x_1)$$
$$\times \mathrm{Tr}\left\{S_u \bar{\rho}_{x_1}[S^\dagger_z - S^\dagger_u][S_{\bar{z}} - S_{\bar{x}_1}]\bar{\rho}_{\bar{x}_1}[S^\dagger_{\bar{u}} + S^\dagger_{\bar{x}_1}]\right\}$$
$$-\frac{1}{2} f(\bar{z}-\bar{u})\cdot f(z-x_1) f(\bar{u}-\bar{x}_1)\cdot f(u-x_1)$$
$$\times \mathrm{Tr}\left\{[S_u + S_{x_1}]\bar{\rho}_{x_1}[S^\dagger_z - S^\dagger_{x_1}][S_{\bar{z}} - S_{\bar{u}}]\bar{\rho}_{\bar{x}_1} S^\dagger_{\bar{u}}\right\}$$

$$\left\langle \hat\rho^c_{x_2}\hat\rho^a_{x_1}\hat\rho^d_{\bar x_2}\hat\rho^b_{\bar x_1}\right\rangle_P = \left\langle \hat\rho^c_{x_2}\hat\rho^a_{x_1}\right\rangle_P\left\langle \hat\rho^d_{\bar x_2}\hat\rho^b_{\bar x_1}\right\rangle_P + \left\langle \hat\rho^c_{x_2}\hat\rho^d_{\bar x_2}\right\rangle_P\left\langle \hat\rho^a_{x_1}\hat\rho^b_{\bar x_1}\right\rangle_P + \left\langle \hat\rho^c_{x_2}\hat\rho^b_{\bar x_1}\right\rangle_P\left\langle \hat\rho^a_{x_1}\hat\rho^d_{\bar x_2}\right\rangle_P$$

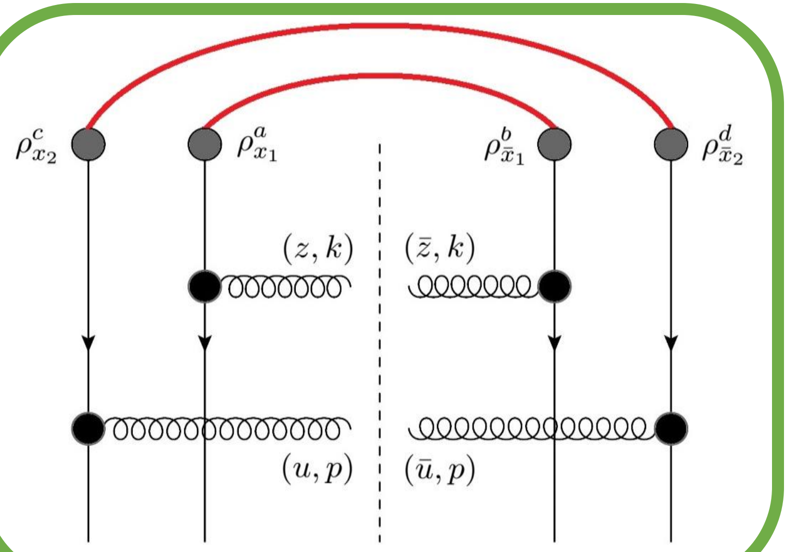
$$\left\langle \hat\rho^a_{x_1}\hat\rho^b_{x_2}\right\rangle_P = \delta^{ab}\mu^2\delta^{(2)}(x_1-x_2)$$

MV MODEL PROJECTILE AVERAGING

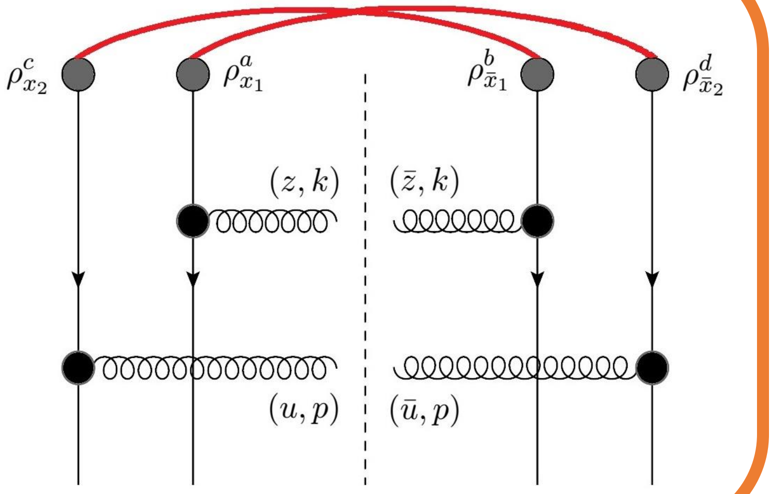
T. Altinoluk, N. Armesto, A. Kovner and M. Lublinsky, "Double and triple inclusive gluon production at mid rapidity: quantum interference in p-A scattering", Eur.Phys.J. C**78** (2018) 9, 702 [arXiv:1805.07739 [hep-ph]].



$\sigma^{4(i)}$



$\sigma^{4(ii)}$



$\sigma^{4(iii)}$

Projectile averaging

$$\sigma^2 = \int_{u,z,\bar{u},\bar{z}} e^{ik\cdot(z-\bar{z})+ip\cdot(u-\bar{u})} \int_{x_1,\bar{x}_1}$$

[A. Kendi, C. Marquet and V. Vila, "in preparation"]

$$\frac{1}{4} f(\bar{z}-\bar{x}_1)\cdot f(z-x_1) f(\bar{u}-\bar{x}_1)\cdot f(u-x_1)$$
$$\times \mathrm{Tr}\left\{[S_u + S_{x_1}]\bar{\rho}_{x_1}[S_z^\dagger - S_{x_1}^\dagger][S_{\bar{z}} - S_{\bar{x}_1}]\bar{\rho}_{\bar{x}_1}[S_{\bar{u}}^\dagger + S_{\bar{x}_1}^\dagger]\right\}$$

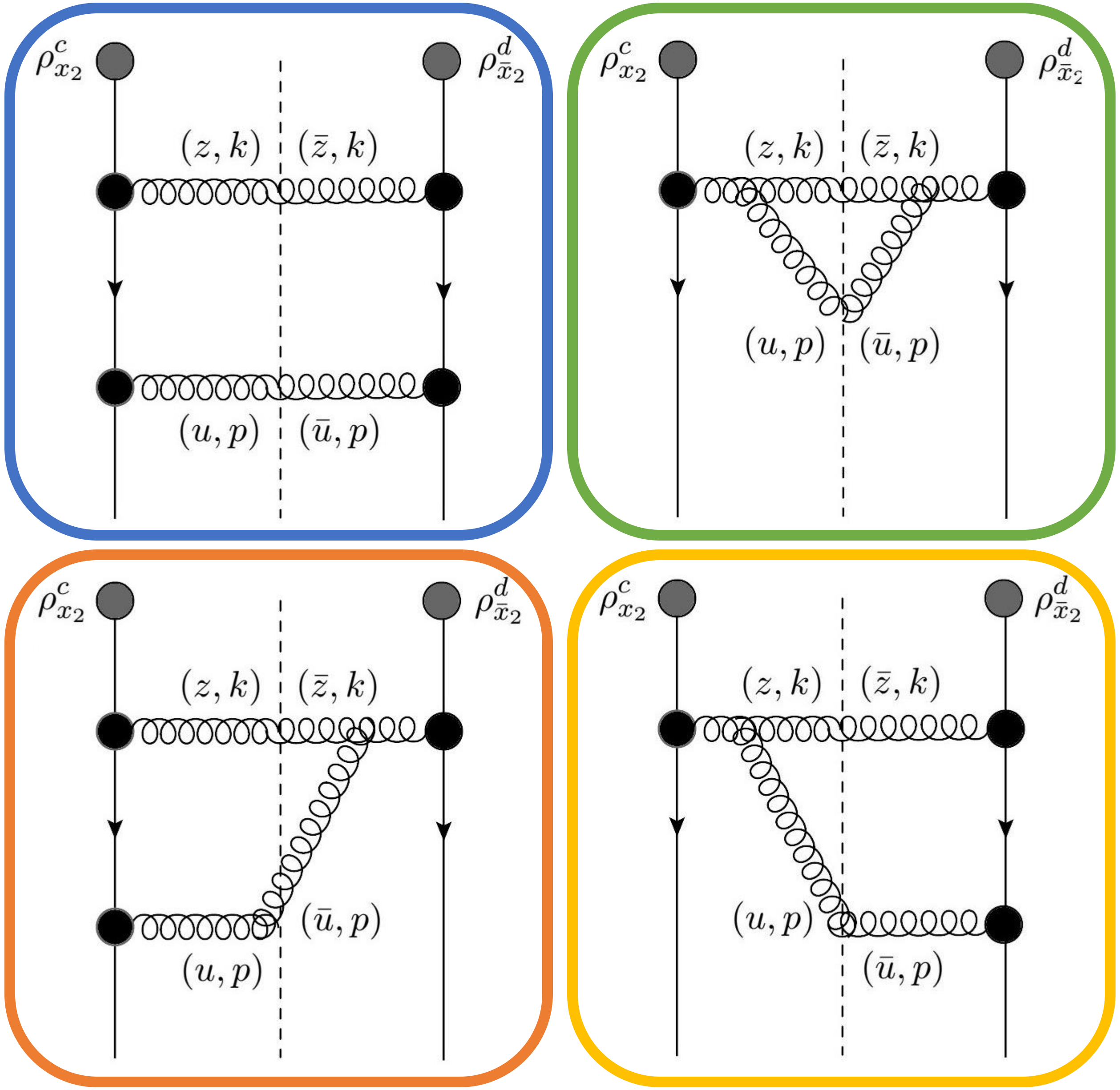
$$+ f(\bar{z}-\bar{u})\cdot f(z-u) f(\bar{u}-\bar{x}_1)\cdot f(u-x_1)$$
$$\times \mathrm{Tr}\left\{S_u\bar{\rho}_{x_1}[S_z^\dagger - S_u^\dagger][S_{\bar{z}} - S_{\bar{u}}]\bar{\rho}_{\bar{x}_1}S_{\bar{u}}^\dagger\right\}$$

$$-\frac{1}{2} f(\bar{z}-\bar{x}_1)\cdot f(z-u) f(\bar{u}-\bar{x}_1)\cdot f(u-x_1)$$
$$\times \mathrm{Tr}\left\{S_u\bar{\rho}_{x_1}[S_z^\dagger - S_u^\dagger][S_{\bar{z}} - S_{\bar{x}_1}]\bar{\rho}_{\bar{x}_1}[S_{\bar{u}}^\dagger + S_{\bar{x}_1}^\dagger]\right\}$$

$$-\frac{1}{2} f(\bar{z}-\bar{u})\cdot f(z-x_1) f(\bar{u}-\bar{x}_1)\cdot f(u-x_1)$$
$$\times \mathrm{Tr}\left\{[S_u + S_{x_1}]\bar{\rho}_{x_1}[S_z^\dagger - S_{x_1}^\dagger][S_{\bar{z}} - S_{\bar{u}}]\bar{\rho}_{\bar{x}_1}S_{\bar{u}}^\dagger\right\}$$

$$\left\langle \hat{\rho}^a_{x_1}\hat{\rho}^b_{\bar{x}_1}\hat{\rho}^c_{\bar{x}_2}\right\rangle_P = 0$$

MV MODEL PROJECTILE AVERAGING



$$\tilde{D}(\bar{u},u) = \left\langle \frac{1}{N^2-1} \mathrm{Tr}\left[S^\dagger(\bar{u})S(u)\right]\right\rangle_T$$
$$\tilde{Q}(\bar{u},u,z,\bar{z}) = \left\langle \frac{1}{N^2-1} \mathrm{Tr}\left[S^\dagger(\bar{u})S(u)S^\dagger(z)S(\bar{z})\right]\right\rangle_T$$

AEA

LARGE N_C

$$\tilde{D}(\bar{u},u) = D^2(\bar{u},u)$$
$$\tilde{Q}(\bar{u},u,z,\bar{z}) \approx D^2(\bar{u},u)D^2(z,\bar{z}) + D^2(\bar{u},\bar{z})D^2(u,z)$$

$$\begin{aligned}\sigma^{4(ii)} = \int_{u,z,\bar{u},\bar{z}} e^{ik\cdot(z-\bar{z})+ip\cdot(u-\bar{u})} \int_{x_1,x_2} f(\bar{z}-x_1)\cdot f(z-x_1)\; f(\bar{u}-x_2)\cdot f(u-x_2) \\ \times (N^2-1)^2\mu^4\Big\{\tilde{D}(z,\bar{z})\tilde{D}(u,\bar{u}) - \tilde{D}(z,\bar{z})\tilde{D}(u,x_2) - \tilde{D}(z,\bar{z})\tilde{D}(x_2,\bar{u}) \\ + \tilde{D}(z,\bar{z}) - \tilde{D}(x_1,\bar{z})\tilde{D}(u,\bar{u}) + \tilde{D}(x_1,\bar{z})\tilde{D}(u,x_2) + \tilde{D}(x_1,\bar{z})\tilde{D}(x_2,\bar{u}) \\ - \tilde{D}(x_1,\bar{z}) - \tilde{D}(z,x_1)\tilde{D}(u,\bar{u}) + \tilde{D}(z,x_1)\tilde{D}(u,x_2) + \tilde{D}(z,x_1)\tilde{D}(x_2,\bar{u}) \\ - \tilde{D}(z,x_1) + \tilde{D}(u,\bar{u}) - \tilde{D}(u,x_2) - \tilde{D}(x_2,\bar{u}) + 1\Big\}\end{aligned}$$

$$\begin{aligned}\sigma^{4(ii)} = \int_{u,z,\bar{u},\bar{z}} e^{ik\cdot(z-\bar{z})+ip\cdot(u-\bar{u})} \int_{x,\bar{x}} f(\bar{z}-x)\cdot f(z-x)\; f(\bar{u}-\bar{x})\cdot f(u-\bar{x}) \\ \times (N^2-1)^2\mu^4\Big\{\left[D^2(z,\bar{z}) - D^2(z,x) - D^2(x,\bar{z}) + 1\right] \\ \times \left[D^2(u,\bar{u}) - D^2(u,\bar{x}) - D^2(\bar{x},\bar{u}) + 1\right]\Big\}\end{aligned}$$

$$f(x-y) = \frac{g_s}{2\pi}\frac{(x-y)^i}{(x-y)^2} = \frac{g_s}{2\pi}\int \frac{d^2q}{2\pi i}\frac{q^i}{q^2}e^{iq\cdot(x-y)}$$
$$D(r) = \int \frac{d^2q}{\pi}e^{-iq\cdot r}\frac{1}{Q_s^2}e^{-\frac{q^2}{Q_s^2}}$$
$$D^2(r) = \int \frac{d^2q}{2\pi}e^{-iq\cdot r}\frac{1}{Q_s^2}e^{-\frac{q^2}{2Q_s^2}}$$

FOURIER TRANSFORMATION OF THE WEIZSACKER-WILLIAMS FIELDS AND THE GBW MODEL FOR THE DIPOLES

$$\sigma^{4([i+iii].\mathrm{I})} \approx \alpha_s^2(4\pi)^2(N^2-1)\mu^4 S_\perp \frac{2\pi}{Q_s^2} e^{-\frac{(k+p)^2}{4Q_s^2}} \times \left[\frac{2\left(k^4+p^4+2\,(k\cdot p)^2\right)}{k^2p^2\,(k-p)^4} + \frac{8Q_s^2\,(k+p)^4}{k^2p^2\,(k-p)^6} + \frac{64Q_s^4\,(k^4+4(k\cdot p)^2+p^4+8(k\cdot p)(k^2+p^2)+14k^2p^2)}{k^2p^2\,(k-p)^8}\right] + \{(p\to -p)\}$$

$$\sigma^{4([i+iii].\mathrm{II})} \approx \alpha_s^2(4\pi)^2(N^2-1)\mu^4 S_\perp (2\pi)^2 \left[\delta^{(2)}(k+p)+\delta^{(2)}(k-p)\right] \times \frac{4}{k^{12}} e^{-\frac{k^2}{Q_s^2}} \left(k^4 + k^2 e^{\frac{k^2}{2Q_s^2}} Q_s^2 + 4e^{\frac{k^2}{2Q_s^2}} Q_s^4\right)^2$$

$$\sigma^{4(ii)} = \alpha_s^2(4\pi)^2(N^2-1)^2\mu^4 S_\perp^2 \times e^{-\frac{k^2}{2Q_s^2}} \left\{\frac{2}{k^2} - \frac{1}{k^2} e^{\frac{k^2}{2Q_s^2}} + \frac{1}{2Q_s^2}\left[\mathrm{Ei}\left(\frac{k^2}{2Q_s^2}\right) - \mathrm{Ei}\left(\frac{k^2\lambda}{2Q_s^2}\right)\right]\right\} \times \{(k\to p)\}$$

- **THE FULLY CORRELATED PIECE ENCAPSULATING TWO EFFECTS:**
  - **BOSE ENHANCEMENT OF GLUONS IN THE WAVE FUNCTION OF THE INCOMING HADRONS**
  - **HANBURY-BROWN-TWISS INTERFERENCE EFFECT IN THE EMISSION OF GLUONS**

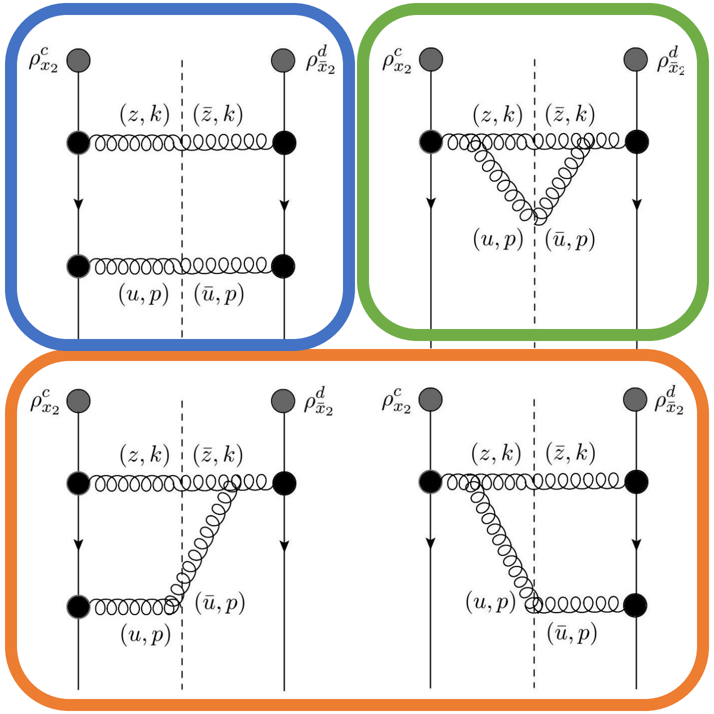
[A. Kendi, C. Marquet and V. Vila, "in preparation"]

THE UNCORRELATED PIECE CORRESPONDING TO THE SQUARE OF THE SINGLE INCLUSIVE GLUON PRODUCTION CROSS-SECTION

$$\sigma^{2(i)} = \alpha_s^2(4\pi)^2 N^3 \mu^2 S_\perp \frac{1}{k^6 p^6} e^{-\frac{k^2+p^2}{2Q_s^2}}$$
$$\times \left[k^4 + e^{\frac{k^2}{2Q_s^2}} k^2 Q_s^2 + 4e^{\frac{k^2}{2Q_s^2}} Q_s^4\right] \left[\left(2e^{\frac{p^2}{2Q_s^2}} - 1\right) p^4 + e^{\frac{p^2}{2Q_s^2}} p^2 Q_s^2 + 4e^{\frac{p^2}{2Q_s^2}} Q_s^4\right]$$

$$\sigma^{2(ii)} = \alpha_s^2(4\pi)^2 N^3 \mu^2 S_\perp \Bigg\{ \frac{1}{(2\pi)^2 Q_s^4} e^{-\frac{k^2+p^2}{2Q_s^2}} \int_{s_1,s_2} \frac{1}{s_1^2} \frac{1}{(s_1-s_2)^2} e^{-\frac{s_1^2+2k\cdot s_1}{2Q_s^2}} e^{-\frac{s_2^2-2p\cdot s_2}{2Q_s^2}}$$
$$+ \frac{1}{2\pi^2 Q_s^4} e^{-\frac{k^2+p^2}{2Q_s^2}} \int_{s_1,s_2} \frac{s_1^i}{s_1^2} \frac{1}{s_2^2} e^{-\frac{2s_1^2+2(k-p)\cdot s_1}{2Q_s^2}} e^{-\frac{s_2^2-2(s_1-p)\cdot s_2}{2Q_s^2}}$$
$$+ \frac{1}{(k+p)^2} \left[1 + \frac{1}{2} \frac{2^3 Q_s^2}{(k+p)^2} + \frac{1}{2} \frac{2^6 Q_s^4}{(k+p)^4}\right] \Bigg\}$$

$$\sigma^{2[(iii)+(iv)]} = \alpha_s^2(4\pi)^2 N^3 \mu^2 S_\perp \Bigg\{ \frac{1}{(2\pi)^2 Q_s^4} e^{-\frac{k^2+p^2}{2Q_s^2}} \int_{s_1,s_2} \left[\left(\frac{s_1^i}{s_1^2} + \frac{k^i}{k^2}\right)^2 \left(\frac{s_2^j}{s_2^2} + \frac{p^j}{p^2}\right) - \frac{1}{k^2} \frac{p^j}{p^2}\right]$$
$$\times e^{-\frac{s_1^2+2k\cdot s_1}{2Q_s^2}} e^{-\frac{s_2^2-2p\cdot s_2}{2Q_s^2}}$$
$$+ \frac{1}{k^2} \frac{p\cdot(k+p)}{p^2(k+p)^2} \left(e^{-\frac{(k+p)^2}{4Q_s^2}} - 1\right) \Bigg\}$$

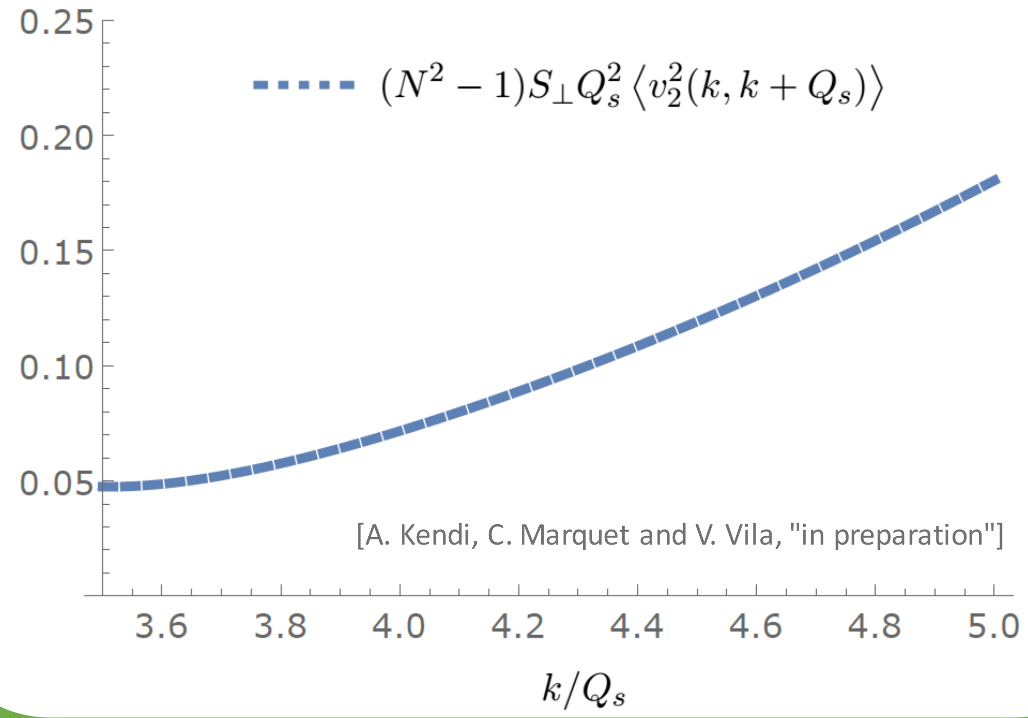


[A. Kendi, C. Marquet and V. Vila, "in preparation"]

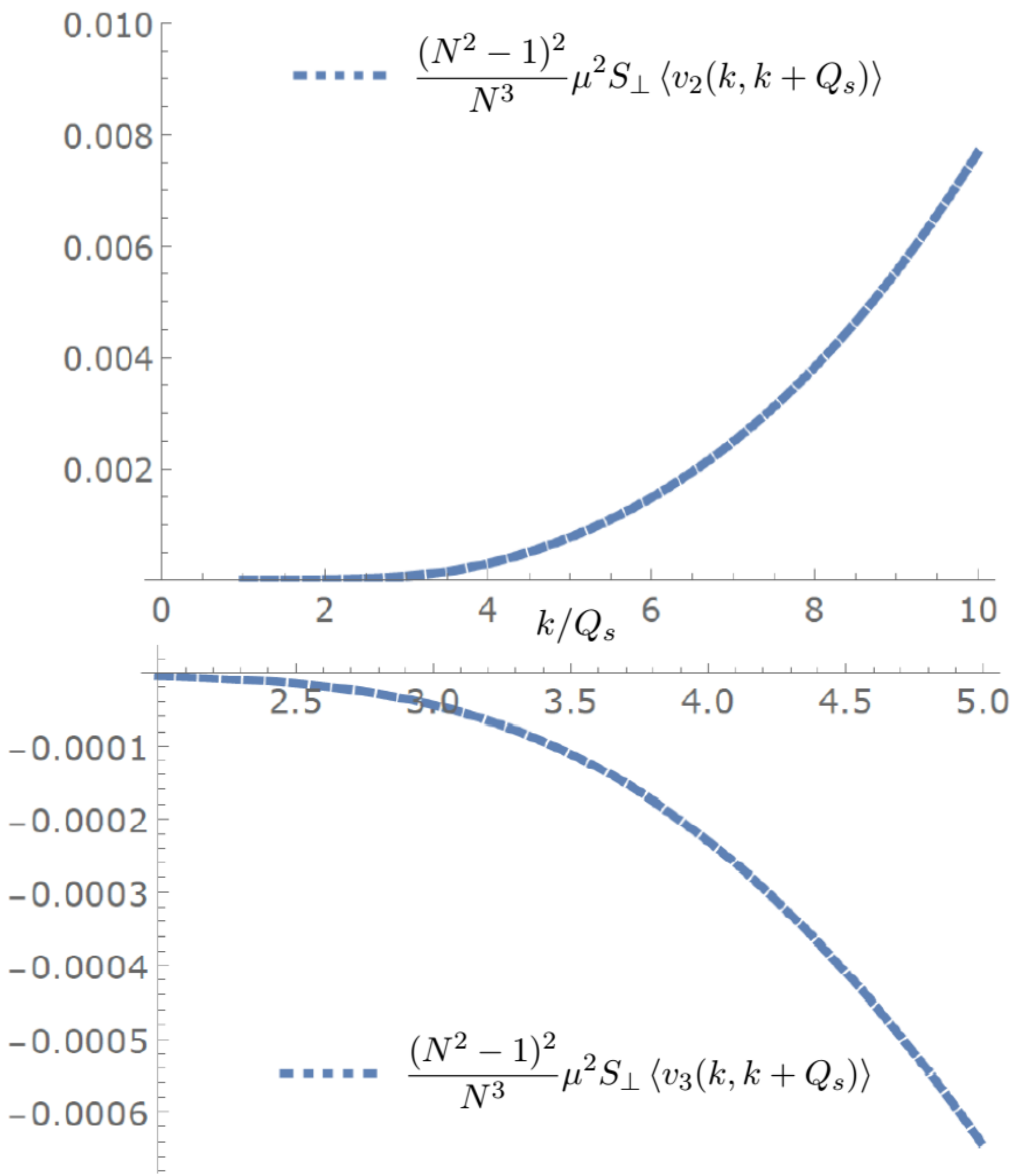
The momentum dependent v_2 and v_3

$$v_n^2(k,p) = \frac{\int d\phi_k d\phi_p e^{in(\phi_k-\phi_p)} \frac{d^2N^{(2)}}{d^2kd^2p}}{\int d\phi_k d\phi_p \frac{d^2N^{(2)}}{d^2kd^2p}}$$

$$\sigma^{4([i+iii].1)} \approx \alpha_s^2(4\pi)^2(N^2-1)\mu^4 S_\perp \frac{2\pi}{Q_s^2} e^{-\frac{(k+p)^2}{4Q_s^2}} \times \left[\frac{2\left(k^4+p^4+2(k\cdot p)^2\right)}{k^2p^2(k-p)^4} + \frac{8Q_s^2(k+p)^4}{k^2p^2(k-p)^6} + \frac{64Q_s^4\left(k^4+4(k\cdot p)^2+p^4+8(k\cdot p)(k^2+p^2)+14k^2p^2\right)}{k^2p^2(k-p)^8}\right] + \{(p\to -p)\}$$



- **BOSE CORRELATIONS REGIME: VERY WEAKLY DEPENDENCE ON THE MOMENTUM**
- **SLOW INCREASE TOWARDS LARGE MOMENTA**
- **BOSE CORRELATED PART SCALES WITH THE SAME POWER OF MOMENTUM AS UNCORRELATED PIECE**



The momentum dependent v_2 and v_3

$$\sigma^{2[(iii)+(iv)]} = \alpha_s^2(4\pi)^2 N^3 \mu^2 S_\perp \left\{ \frac{1}{(2\pi)^2 Q_s^4} e^{-\frac{k^2+p^2}{2Q_s^2}} \int_{s_1,s_2} \left[\left(\frac{s_1^i}{s_1^2} + \frac{k^i}{k^2} \right)^2 \left(\frac{s_2^j}{s_2^2} + \frac{p^j}{p^2} \right) - \frac{1}{k^2}\frac{p^j}{p^2} \right] \right.$$
$$\times\, e^{-\frac{s_1^2+2k\cdot s_1}{2Q_s^2}}\, e^{-\frac{s_2^2-2p\cdot s_2}{2Q_s^2}}$$
$$\left. - \frac{1}{k^2}\frac{p\cdot(k+p)}{p^2(k+p)^2}\left(e^{-\frac{(k+p)^2}{4Q_s^2}} - 1 \right) \right\}$$

- **THE STUDIED PIECE REVEALS BOTH EVEN AND ODD HARMONICS**
- **SAME PATTERN AS THE BOSE CORRELATED PIECE FOR v_2**
- **ODD HARMONICS SURFACING FROM THIS SMALL CONTRIBUTION**
- **TO BE COMPLETED WITH THE REMAINING PIECES (WORK IN PROGRESS)**

[A. Kendi, C. Marquet and V. Vila, "in preparation"]

- We calculate the double inclusive gluon production cross-section within the approach of the dense-dilute CGC via going beyond the Glasma Graph approximation.
- We retrieve the contribution that is responsible for independent production of two gluons as well as the single inclusive spectrum.
- **As a novelty, we provide the quantum correction accounting for the two gluons being correlated in the incoming wave function.**
- The numerical evaluation of the Bose type contribution for the two-gluons independent production configuration confirms the already studied behaviour of v_2.
- **One of the pieces of the quantum correction σ^2 reveals the presence of both even and odd azimuthal harmonics [full numerical evaluation still in progress].**

THANK YOU VERY MUCH FOR YOUR ATTENTION!