Accessing Linearly polarized gluon TMD in back to back J/Ψ and jet production at EIC

Raj Kishore, Asmita Mukherjee, Amol Pawar and Mariyah Siddiqah

IIT Bombay

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Plan of Talk

- Gluon TMDs
- Kinematics
- Azimuthal Asymmetry
- TMD parameterization
- Results and Discussion
- Conclusion

Gluon TMDs

- TMD PDFs $f(x, p_T, Q^2)$
- The Gluon Correlator

Field Strengths **Gauge Links**

$$\Phi^{\mu\nu}(x, q_T) = \int \frac{d\xi^- d^2\xi_T}{M_p(2\pi)^3} e^{iq\cdot\xi} \left\langle P|Tr[F^{+\mu}(0)U^{[C]}F^{+\nu}(\xi)U^{[C]}]|P\right\rangle\Big|_{\xi^+=0}$$

- For unpolarized proton,

Mulders(2001)

$$\Phi_g^{\nu\nu'}(x, \mathbf{p}_T^2) = -\frac{1}{2x}\left\{g_\perp^{\nu\nu'} f_1^g(x, \mathbf{p}_T^2) - \left(\frac{p_T^\nu p_T^{\nu'}}{M_p^2} + g_\perp^{\nu\nu'}\frac{\mathbf{p}_T^2}{2M_p^2}\right) h_1^{\perp g}(x, \mathbf{p}_T^2)\right\}$$

Unpolarized G TMD **Linearly polarized G TMD**

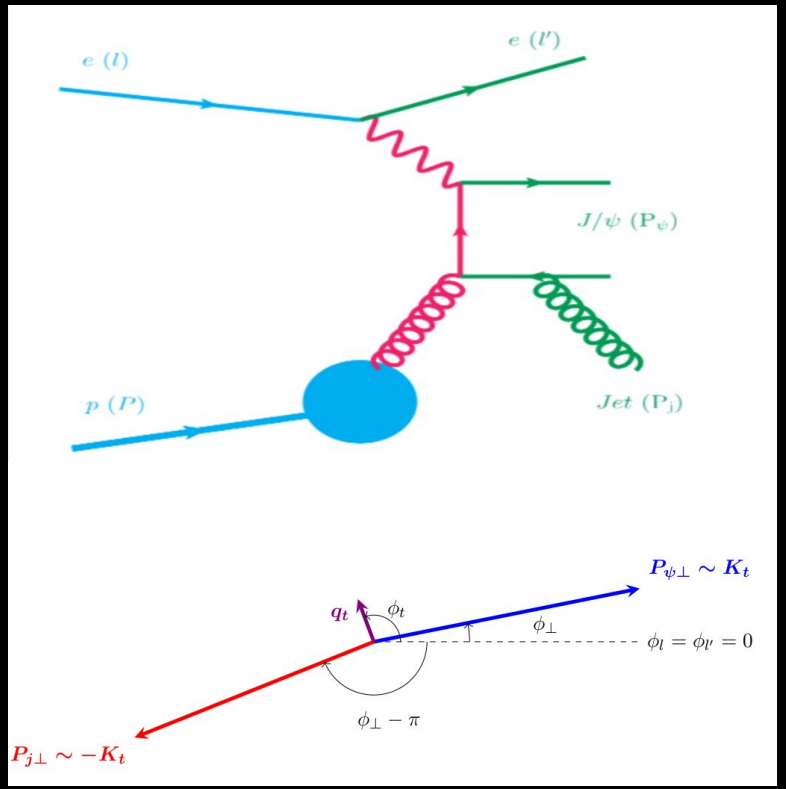
Linearly Polarized Gluon TMD $h_1^{\perp g}(x, \mathbf{p}_T^2)$

- Probed in SIDIS and Drell-Yan processes
- $\cos 2\phi_t$ Azimuthal asymmetries can help to extract
- Not extracted from data
- In small-x region it can be of Weizsacker Williams type or Dipole type with gauge link ++ or - - and +- or -+ of both
- Positivity bound

$$\frac{\mathrm{q}_t^2}{2M_p^2}|h_1^{\perp g}(x, \mathrm{q}_t^2)| \leq f_1^g(x, \mathrm{q}_t^2)$$

Kinematics

$$e^-(l) + p(\mathrm{P}) \to e^-(l') + J/\psi(\mathrm{P}_\psi) + Jet(\mathrm{P}_j) + X$$



- $\gamma^* + g \to c\bar{c}(^{2S+1}L_J^{(1,8)}) + g$ D'Alesio (2019)
- Virtual photon and proton travels along $\pm$ z-axis
- Leptonic plane $\Rightarrow$ measuring azimuthal angles

$$Q^2 = -q^2,\ s = (P+l)^2,$$

$$x_B = \frac{Q^2}{2P\cdot q},\ y = \frac{P\cdot q}{P\cdot l},\ z = \frac{P\cdot \mathrm{P}_\psi}{P\cdot q}$$

$$\mathrm{q}_t \equiv \mathrm{P}_{\psi\perp} + \mathrm{P}_{j\perp}\,, \quad \mathrm{K}_t \equiv \frac{\mathrm{P}_{\psi\perp} - \mathrm{P}_{j\perp}}{2}$$

- In back to back scattering $\Rightarrow$ $|\mathbf{q}_t|^2 \ll |\mathbf{K}_t|^2 \sim M_\psi^2$

  $\Rightarrow$ TMD factorization

- ϕ_t and $\phi_\perp$

Scattering cross-section

TMD Factorization TMDs ⇒ Collinear ⊗ Transverse

Observed states

Delta function

$$d\sigma = \frac{1}{2s}\frac{d^3 l'}{(2\pi)^3 2E_{l'}}\frac{d^3 \mathrm{P}_\psi}{2E_\psi (2\pi)^3}\frac{d^3 \mathrm{P}_j}{2E_j (2\pi)^3}\int dx\, d^2\mathbf{p}_T\, (2\pi)^4 \delta^4(q + p_g - \mathrm{P}_j - \mathrm{P}_\psi)$$

$$\frac{1}{Q^4}\Phi_g^{\nu\nu'}(x, \mathbf{p}_T) \otimes L^{\mu\mu'}(l, q)\, \mathcal{M}_{\mu\nu}^{g\gamma^* \to J/\psi\, g}\, \mathcal{M}_{\mu'\nu'}^{*g\gamma^* \to J/\psi\, g}$$

Leptonic Tensor

Gluon Correlator

Partonic matrix elements

NRQCD factorization

- ★ $k^2 \ll M_c^2 \rightarrow$ Non-relativistic approx to QCD
- ★ matrix element in NRQCD

Perturbative part

Non-perturbative part (LDMEs)

$$\mathcal{M}^{ab\to J/\psi} = \sum_n \mathcal{M}[ab \to c\bar{c}\left({}^{2S+1}L_J^{(1,8)}\right)]\langle 0|\mathcal{O}^{J/\psi}\left({}^{2S+1}L_J^{(1,8)}\right)|0\rangle$$

Bodwin, Braaten, Lepege (1994)

J/Ψ and Jet formation using NRQCD

Angular momentum wave function

$$\mathcal{M}\left(\gamma^* g \to c\bar{c}[^{2S+1}L_J^{(1,8)}]g\right) = \sum_{L_z S_z} \int \frac{d^3\mathbf{k}}{(2\pi)^3} \boxed{\Psi_{LL_z}(\mathbf{k})} \langle LL_z; SS_z | JJ_z \rangle$$

$$\times\, Tr\left[\boxed{O(q, p_g, \mathrm{P}_\psi, k)}\boxed{\mathcal{P}_{SS_z}(\mathrm{P}_\psi, k)}\right]$$

Feynman Diagram contribution

Spin projection operator for J/Ψ

J/Ψ formation using NRQCD

$k^2 \ll M_c^2$ limit, Matrix element ⇒ Taylor series$|_{k=0}$

LDMEs

S-Wave scattering amp

$\mathcal{M}[^{2S+1}S_J^{(1,8)}]$

$\mathcal{M}[^{2S+1}P_J^{(8)}]$

P-Wave scattering amp

$\mathcal{P}_{SS_z}(\mathrm{P}_\psi, k)$

$$= \frac{1}{\sqrt{4\pi}} R_0(0)\, Tr[\mathcal{O}(q, p_g, \mathrm{P}_\psi, k)\mathcal{P}_{SS_z}(\mathrm{P}_\psi, k)]\Big|_{k=0}$$

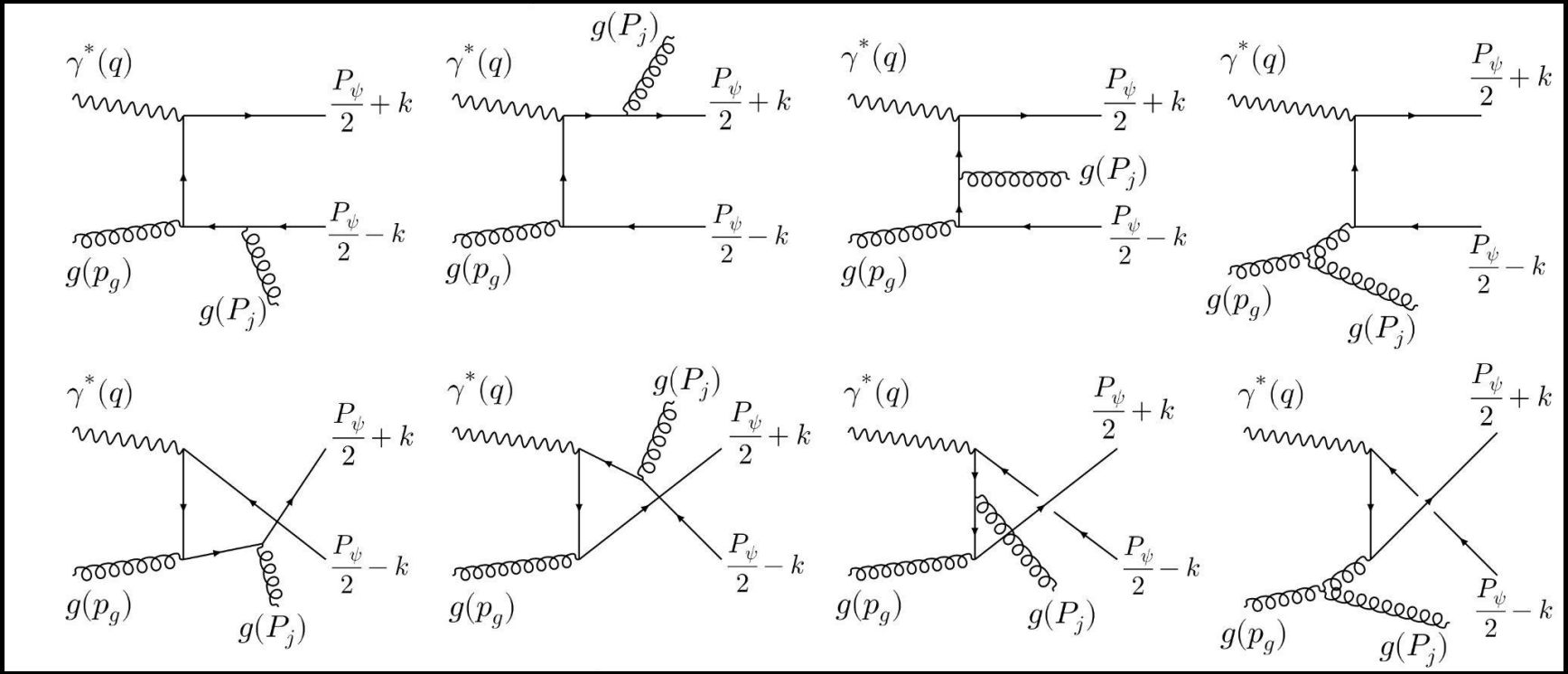
$$= -i\sqrt{\frac{3}{4\pi}} R_1'(0) \sum_{L_z S_z} \varepsilon^{\alpha}_{L_z}(\mathrm{P}_\psi)\langle LL_z; SS_z|JJ_z\rangle$$

$$\times \frac{\partial}{\partial k^\alpha} Tr[\mathcal{O}(q, p_g, \mathrm{P}_\psi, k)\mathcal{P}_{SS_z}(\mathrm{P}_\psi, k)]\Big|_{k=0}$$

$$= \sum_{s_1 s_2} \left\langle \frac{1}{2}s_1; \frac{1}{2}s_2 \middle| SS_z \right\rangle v\left(\frac{\mathrm{P}_\psi}{2} - k, s_1\right) \bar{u}\left(\frac{\mathrm{P}_\psi}{2} + k, s_2\right)$$

$$= \frac{1}{4M_\psi^{3/2}}\left(-\not{\mathrm{P}}_\psi + 2\not{k} + M_\psi\right)\Pi_{SS_z}\left(\not{\mathrm{P}}_\psi + 2\not{k} + M_\psi\right) + \mathcal{O}(k^2)$$

Feynman Diagrams



Azimuthal Asymmetry

$$\frac{\mathrm{d}\sigma}{\mathrm{d}z\,\mathrm{d}y\,\mathrm{d}x_B\,\mathrm{d}^2\mathrm{q}_t\,\mathrm{d}^2\mathrm{K}_t} = \mathrm{d}\sigma^U + \mathrm{d}\sigma^L$$

$$\mathrm{d}\sigma^U = \frac{1}{(2\pi)^4}\frac{1}{16sz(1-z)Q^4}\left(\mathbb{A}_0 + \mathbb{A}_1\cos\phi_\perp + \mathbb{A}_2\cos 2\phi_\perp\right) f_1^g(x,\mathrm{q}_t^2)$$

$$\mathrm{d}\sigma^L = \frac{1}{(2\pi)^4}\frac{1}{16sz(1-z)Q^4}\left(\mathbb{B}_0\cos 2\phi_t + \mathbb{B}_1\cos(2\phi_t-\phi_\perp) + \mathbb{B}_2\cos 2(\phi_t-\phi_\perp)\right.$$

$$\left. + \mathbb{B}_3\cos(2\phi_t - 3\phi_\perp) + \mathbb{B}_4\cos(2\phi_t - 4\phi_\perp)\right)\frac{\mathrm{q}_t^2}{M_P^2}h_1^{\perp g}(x,\mathrm{q}_t^2).$$

D'Alesio (2019)

$$\langle\cos 2\phi_t\rangle \equiv A^{\cos 2\phi_t} = 2\frac{\int \mathrm{d}\phi_t\mathrm{d}\phi_\perp\cos 2\phi_t\mathrm{d}\sigma(\phi_t,\phi_\perp)}{\int \mathrm{d}\phi_t\mathrm{d}\phi_\perp\mathrm{d}\sigma(\phi_t,\phi_\perp)}$$

$$\langle\cos 2\phi_t\rangle \equiv A^{\cos 2\phi_t} = \frac{\int \mathrm{q}_t\,\mathrm{d}\mathrm{q}_t\,\frac{\mathbf{q}_t^2}{M_p^2}\,\mathbb{B}_0\,h_1^{\perp g}(x,\mathbf{q}_t^2)}{\int \mathrm{q}_t\,\mathrm{d}\mathrm{q}_t\,\mathbb{A}_0\,f_1^g(x,\mathbf{q}_t^2)}$$

$$\frac{\mathbf{q}_t^2}{2M_p^2}|h_1^{\perp g}(x,\mathbf{q}_t^2)| = f_1^g(x,\mathbf{q}_t^2)$$

$$A^{\cos 2\phi_t} \rightarrow U = \frac{2*|\mathbb{B}_0|}{\mathbb{A}_0}$$

Gaussian Parameterization

★ Drell-Yan and SIDIS ⇒ transverse momentum spectra → roughly Gaussian in nature. Stefano Melis (2014)

PDFs

TMDs

$$f_1^g(x, \mathbf{q}_t^2) = f_1^g(x, Q) \frac{1}{\pi \langle \mathrm{q}_t^2 \rangle} e^{-\mathrm{q}_t^2 / \langle \mathrm{q}_t^2 \rangle}$$

$$h_1^{\perp g}(x, \mathrm{q}_t^2) = \frac{M_p^2 f_1^g(x,Q)}{\pi \langle \mathrm{q}_t^2 \rangle^2} \frac{2(1-r)}{r} e^{1 - \frac{\mathrm{q}_t^2}{r \langle \mathrm{q}_t^2 \rangle}}$$

$$\frac{\mathrm{q}_t^2}{2M_p^2} |h_1^{\perp g}(x, \mathrm{q}_t^2)| \leq f_1^g(x, \mathbf{q}_t^2).$$

Transverse momentum dependent part

D. Boer and C. Pisano (2012)

Spectator Model

- In this model proton ⇒ g+X
- Remaining particle treated as spectator particle
- spectator particle ⇒ On-Shell ⇒ M_x ⇒ continuous values
- P-g-X coupling is given by vertex ⇒ 2 form factors
- Model parameters fixed by fitting with collinear gluon distribution.

Spectator Model

$$F^g(x, \mathrm{q}_t^2) = \int_M^\infty dM_X\, \rho_X(M_X)\, \boxed{\hat{F}^g(x, \mathrm{q}_t^2; M_X)}$$

TMDs

$$\boxed{\rho_X(M_X)} = \mu^{2a}\left[\frac{A}{B+\mu^{2b}} + \frac{C}{\pi\sigma} e^{-\frac{(M_X-D)^2}{\sigma^2}}\right]$$

Spectral function

Model dependent form factors

$$\boxed{\hat{f}_1^g(x, \mathrm{q}_t^2; M_X)} = -\frac{1}{2} g^{ij}\left[\Phi^{ij}(x, \mathrm{q}_t, S) + \Phi^{ij}(x, \mathrm{q}_t, -S)\right]$$

$$= \Big[\left(2Mxg_1 - x(M+M_X)g_2\right)^2\left[(M_X - M(1-x))^2 + \mathrm{q}_t^2\right]$$

$$+ 2\mathrm{q}_t^2\left(\mathrm{q}_t^2 + xM_X^2\right)g_2^2 + 2\mathrm{q}_t^2 M^2(1-x)\left(4g_1^2 - xg_2^2\right)\Big]$$

$$\times\left[(2\pi)^3\, 4xM^2\left(L_X^2(0) + \mathrm{q}_t^2\right)^2\right]^{-1}$$

$$\boxed{\hat{h}_1^{\perp g}(x, \mathrm{q}_t^2; M_X)} = \frac{M^2}{\varepsilon_t^{ij}\delta^{jm}(\mathrm{q}_t^j\mathrm{q}_t^m + g^{jm}\mathrm{q}_t^2)}\,\varepsilon_t^{ln}\delta^{nr}\left[\Phi^{nr}(x, \mathrm{q}_t, S) + \Phi^{nr}(x, \mathrm{q}_t, -S)\right]$$

$$= \left[4M^2(1-x)g_1^2 + \left(L_X^2(0) + \mathrm{q}_t^2\right)g_2^2\right] \times \left[(2\pi)^3\, x\left(L_X^2(0) + \mathrm{q}_t^2\right)^2\right]^{-1}$$

Spectator Model

gluon momentum

Off-shellness of gluon

$$g_{1,2}(p^2) = \kappa_{1,2} \frac{p^2}{|p^2 - \Lambda_X^2|^2} = \kappa_{1,2} \frac{p^2 \, (1-x)^2}{(q_t^2 + L_X^2(\Lambda_X^2))^2}$$

Normalization constants

Cut-off parameters

A. Bacchetta, F. G. Celiberto, M. Radici, and P. Taels (2020)

TMD Evolution

Impact Parameter space

TMD

Pert Sudakov factor

Solution of RG Evolution eqn

Non pert Sudakov factor

$$\hat{f}(x, \mathrm{b}_t^2; Q_f^2) = \frac{1}{2\pi} \int d^2\mathrm{q}_t \, e^{i\mathrm{q}_t \cdot \mathrm{b}_t} f(x, \mathrm{q}_t^2, Q_f^2)$$

$$\hat{f}(x, \mathrm{b}_t^2, Q_f^2) = \frac{1}{2\pi} \sum_{p=q,\bar{q},g} (C_{g/p} \otimes f_1^p)(x, Q_i^2) \, e^{-\frac{1}{2} S_A(\mathrm{b}_t^2, Q_f^2, Q_i^2)} \, e^{-S_{np}(\mathrm{b}_t^2, Q_f^2)}$$

$$C_{g/p}(x, Q_i) = \delta_{gp}\delta(1-x) + \sum_{k=1}^{\infty} \sum_{p=g,q,\bar{q}} C_{g/p}^k(x) \left(\frac{\alpha_s(Q_i)}{\pi} \right)^k$$

Solutions of Collins -Soper Sterman eqns

$$f_1^g(x, Q_i^2) = f_1^g(x, Q_f^2) - \frac{\alpha_s}{2\pi} (P_{gg} \otimes f_1^g + P_{gi} \otimes f_1^i)(x, Q_f^2) \log \frac{Q_f^2}{Q_i^2} + \mathcal{O}(\alpha_s^2).$$

$$S_A(\mathrm{b}_t^2, Q_f^2, Q_i^2) = \frac{C_A}{\pi} \alpha_s \left(\frac{1}{2} \log^2 \frac{Q_f^2}{Q_i^2} - \frac{11 - 2n_f/C_A}{6} \log \frac{Q_f^2}{Q_i^2} \right).$$

DGLAP evoln eqn

$$\mathrm{b}_t \ll 1/\Lambda_{QCD}$$

$$e^{-\frac{1}{2} S_A(\mathrm{b}_t^2, Q_f^2, Q_i^2)} \Rightarrow 1 - \frac{S_A(\mathrm{b}_t^2, Q_f^2, Q_i^2)}{2}$$

TMD Evolution

$$f_1^g(x, \mathrm{q}_t^2) = \frac{1}{2\pi} \int_0^\infty \mathrm{b}_t d\mathrm{b}_t J_0(\mathrm{b}_t \mathrm{q}_t) \Bigg\{ f_1^g(x, Q_f^2)$$

$$- \frac{\alpha_s}{2\pi} \Bigg[\left(\frac{C_A}{2} \log^2 \frac{Q_f^2}{Q_i^2} - \frac{11 C_A - 2 n_f}{6} \log \frac{Q_f^2}{Q_i^2} \right) f_1^g(x, Q_f^2)$$

$$+ (P_{gg} \otimes f_1^g + P_{gi} \otimes f_1^i)(x, Q_f^2) \log \frac{Q_f^2}{Q_i^2} - 2 f_1^g(x, Q_f^2) \Bigg] \Bigg\} \times e^{-S_{np}(\mathrm{b}_t^2)}.$$

$$\frac{\mathrm{q}_t^2}{M_p^2} h_1^{\perp g(2)}(x, \mathrm{q}_t^2) = \frac{\alpha_s}{\pi^2} \int_0^\infty d\mathrm{b}_t \mathrm{b}_t \, J_2(\mathrm{q}_t \mathrm{b}_t) \Bigg[C_A \int_x^1 \frac{d\hat{x}}{\hat{x}} \left(\frac{\hat{x}}{x} - 1 \right) f_1^g(\hat{x}, Q_f^2)$$

$$+ C_F \sum_{p=q,\bar{q}} \int_x^1 \frac{d\hat{x}}{\hat{x}} \left(\frac{\hat{x}}{x} - 1 \right) f_1^p(\hat{x}, Q_f^2) \Bigg] \times e^{-S_{np}(\mathrm{b}_t{}^2)}.$$

non perturbative region

functional form (Scarpa(2020))

bt range (0.0-1.5 GeV^2) (C. P. Yuan (2003), Scarpa (2020))

$$S_{np} = \frac{A}{2} \log \left(\frac{Q_f}{Q_{np}} \right) \mathrm{b}_c^2,$$

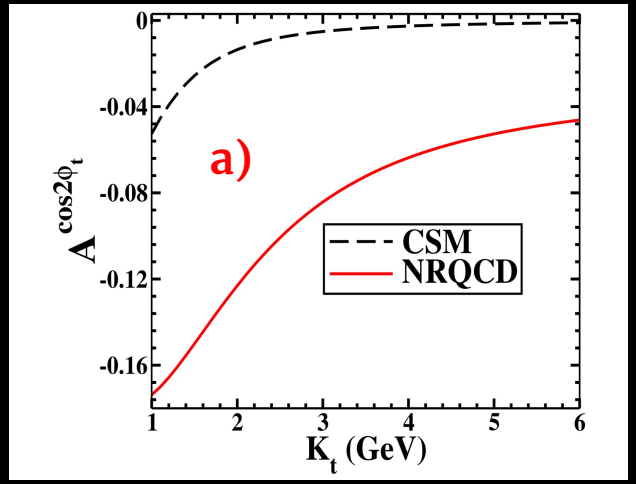
$$Q_{np} = 1 \text{ GeV},$$

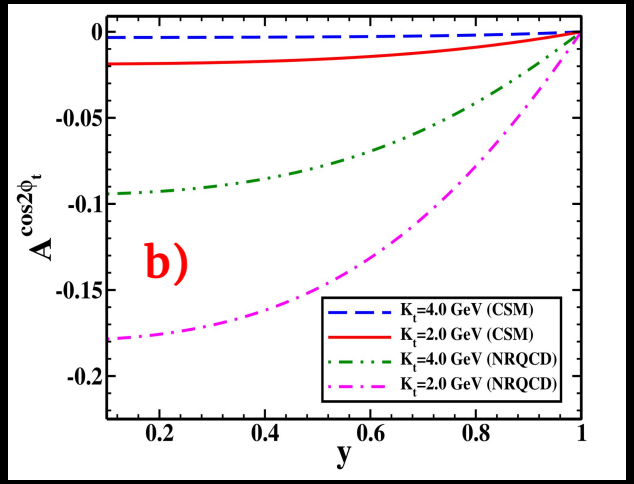
$$\mathrm{b}_c = \sqrt{\mathrm{b}_t^2 + \left(\frac{2 e^{-\gamma_E}}{Q_f} \right)^2}$$

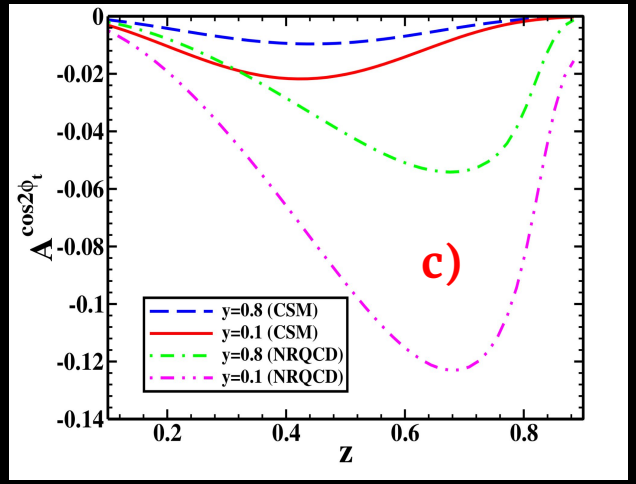
Results and Discussion

Gaussian Parameterization

$\sqrt{s}$ = 140 GeV







y∈(0,1)

z=0.7

K_t=3.0 GeV

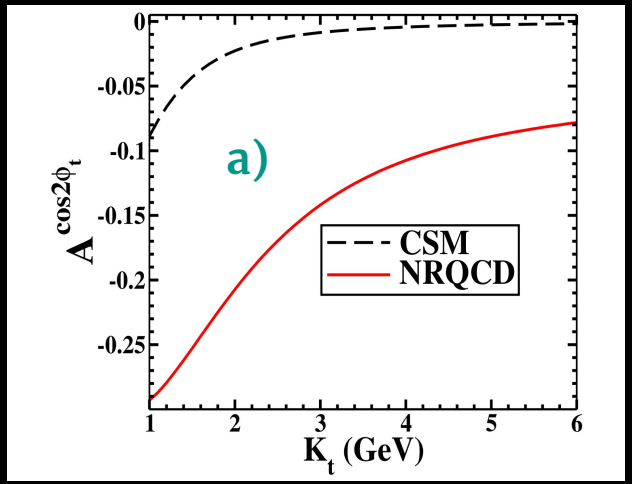
CMSWZ set of LDMEs

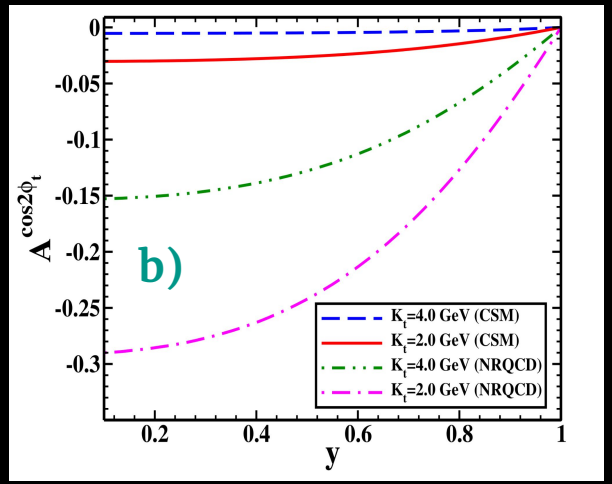
$$Q^2 = M_\psi^2 + K_t^2$$

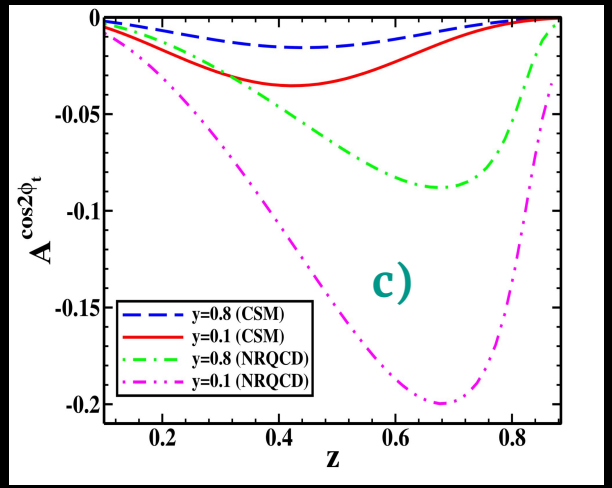
Results and Discussion

Spectator Model

$\sqrt{s}$ = 140 GeV







$y \in (0,1)$

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CMSWZ set of LDMEs

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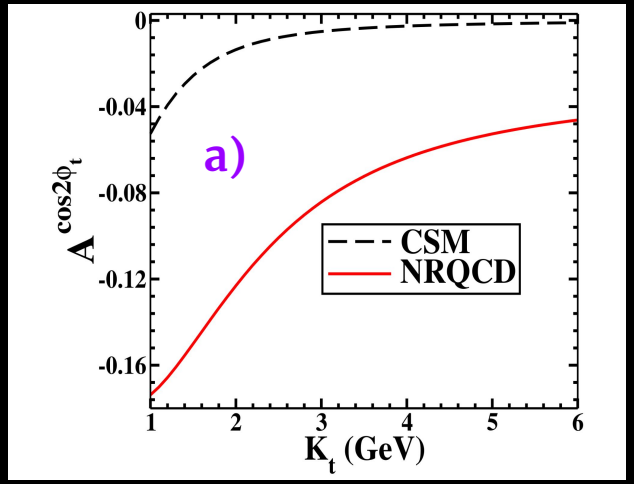
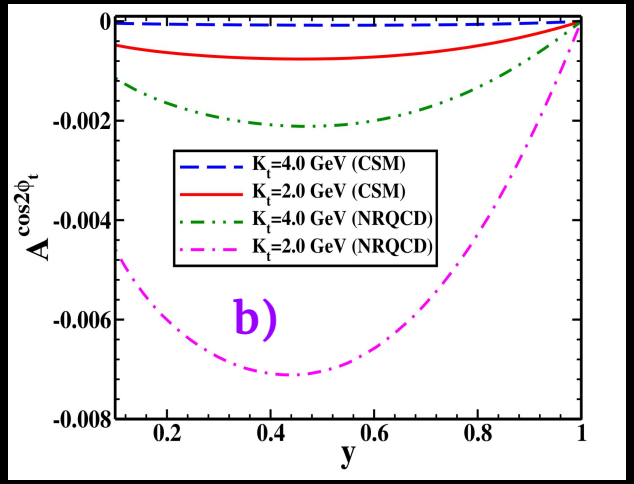
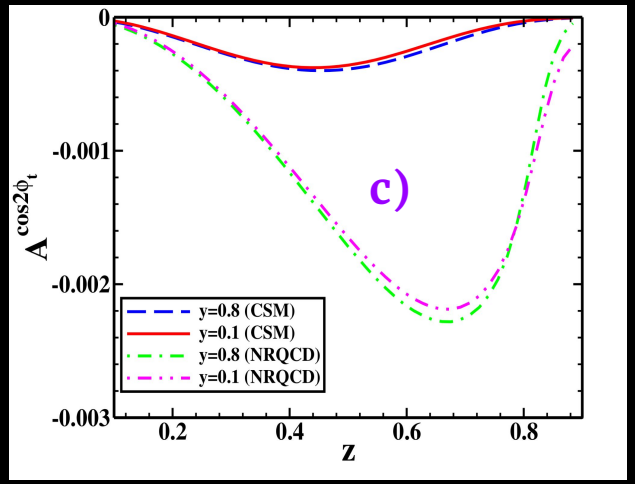
Results and Discussion

TMD Evolution

$\sqrt{s}$ = 140 GeV







y∈(0,1)

z=0.7

K_t=3.0 GeV

CMSWZ set of LDMEs

$$Q^2 = M_\psi^2 + K_t^2$$

Results and Discussion

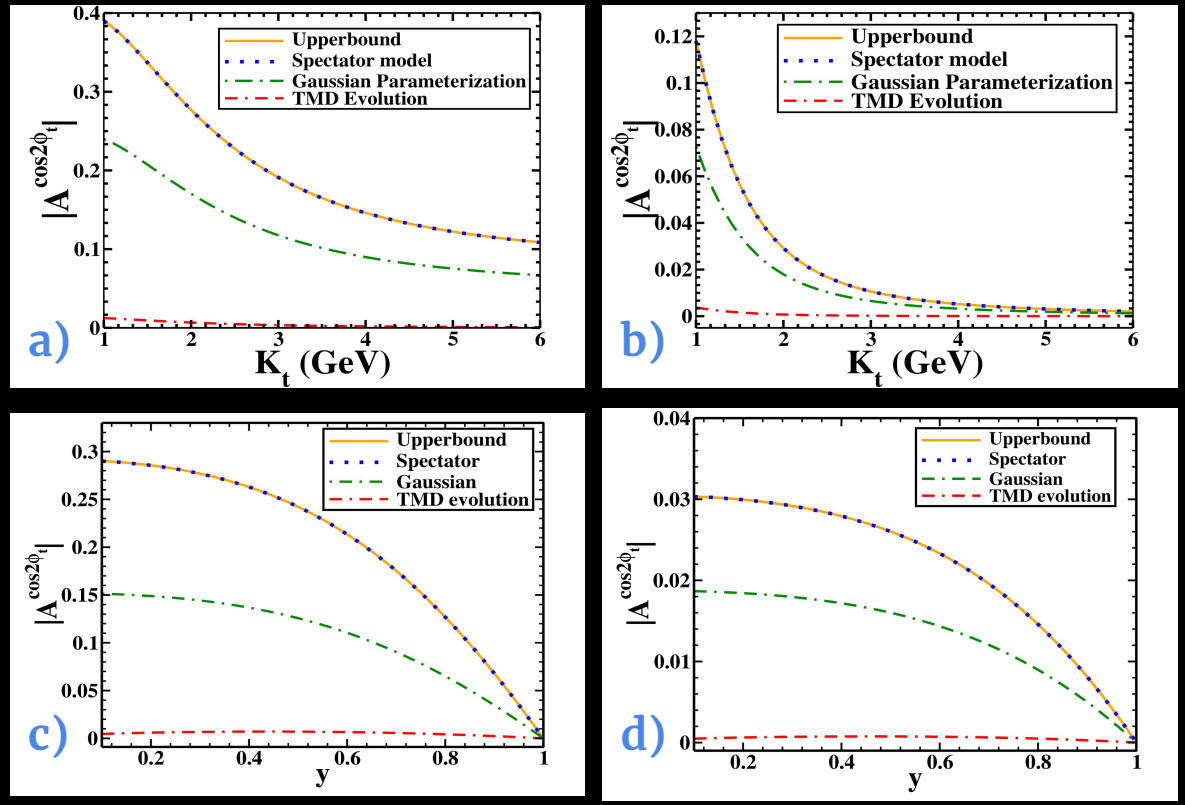
Upperbound

$\sqrt{s}$ = 140 GeV

y=0.3

z=0.7

K_t=2.0 GeV



CMSWZ set of LDMEs

$$Q^2 = M_\psi^2 + K_t^2$$

Upperbound - Spectator model

$$F^g(x, \mathrm{q}_t^2) = \int_M^\infty dM_X\, \rho_X(M_X)\, \hat{F}^g(x, \mathrm{q}_t^2; M_X)$$

$$\rho_X(M_X) = \mu^{2a}\left[\frac{A}{B+\mu^{2b}} + \frac{C}{\pi\sigma} e^{-\frac{(M_X-D)^2}{\sigma^2}}\right]$$

$$\hat{f}_1^g(x, \mathrm{q}_t^2; M_X) = -\tfrac{1}{2}\, g^{ij}\, \left[\Phi^{ij}(x, \mathrm{q}_t, S) + \Phi^{ij}(x, \mathrm{q}_t, -S)\right]$$

$$= \Big[\left(2Mxg_1 - x(M+M_X)g_2\right)^2 \left[(M_X - M(1-x))^2 + \mathrm{q}_t^2\right]$$

$$+ 2\mathrm{q}_t^2\, (\mathrm{q}_t^2 + xM_X^2)\, g_2^2 + 2\mathrm{q}_t^2 M^2\, (1-x)\, (4g_1^2 - xg_2^2)\Big]$$

$$\times \left[(2\pi)^3\, 4xM^2\, (L_X^2(0) + \mathrm{q}_t^2)^2\right]^{-1}$$

$$\hat{h}_1^{\perp g}(x, \mathrm{q}_t^2; M_X) = \frac{M^2}{\varepsilon_t^{ij}\, \delta^{jm}\, (\mathrm{q}_t^j \mathrm{q}_t^m + g^{jm} \mathrm{q}_t^2)}\, \varepsilon_t^{ln}\, \delta^{nr}\, \left[\Phi^{nr}(x, \mathrm{q}_t, S) + \Phi^{nr}(x, \mathrm{q}_t, -S)\right]$$

$$= \left[4M^2\, (1-x)\, g_1^2 + (L_X^2(0) + \mathrm{q}_t^2)\, g_2^2\right] \times \left[(2\pi)^3\, x\, (L_X^2(0) + \mathrm{q}_t^2)^2\right]^{-1}$$

$$\frac{\mathbf{q}_t^2}{2M_p^2}\left|h_1^{\perp g}(x, \mathbf{q}_t^2)\right| = f_1^g(x, \mathbf{q}_t^2)$$

$$\langle \cos 2\phi_t \rangle \equiv A^{\cos 2\phi_t} = 2\,\frac{\int \mathrm{d}\phi_t \mathrm{d}\phi_\perp \cos 2\phi_t \mathrm{d}\sigma(\phi_t, \phi_\perp)}{\int \mathrm{d}\phi_t \mathrm{d}\phi_\perp \mathrm{d}\sigma(\phi_t, \phi_\perp)}$$

$$\langle \cos 2\phi_t \rangle \equiv A^{\cos 2\phi_t} = \frac{\int \mathrm{q}_t\, \mathrm{d}\mathrm{q}_t\, \frac{\mathbf{q}_t^2}{M_p^2}\, \mathbb{B}_0\, h_1^{\perp g}(x, \mathbf{q}_t^2)}{\int \mathrm{q}_t\, \mathrm{d}\mathrm{q}_t\, \mathbb{A}_0\, f_1^g(x, \mathbf{q}_t^2)}$$

Upperbound TMD evolution

$$f_1^g(x,\mathrm{q}_t^2) = \frac{1}{2\pi}\int_0^\infty \mathrm{b}_t d\mathrm{b}_t J_0(\mathrm{b}_t\mathrm{q}_t)\Bigg\{ f_1^g(x,Q_f^2)$$

$$-\frac{\alpha_s}{2\pi}\Bigg[\left(\frac{C_A}{2}\log^2\frac{Q_f^2}{Q_i^2} - \frac{11C_A-2n_f}{6}\log\frac{Q_f^2}{Q_i^2}\right) f_1^g(x,Q_f^2)$$

$$+(P_{gg}\otimes f_1^g + P_{gi}\otimes f_1^i)(x,Q_f^2)\log\frac{Q_f^2}{Q_i^2} - 2f_1^g(x,Q_f^2)\Bigg]\Bigg\}\times e^{-S_{np}(\mathrm{b}_t^2)}.$$

$$\alpha_s^0$$

$$\frac{\mathrm{q}_t^2}{M_p^2}h_1^{\perp g(2)}(x,\mathrm{q}_t^2) = \frac{\alpha_s}{\pi^2}\int_0^\infty d\mathrm{b}_t\,\mathrm{b}_t\, J_2(\mathrm{q}_t\mathrm{b}_t)\left[C_A\int_x^1\frac{d\hat{x}}{\hat{x}}\left(\frac{\hat{x}}{x}-1\right)f_1^g(\hat{x},Q_f^2)\right.$$

$$\left.+C_F\sum_{p=q,\bar{q}}\int_x^1\frac{d\hat{x}}{\hat{x}}\left(\frac{\hat{x}}{x}-1\right)f_1^p(\hat{x},Q_f^2)\right]\times e^{-S_{np}(\mathrm{b}_t{}^2)}.$$

$$\alpha_s^1$$

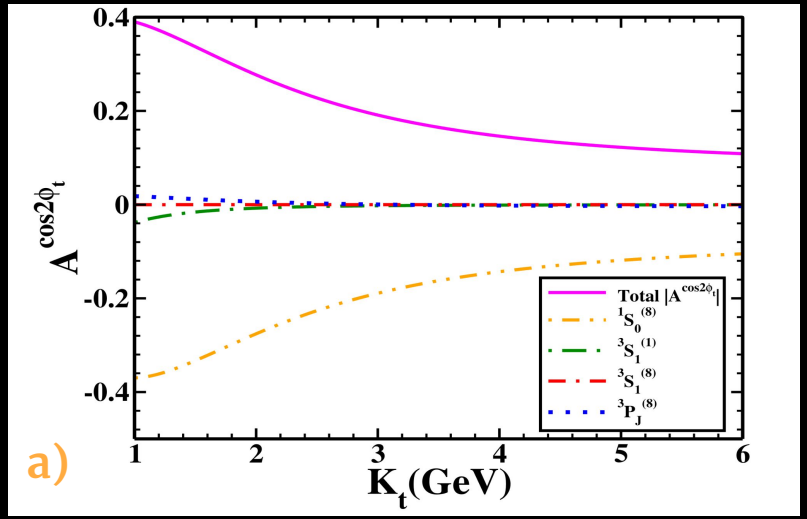
$$\langle\cos 2\phi_t\rangle \equiv A^{\cos 2\phi_t} = 2\frac{\int \mathrm{d}\phi_t \mathrm{d}\phi_\perp \cos 2\phi_t \mathrm{d}\sigma(\phi_t,\phi_\perp)}{\int \mathrm{d}\phi_t \mathrm{d}\phi_\perp \mathrm{d}\sigma(\phi_t,\phi_\perp)}$$

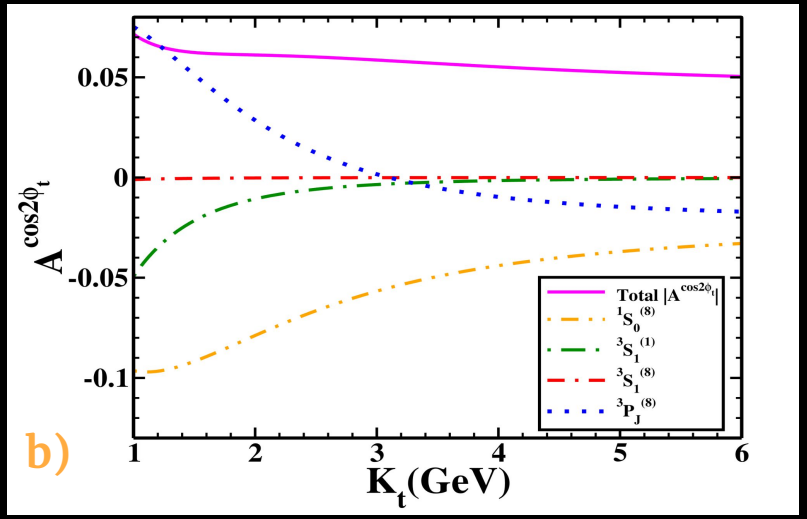
$$\langle\cos 2\phi_t\rangle \equiv A^{\cos 2\phi_t} = \frac{\int \mathrm{q}_t\,\mathrm{dq}_t\,\frac{\mathbf{q}_t^2}{M_p^2}\,\mathbb{B}_0\,h_1^{\perp g}(x,\mathbf{q}_t^2)}{\int \mathrm{q}_t\,\mathrm{dq}_t\,\mathbb{A}_0\,f_1^g(x,\mathbf{q}_t^2)}$$

Results and Discussion

LDMEs Comparison

$\sqrt{s}$ = 140 GeV





CMSWZ set of LDMEs

SV set of LDMEs

z=0.7

y=0.3

$$Q^2 = M_\psi^2 + K_t^2$$

Conclusion

- NRQCD → J/Ψ and Jet production rate
- parameterized gluon TMDs → Gaussian, Spectator model and implemented TMD Evolution
- Asymmetry: TMD evolution < Gaussian < Spectator ≤ Upperbound.
- These kinematical regions will be accessible at EIC.
- These results will help us to extract the Linearly polarized gluon TMD

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Thank You