Dijet production in intermediate x at EIC

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高能物理学术年会

中国广州 2026-07-17

CONTENTS

Background: Building the bridge between large/small x

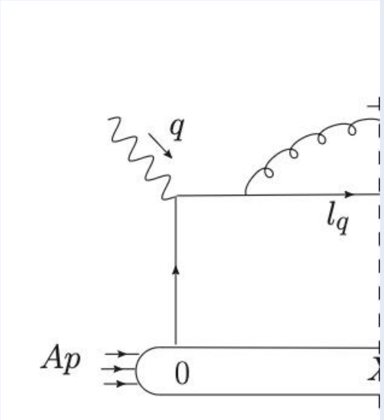
Photon-Gluon Fusion using Generalized High-Twist approach

Nuclear modification of dijet production at intermediate-x

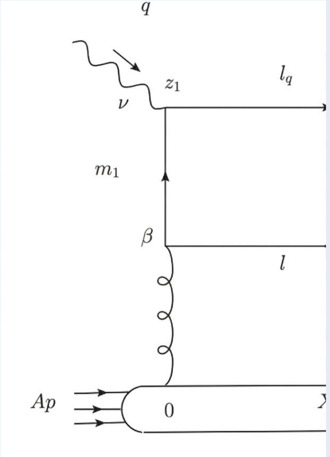
Summary and Outlook

Different processes dominates at large/small x

QCD Compton(QCDC) - large x



Photon-Gluon Fusion(PGF) - small x



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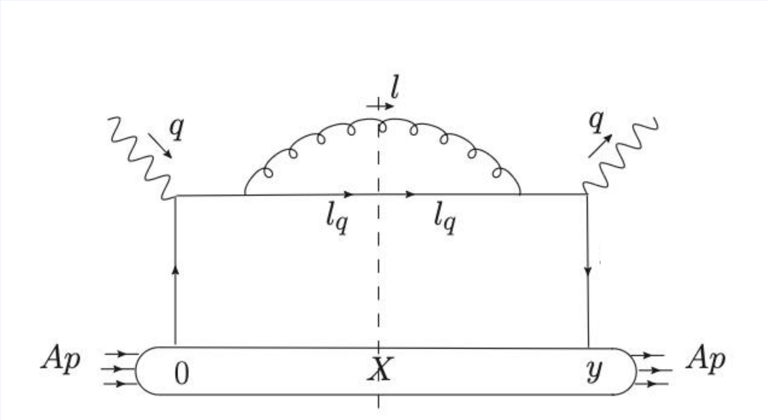

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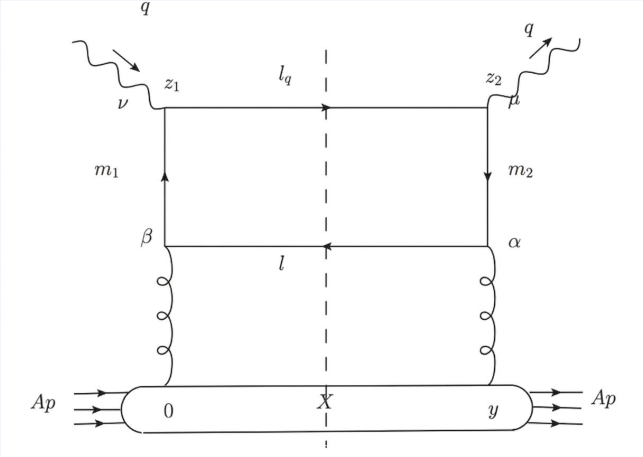


building the bridge

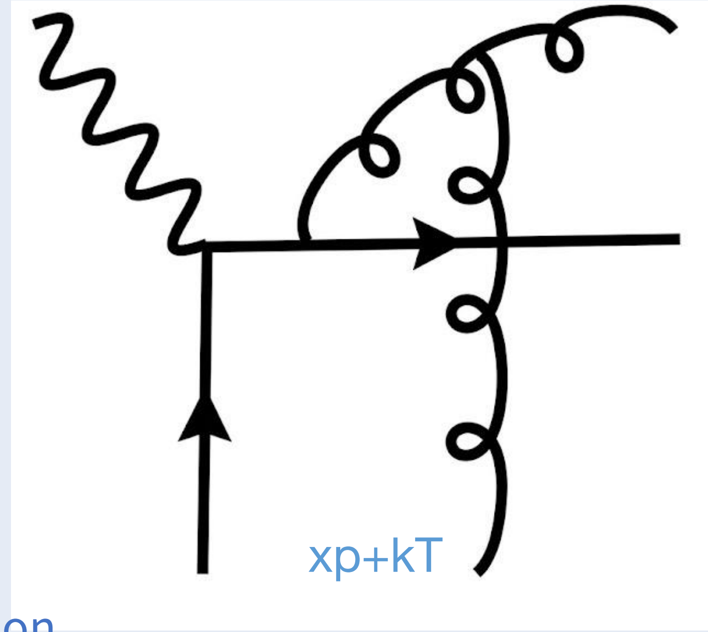
LPM effect at large x

medium-induced radiation

medium gluon kick the radiated gluon

⟶ influence gluon formation time τ_f

LPM factor: $1 - \cos\frac{y^-}{\tau_f}$



{ in QGP : jet energy loss LBT model

in cold nuclei : dijet ϕ/rapidity gap/R_A distribution

YYZ, X-N Wang Phys.Rev.D 105 (2022) 3, 034015

Shock-wave and dipole at small-x

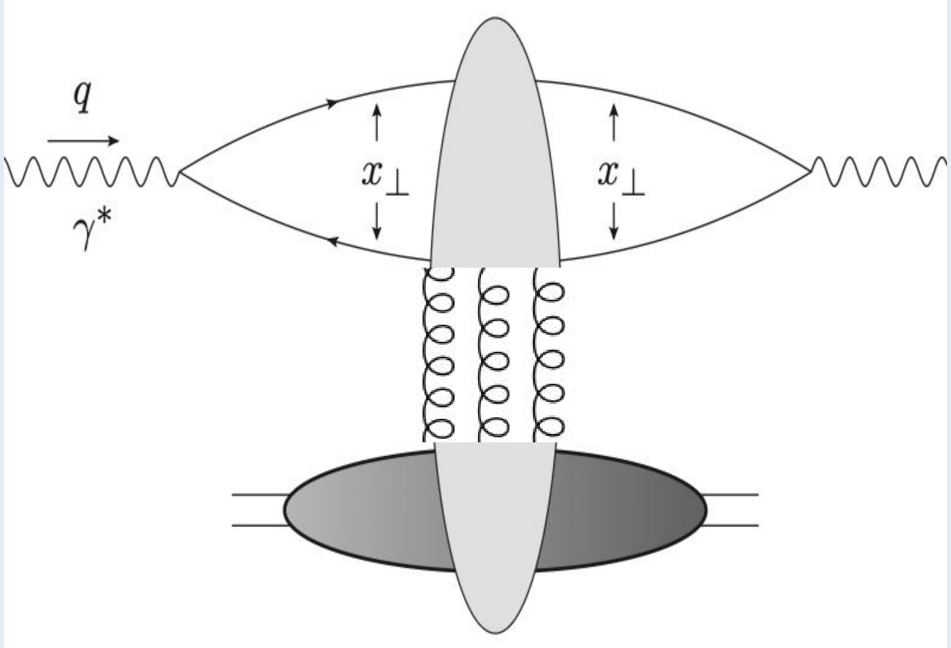


Fig 4.1 from Kovchegov, Y.V. and Levin, E. (2022). Quantum Chromodynamics at High Energy. Cambridge: Cambridge University Press.

Dipole go through Shock-wave

photon→ q qbar (dipole)

Nucleus seen by dipole as shock wave

Back-to-back dijet probe WW gluon distri.

small-x gluon resummed together (wilson line)

no longtudinal momentum transfer (x≈0)

Efforts from two direction

small-x $\rightarrow$ intermediate-x

- next-to-eikonal (NEik)(finite width nucleus) correction in different processes

  forward dijet in pA — T Altinoluk *et al.*, JHEP 06 (2024) 097

  back-to-back dijet in eA — T Altinoluk *et al.*, PRD 111 (2025) 1, 014010

- subeikonal operator development

  sub-eikonal quark/gluon propagator — G A Chirilli, JHEP 01 (2019) 118

- gluon TMD

  rapidity evolution — I Balitsky & A Tarasov, JHEP 10 (2015) 017

  back-to-back dijet in eA at arbitrary x — S Mukherjee ... A Tarasov, arXiv: 2602.15137

Efforts from two direction

large-x → intermediate-x

- CGC add longitudinal phase , expand in A+ , match High-Twist Result (pA)

Y Fu, Z-B Kang, X-N Wang, H-X Xing
Phys.Rev.Lett. 135 (2025) 3, 032301

The connection between CGC and generalized High-Twist formalism in eA dijet ?

Efforts from two direction

large-x → intermediate-x

- CGC add longitudinal phase, expand in A+ , match High-Twist Result (pA)

  Y Fu, Z-B Kang, X-N Wang, H-X Xing
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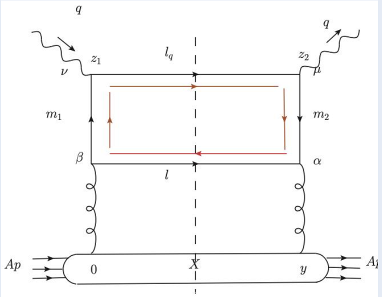
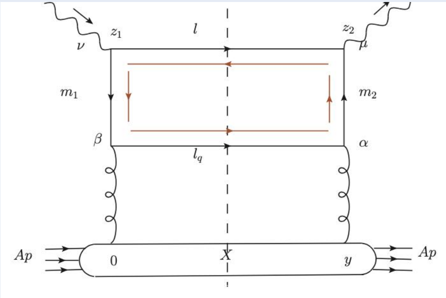
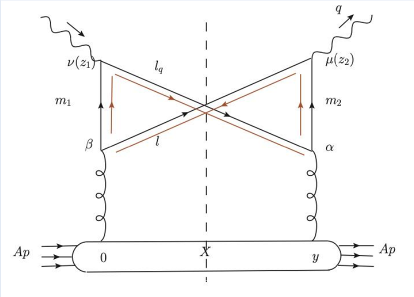
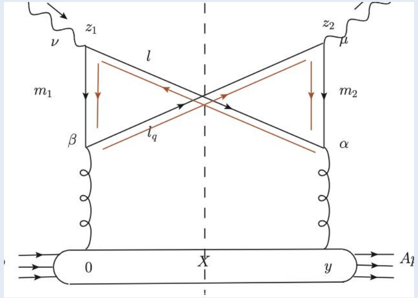
- Do we see interference in photon-gluon twist-4 contribution ? (like LPM in photon-quark)
- How photon-gluon result connect with small-x results?
- Relative nuclear modification of photon-quark and photon-gluon in intermediate-x region?

Photon-Gluon Fusion Leading Twist Diagrams





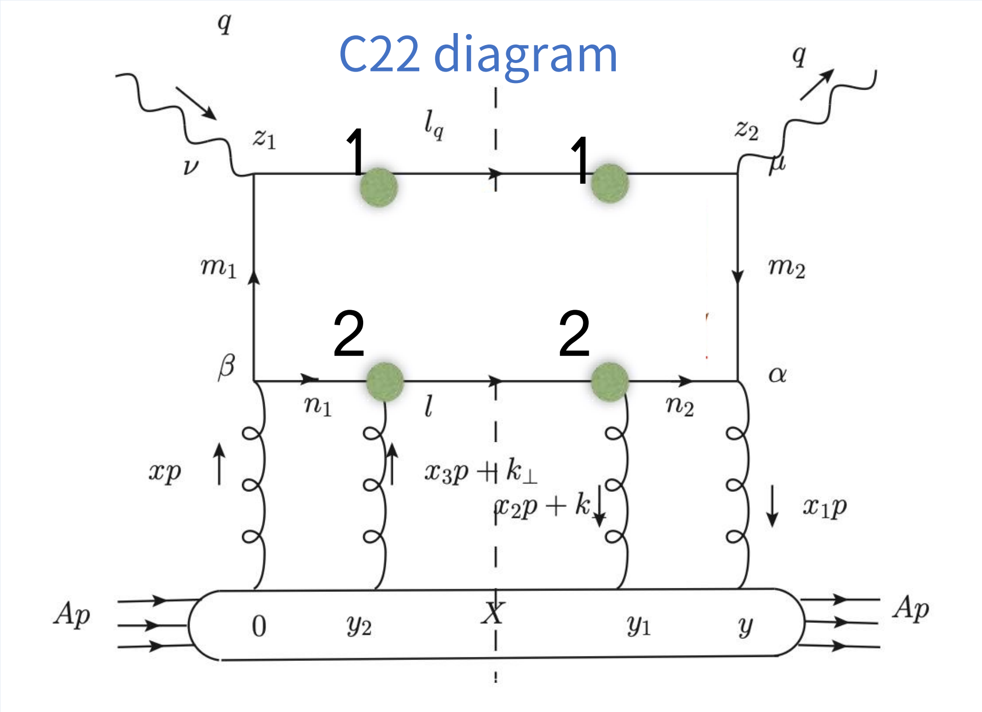




LT-1 LT-2 LT-3 LT-4

4 diagrams

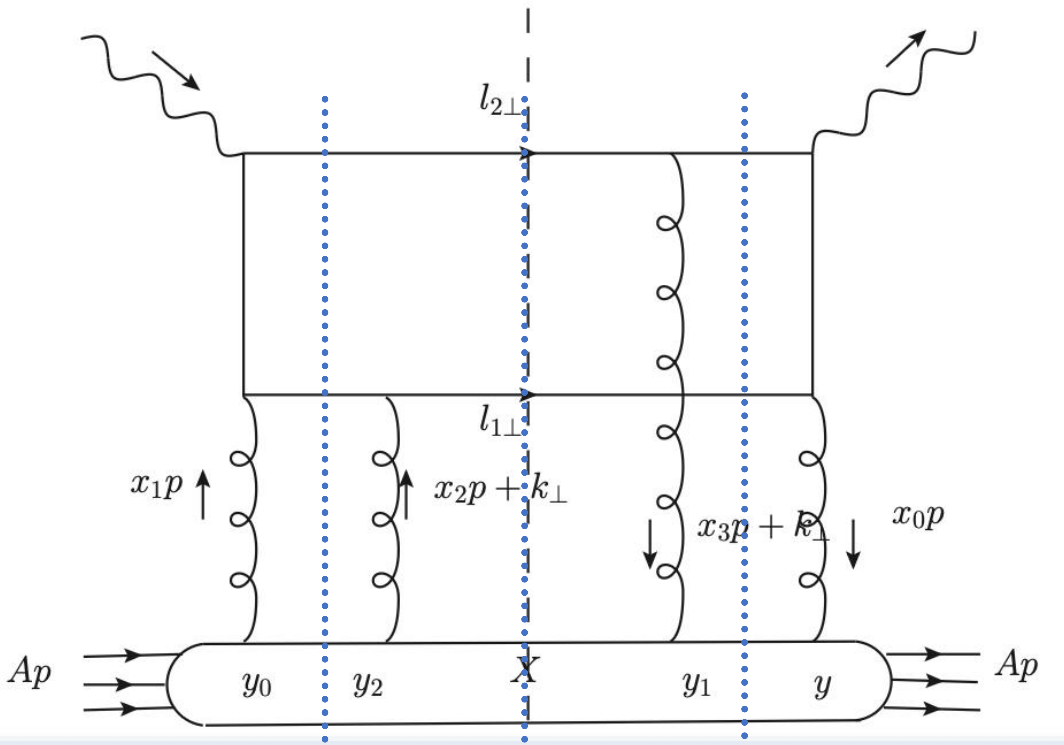
Photon-Gluon Fusion Twist-4 -Diagrams



4 attachment patterns

Photon-Gluon Fusion Twist-4 -Diagrams

left-cut ,central cut, right cut



3 final state cut lines

Photon-Gluon Fusion Twist-4 -Results

$$\frac{d\sigma_{\Sigma}}{dy_1 dy_2 d^2 l_{1\perp} d^2 l_{2\perp}} \propto \rho(y_0) x_0 f_g(x_0) \rho(y_1) \frac{\Phi(x_1, k_\perp)}{k_\perp^2}$$

$$\{ N + I_D \cos(\frac{x_D p^+ y_1^-}{1-z}) + I_C \cos(\frac{x_C p^+ y_1^-}{1-z}) \}$$

The interference term are two gluon attach to different quark line, these terms resolve the dipole structure.

Interference term are suppressed by $\frac{1}{(N_c^2 - 1)}$,easy to check

by color factor calculation

Photon-Gluon Fusion Leading Twist + Twist-4
- reproduce CGC at back-to-back limit

Under $k_\perp \ll l_\perp$ approx, dipole size$(r_\perp \sim \frac{1}{[l_\perp-(1-z)k_\perp]})$ very small, medium can not resolve q and qbar, different gluon attachment are the same

$$\frac{d\sigma_\Sigma}{dy_1 dy_2 d^2 l_{1\perp} d^2 l_{2\perp}} \propto xG^{(1)}(x, k_\perp) F(\vec{l}_{1\perp})$$

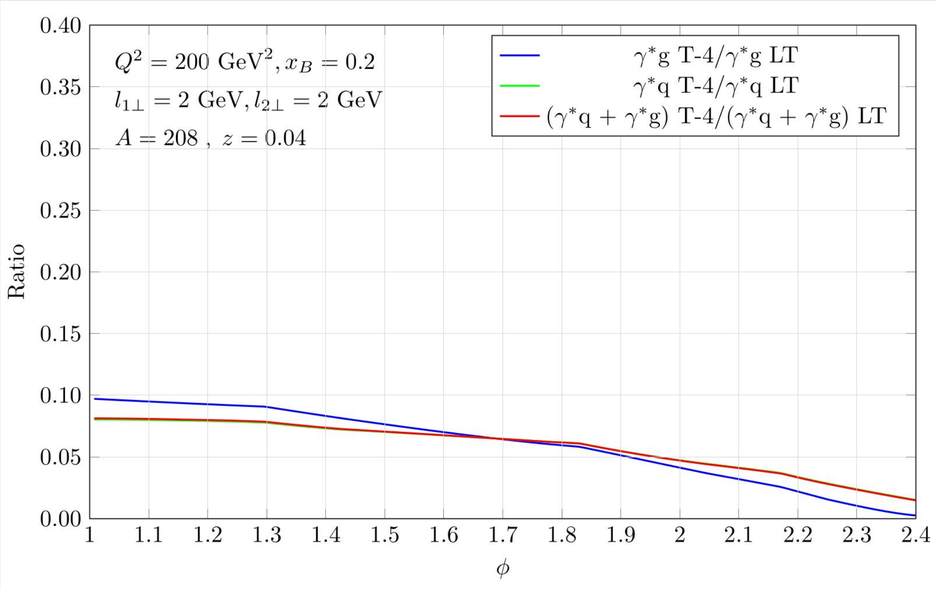
here $xG^{(1)}$ gauge-link $1 - igt^a \int d\zeta^- A^+(\zeta^-)$

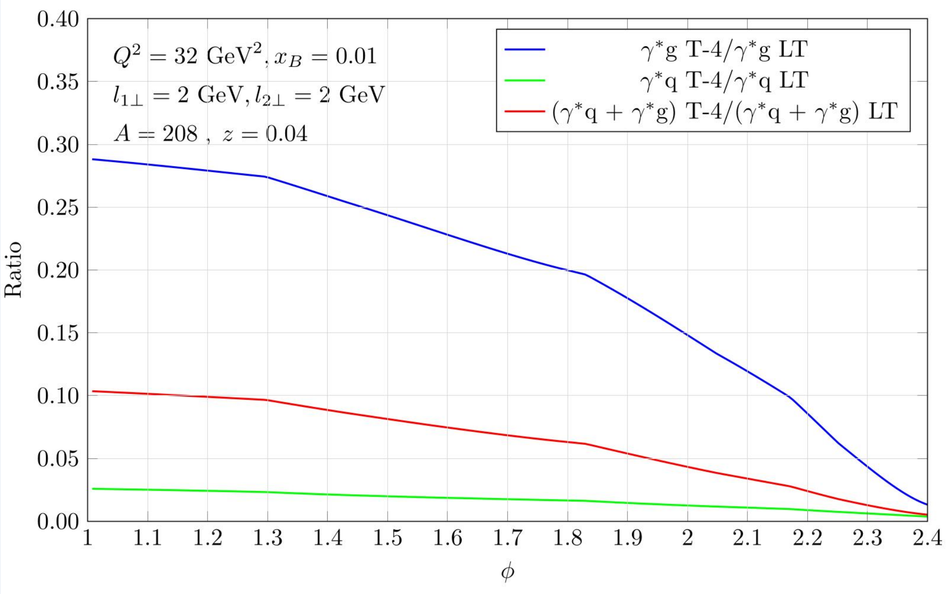
Agree with TMD factorization result / CGC eA dijet result in

F Dominguez, C Marquet , B-W Xiao, F Yuan
Phys.Rev.D 83 (2011) 105005

Numerical Results- ϕ distribution

ϕ: angle between $l_{1\perp}$ and $l_{2\perp}$



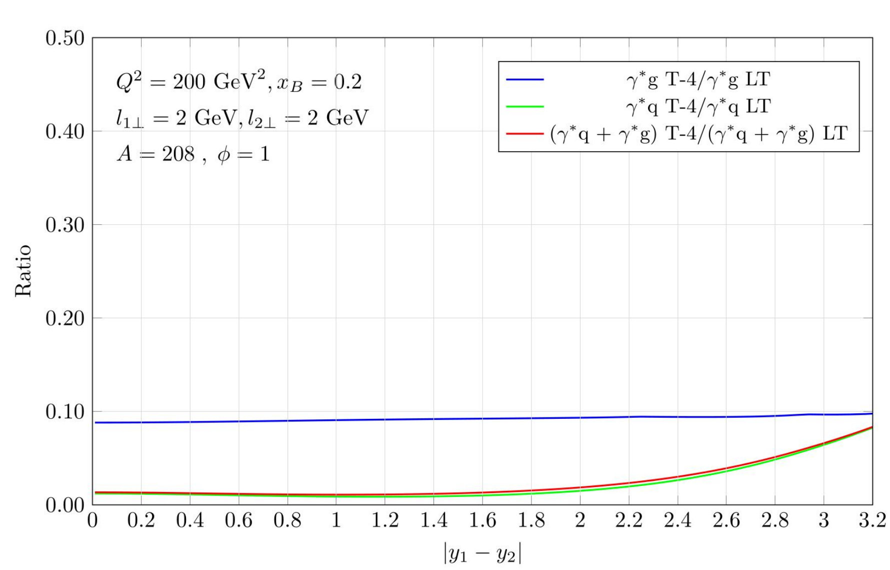


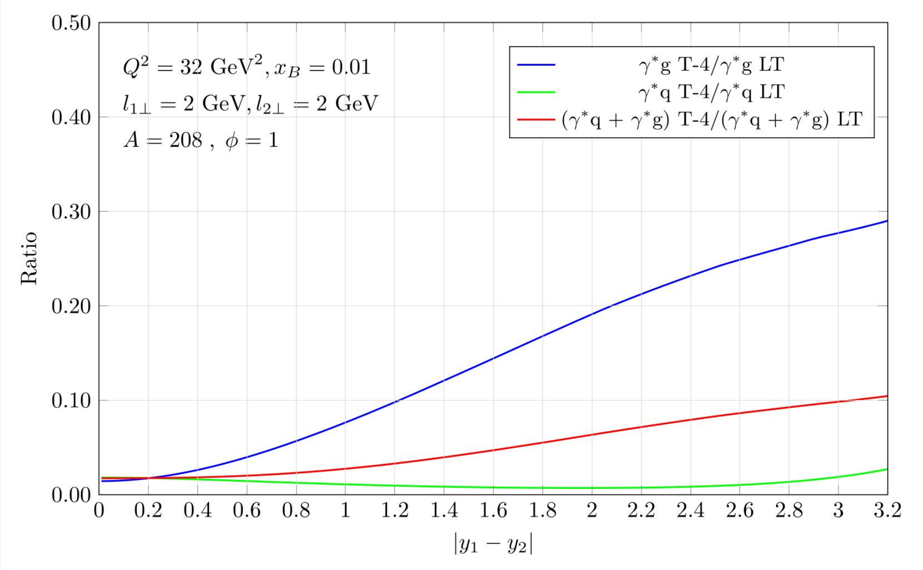
$Q^2 = 200$ GeV^2, x = 0.2

$Q^2 = 32$ GeV^2, x = 0.01

Numerical Results-ygap distribution

ygap: rapidity gap between two jet $|y_1 - y_2|$





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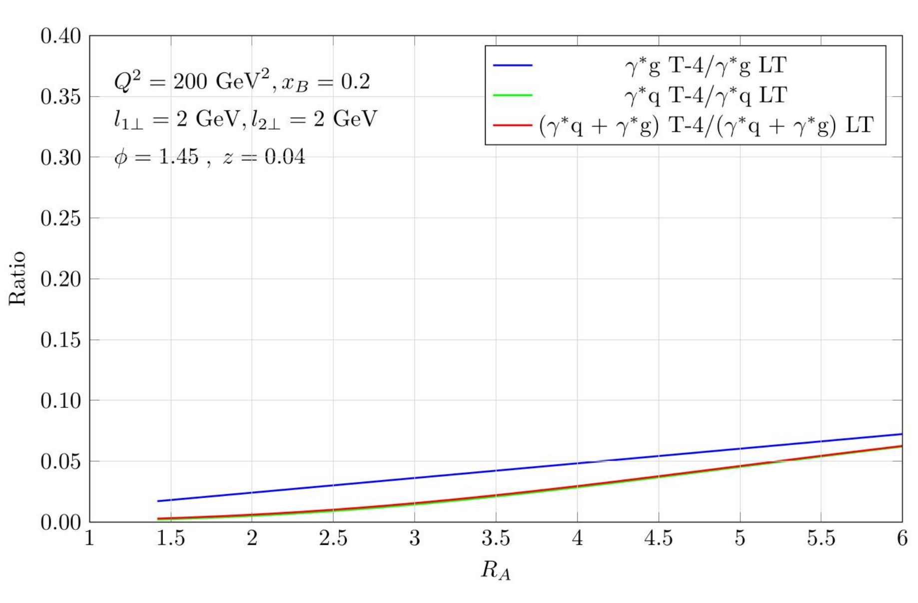
Numerical Results-R_A distribution

R_A : nuclear size



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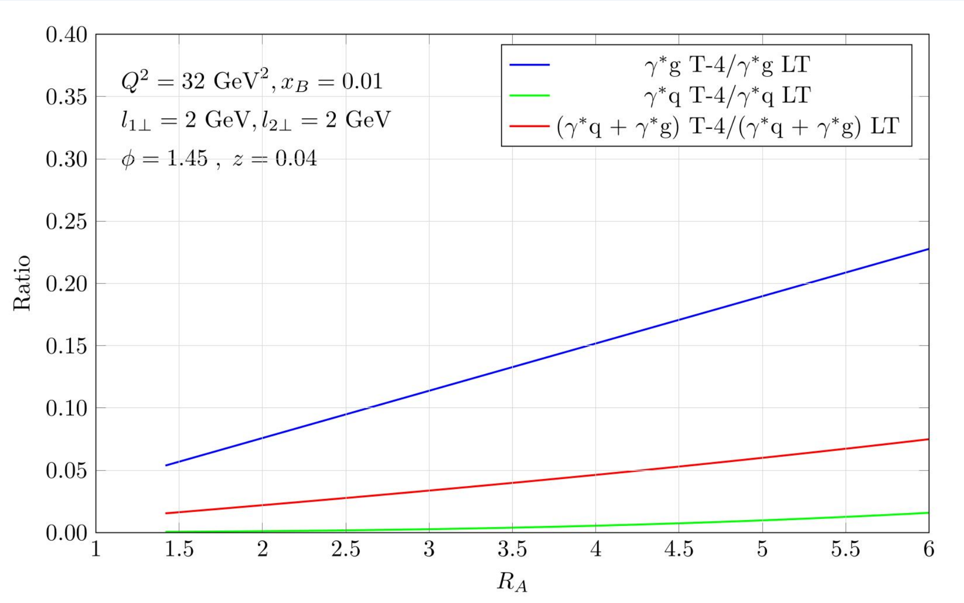

$Q^2 = 32\ \mathrm{GeV}^2$, x = 0.01

Summary and Outlook

Get photon-gluon fusion Twist-4 result, find interference term suppressed by $\frac{1}{N_c^2-1}$

Show under back-to-back limit, photon-gluon fusion leading twist + twist-4 recover CGC result for dijet eA

Caculate nuclear modification(Twist-4/ Leading Twist) Ratio, photon-gluon contribution dominate at intermediate-x

Implement to ehijing, large-x and intermediate-x using same method

Compare with small-x CGC sub-eikonal results, more observables ...

THE END

THANKS