TMD factorization Bridging Large and Small x

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MSTT(-erious) factorization of gluon TMDPDF operator

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Unified description of DGLAP, CSS, and BFKL evolution: TMD factorization bridging large and small *x*

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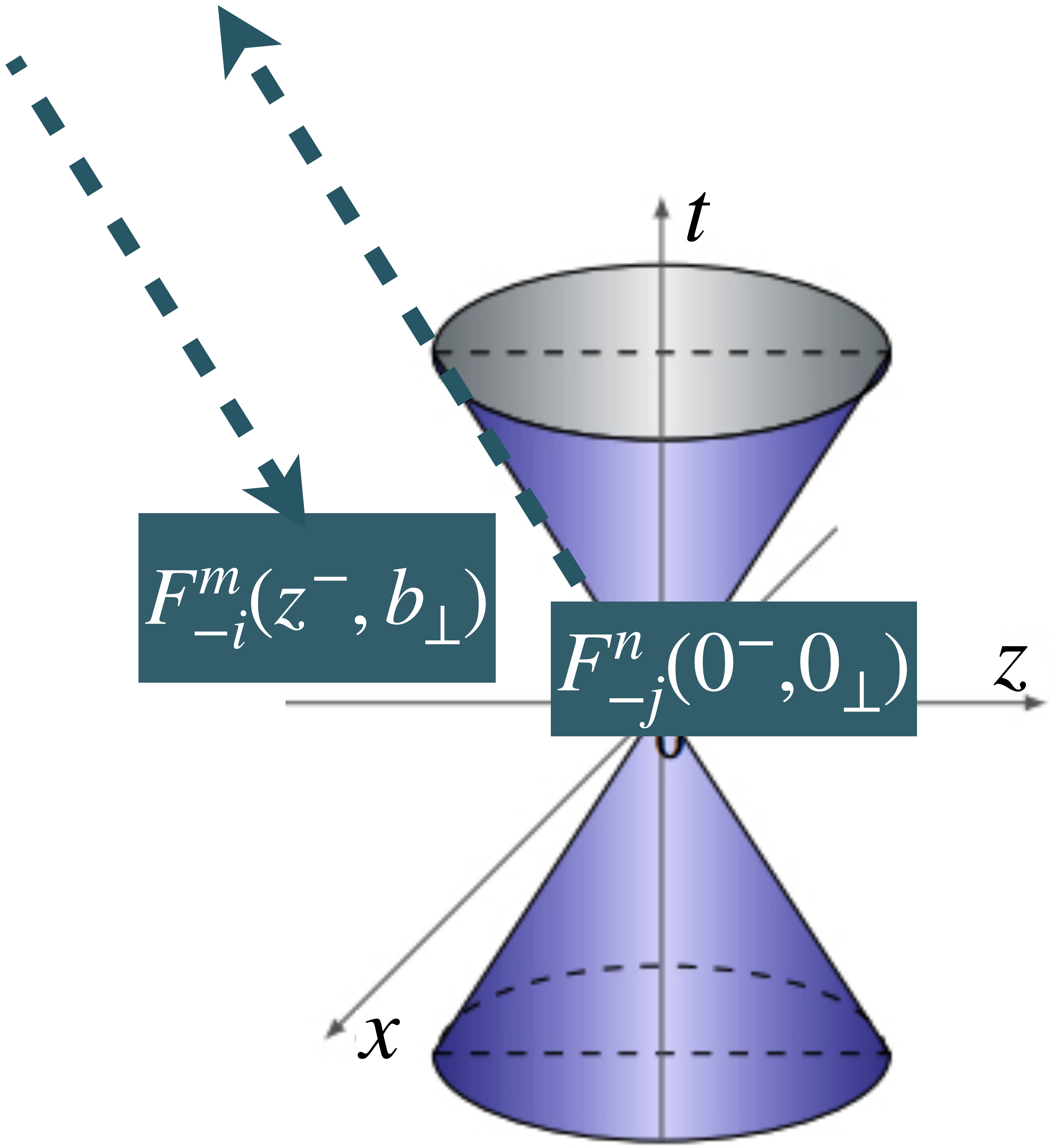
new transverse-momentum dependent (TMD) factorization unifying IR structures at large and small x

(1) gluon TMD beam function:

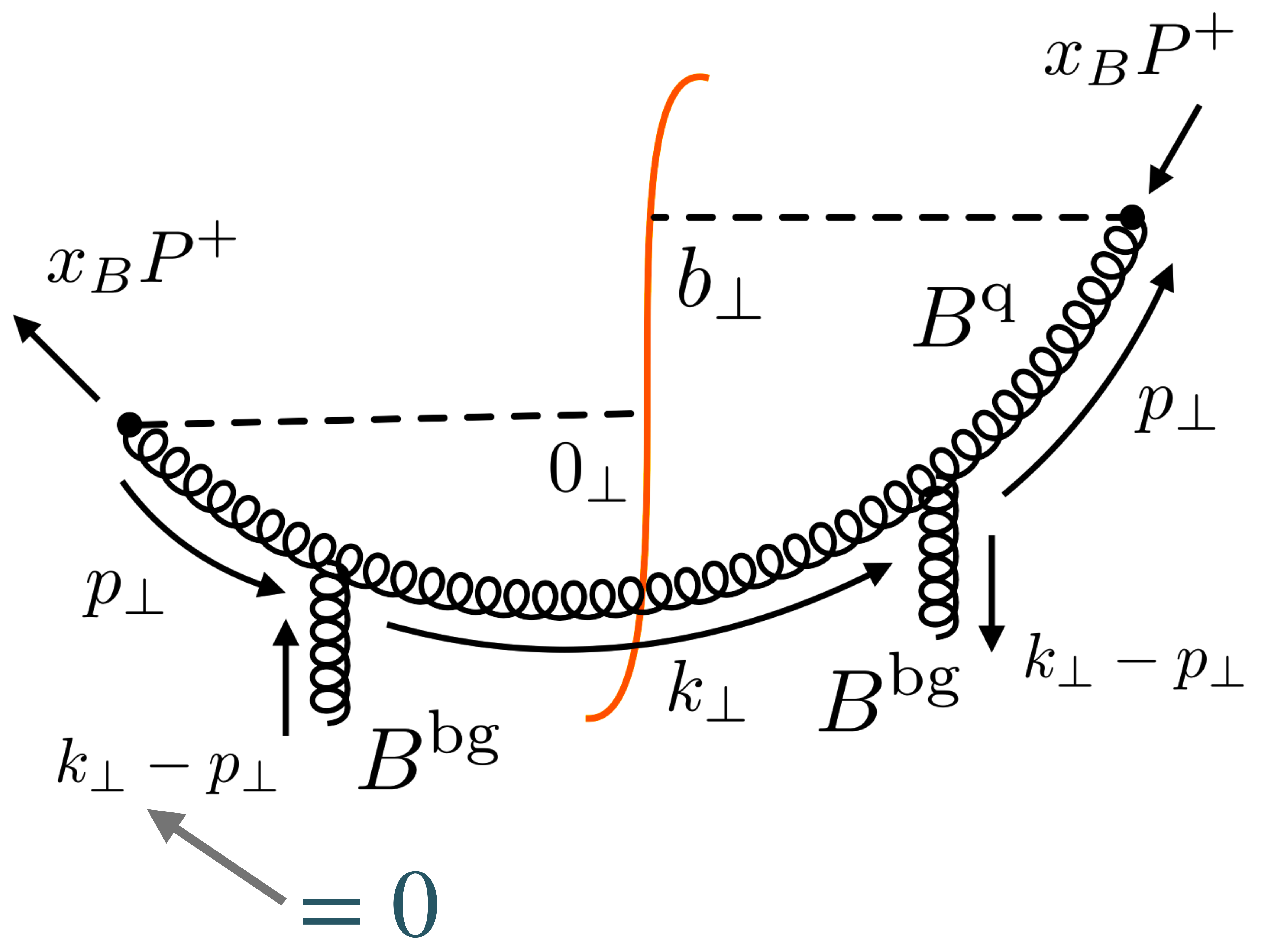
$f_{ij} =$



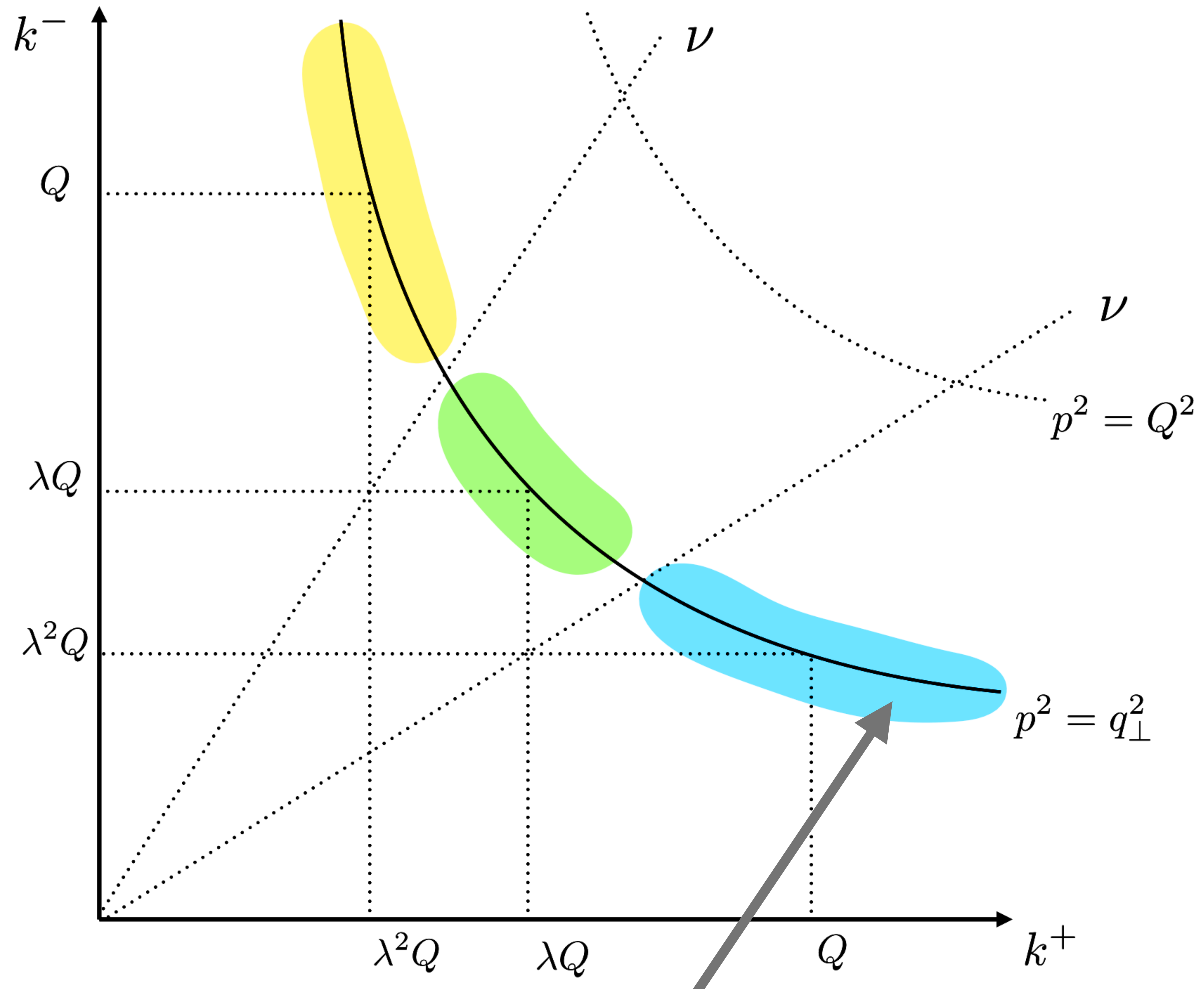
(1) gluon TMD beam function: f_{ij}

(2) $\mathcal{O}(\alpha_s)$ corrections in dilute background of 2 gluons

CSS/SCET factorization …



no trans. mom. supplied
by the background field

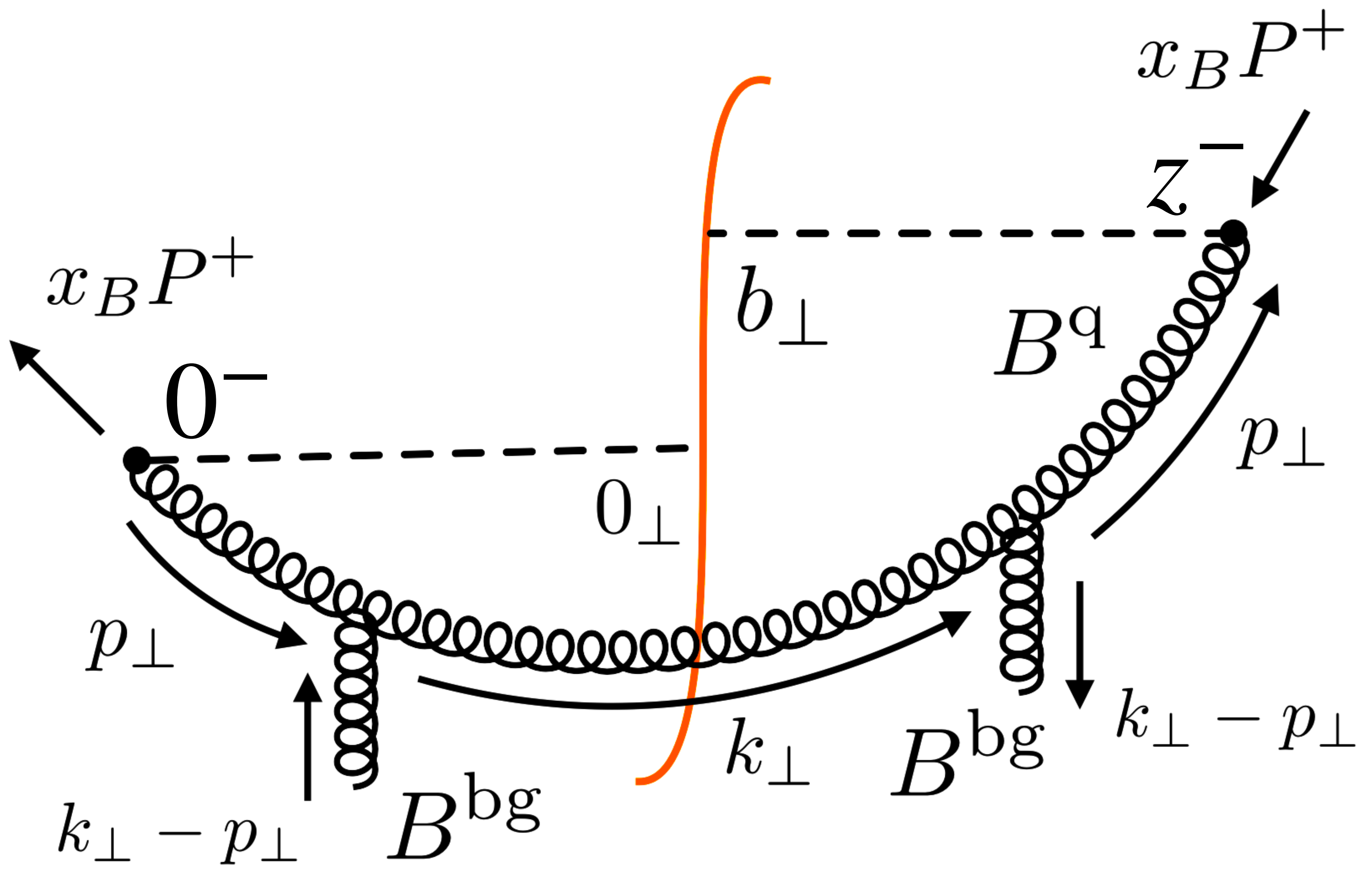


collinear modes are
approx. on mass-shell

no virtual corrections

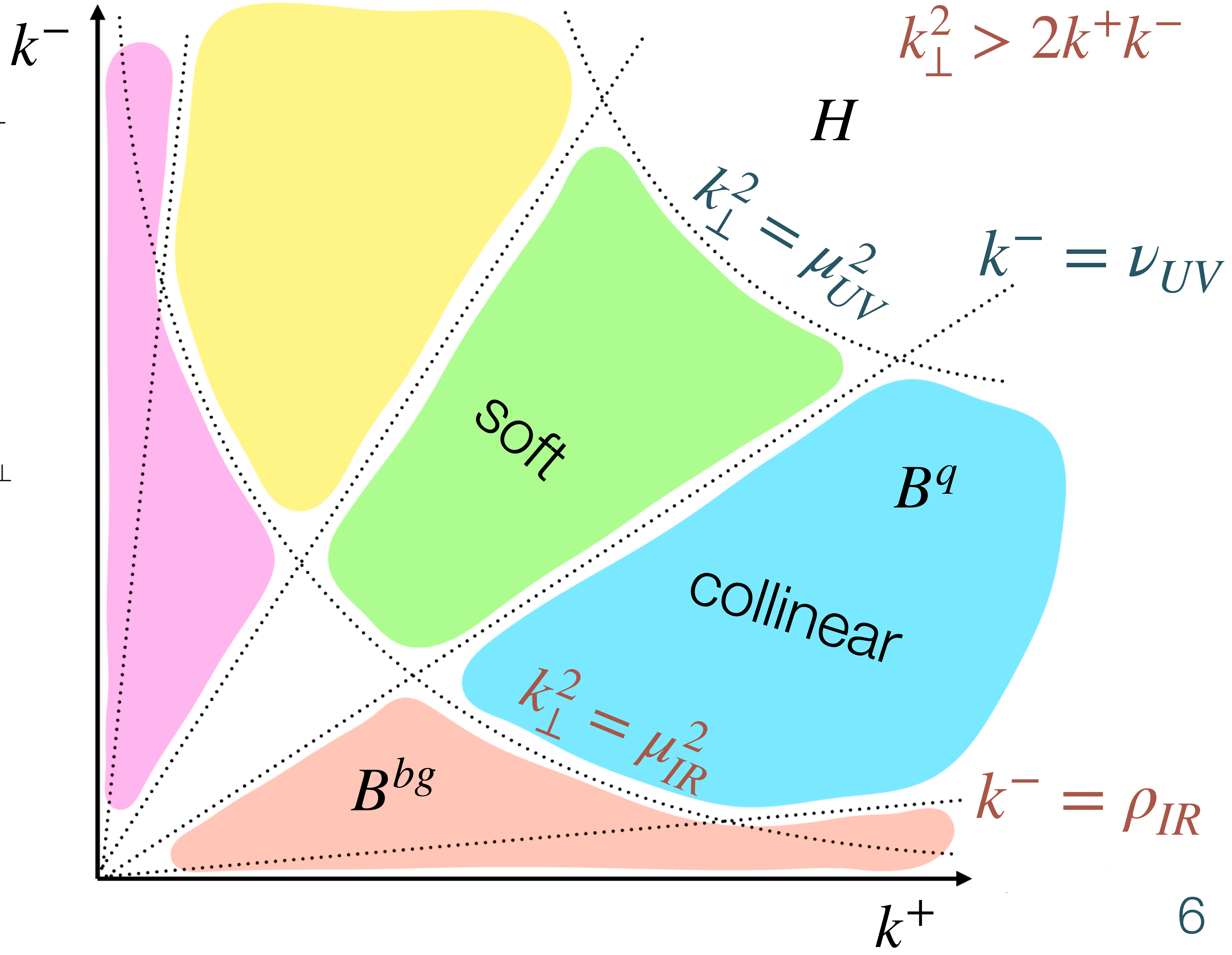
… vs. MSTT

include virtual corrections



$$k_\perp - p_\perp > 0$$

trans. mom. supplied by the background field



(1) gluon TMD beam function: f_{ij}

(2) $\mathcal{O}(\alpha_s)$ corrections in background of 2 gluons

(3) f_{ij} @ $\mathcal{O}(\alpha_s)$:

(a) real + virtual corrections

(b) UV + IR divs. in $k_\perp$, UV + IR divs. in k^-

(1) gluon TMD beam function: f_{ij}

(2) dilute background of 2 gluons

(3) f_{ij} @ $\mathcal{O}(\alpha_s)$: real+virtual, UV+IR divs. in $k_\perp$ & k^-

(4) regulate divergences:

(a) dim. reg. for $k_\perp$

(b) η-scheme for k^-

(1) gluon TMD beam function: f_{ij}

(2) dilute background of 2 gluons

(3) f_{ij} @ $\mathcal{O}(\alpha_s)$: real+virtual, UV+IR divs. in $k_\perp$ & k^-

(4) regulate divs: dim. reg. for $k_\perp$, η-scheme for k^-

(5) renormalize $f_{ij} \to f_{ij}^R$:

(a) gluon wave function renormalization for UV div in $k_\perp$

(b) TMD soft function for UV div in k^-

(1) gluon TMD beam function: f_{ij}

(2) dilute background of 2 gluons

(3) f_{ij} @ $\mathcal{O}(\alpha_s)$: real+virtual, UV+IR divs. in $k_\perp$ & k^-

(4) regulate divs: dim. reg. for $k_\perp$, η-scheme for k^-

(5) renormalized f_{ij}^R: gluon wave function renormalization, TMD soft function

$$f_{ij}^R(x_B, b_\perp, \mu_{UV}, \zeta) = C^{NLO}(z, z_\perp, \mu_{UV}, \zeta, \mu_{IR}, \rho_{IR}) \otimes f_{ij}^{BG}(zx_B, z_\perp b_\perp, \mu_{IR}, \rho_{IR})$$

rapidity ~ $\zeta = x_B P^+$

summary: MSTT factorization

2-gluon background field corrections to gluon TMDPDF operator

$$C^{NLO}\left(\ln[b_\perp \mu_{UV}],\, \ln[b_\perp \mu_{IR}],\, \ln[\mu_{UV}/\zeta],\, \ln[\rho_{IR}/\zeta] \right)$$

general structure involving IR & UV in rapidity, new general evolution

$x_B \to 0$

BFKL $\left(\ln[b_\perp \mu_{IR}],\, \ln[\rho_{IR}/\zeta] \right)$

+ CSS $\left(\ln[b_\perp \mu_{UV}],\, \ln[\mu_{UV}/\zeta] \right)$

$\otimes$ Weizsaecker-Williams $(x_B = 0, b_\perp)$

coll. limit

DGLAP $\left(\ln[b_\perp \mu_{IR}] \right)$

+ CSS $\left(\ln[b_\perp \mu_{UV}],\, \ln[\mu_{UV}/\zeta] \right)$

$\otimes$ PDF $(x_B, b_\perp = 0)$