Odderon at the EIC from exclusive production of C-even quarkonia

Sanjin Benić (University of Zagreb)

SB, Dumitru, Kaushik, Motyka, Stebel, in preparation

SB, Horvatić, Kaushik, Vivoda, Phys. Rev. D **108** (2023) 7, 074005

Synergies between the EIC and the LHC, Hamburg, Germany, December 15, 2023

Odderon in QCD

. odderon is state with vacuum quantum numbers which is C-odd

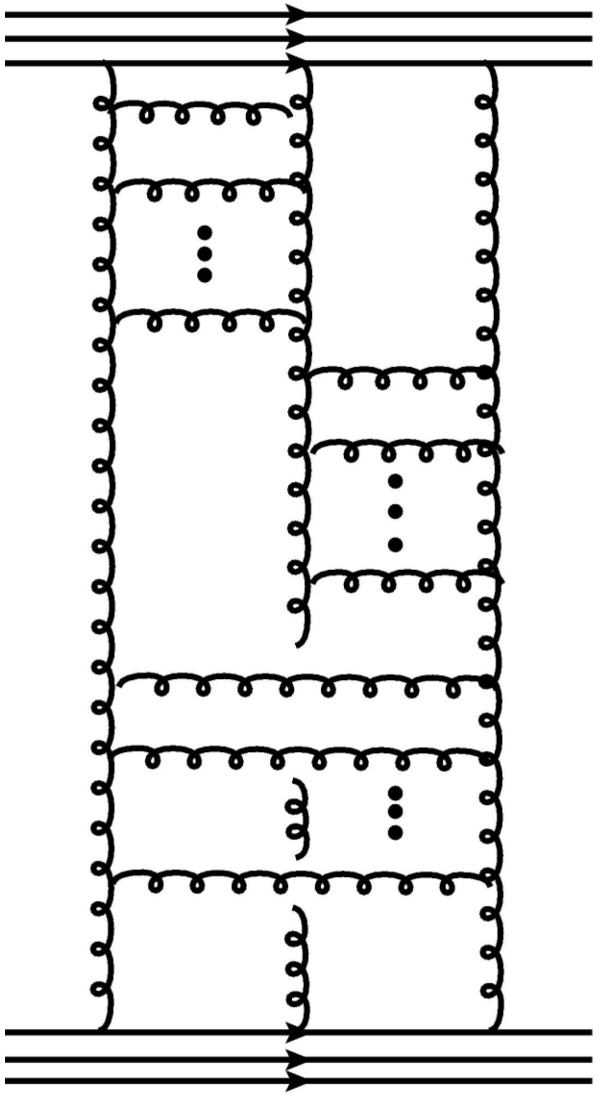
Lukaszuk, Nicolescu (1973)

-> In QCD at least three gluons contracted with d_{abc} color factor

. is pp and p$\bar{p}$ scattering same at high energy?

. Bartels-Jaroszewicz-Kwiecinski-Praszalowicz (BJKP) equation was constructed

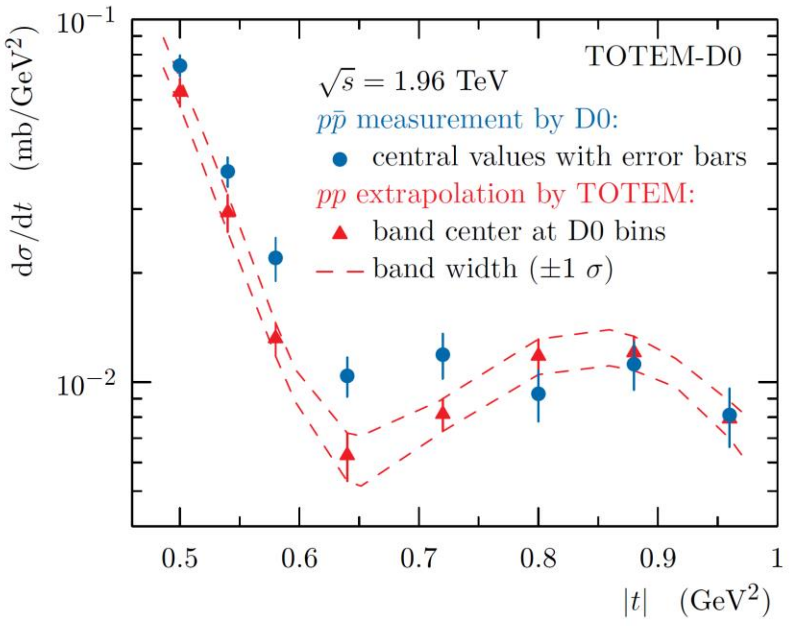
-> pairwise BFKL ladders between three (reggeized) gluons



Bartels (1979)
Jaroszewicz (1980)
Kwiecinski, Praszalowicz (1980)

Odderon searches

TOTEM, D0 (2021)



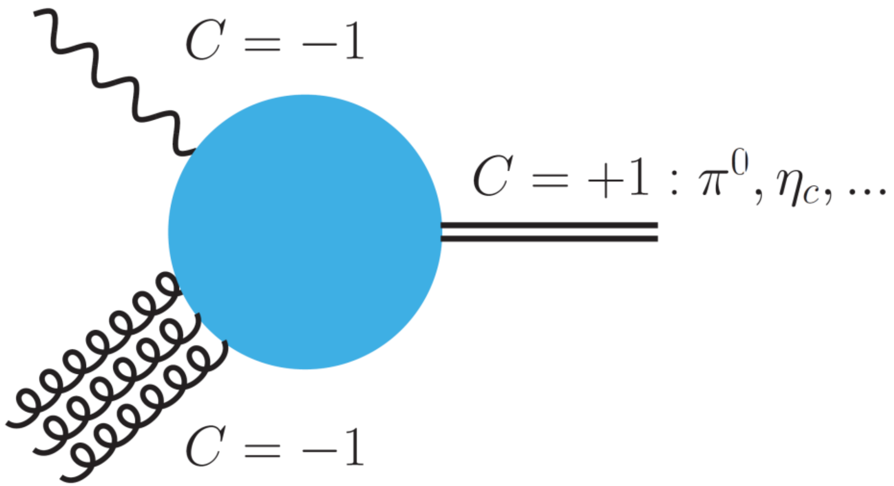
. recent exciting news by the 5 sigma odderon discovery in pp vs $p\bar{p}$

. interpretation in terms of a hard (p)QCD odderon?

→ turn to DIS for better control

. odderon exchange guaranteed

by C=+1 meson/quarkonia in the final state



. HERA: null result from H1 collaboration

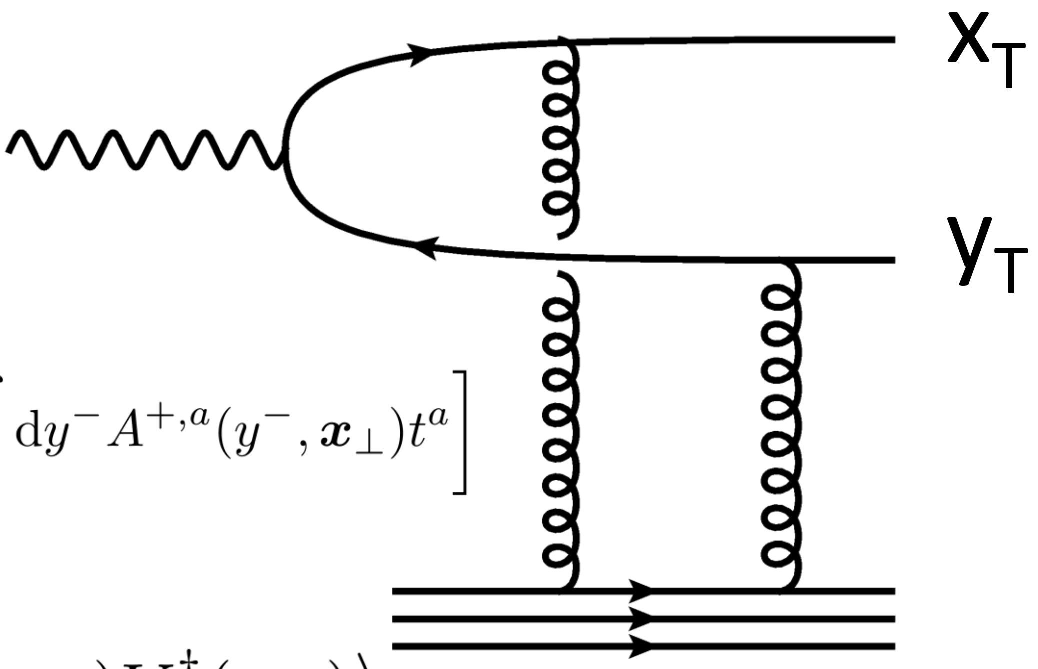
H1 (2002)

$\sigma(\gamma^* p \to \pi^0 N^*) < 49$ nb

. similar for a_2 and f_2 tensor mesons Ewerz (2003)

Odderon: a modern perspective

Kovchegov, Szymanowski, Wallon (2004)
Hatta, Iancu, Itakura, McLerran (2005)



. dipole S-matrix

$$\mathcal{D}(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp) = \frac{1}{N_c} \mathrm{tr} \left\langle V(\boldsymbol{x}_\perp) V^\dagger(\boldsymbol{y}_\perp) \right\rangle$$

$$V(\boldsymbol{x}_\perp) = \mathcal{P} \exp\left[-\mathrm{i}g \int \mathrm{d}y^- A^{+,a}(y^-, \boldsymbol{x}_\perp) t^a\right]$$

. odderon as the imaginary part

$$\mathcal{O}(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp) = -\frac{1}{2\mathrm{i}N_c} \mathrm{tr} \left\langle V(\boldsymbol{x}_\perp) V^\dagger(\boldsymbol{y}_\perp) - V(\boldsymbol{y}_\perp) V^\dagger(\boldsymbol{x}_\perp) \right\rangle$$

. expand the Wilson line

$$\mathcal{O}(\boldsymbol{x}_\perp, \boldsymbol{y}_\perp) = -\frac{g^3}{24N_c} d^{abc} (\alpha^a(\boldsymbol{x}_\perp) - \alpha^a(\boldsymbol{y}_\perp))(\alpha^b(\boldsymbol{x}_\perp) - \alpha^b(\boldsymbol{y}_\perp))(\alpha^c(\boldsymbol{x}_\perp) - \alpha^c(\boldsymbol{y}_\perp))$$

. charge conjugation $\boldsymbol{x}_\perp \leftrightarrow \boldsymbol{y}_\perp$ ➡ odderon flips sign (C-odd)

Odderon: a modern perspective

Kovchegov, Szymanowski, Wallon (2004)
Hatta, Iancu, Itakura, McLerran (2005)
Motyka (2006)

$\boldsymbol{r}_\perp = \boldsymbol{x}_\perp - \boldsymbol{y}_\perp$ (dipole size) $\boldsymbol{b}_\perp = \frac{1}{2}(\boldsymbol{x}_\perp + \boldsymbol{y}_\perp)$ (impact parameter)

-> odderon linear in $\boldsymbol{r}_\perp$ -> need another vector: $\boldsymbol{r}_\perp \cdot \boldsymbol{b}_\perp$

-> odderon as a GTMD (generalized transverse momentum distribution)

-> vanishes at b_T=0

$$\mathcal{D}(\boldsymbol{r}_\perp, \boldsymbol{b}_\perp) = 1 - \mathcal{N}(\boldsymbol{r}_\perp, \boldsymbol{b}_\perp) + \mathrm{i}\mathcal{O}(\boldsymbol{r}_\perp, \boldsymbol{b}_\perp)$$

. non-linear (Balitsky-Kovchegov) evolution equation

$$\frac{\partial \mathcal{O}(\boldsymbol{r}_\perp, \boldsymbol{b}_\perp)}{\partial Y} = \frac{\alpha_S N_c}{2\pi^2} \int_{\boldsymbol{r}_{1\perp}} \frac{\boldsymbol{r}_\perp^2}{\boldsymbol{r}_{1\perp}^2 \boldsymbol{r}_{2\perp}^2} \Big[\mathcal{O}(\boldsymbol{r}_{1\perp}, \boldsymbol{b}_\perp) + \mathcal{O}(\boldsymbol{r}_{2\perp}, \boldsymbol{b}_\perp) - \mathcal{O}(\boldsymbol{r}_\perp, \boldsymbol{b}_\perp)$$

$$- \mathcal{N}(\boldsymbol{r}_{1\perp}, \boldsymbol{b}_\perp)\mathcal{O}(\boldsymbol{r}_{2\perp}, \boldsymbol{b}_\perp) - \mathcal{O}(\boldsymbol{r}_{1\perp}, \boldsymbol{b}_\perp)\mathcal{N}(\boldsymbol{r}_{2\perp}, \boldsymbol{b}_\perp)\Big]$$

linear piece: equivalent to BJKP

saturation corrections: acts to suppress the odderon at high energy

$$Y = \log(1/x)$$

Theory status (with η_c)

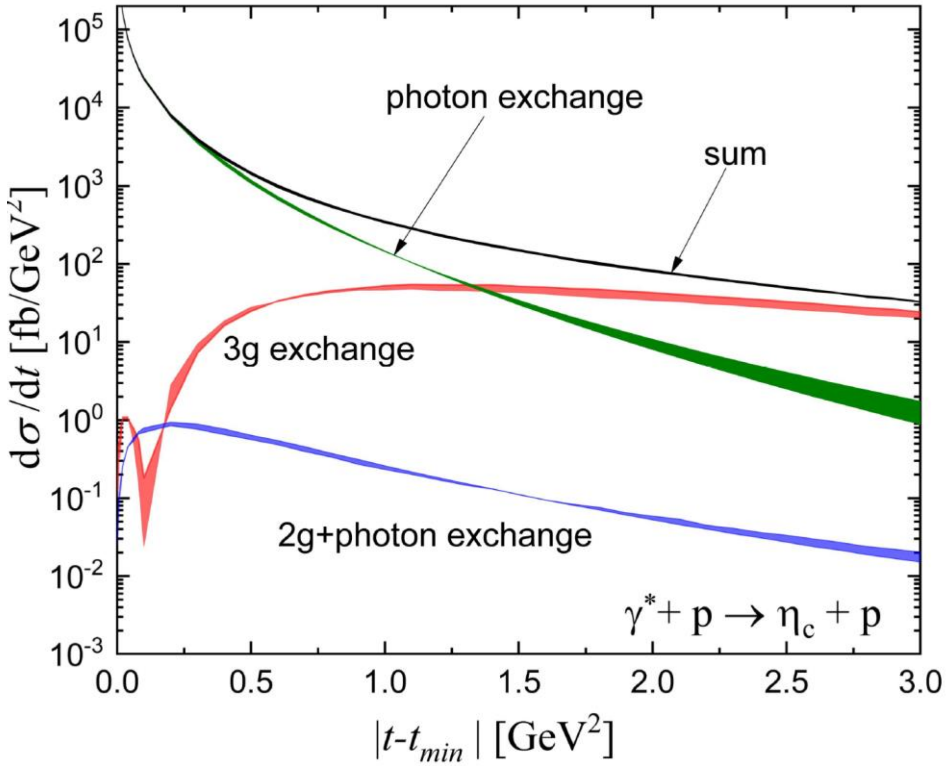
Czyzewski, Kwiecinski, Motyka, Sadzikowski (1997)
Bartels, Braun, Colferai, Vacca (2001)
Dumitru, Stebel (2019)

. no experimental detection so far -> EIC, LHC (UPC)?

. from late 90's theorists start to explore exclusive production of C-even quarkonia -> focus is on η_c

-> prominent feature: almost flat cross section (Donnachie-Landshoff mechanism)

Dumitru, Stebel (2019)



1. issues with η_c detection

(small branching ratios, $J/\psi \to \eta_c \gamma$ feed-down)

2. odderon cross sections in general small

~ 10^2 fb/GeV^2 for moderate x (x = 0.

3. no quantum evolution

Motivations

1. issues with η_c detection

SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

➔ consider other C=+1 quarkonia: χ_{cJ} (J = 0, 1, 2) family

. decay mode χ_{cJ}->J/ψ γ (χ_c is a P-wave, BR ~ 30% for χ_{c1}!)

Pentchev, DIS2023, GHP 2023

. about 56 χ_{c1}'s and ~12 χ_{c2}'s detected (!) near threshold with GlueX

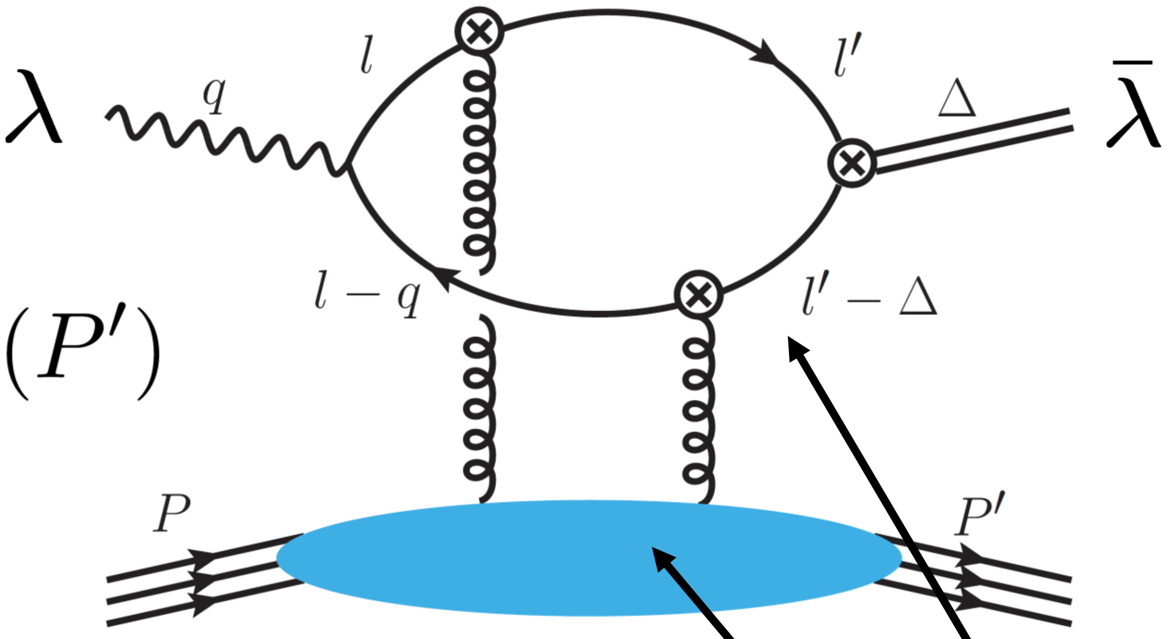
2. odderon cross sections in general small

➔ **utilize** high luminosity at the EIC

3. no quantum evolution effects -> solve the BK evolution for the odderon

Amplitude

$$\gamma^*(q)p(P) \to \mathcal{H}(\Delta)p(P')$$



$$\langle \mathcal{M}_{\lambda\bar{\lambda}} \rangle = 2q^- N_c \int_{\boldsymbol{r}_\perp \boldsymbol{b}_\perp} \mathrm{e}^{-\mathrm{i}\boldsymbol{\Delta}_\perp \cdot \boldsymbol{b}_\perp} \boxed{\mathrm{i}\mathcal{O}(\boldsymbol{r}_\perp, \boldsymbol{b}_\perp)} \mathcal{A}_{\lambda\bar{\lambda}}(\boldsymbol{r}_\perp, \boldsymbol{\Delta}_\perp)$$

. reduced amplitude $\mathcal{A}_{\lambda\bar{\lambda}}(\boldsymbol{r}_\perp, \boldsymbol{\Delta}_\perp) = \int_z \int_{\boldsymbol{l}_\perp \boldsymbol{l}'_\perp} \sum_{h\bar{h}} \Psi^{\gamma}_{\lambda, h\bar{h}}(\boldsymbol{l}_\perp, z) \Psi^{\mathcal{H}*}_{\bar{\lambda}, h\bar{h}}(\boldsymbol{l}'_\perp - z\boldsymbol{\Delta}_\perp, z) \mathrm{e}^{\mathrm{i}(\boldsymbol{l}_\perp - \boldsymbol{l}'_\perp + \frac{1}{2}\boldsymbol{\Delta}_\perp)\cdot \boldsymbol{r}_\perp}$

. perturbative photon wave function $\Psi^{\gamma}_{\lambda, h\bar{h}}(\boldsymbol{k}_\perp, z) \equiv \sqrt{z\bar{z}} \frac{\bar{u}_h(k) e q_c \not{\epsilon}(\lambda, q) v_{\bar{h}}(q-k)}{\boldsymbol{k}_\perp^2 + \varepsilon^2}$

$$\varepsilon \equiv \sqrt{m_c^2 + z\bar{z}Q^2}$$

$$z = \frac{k^-}{q^-} \qquad \bar{z} \equiv 1 - z$$

Charmonia wave functions

scalar function: boosted Gaussian ansatz

$$\Psi^{\mathcal{H}}_{\bar{\lambda},h\bar{h}}(\boldsymbol{k}_\perp, z) \equiv \frac{1}{\sqrt{z\bar{z}}}\bar{u}_h(k)\Gamma^{\mathcal{H}}_{\bar{\lambda}}(k,k')v_{\bar{h}}(k')\phi_{\mathcal{H}}(\boldsymbol{k}_\perp, z)$$

spin structure

Forshaw, Sandapen, Shaw (2004)
Kowalski, Motyka, Watt (2006)

. covariant ansatz

$$\Gamma^{\mathcal{H}}_{\bar{\lambda}}(k,k') = \begin{cases} \mathrm{i}\gamma_5 \,, & \mathcal{H} = \mathcal{P} \\ 1 \,, & \mathcal{H} = \mathcal{S} \\ \mathrm{i}\gamma_5 \not{E}(\bar{\lambda}, \Delta_0) \,, & \mathcal{H} = \mathcal{A} \\ \frac{1}{4}\left(\gamma_\mu(k_\nu - k'_\nu) + \gamma_\nu(k_\mu - k'_\mu)\right) E^{\mu\nu}(\bar{\lambda}, \Delta_0) \,, & \mathcal{H} = \mathcal{T} \end{cases}$$

polarization vector for spin 1

$\mathcal{H} = \mathcal{P}$ → η_c

$\mathcal{H} = \mathcal{S}, \mathcal{A}, \mathcal{T}$ → χ_c

Dumitru, Stebel (2019)

spin 2 -> coupling to the energy momentum tensor

spin 2 polarization tensor: in terms of $E^{\mu}(\bar{\lambda}, \Delta_0)$ via Clebsch-Gordan coeffs

. transversality condition

$$\Delta_0 \cdot E(\bar{\lambda}, \Delta_0) = 0 \qquad \Delta_0 = k + k'$$

Berger, Donnachie, Dosch, Nachtmann (2000)
SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

Final amplitudes: scalar charmonia

SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

. reduced amplitudes

off-forward phase $\boldsymbol{\delta}_\perp = \frac{1}{2}(z-\bar{z})\boldsymbol{\Delta}_\perp$

$$\mathcal{A}_0(\boldsymbol{r}_\perp, \boldsymbol{\Delta}_\perp) = eq_c \int_z \mathrm{e}^{-\mathrm{i}\boldsymbol{\delta}_\perp\cdot\boldsymbol{r}_\perp} \mathcal{A}_L(r_\perp)$$

$$\mathcal{A}_{\lambda=\pm1}(\boldsymbol{r}_\perp, \boldsymbol{\Delta}_\perp) = eq_c\lambda \mathrm{e}^{\mathrm{i}\lambda\phi_r} \int_z \mathrm{e}^{-\mathrm{i}\boldsymbol{\delta}_\perp\cdot\boldsymbol{r}_\perp} \mathcal{A}_T(r_\perp)$$

$$\mathcal{A}_L(r_\perp) \equiv -\frac{2}{\pi} m_c Q(z-\bar{z}) K_0(\varepsilon r_\perp)\phi_S(r_\perp, z)$$

$$\mathcal{A}_T(r_\perp) \equiv \frac{\mathrm{i}\sqrt{2}}{2\pi}\frac{m_c}{z\bar{z}}\left[(z-\bar{z})^2 \varepsilon K_1(\varepsilon r_\perp)\phi_S(r_\perp, z) - K_0(\varepsilon r_\perp)\frac{\partial \phi_S}{\partial r_\perp}\right]$$

spin 1 to spin 0 transition -> quark spin flip: only from mass in the eikonal approximation

. full amplitudes (after removing overall phase)

odderon harmonics

$$\widetilde{\mathcal{M}}_L = 8\pi N_c e q_c \sum_{k=0}^{\infty}(-1)^k \int_z \int_0^{\infty} r_\perp \mathrm{d}r_\perp \mathcal{O}_{2k+1}(r_\perp, \Delta_\perp) \mathcal{A}_L(r_\perp) \,\mathrm{sgn}(z-\bar{z}) J_{2k+1}(r_\perp\delta_\perp)$$

$$\widetilde{\mathcal{M}}_T = 4\pi \mathrm{i} N_c e q_c \sum_{k=0}^{\infty}(-1)^k \int_z \int_0^{\infty} r_\perp \mathrm{d}r_\perp \mathcal{O}_{2k+1}(r_\perp, \Delta_\perp) \mathcal{A}_T(r_\perp) \left[J_{2k}(r_\perp\delta_\perp) - J_{2k+2}(r_\perp\delta_\perp)\right]$$

Final amplitudes: axial vector charmonia

$$\mathcal{A}_{LL}(r_\perp) = 0$$

→ no contribution when photon and axial charmonia are longitudinally polarized

$$\mathcal{A}_{LT}(r_\perp) \equiv \frac{\sqrt{2}}{\pi} Q K_0(\varepsilon r_\perp) \frac{\partial \phi_{\mathcal{A},T}}{\partial r_\perp}$$

$$\mathcal{A}_{TL}(r_\perp) \equiv \frac{\sqrt{2}}{\pi} \frac{1}{z\bar{z}} \frac{1}{M_{\mathcal{A}}} \left[-m_c^2 K_0(\varepsilon r_\perp) \frac{\partial \phi_{\mathcal{A},L}}{\partial r_\perp} + \varepsilon K_1(\varepsilon r_\perp) \boldsymbol{\nabla}_\perp^2 \phi_{\mathcal{A},L} \right]$$

$$\mathcal{A}_{TT}(r_\perp) \equiv -\frac{\mathrm{i}}{\pi} \frac{z-\bar{z}}{z\bar{z}} \left[\frac{\partial \phi_{\mathcal{A},T}}{\partial r_\perp} \varepsilon K_1(\varepsilon r_\perp) - m_c^2 K_0(\varepsilon r_\perp) \phi_{\mathcal{A},T} \right]$$

only polarization preserving transition

$$\widetilde{\mathcal{M}}_i = 4\pi \mathrm{i} N_c e q_c \sum_{k=0}^{\infty} (-1)^k \int_z \int_0^\infty r_\perp \mathrm{d}r_\perp \mathcal{O}_{2k+1}(r_\perp, \Delta_\perp) \mathcal{A}_i(r_\perp) \left[J_{2k}(r_\perp \delta_\perp) - J_{2k+2}(r_\perp \delta_\perp) \right], \qquad i = TL, LT$$

$$\widetilde{\mathcal{M}}_{TT} = 8\pi N_c e q_c \sum_{k=0}^{\infty} (-1)^k \int_z \int_0^\infty r_\perp \mathrm{d}r_\perp \mathcal{O}_{2k+1}(r_\perp, \Delta_\perp) \mathcal{A}_{TT}(r_\perp)\, \mathrm{sgn}(z-\bar{z}) J_{2k+1}(r_\perp \delta_\perp)$$

SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

Final amplitudes: tensor charmonia

$$\widetilde{\mathcal{M}}_i = -4\pi N_c e q_c \sum_{k=0}^{\infty}(-1)^k \int_z \int_0^{\infty} r_\perp \mathrm{d}r_\perp \mathcal{O}_{2k+1}(r_\perp,\Delta_\perp)\mathcal{A}_i(r_\perp)\mathrm{sign}(z-\bar{z})\left[J_{2k+3}(r_\perp\delta_\perp)+J_{2k-1}(r_\perp\delta_\perp)\right], \quad i = LT2, TTf$$

$$\widetilde{\mathcal{M}}_i = 4\pi\mathrm{i} N_c e q_c \sum_{k=0}^{\infty}(-1)^k \int_z \int_0^{\infty} r_\perp \mathrm{d}r_\perp \mathcal{O}_{2k+1}(r_\perp,\Delta_\perp)\mathcal{A}_i(r_\perp)\left[J_{2k}(r_\perp\delta_\perp)-J_{2k+2}(r_\perp\delta_\perp)\right], \quad i = TT2p, LT, TL,$$

$$\widetilde{\mathcal{M}}_i = 8\pi N_c e q_c \sum_{k=0}^{\infty}(-1)^k \int_z \int_0^{\infty} r_\perp \mathrm{d}r_\perp \mathcal{O}_{2k+1}(r_\perp,\Delta_\perp)\mathcal{A}_i(r_\perp)\mathrm{sgn}(z-\bar{z})J_{2k+1}(r_\perp\delta_\perp), \quad i = TTp, LL$$

$$\widetilde{\mathcal{M}}_{TT2f} = 4\pi\mathrm{i} N_c e q_c \sum_{k=0}^{\infty}(-1)^k \int \int_{\cdot}^{\infty} r_\perp \mathrm{d}r_\perp \mathcal{O}_{2k+1}(r_\perp,\Delta_\perp)\mathcal{A}_{TT2f}(r_\perp)\left[J_{2k+4}(r_\perp\delta_\perp)-J_{2k-2}(r_\perp\delta_\perp)\right],$$

$$\mathcal{A}_{LT2}(r_\perp) \equiv \frac{1}{\pi}(z-\bar{z})QK_0(\varepsilon r_\perp)\left(\frac{\partial^2\phi_{\mathcal{T},T2}}{\partial r_\perp^2} - \frac{1}{r_\perp}\frac{\partial\phi_{\mathcal{T},T2}}{\partial r_\perp}\right),$$

$$\mathcal{A}_{TT2,p}(r_\perp) \equiv -\frac{\mathrm{i}}{\sqrt{2}\pi}\frac{1}{z\bar{z}}\left((z^2+\bar{z}^2)\varepsilon K_1(\varepsilon r_\perp)\left(\frac{\partial^2\phi_{\mathcal{T},T2}}{\partial r_\perp^2} - \frac{1}{r_\perp}\frac{\partial\phi_{\mathcal{T},T2}}{\partial r_\perp}\right) + m_c^2 K_0(\varepsilon r_\perp)\frac{\partial\phi_{\mathcal{T},T2}}{\partial r_\perp}\right),$$

$$\mathcal{A}_{TT2,f}(r_\perp) \equiv \frac{\mathrm{i}\sqrt{2}}{\pi}\varepsilon K_1(\varepsilon r_\perp)\left(\frac{\partial^2\phi_{\mathcal{T},T2}}{\partial r_\perp^2} - \frac{1}{r_\perp}\frac{\partial\phi_{\mathcal{T},T2}}{\partial r_\perp}\right),$$

$$\mathcal{A}_{LT}(r_\perp) \equiv -\frac{\mathrm{i}}{2\pi}QM_{\mathcal{T}}\left(3-4(z^2+\bar{z}^2)\right)K_0(\varepsilon r_\perp)\frac{\partial\phi_{\mathcal{T},T}}{\partial r_\perp},$$

$$\mathcal{A}_{TT,p}(r_\perp) = -\frac{\sqrt{2}M_{\mathcal{T}}}{4\pi}\frac{z-\bar{z}}{z\bar{z}}\left[m_c^2 K_0(\varepsilon r_\perp)\phi_{\mathcal{T},T}(r_\perp,z) - (z-\bar{z})^2\varepsilon K_1(\varepsilon r_\perp)\frac{\partial\phi_{\mathcal{T},T}}{\partial r_\perp}\right],$$

$$\mathcal{A}_{TT,f}(r_\perp) = -\frac{\sqrt{2}M_{\mathcal{T}}}{\pi}(z-\bar{z})\varepsilon K_1(\varepsilon r_\perp)\frac{\partial\phi_{\mathcal{T},T}}{\partial r_\perp},$$

$$\mathcal{A}_{LL}(r_\perp) = -\frac{\sqrt{2}Q}{\sqrt{3}\pi}(z-\bar{z})K_0(\varepsilon r_\perp)\left(3\nabla_\perp^2 - 2m_c^2\right)\phi_{\mathcal{T},L}(r_\perp,z),$$

$$\mathcal{A}_{TL}(r_\perp) = \frac{\mathrm{i}}{2\pi\sqrt{3}}\frac{1}{z\bar{z}}\left[\varepsilon K_1(\varepsilon r_\perp)(z-\bar{z})^2\left(3\nabla_\perp^2 - 2m_c^2\right)\phi_{\mathcal{T},L} - m_c^2 K_0(\varepsilon r_\perp)\frac{\partial\phi_{\mathcal{T},L}}{\partial r_\perp}\right].$$

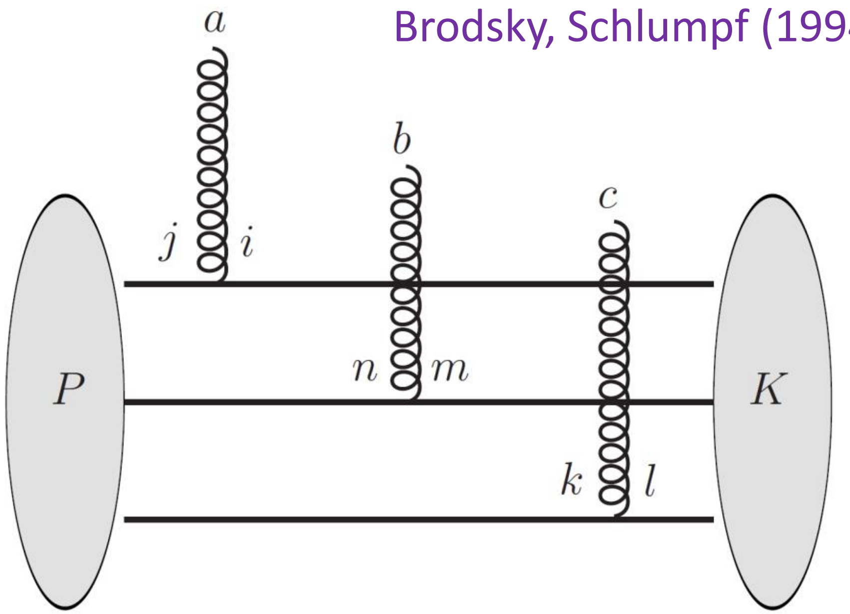
all overlaps calculated, all amplitudes found

SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

Odderon initial condition

. a microscopic quark model of the proton

Dumitru, Miller, Venugopalan (2018)
Brodsky, Schlumpf (1994)



. a key element in incorporating the Donnachie-Landshoff mechanism

even a high-t three gluon exchange may not break up the proton

Donnachie, Landshoff (1979)

. model computation fixes overall sign of the odderon

. evolution linear in O -> odderon sign not changed by evolution

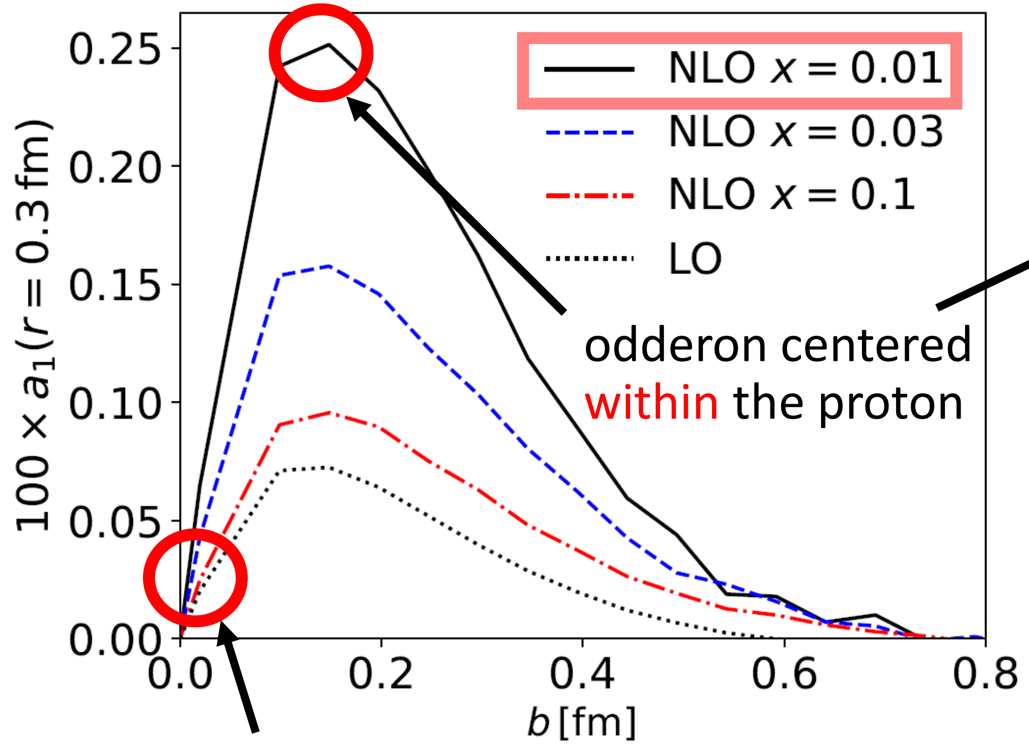
Odderon evolved

. initial condition from NLO computation by Dumitru, Mantysaari and Paatelainen

we take $\alpha_s(2m_c)$~0.25

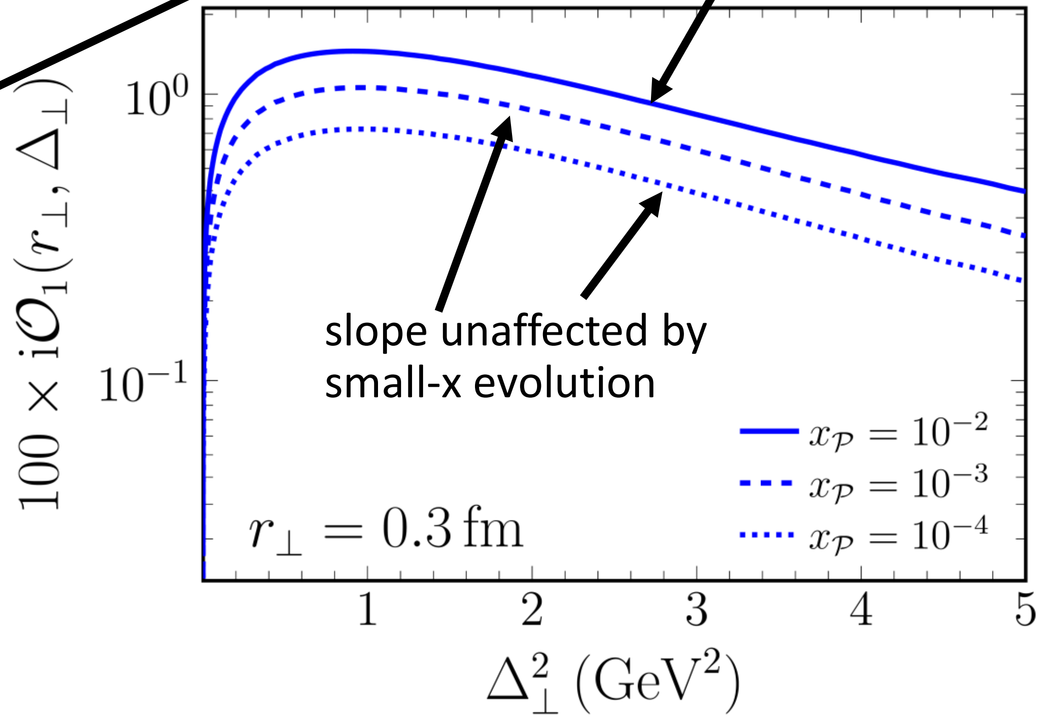
-> proton made up of three valence quarks + gluon
-> 100+ diagrams!

Donnachie-Landshoff mechanism



vanishes at the origin

Fourier transform



Dumitru, Mantysaari, Paatelainen (2022)
Dumitru, Mantysaari, Paatelainen (2023)

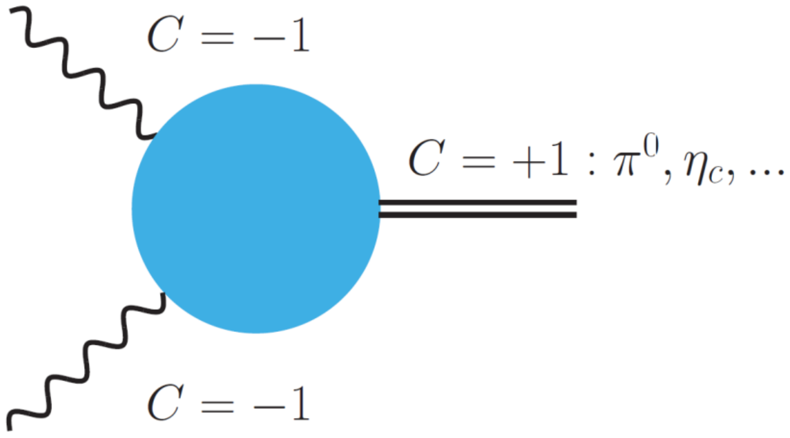
SB, Horvatic, Kaushik, Vivoda (2023)
SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

The Primakoff process

SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

. replace odderon with photon exchange

$$\gamma^*(q)\gamma^*(\ell) \to \mathcal{H}(\Delta)$$



$$\mathcal{O}(\boldsymbol{r}_\perp, \boldsymbol{\Delta}_\perp) \to 8\pi i q_c \alpha \sin\left(\frac{\boldsymbol{\Delta}_\perp \cdot \boldsymbol{r}_\perp}{2}\right) \frac{F_1(\Delta_\perp)}{\boldsymbol{\Delta}_\perp^2}$$

charge form factor

. usually we do not care about QED contributions to QCD process

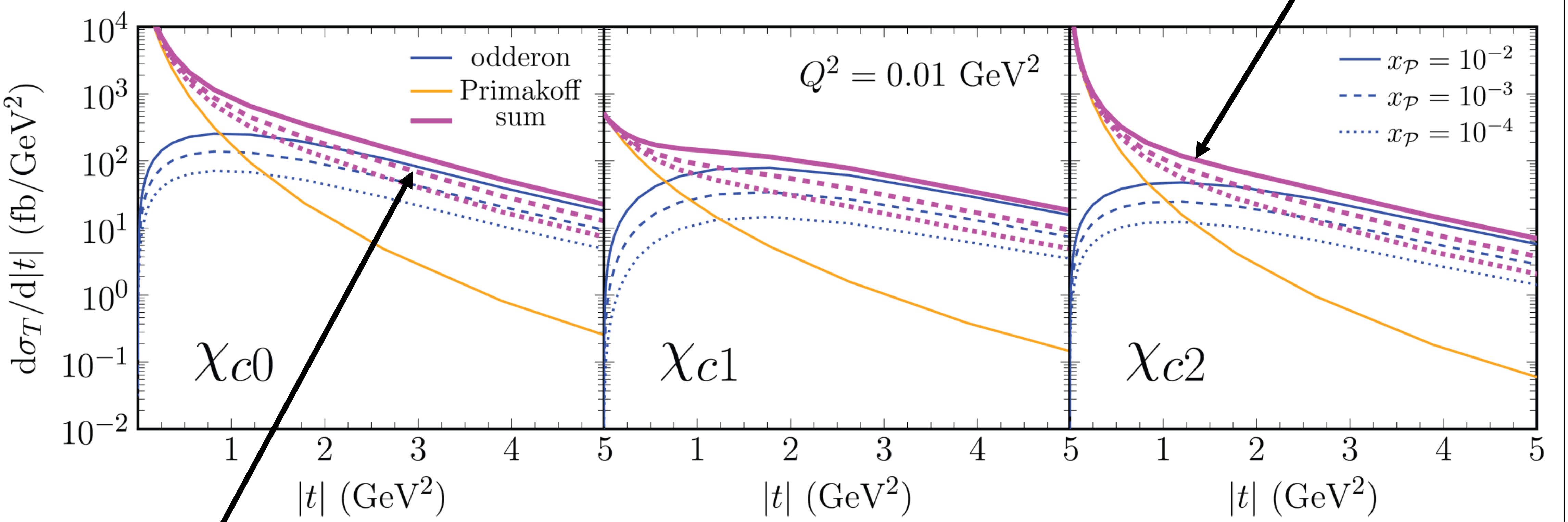
. but in case of odderon QCD cross section is small (~α_s^6)

-> Primakoff process becomes a serious background to the odderon searches

Numerical results: t-distributions

. odderon important after |t|~ 1 GeV^2 , low t-region dominated by Primakoff

coherent sum of photon+odderon

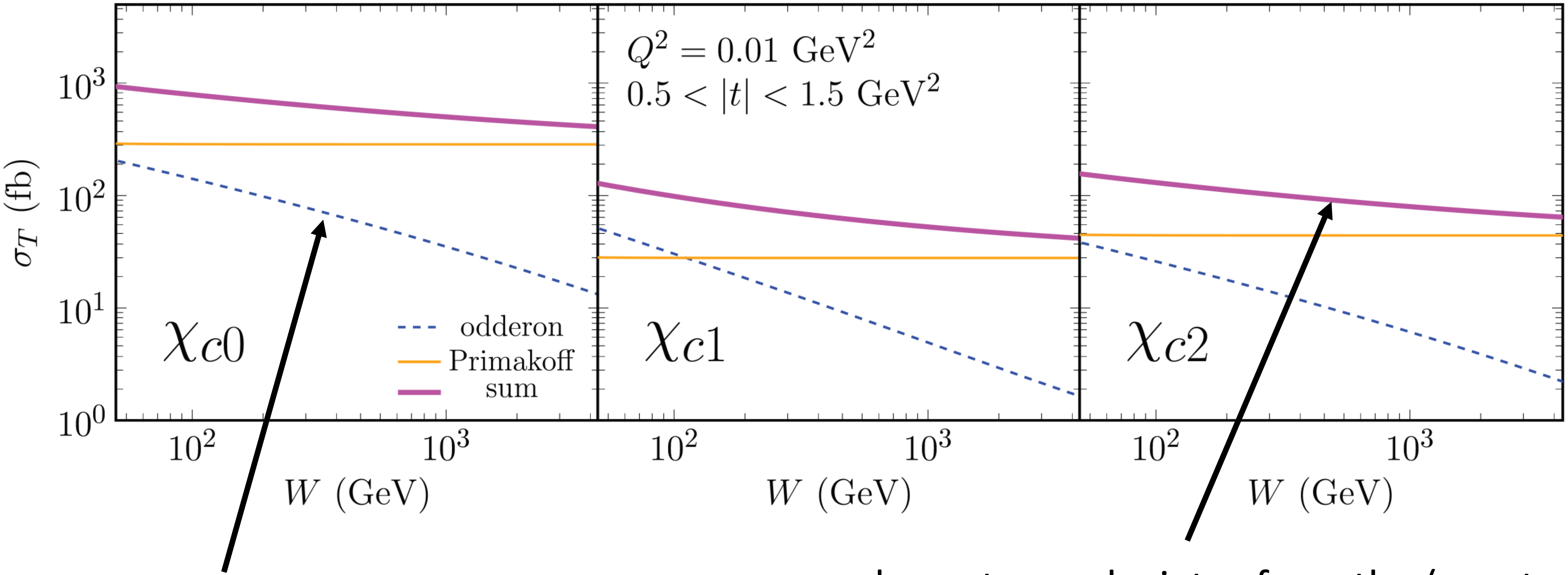


Donnachie-Landshoff mechanism

photon and odderon interfere constructively

SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

Numerical results: W distributions

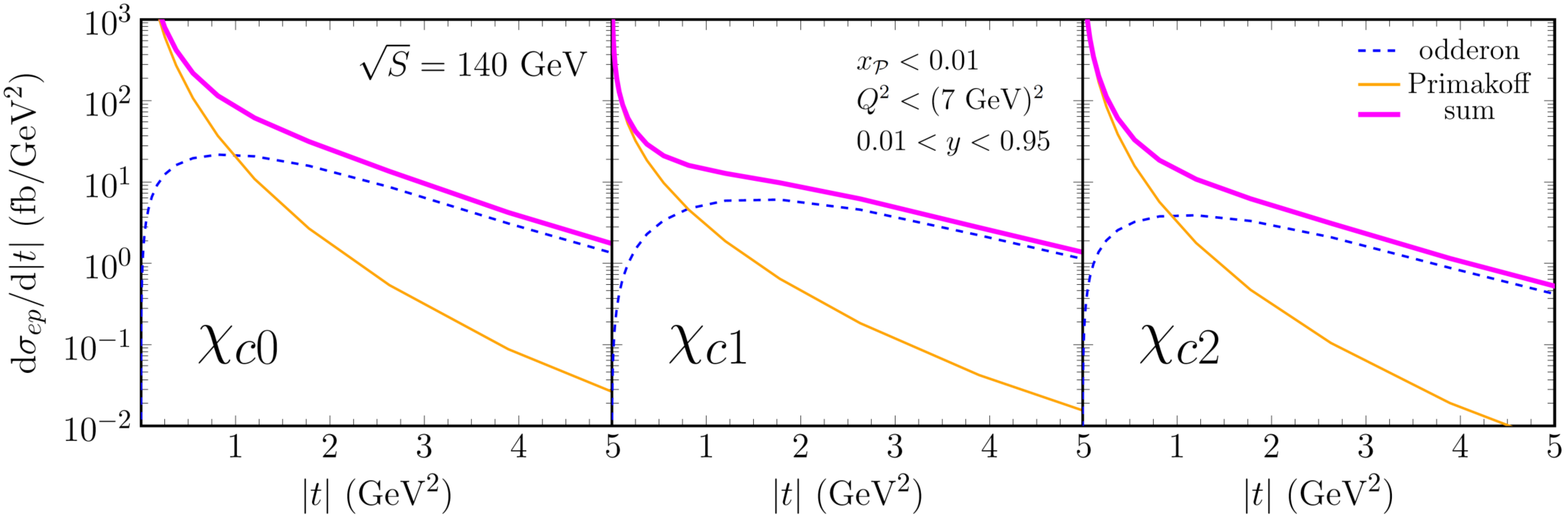


Odderon drops with evolution (saturation corrections)

coherent sum deviates from the (constant) Primakoff contribution: few times higher in magnitude and with a negative slope

SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

Numerical results: t-distributions in electroproduction for EIC kinematics

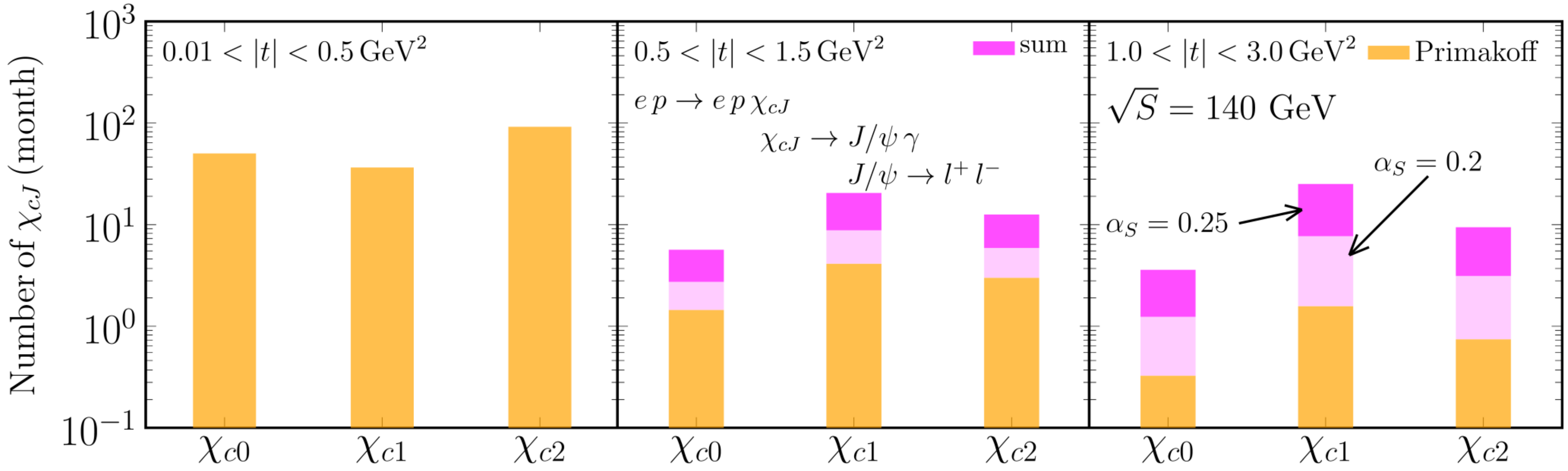


. excess above the Primakoff contribution after about $|t|$~0.5 GeV^2

SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

Expected number of events at the EIC

SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)



. detection channel: χ_{cJ} -> J/ψ + γ

. we predict **excess** in odderon events over Primakoff background

. χ_{c1} most promising (30% BR to J/ψ + γ): with EIC luminosity 10^{34} cm^{-2} s^{-1} expect ~30 events/month (only Primakoff~3 events/month)

. note: at the EIC proton detection is up to p_T<1.3 GeV EIC Yellow report

Concluding remarks

. we suggest exclusive χ_c to detect the odderon at the EIC: a constructive interference with the Primakoff channel leads to an event excess – we find about a few dozen events per month at the EIC

. was not possible at HERA.. (luminosity ~ 10^{32} cm^{-2} s^{-1})

. theoretical uncertainties:

1. χ_c wave functions -> constrain by first detecting the Primakoff channel at low t

-> can use to calibrate the $\gamma\gamma$ form-factors

2. value of α_S , QCD corrections..

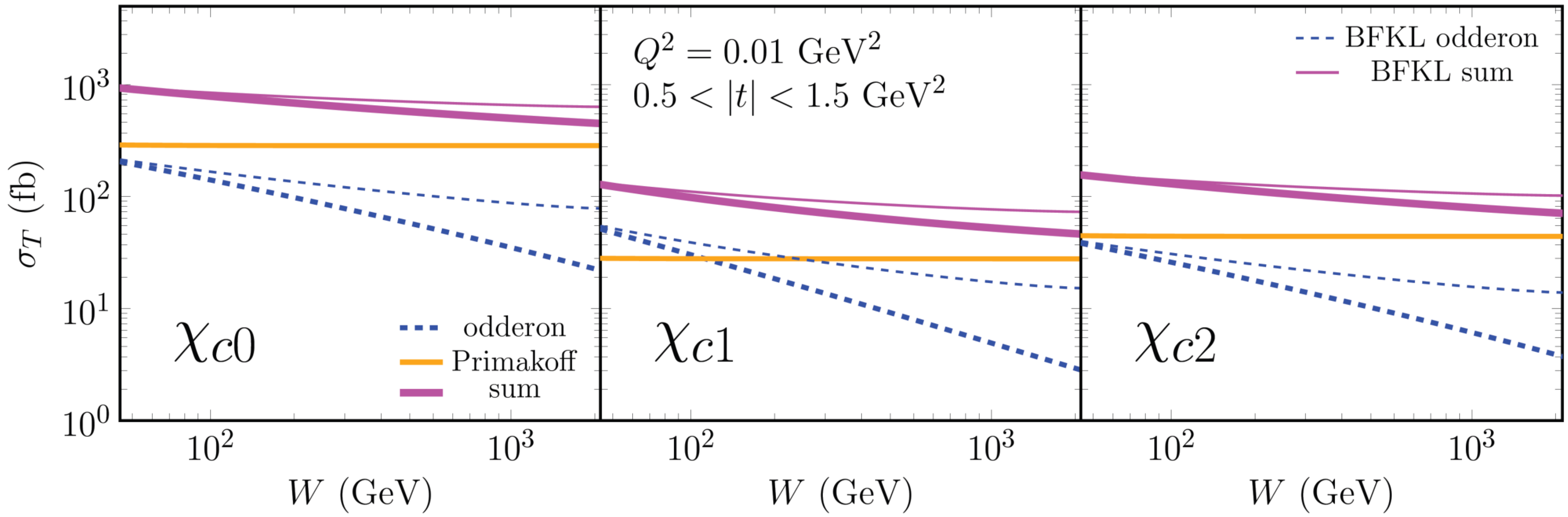
3. potential contribution from the gluon Sivers function (spin-dependent odderon) Boussarie, Hatta, Szymanowski, Wallon (2020)

-> finite at t = 0 -> a computation of the initial condition is required

Numerical results: linear vs nonlinear evolution

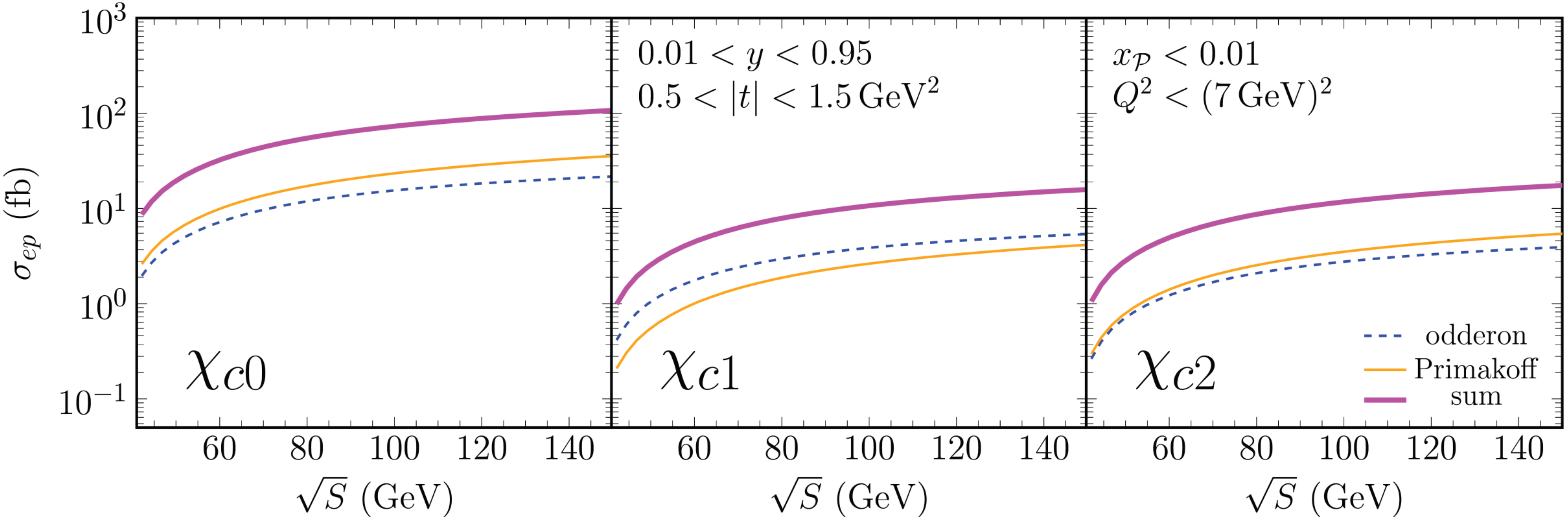
. with linear evolution the cross section flattens to a constant for asymptotically large W - agrees with the Bartels-Lipatov-Vacca odderon

Bartels, Lipatov, Vacca (2000)



SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

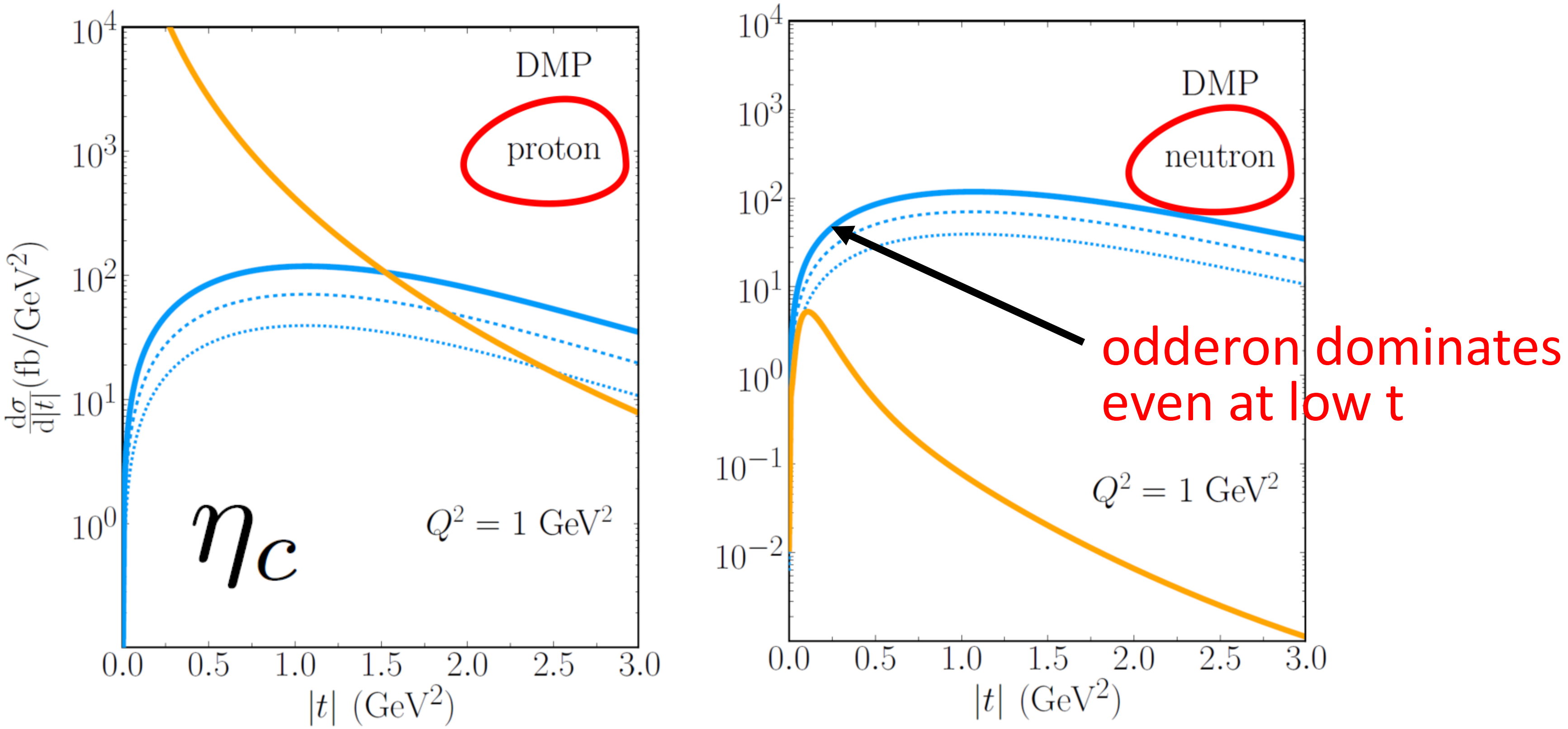
Numerical results: total electroproduction cross section



SB, Dumitru, Kaushik, Motyka, Stebel (in preparation)

Numerical results: neutron target

-> use neutron targets to suppress Primakoff background



. measurement prospect: d or ^{3}He targets with spectator proton tagging in the forward region

SB, Horvatic, Kaushik, Vivoda (2023)
CLAS (2012)
Friscic et al (2021)