2024 JAN 29-31 EIC Asia Workshop

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Meson Structure Via EIC

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Outline

1. Introduction
2. Meson structure
3. Meson generalized parton distribution
4. Summary and outlook

Introduction-1 (Physics program at the EIC)

- To understand the origin and hadron structure dynamics from QCD theory-confinement and spontaneous breaking of chiral symmetry (SBCS)

- **Four crucial questions:**

1. How do the hadron, in particular, pion and kaon masses emerge for the light quarks based on QCD?

2. What is the origin and role of dynamical chiral symmetry breaking (DCSB)?

3. What is the interplay of the strong and Higgs-driven mass generation mechanisms?

4. What basic mechanisms determine the distribution of mass, momentum, charge, spin, and so forth inside the hadron?

Arlene C. Aguilar et al., EPCJA (2019)

Introduction-1 (Physics program at the EIC)

5 key EIC measurements

Arlene C. Aguilar, et al., Eur. Phy. J. A (2019) DOI:10.1140/epja/i2019-12885-0

1. Measurement of pion and kaon structure functions and their GPDs
   - insights into quark and gluon energy contributions to hadron masses
2. Measurement of open-charm production
   - settle question of whether gluons persist or disappear within pions in the chiral limit
3. Measurement of the charged-pion form factor up to Q^2~35 GeV^2
   - Quantitatively related to emergent-mass acquisition from DCSB
4. Measurement of the behavior of (valence) u-quarks in the pion and kaon
   - quantitative measure of the contributions of gluons to NG boson masses and differences between the impacts of emergent and Higgs-driven mass generating mechanisms
5. Measurement of the fragmentation of quarks into pions and kaons
   - a timelike analog of mass acquisition, which can potentially reveal relationships between DCSB and confinement mechanism

Trotta's talk at Temple EIC Meeting

Introduction-1

- Generalized Parton distribution function: a tool to study three (multi)-dimensional structure of hadrons — connecting with the chiral symmetry breaking—**Radyushkin, PRD56 (1997), M.Diehl, PR388(2003), Belitsky&Radyushkin, PR418(2005)**
- Gluon content plays a crucial role in pions, in comparison with kaons, in response to the pion's deeply virtual Compton scattering (DVCS) in the Electron-ion collider (EIC) kinematics
- Amongst hadrons, as (pseudo)-Goldstone boson of QCD, pions are expected to play an important role in deeply understanding the mass origin or emergent hadron mass (EHM)—how gluons and quarks give rise to mass to the pions

Introduction-2

- Hard exclusive processes: DVCS and deeply virtual meson production (DVMP) — generalized Parton distributions (GPDs)
- Experimentally, the study of GPDs could be interesting for the upgraded Jlab-12 — which potentially provides very precise experimental data
- Many attempts/studies have been made to investigate the GPDs: BSE—NJL model—**PTPH, Ian Cloet, Anthony Thomas, PRC94(2016), Ian Cloet PRC90(2014)**, Light-front holographic model—**Brodsky&Teramond, PRL102 (2009)**, Chiral—quark model—**H.Weigel, Pramana61 (2003)**, Dyson—Schwinger equations (DSEs) model—**P.Maris&Roberts, IJMPE12 (2003), Roberts, AG.Williams, PPNP33(1994)**, and many more models available in the literature
- These model studies are very useful for interpreting the data — as we know that the GPDs, PDFs, and FFs data for the pion and kaon are very limited and scarce

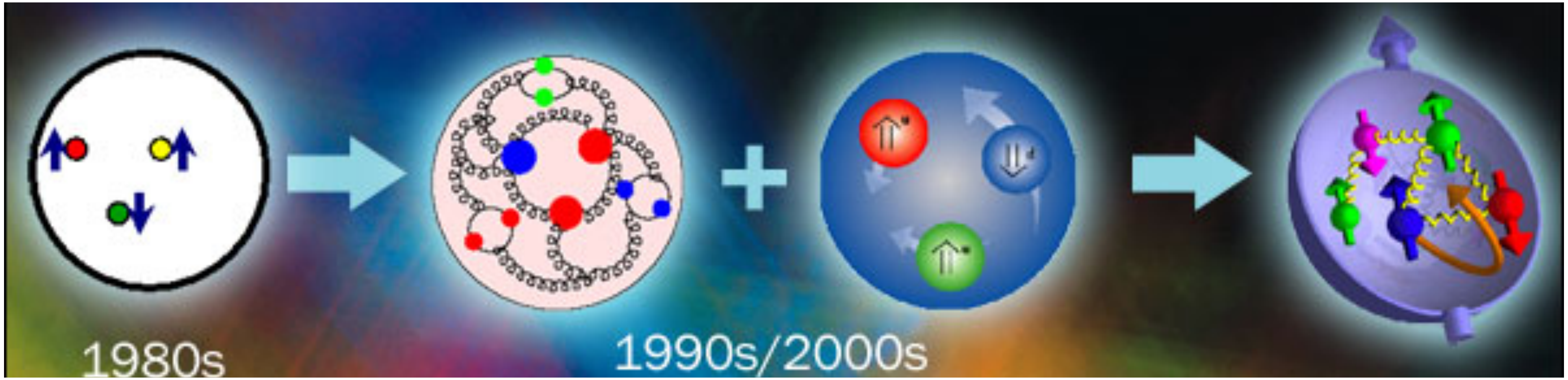
Introduction-3

- "Tension" on the power counting at asymptotic regime x—>1 or at endpoint features remain uncertain, i.e.
- JAM Analysis—PC.Barry, et.al, PRL127(2021), PRD105(2022) prediction $(1-x)^{1.0-1.2}$, which is similar to BSE-NJL model—PTPH, Ian Cloet, Anthony Thomas, PRC94(2016) after evolving via QCD evolution prediction and DSE yields $(x-1)^{2.0}$
- To resolve this issue, more new data from experiment facilities are needed as well as the Lattice-QCD simulation
- Besides this power counting rule at high-x, the gluon distributions for the pion and kaon for different models yield rather different results

Hadron Structure

QCD theory and scale

- In quantum chromodynamics (QCD), hadron (meson and nucleon) structure should describe in terms of the quarks and gluon's degrees of freedom

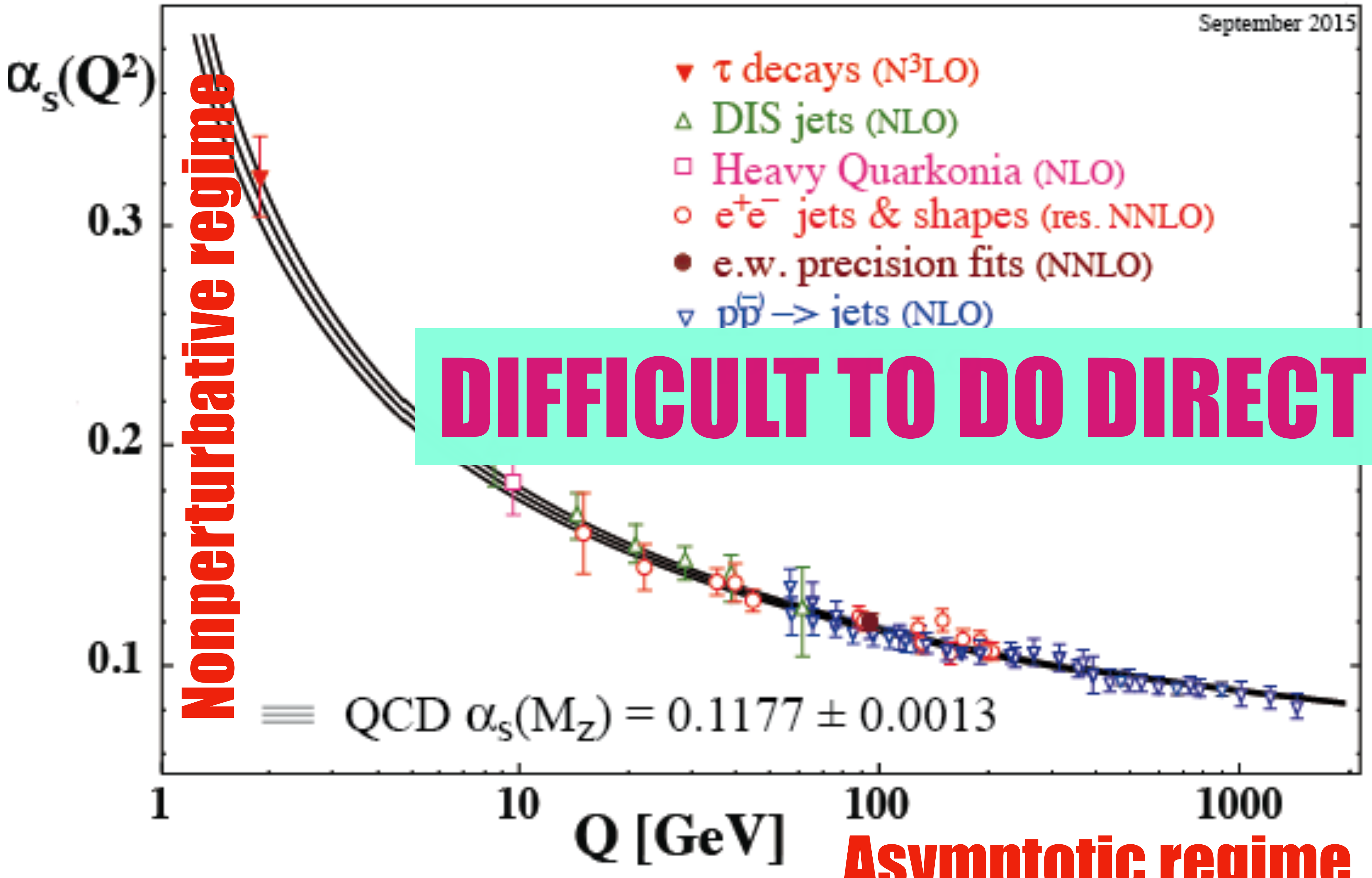


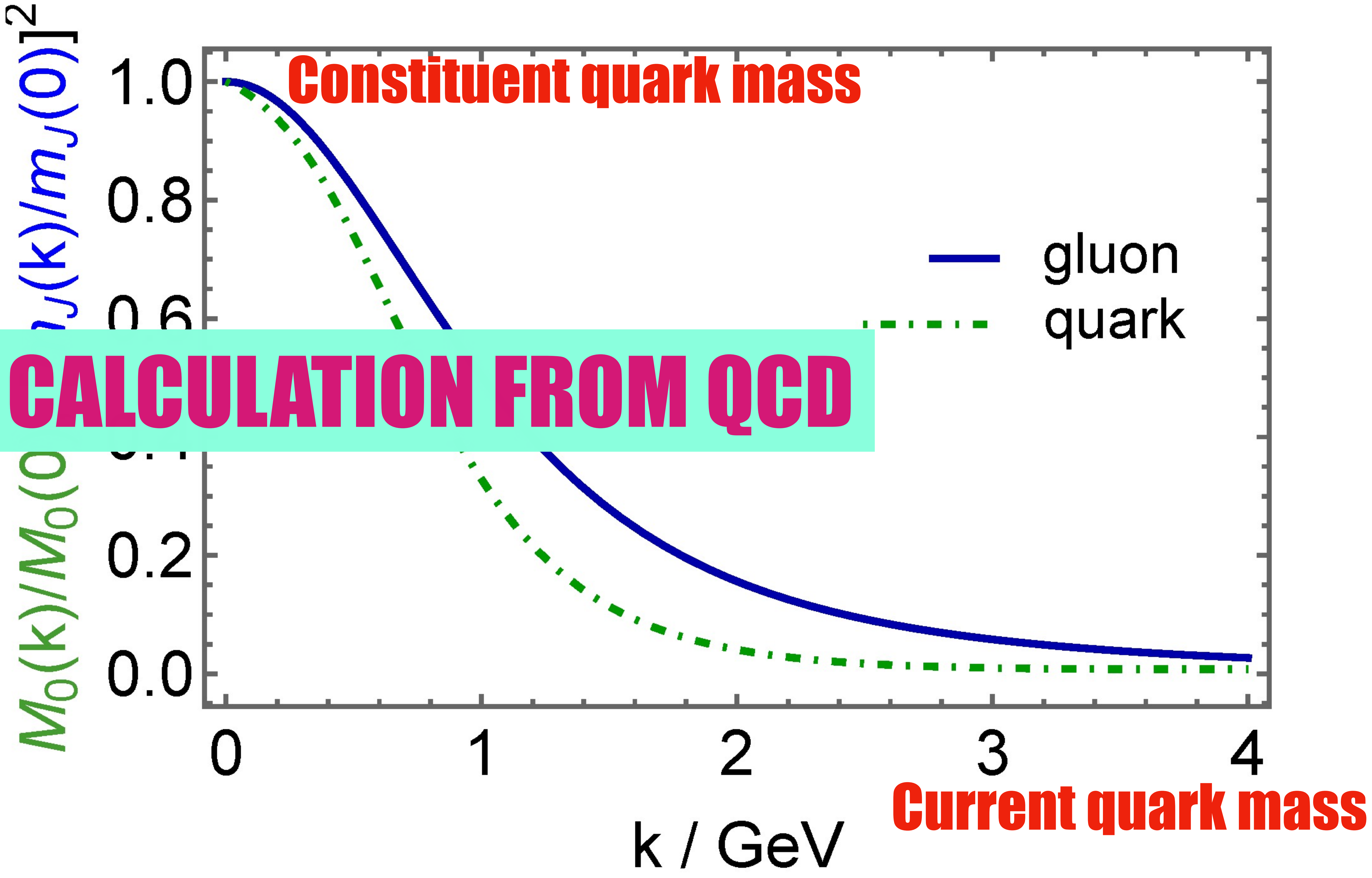
The structure becomes complex and complicated

QCD Properties

Confinement & spontaneous breaking of chiral symmetry (SBχS)

- Properties of QCD: Confinement and SBχB (Emergent mass)





DIFFICULT TO DO DIRECT CALCULATION FROM QCD

Empirical Evidence

Experimental data from the Drell-Yan process

- Existed old data for the meson structure function

PHYSICAL REVIEW D VOLUME 39, NUMBER 1 1 JANUARY 1989

Experimental study of muon pairs produced by 252-GeV pions on tungsten

J. S. Conway,* C. E. Adolphsen,† J. P. Alexander,‡ K. J. Anderson, J. G. Heinrich,
J. E. Pilcher, and A. Possoz

Enrico Fermi Institute

Ames Laborator

C. Biino,§ J. F

Experimental Determination of the π Meson Structure Functions by the Drell-Yan Mechanism

NA3 Collaboration

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a, Switzerland, [3] Collège de France, Paris, France
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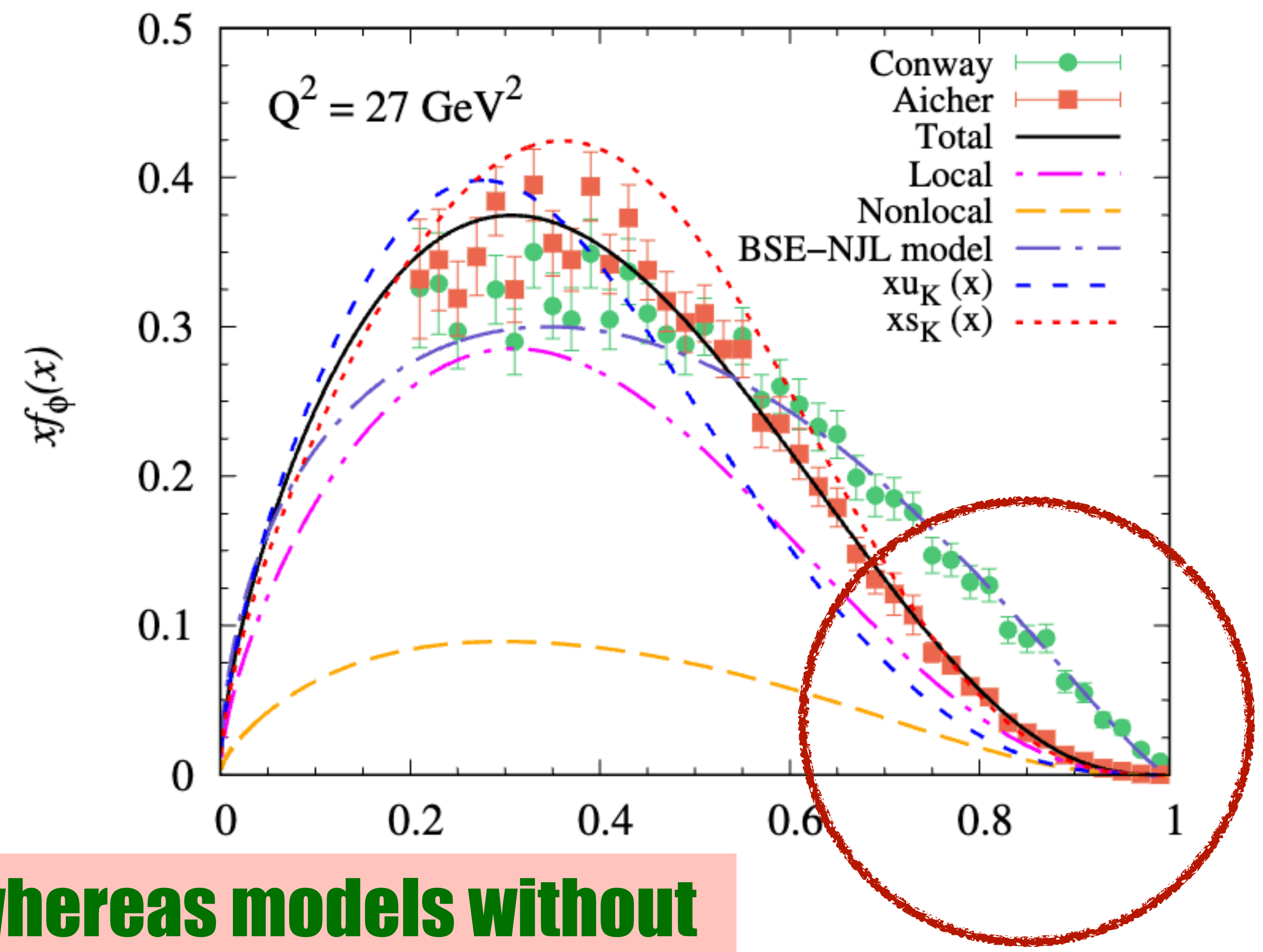
Need new data like EIC, EicC, & COMPASS-AMBER

Current Situation

Hadron structure model predictions and experimental data

- The discrepancy between the old existing data and the model predictions in particular at large-x
- NJL model prediction at large-x $\longleftrightarrow$ $(1-x)^1$
- Dyson-Schwinger model at large x $\longleftrightarrow$ $(1-x)^2$
- JAM analysis $\longleftrightarrow$ $(1-x)^1$
- Our prediction from NLχQM $\longleftrightarrow$ $(1-x)^2$



Conclusion: Model predictions with momentum dependent have $(1-x)^2$, whereas models without momentum dependent have $(1-x)^1$

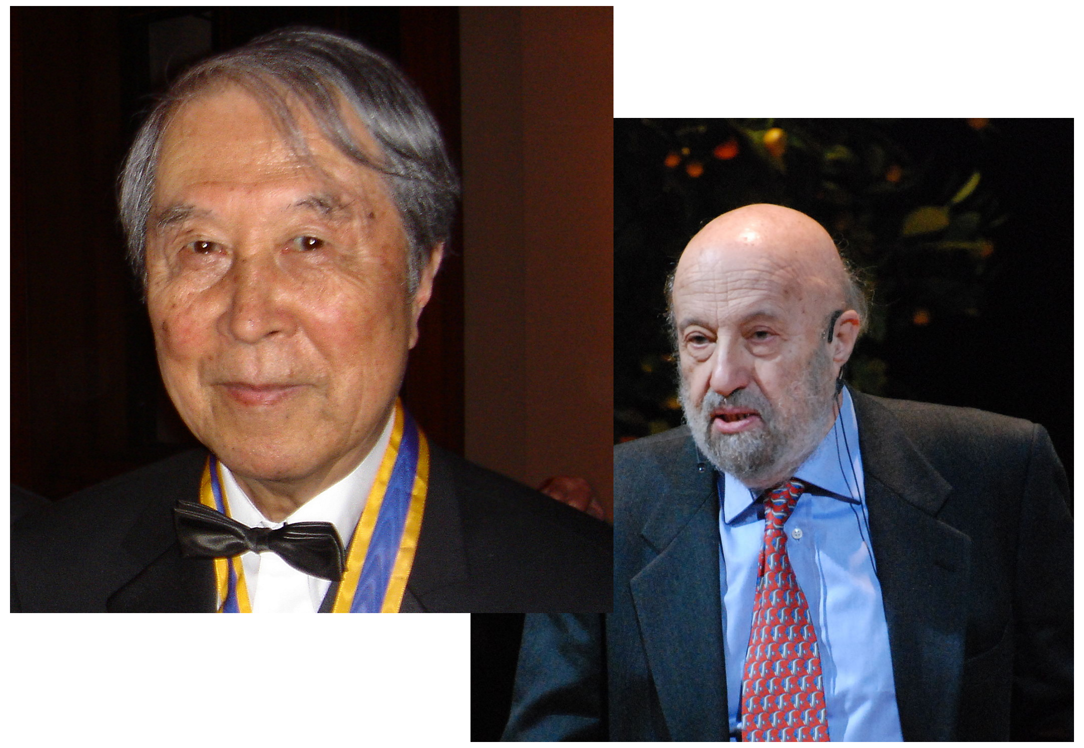
BSE-NJL model

The Lagrangian NJL model—contain local four-fermion interactions—**PTPH**, Ian Cloet, Anthony Thomas, PRC94(2016), Ian Cloet PRC90(2014)

$$\mathscr{L}_{\mathrm{NJL}} = \bar{\psi}[i\partial\!\!\!/ - \widehat{m}\,]\psi + G_\pi \sum_{a=0}^{8} [(\bar{\psi}\lambda_a\psi)^2 + (\bar{\psi}\lambda_a\gamma_5\psi)^2] + G_\rho \sum_{a=0}^{8} [\bar{\psi}\lambda_a\gamma^\mu\psi)^2 + (\bar{\psi}\lambda_a\gamma^\mu\gamma_5\psi)^2] - G_\omega(\bar{\psi}\gamma^\mu\psi)^2$$

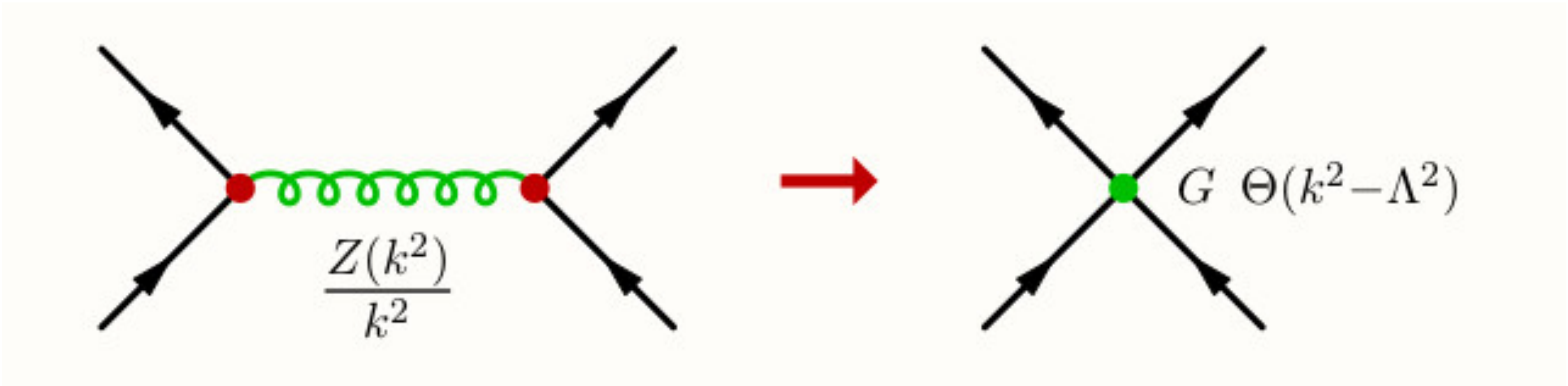
where

- $\psi = (u, d, s)^T$ is the quark field with the flavor components
- $G_\pi, G_\rho,$ andG_ω are local four-fermion coupling constants
- $\widehat{m}_q = \mathrm{diag}[m_u, m_d, m_s]$ is the current quark mass matrix



BSE-NJL model

- In the NJL model, the gluon fields are integrated out and absorbing in the G_π coupling constants—Local four-fermion contact interactions—**PTPH**, Ian Cloet, Anthony Thomas, PRC94(2016), Ian Cloet PRC90(2014), S.Klevansky, RMP64(1992), Vogl &Weise, PPNP27(1991), Hatsuda&Kunihiro, PR247(1994)



- NJL model — lack of the confinement and divergence (pole in quark propagator) — We perform the Proper-time regularization (PTR) scheme — Simulating the confinement of QCD—**PTPH**, Ian Cloet, Anthony Thomas, PRC94(2016), Ian Cloet PRC90(2014)

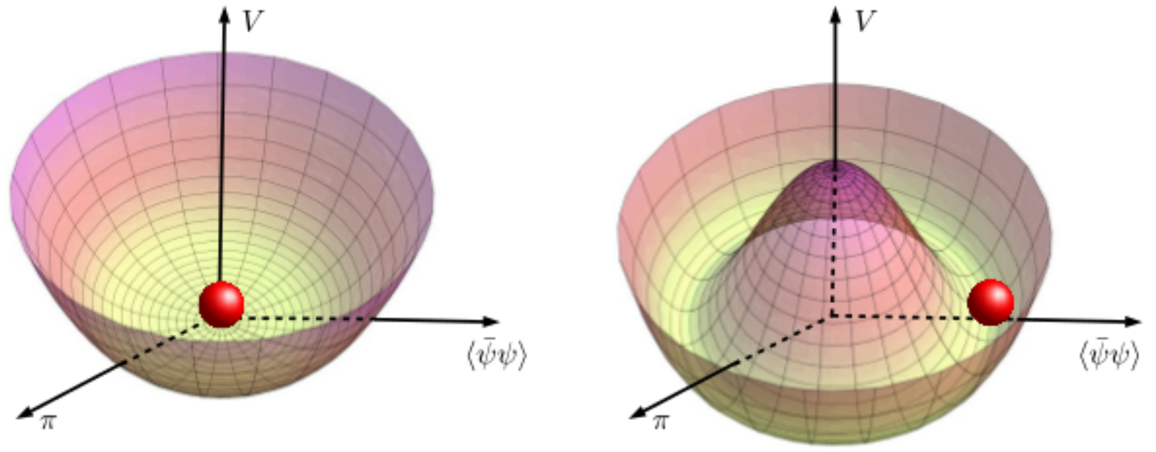
$$\frac{1}{(G)^n} = \frac{1}{[n-1]!}\int_0^\infty d\tau\tau^{[n-1]}\exp[-\tau G] \rightarrow \frac{1}{[n-1]}\int_{\tau_{\mathrm{UV}}}^{\tau_{\mathrm{IR}}} d\tau\tau^{[n-1]}\exp[-\tau G]$$

BSE-NJL model

- Where $\tau_{\rm UV} = \dfrac{1}{\Lambda^2_{\rm UV}}$ and $\tau_{\rm IR} = \dfrac{1}{\Lambda^2_{\rm IR}}$ with $\Lambda_{\rm IR} \simeq \Lambda_{\rm QCD} \simeq 240{\rm MeV}$ and $\Lambda_{\rm UV}$ is determined to fit the pion mass and pion weak decay constant $(m_\pi = 140{\rm MeV}\,{\rm and}\, f_\pi = 93{\rm MeV})$

- NJL gap equation —dynamical quark mass— is determined through the quark propagator in momentum space

$$M_q = m_q + M_q \frac{3G_\pi}{\pi^2}\int_{\tau_{\rm UV}}^{\tau_{\rm IR}} \frac{d\tau}{\tau^2}\exp[-\tau M_q^2] = m_q - 2G_\pi \left\langle \overline{\psi}\psi \right\rangle$$

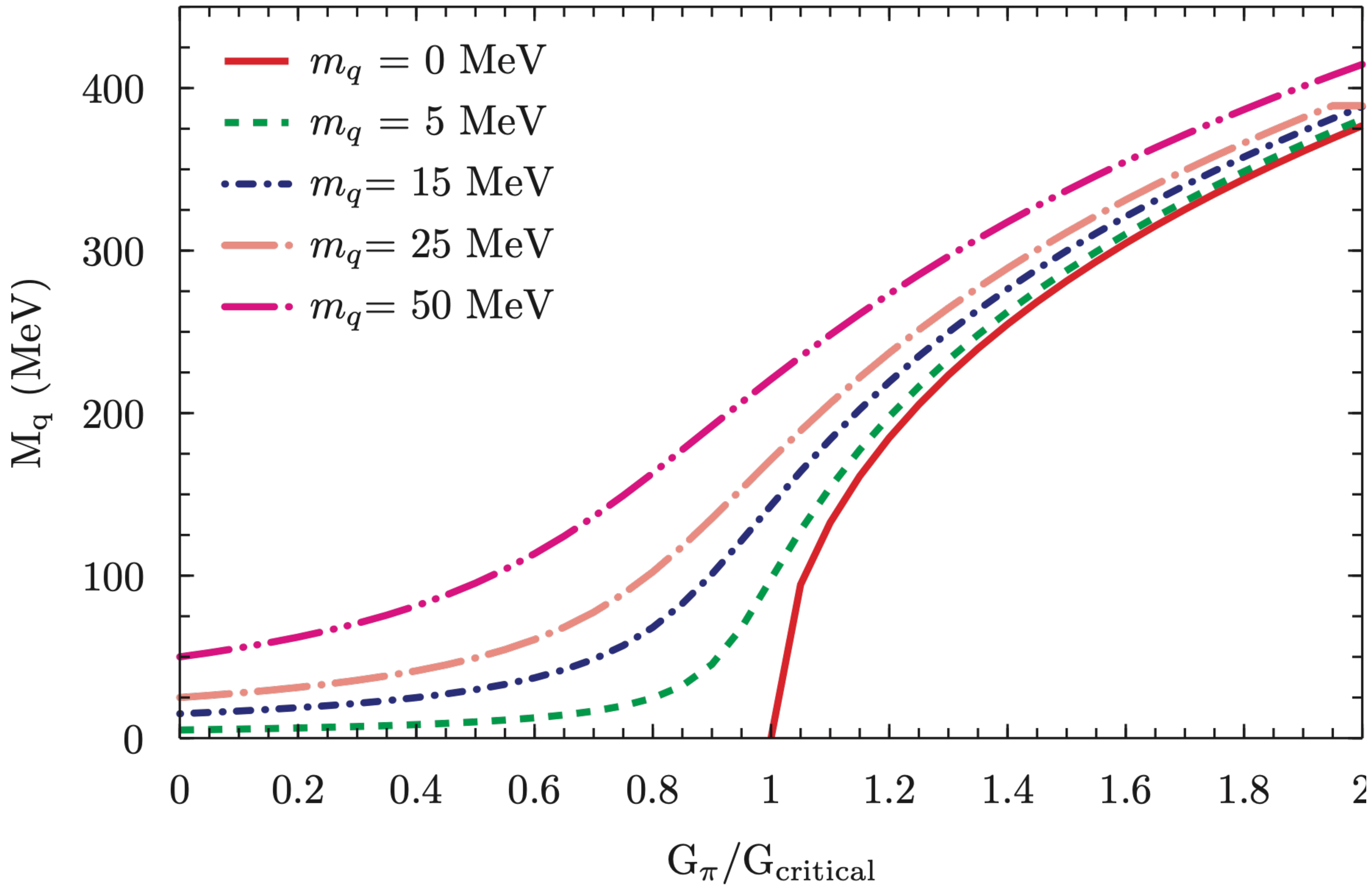


- $\langle\overline{\psi}\psi\rangle \neq 0$ —chiral QCD condensate—order parameter of chiral spontaneously symmetry breaking (CSSB)—generated mass via interaction with vacuum

BSE-NJL model

NJL Gap equation — dynamical quark mass

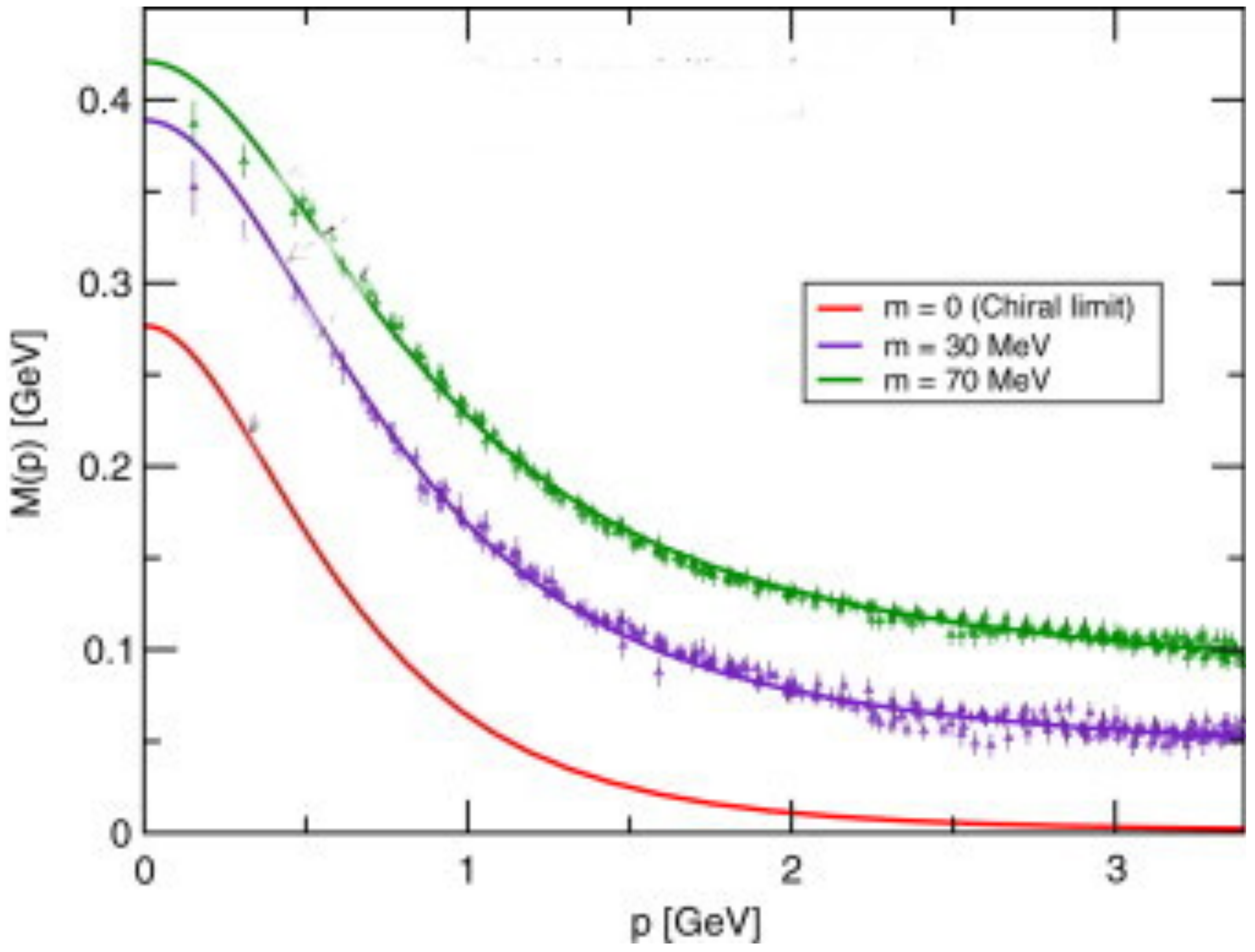
- Result for the NJL dynamical quark mass—without momentum dependent

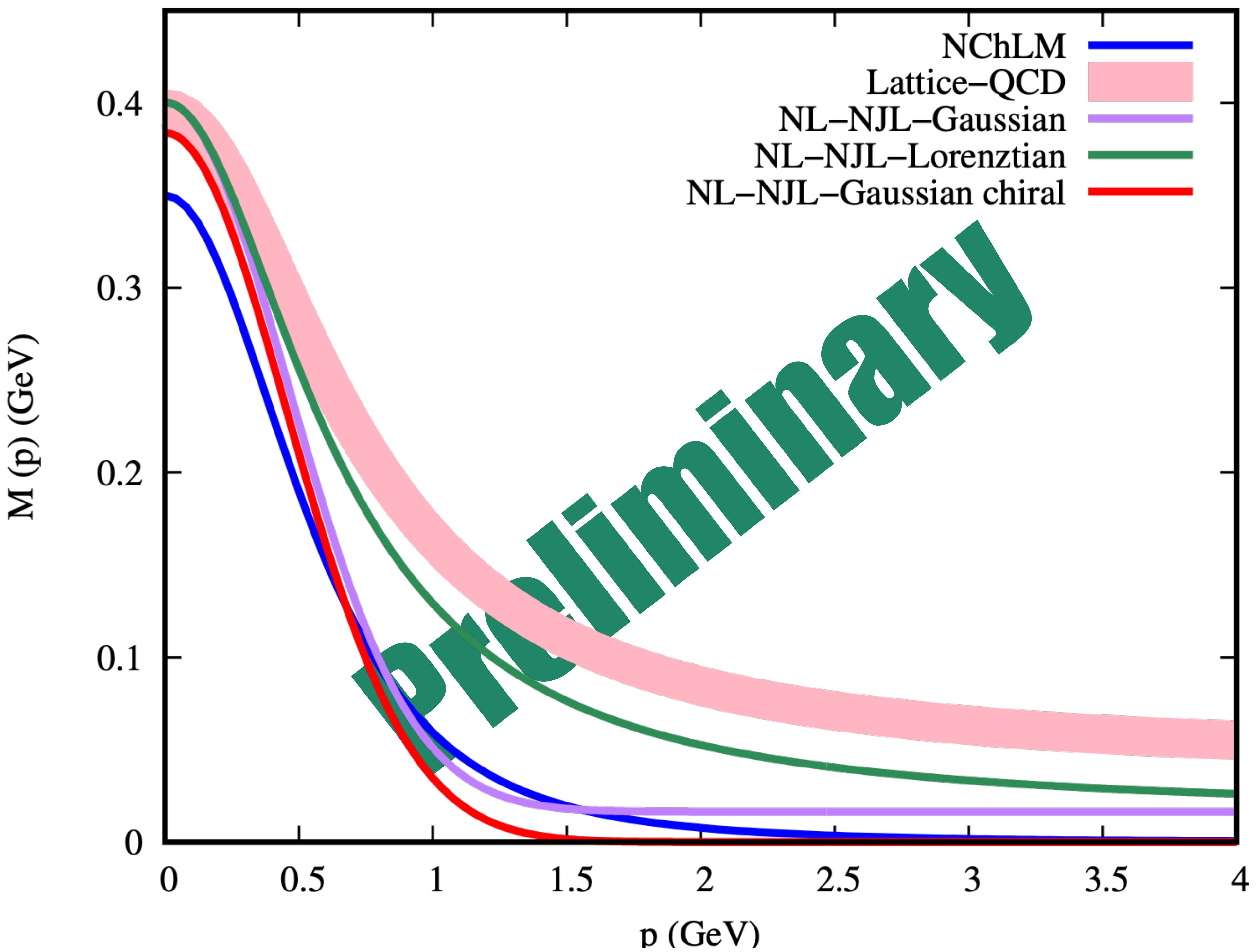


BSE-NJL model

DSE model—comparison with the BSE—NJL model

- Dynamical quark mass in the DSE model



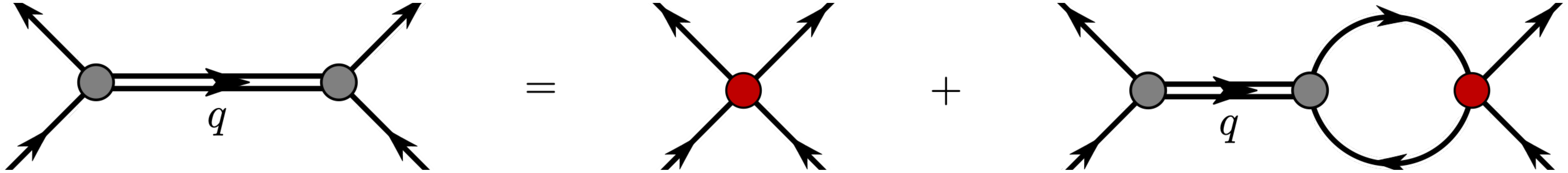


BSE-NJL model

Bethe-Salpeter Equation (BSE)—bound states

- In the BSE-NJL model, the dressed quark and anti-dressed quark bound state whose the properties are determined by solving the BSE:

$$\mathcal{T}(q) = \mathcal{K} + \int \frac{d^4k}{(2\pi)^4} \mathcal{K} S(q+k) \mathcal{T}(q) S(k)$$



- Simply we obtain the reduced t-matrix in the appropriate channel

$$t_\alpha(q) = \frac{-2iG_\pi}{[1 + 2G_\pi \Pi_{(\pi,K)}(q^2)]}$$

BSE-NJL model
Polarization insertion—Bubble diagram

- The polarization insertion for the pion and kaon are given by

$$\Pi_{(\pi,K)} = 6i \int \frac{d^4k}{(2\pi)^4} \mathrm{Tr}[\gamma_5 S_l(k) \gamma_5 S_s(k+q)]$$

- Meson masses can be evaluated via the pole of the t-matrix

$$1 + 2G_\pi \Pi_{(\pi,K)}(k^2 = m^2_{(\pi,K)}) = 0$$

- Analytically, the expression for the pion and kaon masses

$$m_\pi^2 = \frac{m}{M_l} \frac{2}{G_\pi \mathcal{I}_{ll}(m_\pi^2)} m_K^2 = (\frac{m_s}{M_s} + \frac{m}{M_l}) \frac{1}{G_\pi \mathcal{I}_{ls}(m_K^2)} + (M_s - M_l)^2$$

BSE-NJL model

Meson-quark coupling and meson weak decay constants

- The meson-quark coupling constants are given by

$$g^2_{(\pi,K)q\bar{q}} = -\,[\frac{\partial \Pi_{(\pi,K)}(q^2)}{\partial q^2}]\,|_{q^2=m^2_{(\pi,K)}}$$

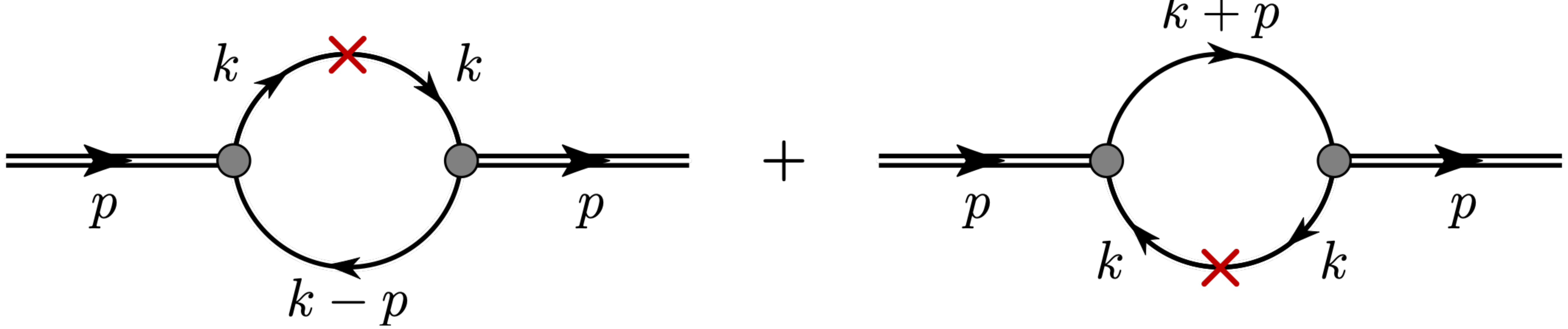
- Meson decay constants

$$f_{(\pi,K)} = \frac{N_c g_{(\pi,K)}}{4\pi^2}[(1-x)M_2 + xM_1]\int_0^1 dx \int_{\tau_{\mathrm{UV}}}^{\tau_{\mathrm{IR}}} \frac{d\tau}{\tau}\exp[-\tau(k^2(x^2-x) + xM_2^2 + (1-x)M_1^2)]$$

BSE-NJL model

Generalized Parton distributions (GPDs)

- In the NJL model, meson GPDs



- where the initial and final meson momentum are respectively given by p and p'

$$p^2 = p'^2 = m^2_{(\pi,K)}, t = q^2 = -Q^2 = (p'-p)^2, P = \frac{p+p'}{2}, \xi = \frac{p^+ - p'^+}{p^+ + p'^+}$$

- With ξ stands for the skewness parameter and the light-cone four-vector is given as $n = (1,0,0,-1)$

BSE-NJL model

The vector and tensor quark GPDS of the meson — General definition

- The vector (**no spin flip**) and tensor (**spin flip**) quark GPDs of the meson are given by

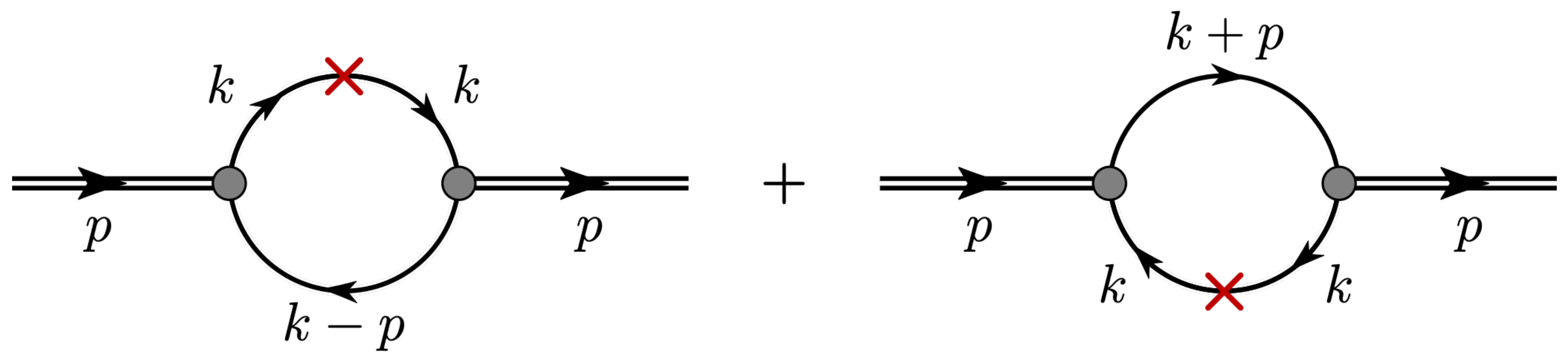
$$H^q(x,\xi,t) = \frac{1}{2}\int \frac{dz^-}{2\pi}\exp[ixP^+z^-]\left\langle p' \mid \overline{\psi}_q\left(-\frac{1}{2}z\right)\gamma^+\overline{\psi}_q\left(\frac{1}{2}z\right) \mid p \right\rangle|_{z^+=0,Z=0}$$

$$E^q(x,\xi,t) = \frac{P^+m_{(\pi,K)}}{2(P^+q^j - P^jq^+)}\int \frac{dz^-}{2\pi}\exp[ixP^+z^-]\left\langle p' \mid \overline{\psi}_q\left(-\frac{1}{2}z\right)i\sigma^{+j}\psi_q\left(\frac{1}{2}z\right) \mid p \right\rangle|_{z^+=0,Z=0}$$

- Where x is the longitudinal momentum

BSE-NJL model

Up-quark vector and tensor GPDs for the kaon



- In the NJL model, up-quark vector and tensor GPDs for the kaon is given by

$$H^u(x,\xi,t) = 2iN_c g^2_{Kq\bar{q}} \int \frac{d^4k}{(2\pi)^4)} \delta\left(xP^+ - k^+\right) \mathrm{Tr}[\gamma_5 S_u(k+\frac{q}{2})\gamma^+ S_u(k-\frac{q}{2})\gamma_5 S_s(k-P)]$$

$$E^u(x,\xi,t) = 2iN_c g^2_{Kq\bar{q}} \left(\frac{P^+ m_K}{(P^+q^j - P^j q^+)}\right) \int \frac{d^4k}{(2\pi)^4} \delta\left(xP^+ - k^+\right) \mathrm{Tr}[\gamma_5 S_u(k+\frac{q}{2} i\sigma^{+j} S_u(k-\frac{q}{2})\gamma_5 S_s(k-P)]$$

- Performing the Feynman parametrization, WTI-like, and the proper-time regularization scheme

- Finally, the up-quark vector and tensor GPDs for the kaon are obtained by

BSE-NJL model

NJL up-quark vector and tensor GPDs for the kaon — final expressions

- Vector GPDs for the kaon in the proper-time regularization scheme

$$H^u(x,\xi,t) = \frac{N_c g_{Kq\bar{q}}^2}{8\pi^2}\left[\Theta_{\bar{\xi}_1}\overline{C}_1(\sigma_3) + \Theta_{\xi_1}\overline{C}_1(\sigma_4) + \frac{\Theta_{\bar{\xi}\xi}}{\xi}x\overline{C}_1(\sigma_5)\right] + \frac{N_c g_{Kq\bar{q}}^2}{8\pi^2}\int_0^1 dx\frac{\Theta_{x\xi}}{\xi}\frac{1}{\sigma_6}\overline{C}_2(\sigma_6)((1-x)t + 2x(m_K^2 - (M_u - M_s)^2))$$

- Tensor GPDs for the kaon in the proper-time regularization scheme

$$E^u(x,\xi,t) = \frac{N_c g_{Kq\bar{q}}^2}{4\pi^2}\int_0^1 dx\frac{\Theta_{x\xi}}{\xi}m_K((M_s - M_u)x + M_u)\frac{1}{\sigma_6}\overline{C}_2(\sigma_6)$$

- The Θ is the step function

BSE-NJL model

Properties of the GPDs

1. Forward limit $-\xi = 0$,and$t = 0$, the vector GPDs can be reduced into the kaon PDFs

2. Symmetries properties

$$H^{[I=0]}(x, \xi, t) = H^u(x, \xi, t) - H^u(-x, \xi, t)$$

$$H^{[I=1]}(x, \xi, t) = H^u(x, \xi, t) + H^u(-x, \xi, t)$$

3. The NJL results preserve the time reversal invariance property of GPDs

$$H^u(x, \xi, t) = H^u(x, -\xi, t) E^u(x, \xi, t) = E^u(x, -\xi, t)$$

BSE-NJL model

Properties of the GPDs

4. Condition of the Polynomiality

$$\int_{-1}^{1} x^n dx H^q(x,\xi,t) = \sum_{i=0}^{((n+1)/2)} \xi^{2i} \mathscr{A}^q_{(n+1),2i}(t)$$

$$\int_{-1}^{1} dx E^q(x,\xi,t) = \sum_{i=0}^{((n+1)/2)} \xi^{2i} \mathscr{B}^q_{(n+1),2i}(t)$$

5. For n = 0, we simply obtain the u-quark vector FFs ($F^u_K(Q^2)$) and tensor FFs ($F^u_T(Q^2)$)

$$\int_{-1}^{1} H^u(x,\xi,t)dx = \mathscr{A}^u_{1,0}(t) = F^u_K(Q^2) \int_{-1}^{1} E^u(x,\xi,t)dx = \mathscr{B}^u_{1,0}(t) = F^u_T(Q^2)$$

BSE-NJL model
Properties of the GPDs

6. For n= 1, the GPDs will preserve the sum rule:

$$\int_{-1}^{1} xH^u(x,\xi,t)dx = \mathscr{A}^u_{2,0}(t) + \xi^2\mathscr{A}^u_{2,2}(t) = \Theta^u_2(t) - \xi^2\Theta^u_1(t)$$

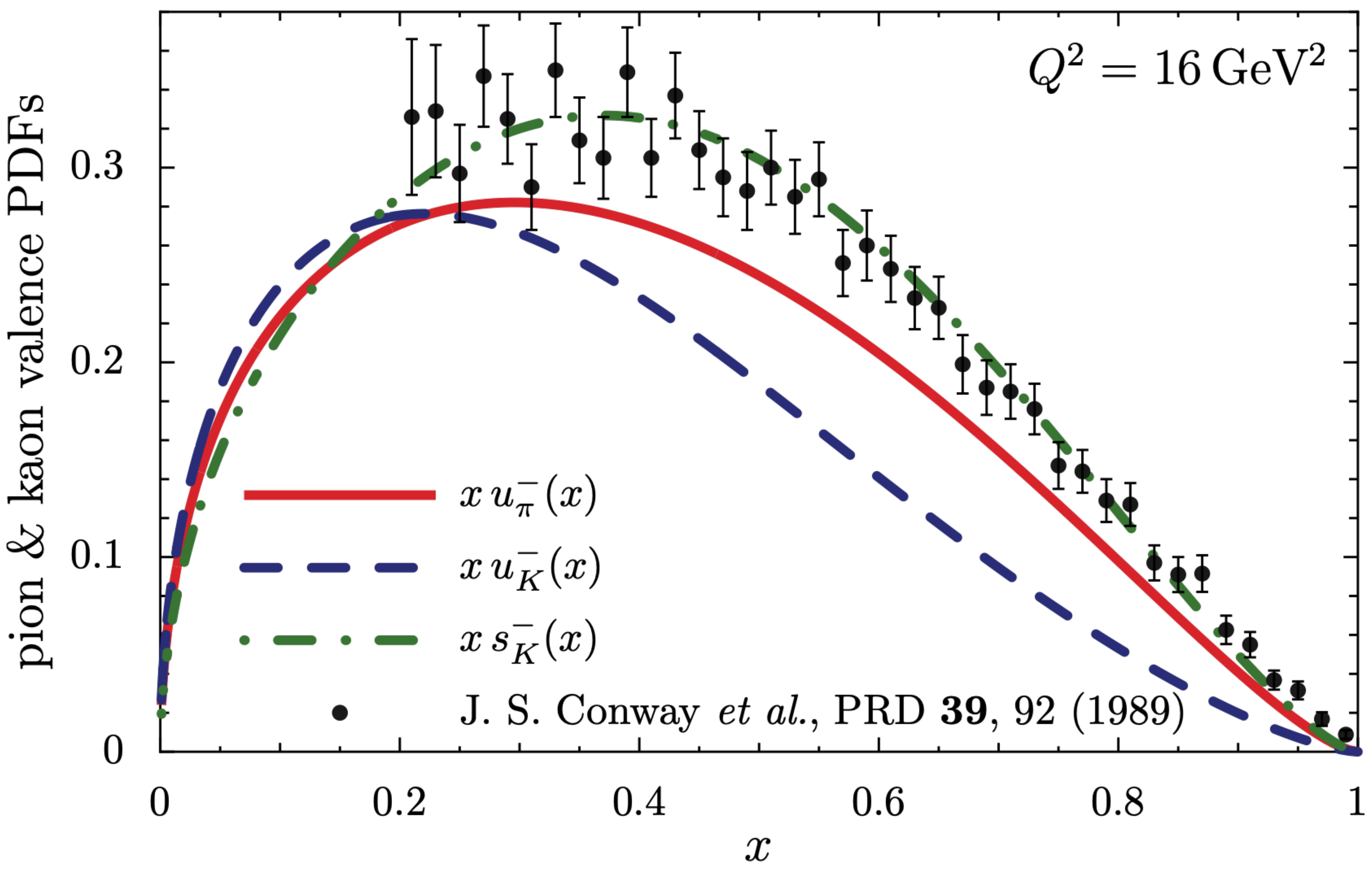
- $\Theta^u_2(t)$ and $\Theta^u_1(t)$ – the u-quark distribution for the kaon and pressure distribution
- $\mathscr{A}^u_{2,0}(Q^2)$ and $\mathscr{A}^u_{2,2}(Q^2)$ are the generalized FFs for n=1 in the BSE-NJL model
- The first derivation of $\mathscr{A}^u_{2,0}(Q^2)$ in respect with Q^2 at around $Q^2 = 0$ will give the light-cone energy radius
- $\mathscr{B}^u_{2,0}(Q^2)$ and $\mathscr{B}^u_{2,2}(Q^2) = 0$ are the u-quark tensor GPD for the kaon in the BSE-NJL model

$$\int_{-1}^{1} xE^u(x,\xi,t)dx = \mathscr{B}^u_{2,0}(t) + \xi^2\mathscr{B}^u_{2,2}(t)$$

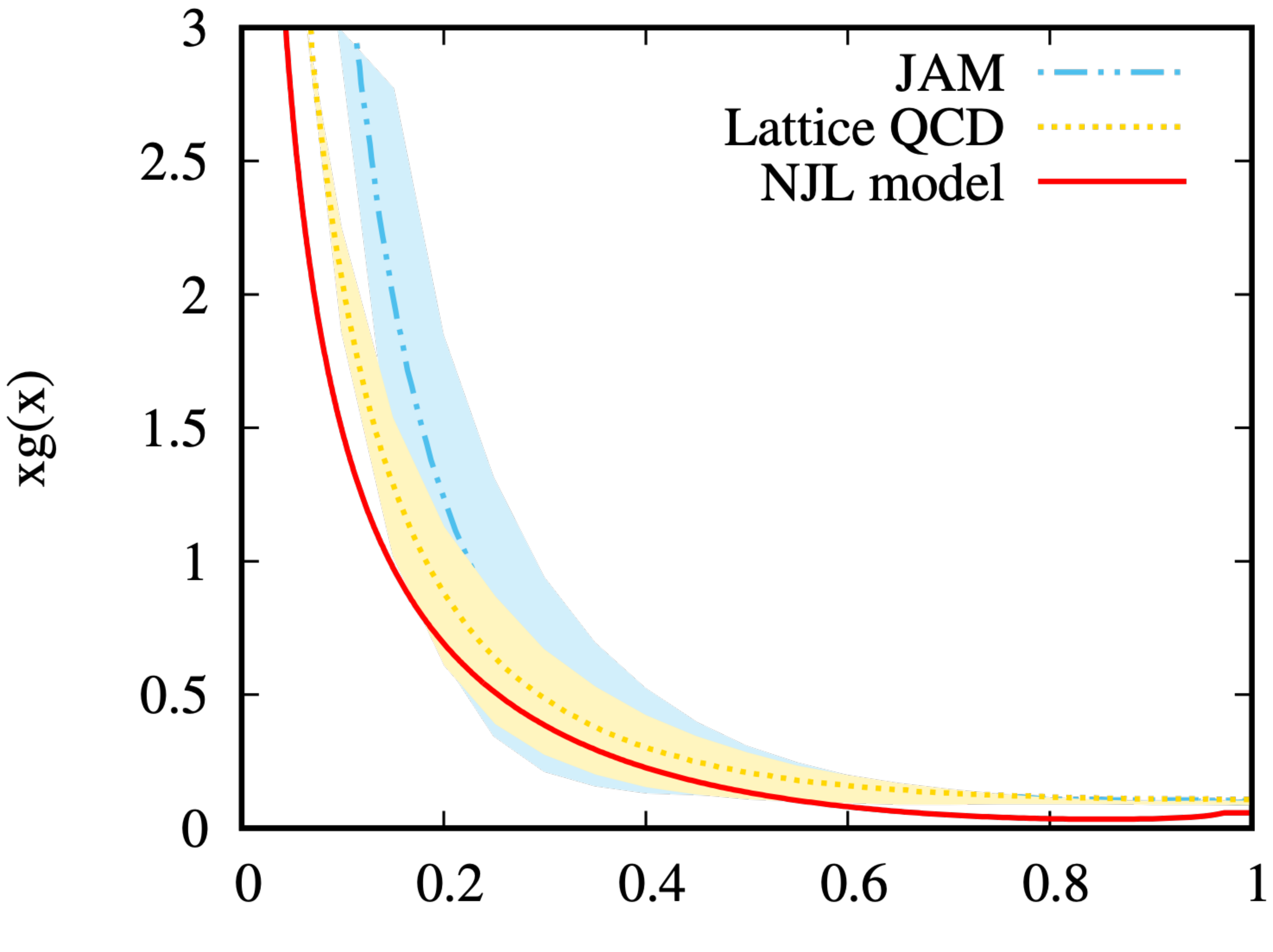
BSE-NJL model

Parton distribution functions for the meson—Forward limit $\xi = 0$ and $t = 0$

- Parton distribution functions for the pion and kaon after evolving at Q^2 =16 GeV² using NLO—DGLAP QCD evolution



PTPH, Ian Cloet & Anthony Thomas, PRC94(2016)

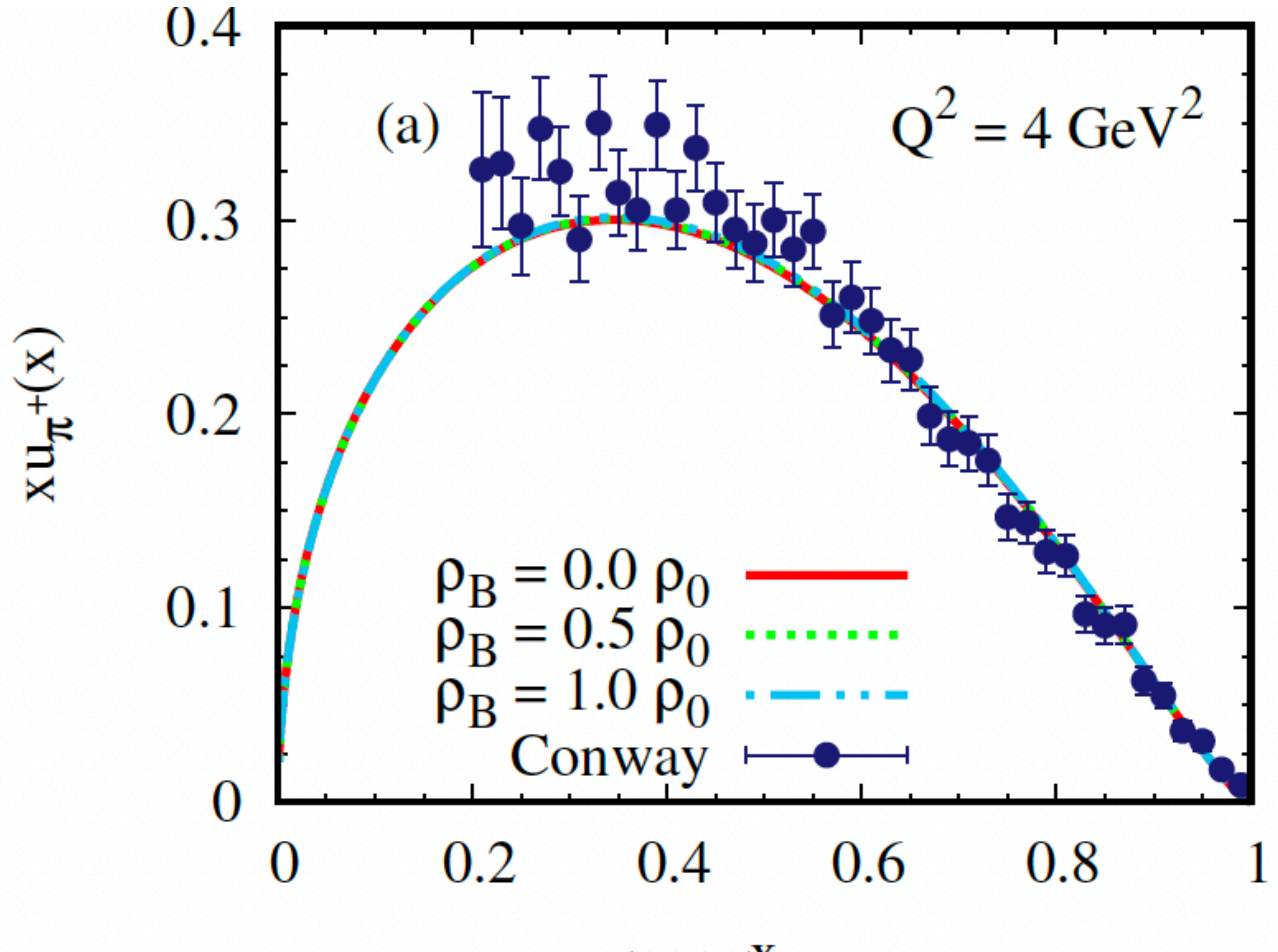


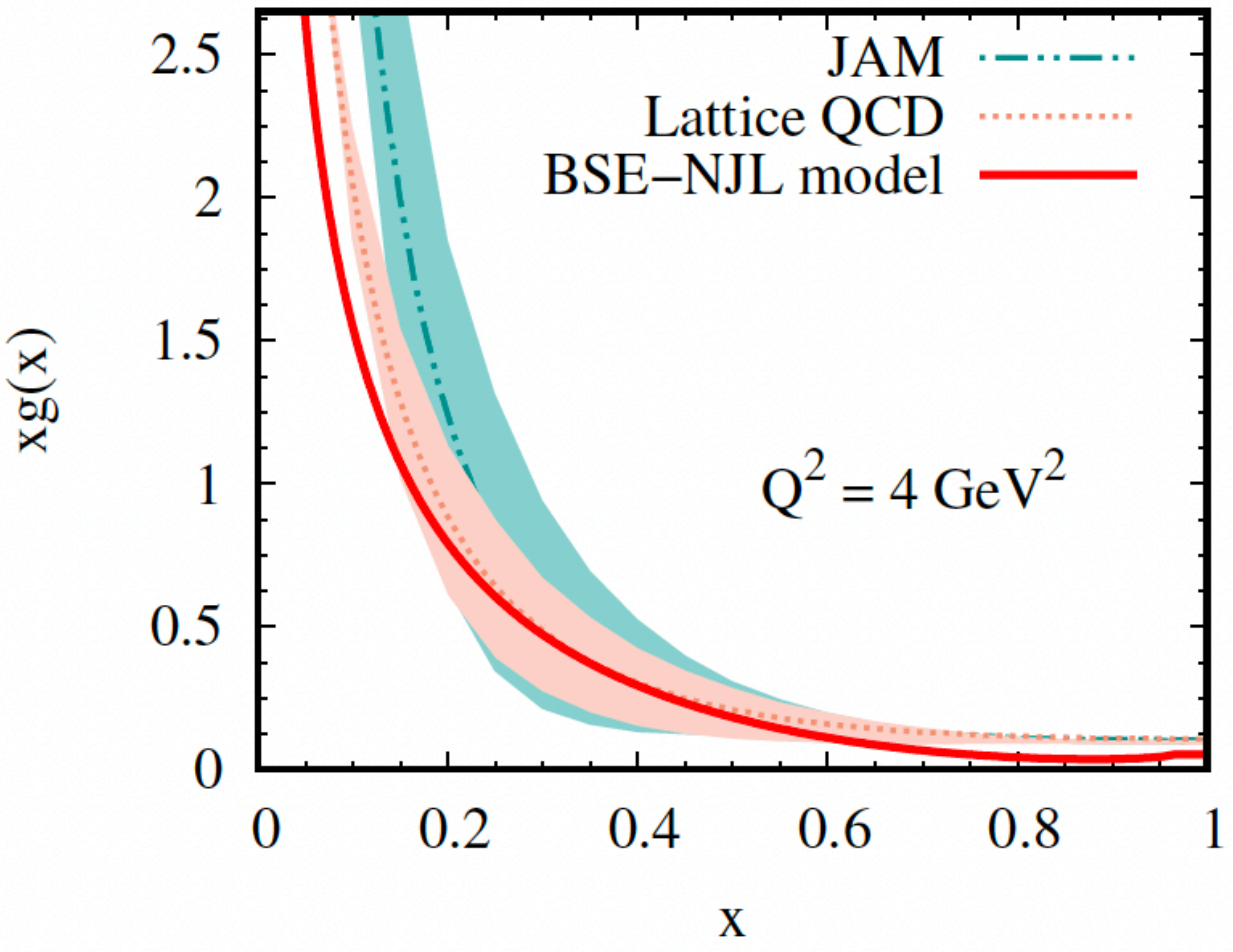
PTPH & Seung-il Nam, PRD105(2022)

BSE-NJL model

Parton distribution functions for the meson—Forward limit $\xi = 0$ and $t = 0$

- Valence and gluon distributions for the pion at Q^2 = 4 GeV²



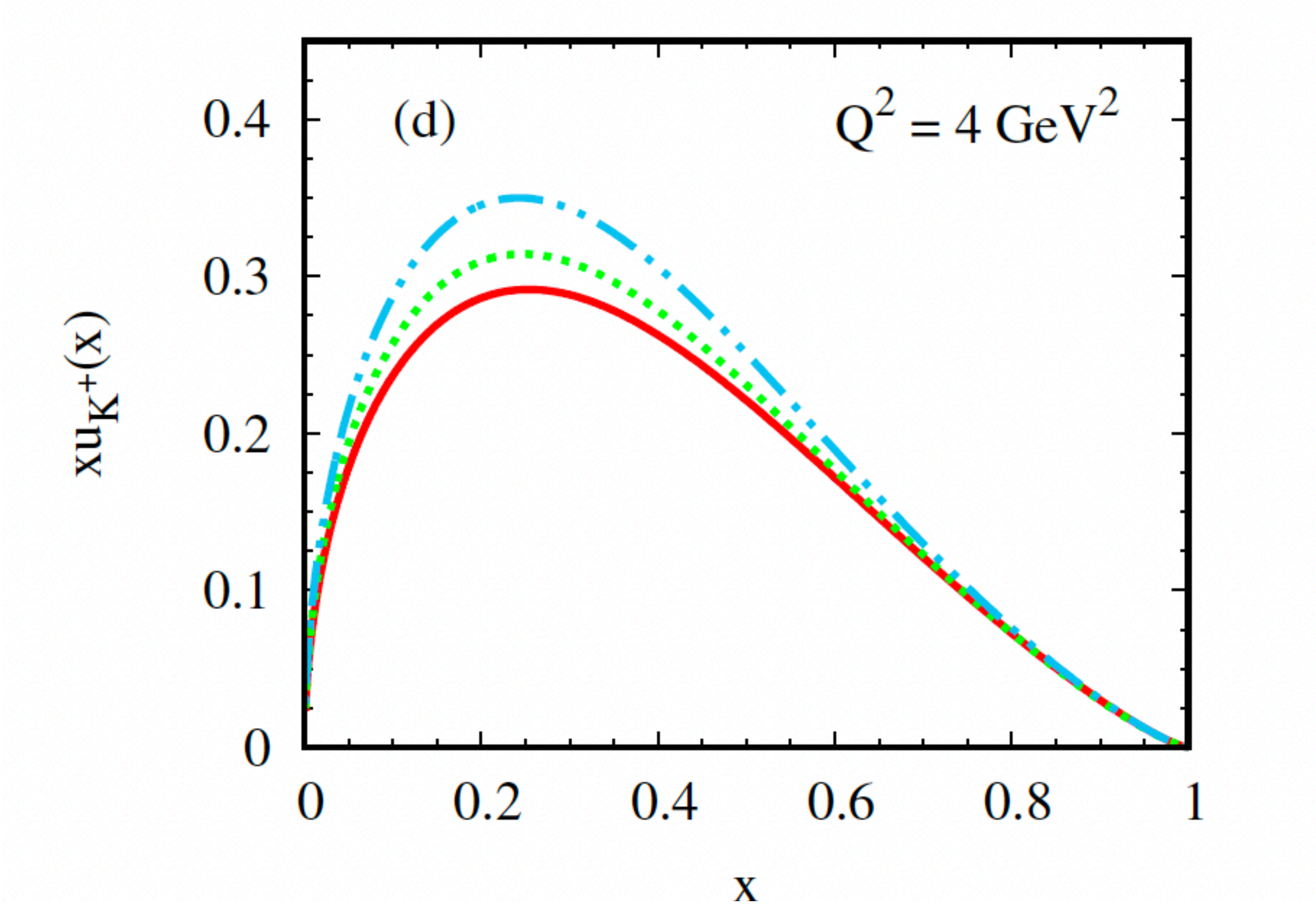


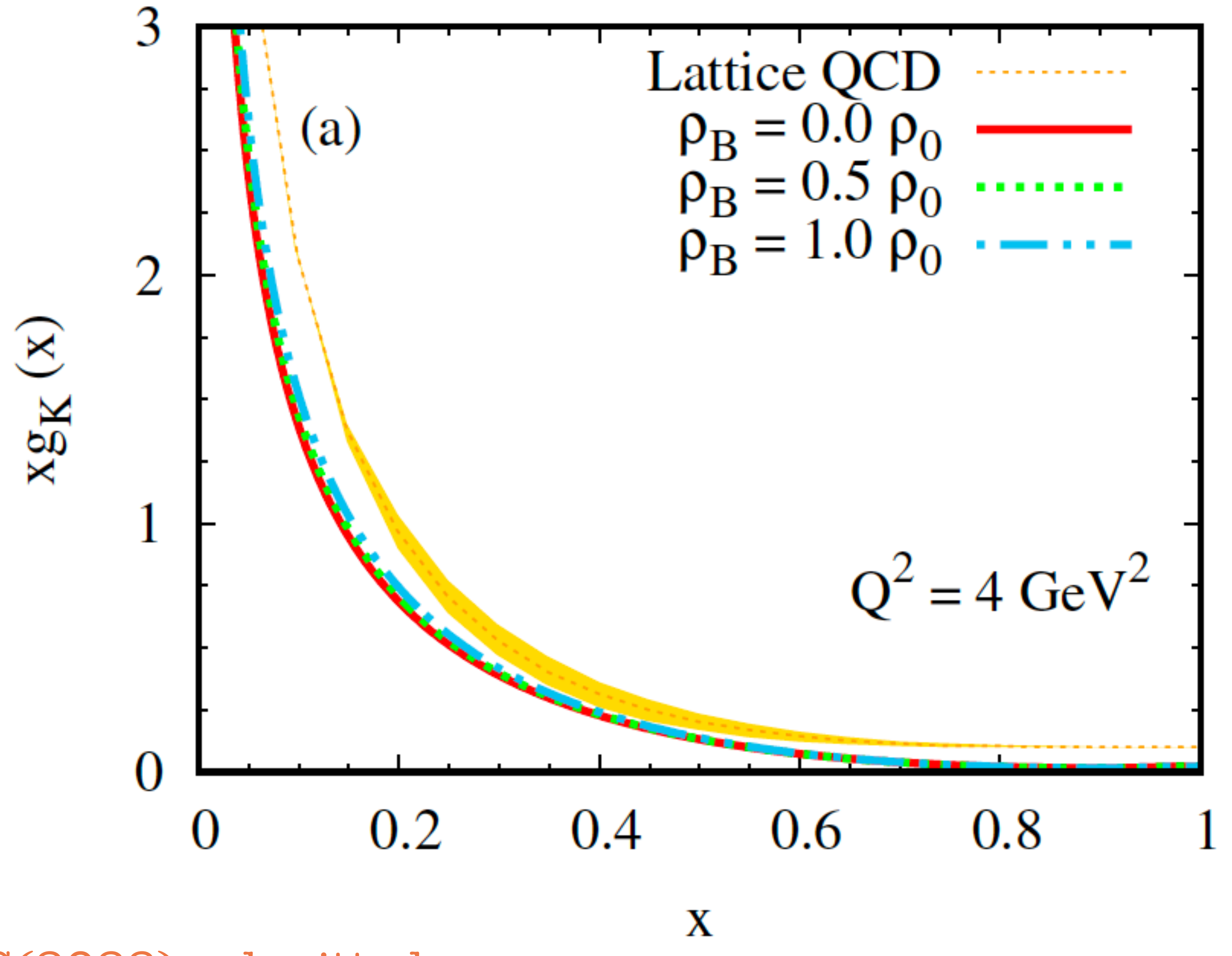
PTPH, EPJA(2022) submitted

BSE-NJL model

Parton distribution functions of the meson—Forward limit $\xi = 0$ and $t = 0$

- The valence and gluon distributions for the kaon at Q^2 = 4 GeV²

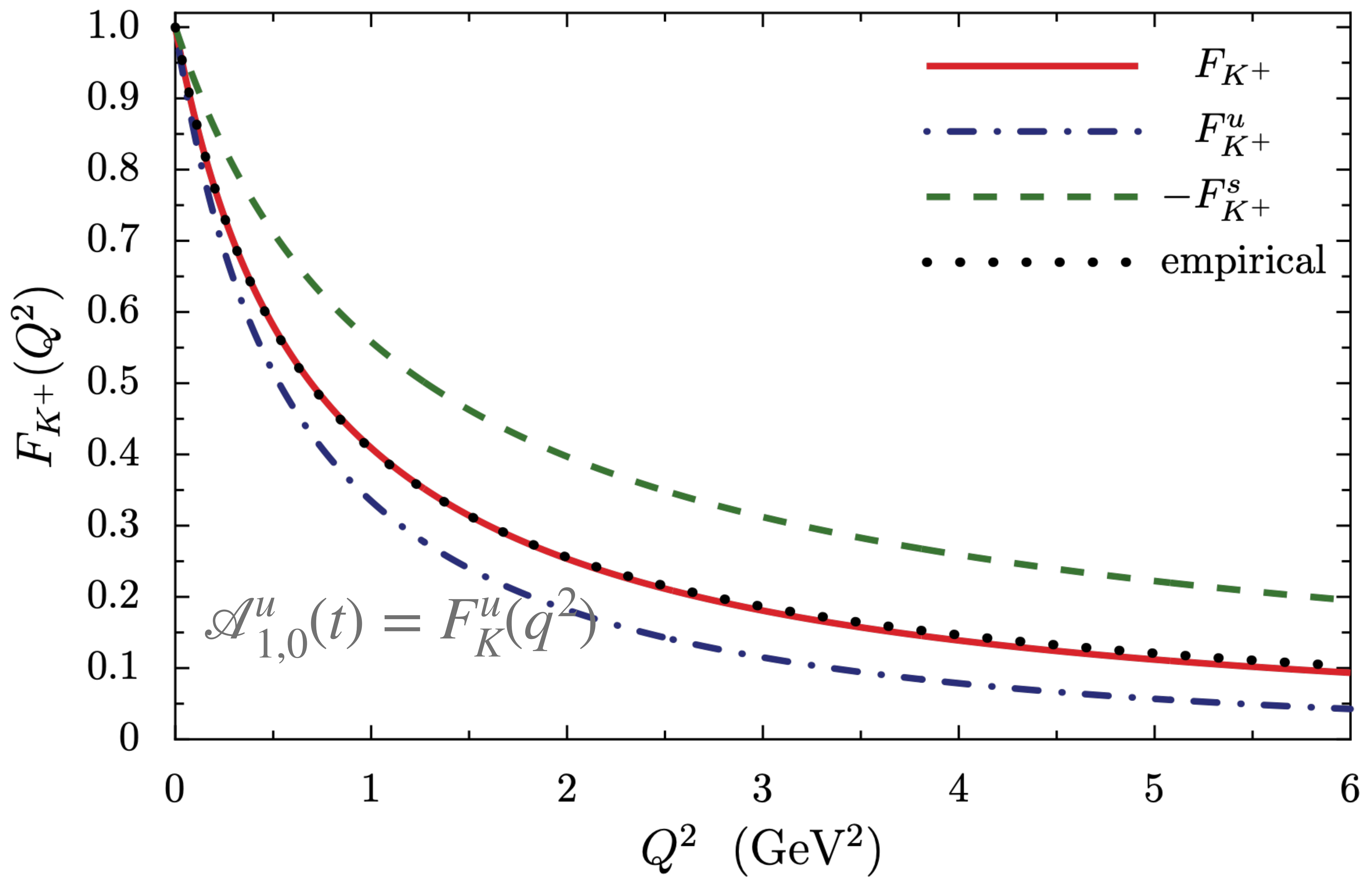


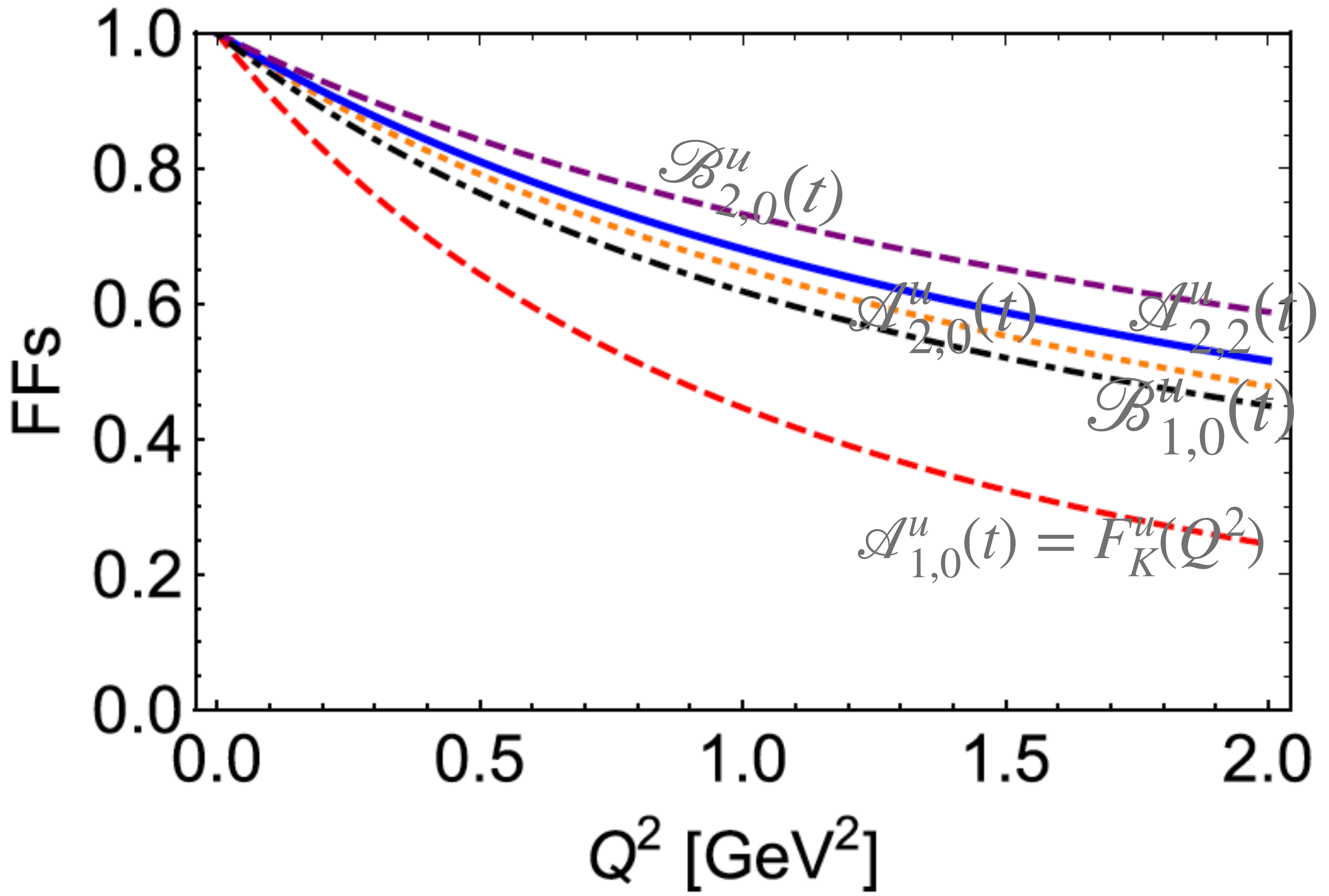


PTPH, EPJC(2022) submitted

BSE-NJL model
Form Factors for the meson

- Form factor for the pion and kaon $\mathscr{A}^u_{1,0}(t) = F^u_K(Q^2)$ and $\mathscr{B}^u_{1,0}(t) = F^u_T(Q^2)$

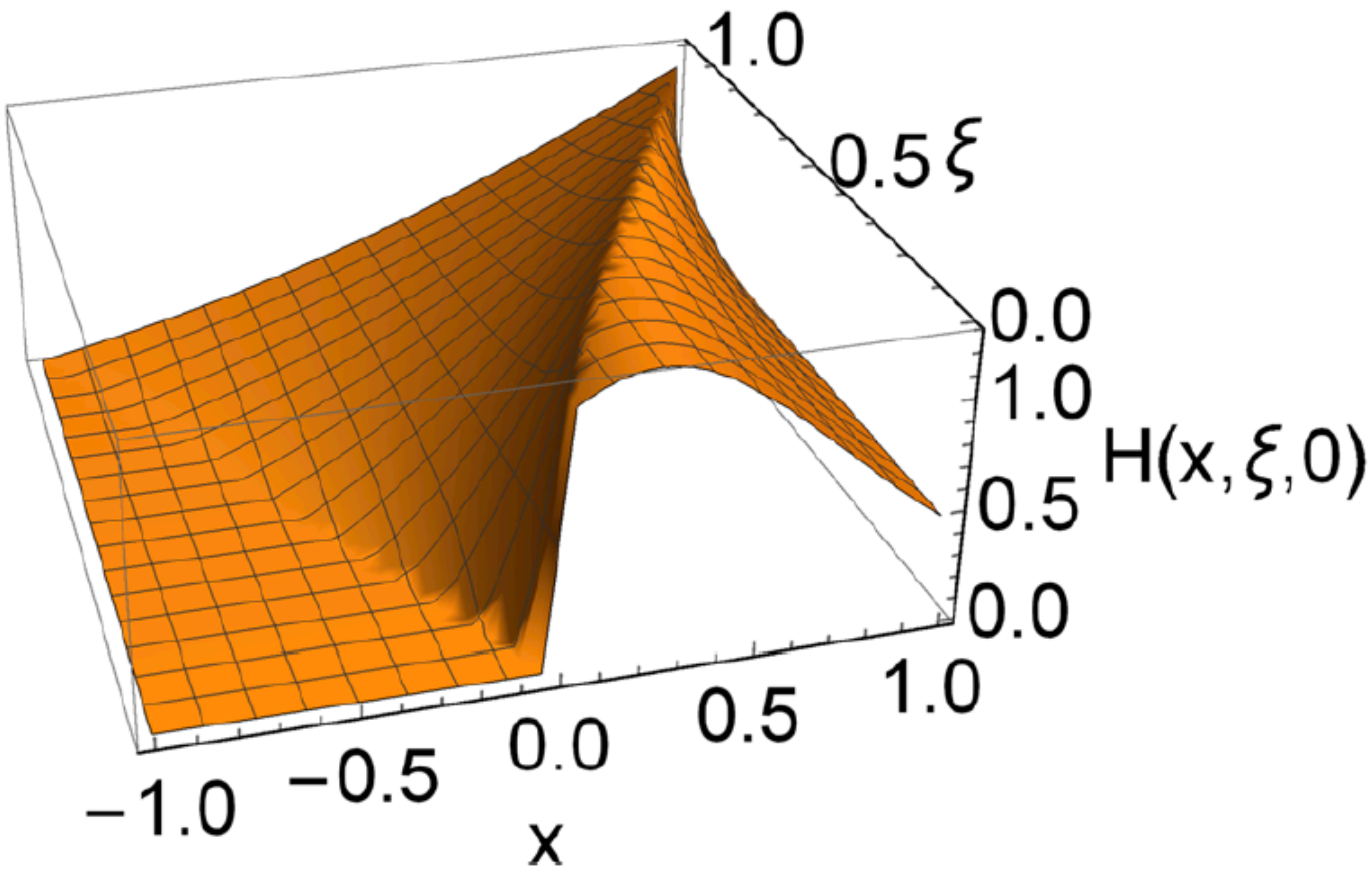


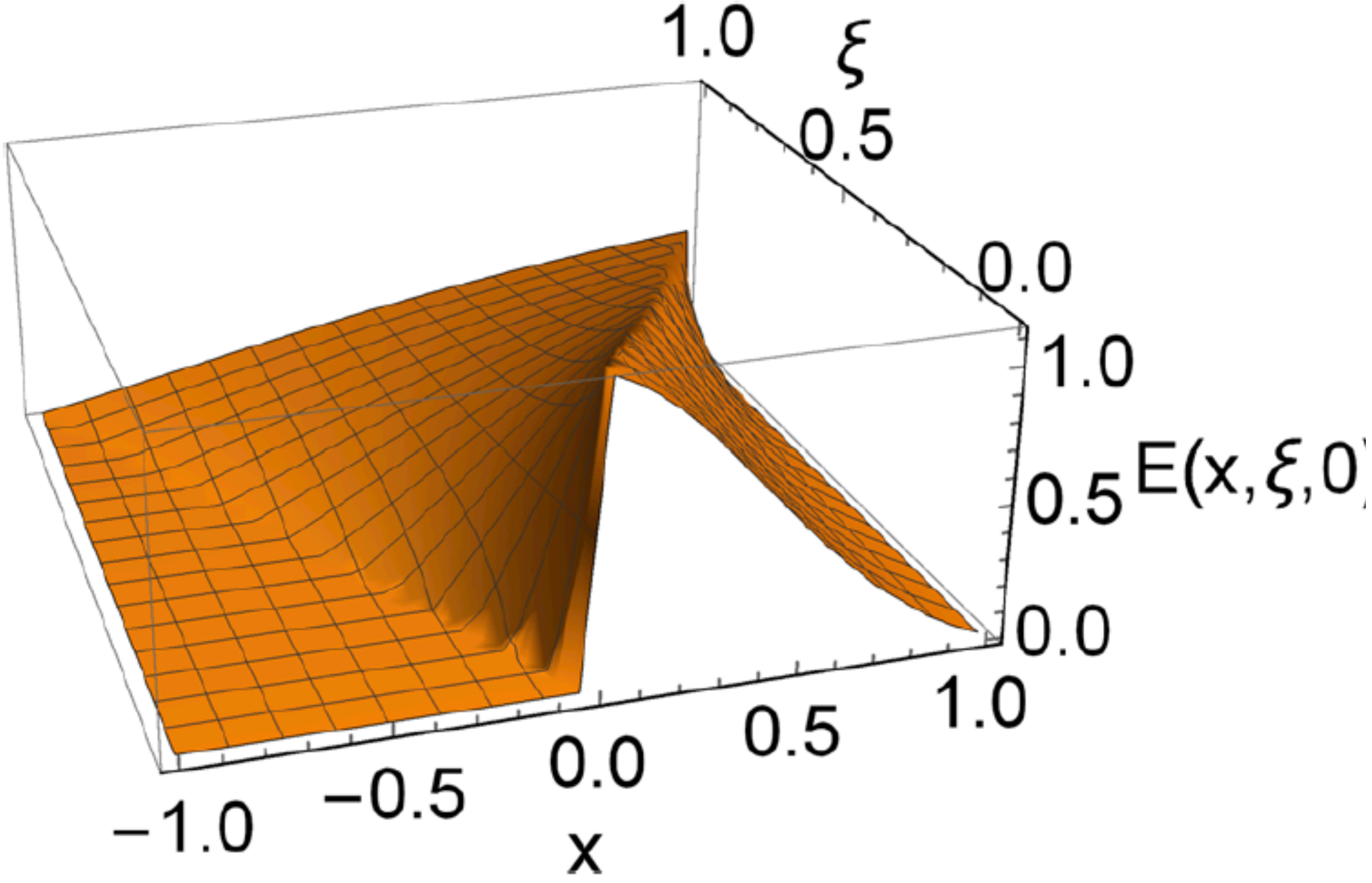


BSE-NJL model

Kaon vector GPD—$H^u(x, \xi, 0)$ and tensor GPD—$E^u(x, \xi, 0)$

- Kaon vector and tensor GPDs for the kaon for $\xi > 0$





Our Results from the Current Analysis

In comparison with the Bethe-Salpeter Nambu—Jona-Lasinio (BSE_NJL) model

- The expression for the QDF for the f-flavored quark inside the meson in the NLχQM is given by

Detail calculation, please look at 2302.05566

$$f_\phi(x) = -\frac{iN_c}{2F_\phi^2}\int \frac{d^4k}{(2\pi)^4}\delta\left(k\,.\,n - xp\,.\,n\right)\mathrm{Tr}_\gamma\Big[\sqrt{\mathrm{M_b}}\gamma_5\sqrt{\mathrm{M_a}}\mathrm{S_a}\not{n}\,\mathrm{S_a}\sqrt{\mathrm{M_a}}\gamma_5\sqrt{\mathrm{M_b}}\mathrm{S_b}$$

$$+\left(\sqrt{M_b}\,.\,n\right)\gamma_5\sqrt{M_a}S_a\sqrt{M_a}\gamma_5\sqrt{M_b}S_b - \sqrt{M_b\gamma_5}\left(\sqrt{M_a}\,.\,n\right)S_a\sqrt{M_a}\gamma_5\sqrt{M_b}S_b\Big]$$

- The quark propagator and momentum-dependent mass are respectively defined

$$S_a(k_a) = \frac{\not{k}_a + \tilde{M}_a}{k_a^2 - M_a^2 + i\epsilon}, \qquad M_a = M_0\left[\frac{\mu^2}{k_a^2 - M_a^2 + i\epsilon}\right]^2, \qquad \sqrt{M_{a\mu}} = -\frac{\sqrt{M_a k_{a\mu}}}{(k_a^2 - \mu^2 + i\epsilon)}$$

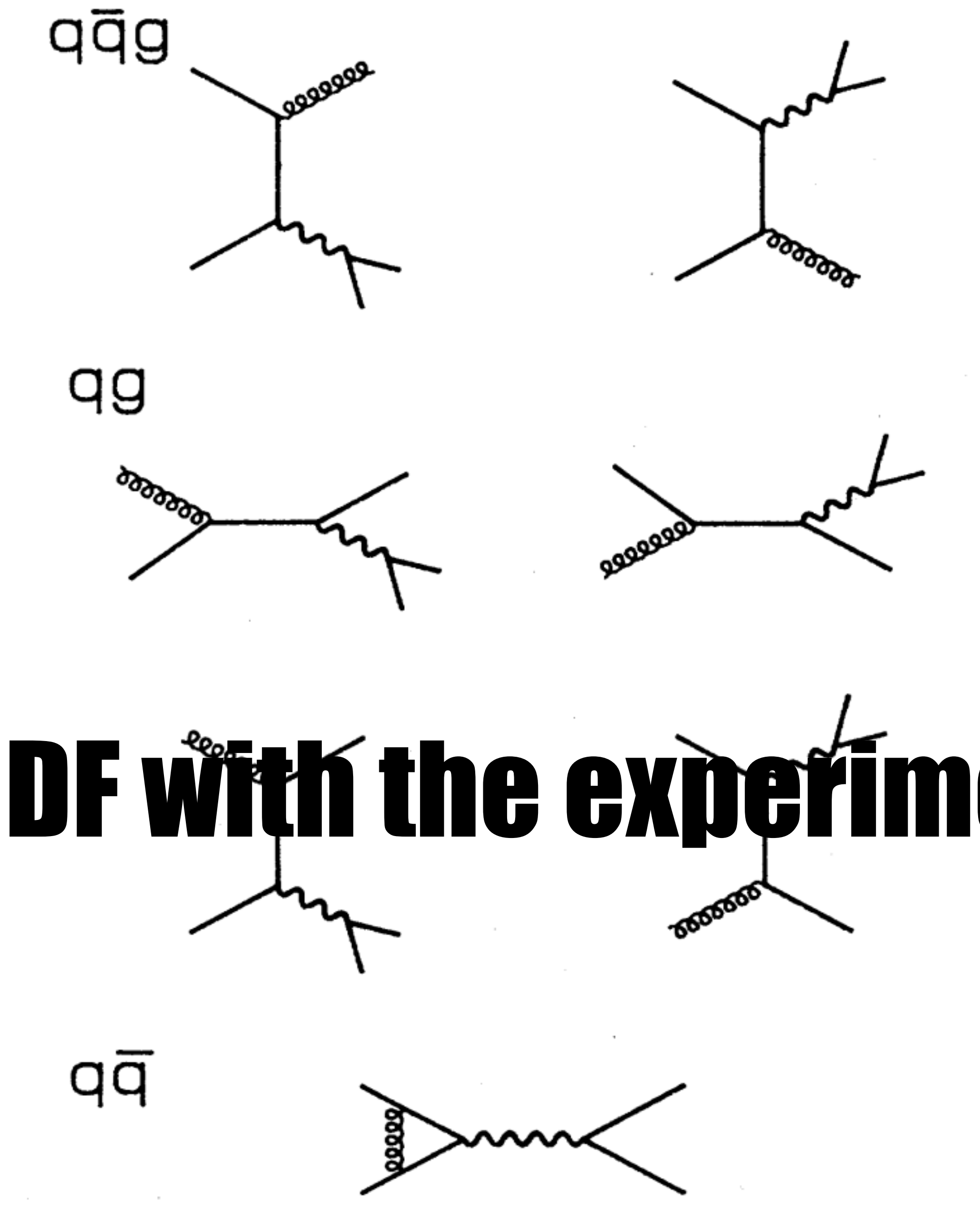
Our Results from the Current Analysis

In comparison with the Bethe-Salpeter Nambu—Jona-Lasinio (BSE_NJL) model

- The gluon distribution function is obtained in the NLO DGLAP equation

$$\frac{\partial}{\partial \ln(Q^2)}\begin{bmatrix} f_\phi^S(x,Q^2) \\ g_\phi(x,Q^2)\end{bmatrix} = \begin{bmatrix} P_{ff} & P_{fg} \\ P_{gf} & P_{gg}\end{bmatrix} \otimes \begin{bmatrix} f_\phi^S(x,Q^2) \\ g_\phi(x,Q^2)\end{bmatrix}$$

splitting functions   QDF and SDF functions



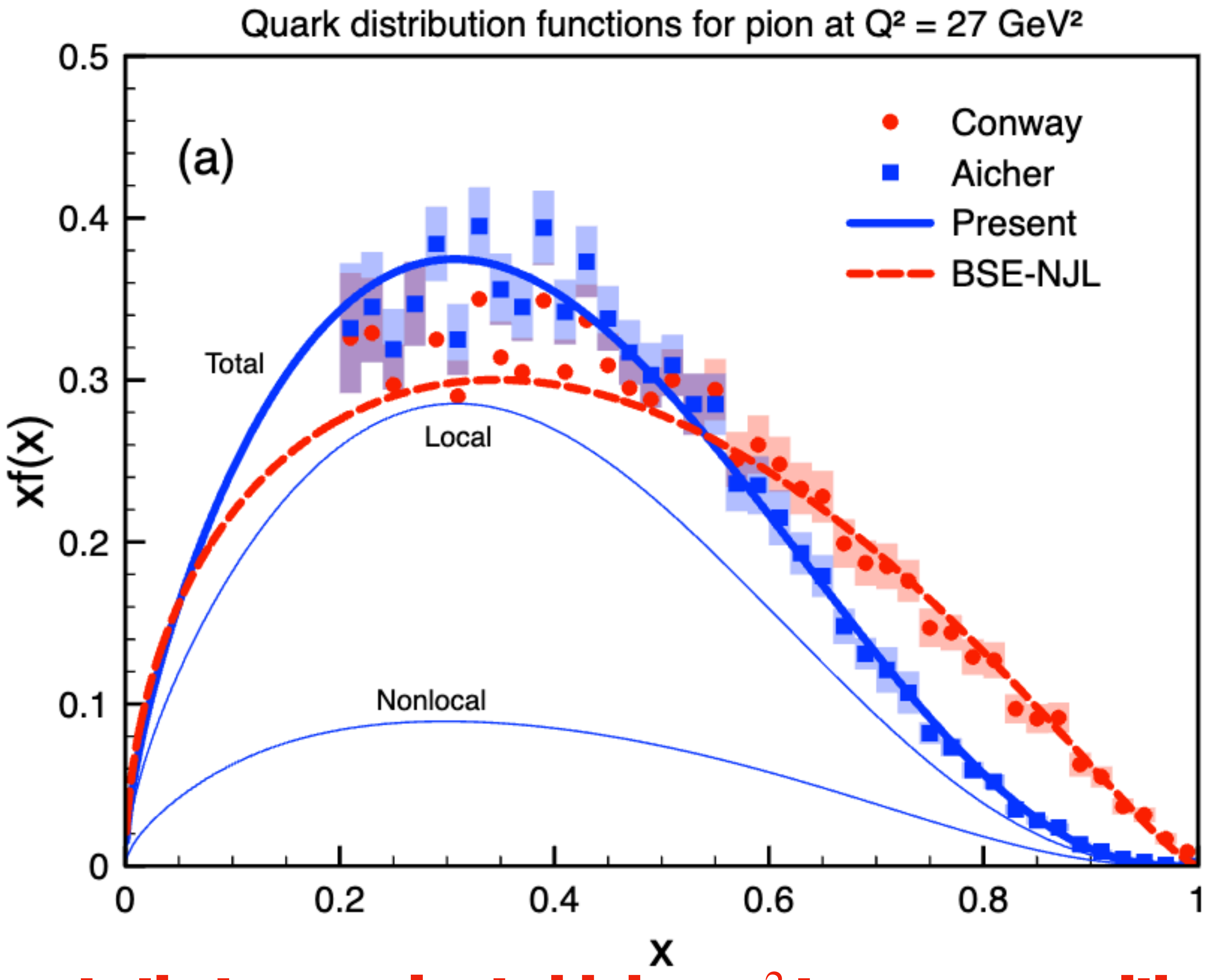
- NLO DGLAP is required to be able to compare the QDF and GDF with the experimental data in particular Q^2 or lattice QCD data

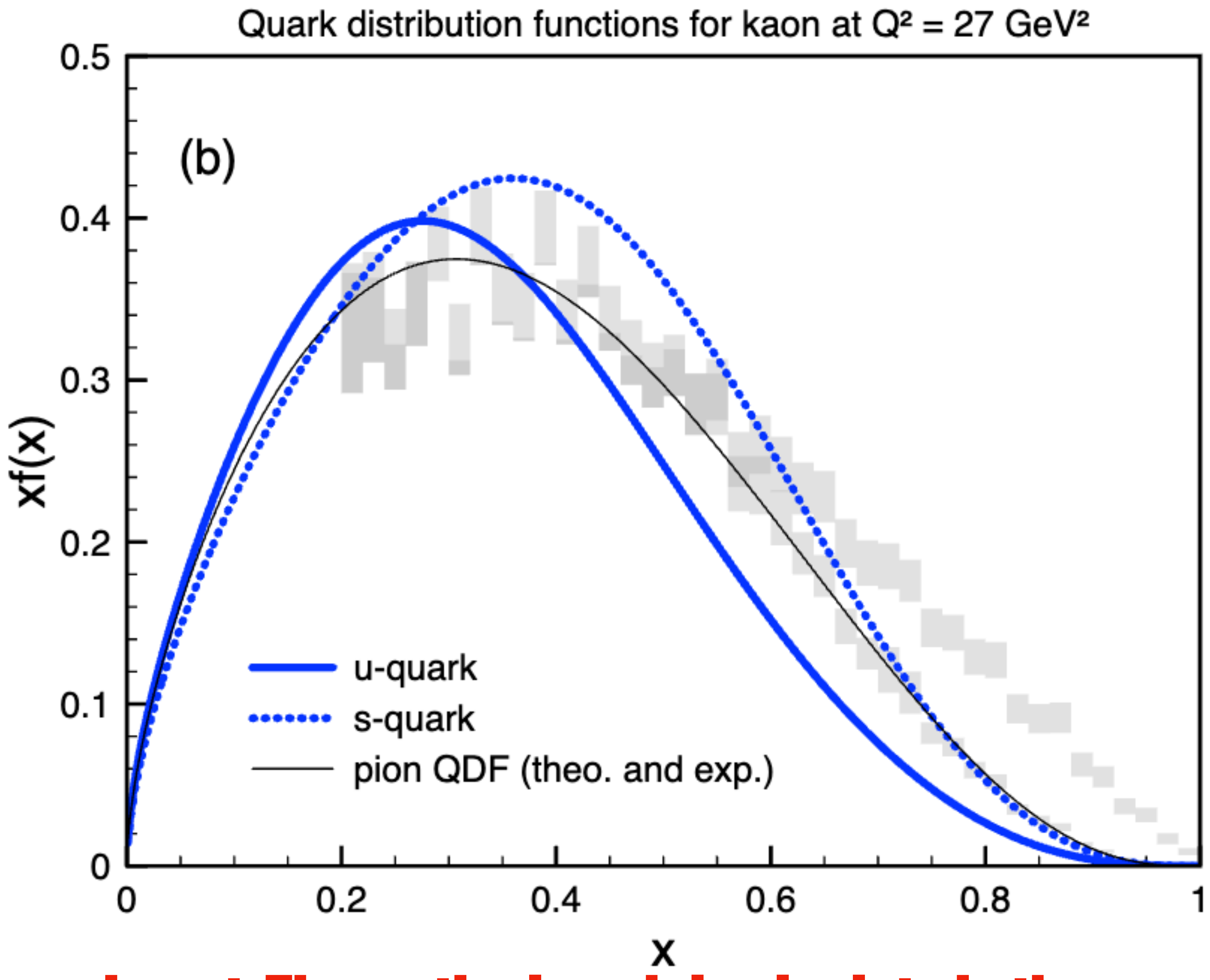
Detail calculation, please look at 2302.05566

Our Results from the Current Analysis

In comparison with the Bethe-Salpeter Nambu—Jona-Lasinio (BSE_NJL) model

- **Results for QDF for Pion and Kaon at $Q^2 = 27\ \mathrm{GeV}^2$**



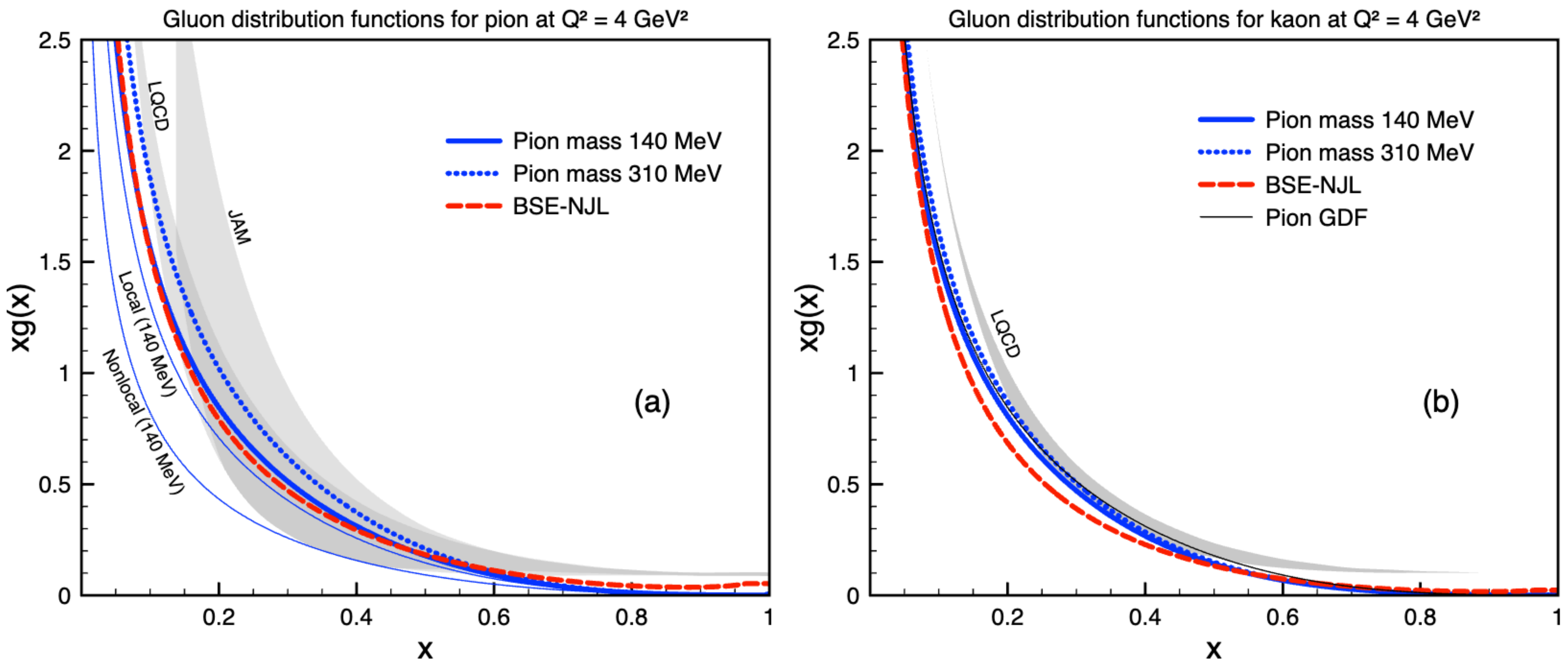


Please note that we evolve to higher Q^2 to compare with experiment, Theoretical model calculate in the very low Q

Our Results from the Current Analysis

In comparison with the Bethe-Salpeter Nambu—Jona-Lasinio (BSE_NJL) model

- Results for GDF for the pion and kaon at $Q^2 = 4\ \mathrm{GeV}^2$



Summary and outlook

- We have calculated the GPDs of the meson in the BSE—NJL model and the prediction results are shown—GPD in the NLChQM *[See Hyeondong Son's Talk on Kaon GPDs and GFF]*
- New data from the EIC, EIcC, AMBER COMPASS, and upgrade JLab-12 are required to resolve the "tension" on the Parton distribution functions for the meson at high—x [power counting rule or the endpoint behavior] and to understand the gluon distributions for the meson at the low-x
- Besides the PDFs for the meson, the data for the form factor of the meson are also needed to firmly understand the structure of the meson as the Goldstone boson
- Understanding the meson structure in the BSE—NJL model will pave the way to understanding the nucleon structure (more complex structure) using the more sophisticated model and lattice QCD

Summary and Outlook

Current situation and the next challenge to do

- We have explained our new analysis for the gluon and quark distributions in the hadron in the NLχQM.
- The explanation for the data discrepancy with the current theory predictions is found, confirming the previous analysis results— need more data to pin down the problem.
- Next plan, we will calculate the hadron's generalized parton distribution (GPD)—3D tomography imaging—using the NLχQM. **Please stay tune!**
- Also, we plan to use the same model (NLχQM and BSE-NJL models) to calculate the nuclear PDF **Please stay tune!**
- The GPD and nuclear PDF results are very important for a future electron-ion collider (EIC) in 2030. **Very exciting to wait for the new data!**

Summary and Outlook

Current situation and the next challenge to do

- Based on the Sea Quest experiment we have different light quarks of u and d—-it is interesting to consider the difference (Charge Symmetry Violation) in the calculation of Meson GPD —Valence, sea, and gluon distributions

- Higher twist, GPD at DGLAP and ERBL regimes

Thank you for attention!

This work was partially supported by the National Research Foundation of Korea (NRF) funded by the Korea Government (MSIT) Grant No. 2018R1A5A1025563 and No. 2022R1A2C10003964