Quark unpolarized transverse-momentum distribution functions of the pion

Ydrefors, de Paula, TF, Salmè, e-Print: 2301.11599 [hep-ph]

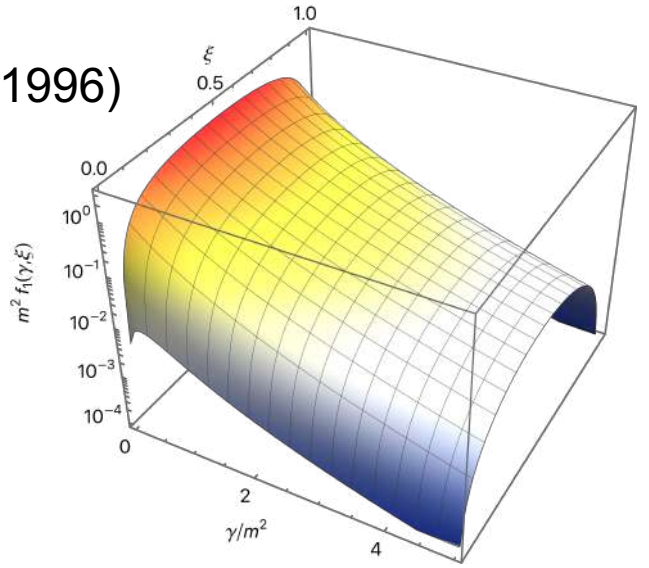
T-even uTMD leading-twist from the quark-quark correlator

Mulders & Tangerman NPB461, 197 (1996)

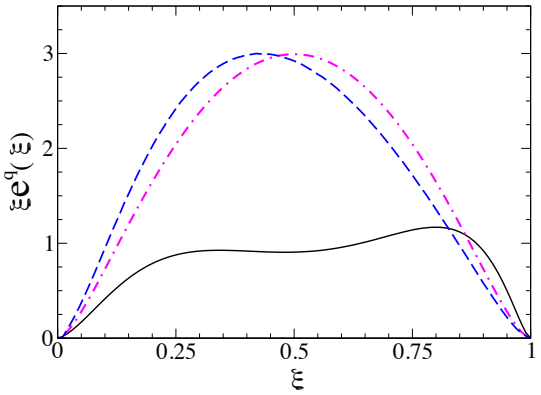
$$f_1^q(\gamma,\xi) = \frac{N_c}{4}\int d\phi_{\hat{\mathbf{k}}_\perp}\int_{-\infty}^{\infty}\frac{dy^- d\mathbf{y}_\perp}{2(2\pi)^3}$$

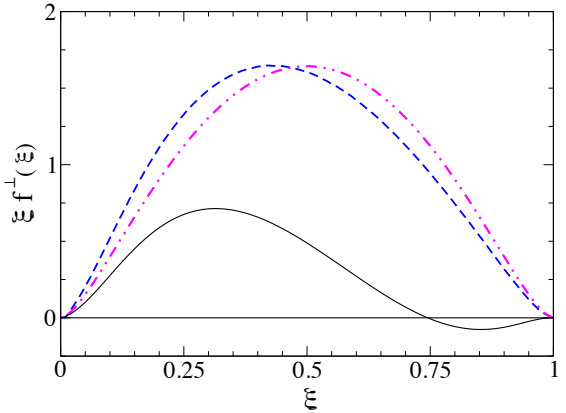
$$\times\, e^{i[\xi P^+\frac{y^-}{2}-\mathbf{k}_\perp\cdot\mathbf{y}_\perp]}\langle P|\bar{\psi}_q(-\tfrac{y}{2})\gamma^+\psi_q(\tfrac{y}{2})|P\rangle\big|_{y^+=0}$$

$$\gamma = |\mathbf{k}_\perp|^2$$



Subleading-twist 3 uTMDs





$$\xi\; e^q_{EoM}(\gamma,\xi) = \xi\; \tilde{e}^q(\gamma,\xi) + \frac{m}{M}\; f^q_{1;EoM}(\gamma,\xi)$$

$$\xi\; f^{q\perp}_{EoM}(\gamma,\xi) = \xi\; \tilde{f}^{q\perp}(\gamma,\xi) + f^q_{1;EoM}(\gamma,\xi)\;,$$

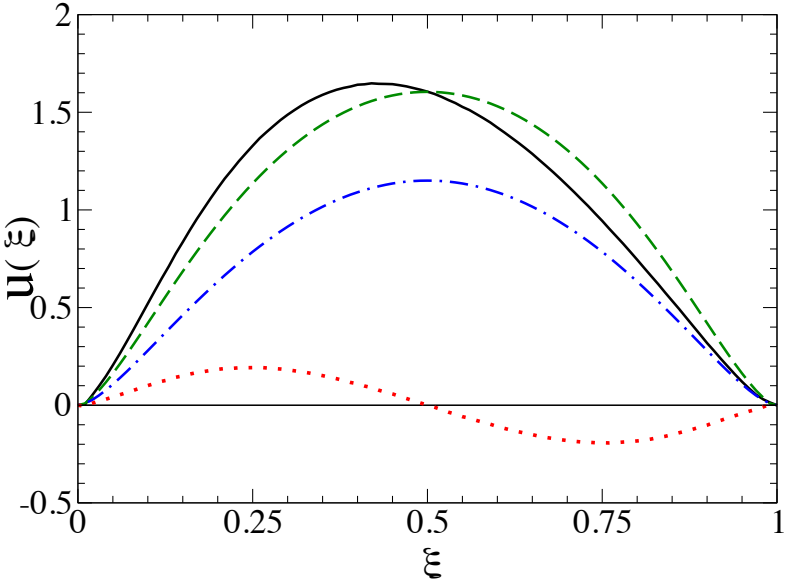
Lorcé, Pasquini, Schweitzer, EPJ C 76, 415 (2016)

Gluon momentum in the pion

$$|\pi\rangle = |q\bar{q}\rangle + |q\bar{q}g\rangle + |q\bar{q}\,2g\rangle + \cdots$$

quark momentum distribution

$$u^q(\xi) = \sum_{n=2}^{\infty} \left\{ \prod_i^n \int \frac{d^2k_{i\perp}}{(2\pi)^2} \int_0^1 d\xi_i \right\}$$
$$\times \delta\left(\xi - \xi_1\right) \delta\left(1 - \sum_{i=1}^n \xi_i\right) \delta\left(\sum_{i=1}^n \mathbf{k}_{i\perp}\right)$$
$$\times \left|\Psi_n(\xi_1, \mathbf{k}_{1\perp}, \xi_2, \mathbf{k}_{2\perp}, \ldots)\right|^2,$$



$$\langle \xi_q \rangle = \int_0^1 d\xi \int_0^\infty d\gamma\ \xi\ f_1^q(\gamma, \xi) = 0.471$$

first-moment

$$\langle \xi_q \rangle = P_{val}\ \langle \xi_q \rangle_{val} + \sum_{n>2} P_n\ \langle \xi_q \rangle_n$$
$$= P_{val}\ \langle \xi_q \rangle_{val} + (1 - P_{val})\ \langle \xi_q \rangle_{HFS}$$

0.471 0.5 0.4 P_{val}=0.3

momentum sum-rule in the HFS

$$\langle \xi_q \rangle_{HFS} = 1 - \langle \xi_{\bar{q}} \rangle_{HFS} - \langle \xi_g \rangle$$

0.2

Gluons carry 6% of the longitudinal momentum of the pion! @ the pion scale

Working now on the inclusion of quark self-energy in the BS equation in Minkowski...