Valence quark special distributions ($\xi = 0$)

Two approaches

Goloskokov and Kroll (K Regali thesis)
$GPD(\xi, x, t)$ double distribution
$\left(\text{Lim } \xi \to 0\right)$

Valence quark $\xi = 0$
GPD(x,t) Parameterization
Diehl-Feldman-Jakob-Kroll-1-0408173.pdf
et seq., e.g.
- Diehl and Kroll, -1302.4604
- Diehl-Hagler-0504175
- Kroll-Passek-Kumericki-1802.06597

Quote from Diehl-Feldman-Jakob-Kroll-1-0408173

- the low-x behavior of $f_q(x)$ should match the form (13), where we now impose the value $\alpha' = 0.9\ \mathrm{GeV}^2$ from Regge phenomenology,
- the high-x behavior should be controlled by the parameter A_q in (15) and not by α',
- the intermediate x-region should smoothly interpolate between the two limits, with a few additional parameters providing enough flexibility to enable a good fit to the form factor data.

We found these requirements to be satisfied by the forms

$$f_q(x) = \alpha'(1-x)^2 \log\frac{1}{x} + B_q(1-x)^2 + A_q\, x(1-x) \tag{28}$$

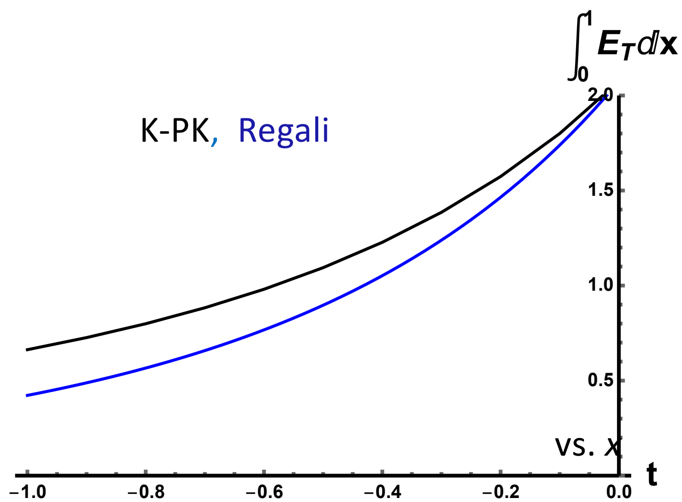
and

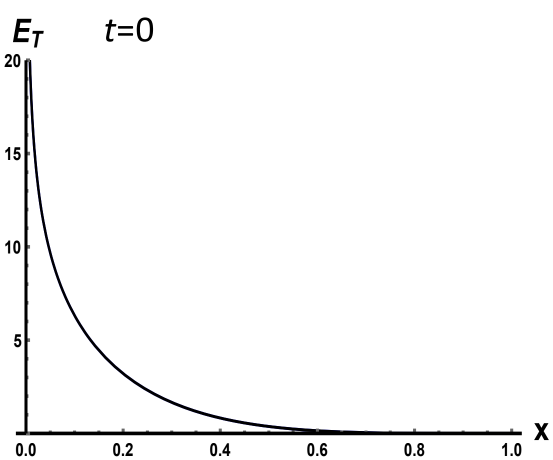
$$f_q(x) = \alpha'(1-x)^3 \log\frac{1}{x} + B_q(1-x)^3 + A_q\, x(1-x)^2\ , \tag{29}$$

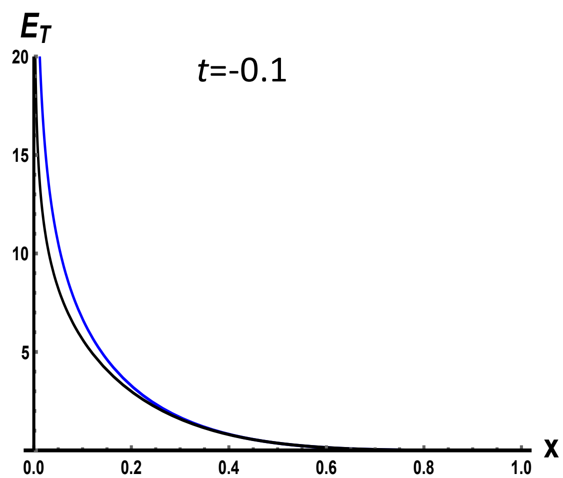
which respectively correspond to $n = 1$ and $n = 2$ in (15). At large x, the individual terms behave like $\alpha'(1-x)^{n+2}$, $B_q(1-x)^{n+1}$ and $A_q(1-x)^n$, which in particular prevents the term with α' from being too important in the high-x region.

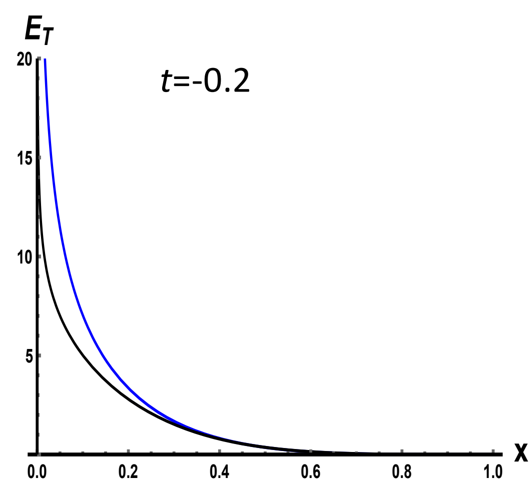
Goloskokov and Kroll (K Regali thesis)
$GPD(\xi,x,t)$ double distribution
$(\text{Lim}\ \xi \to 0)$

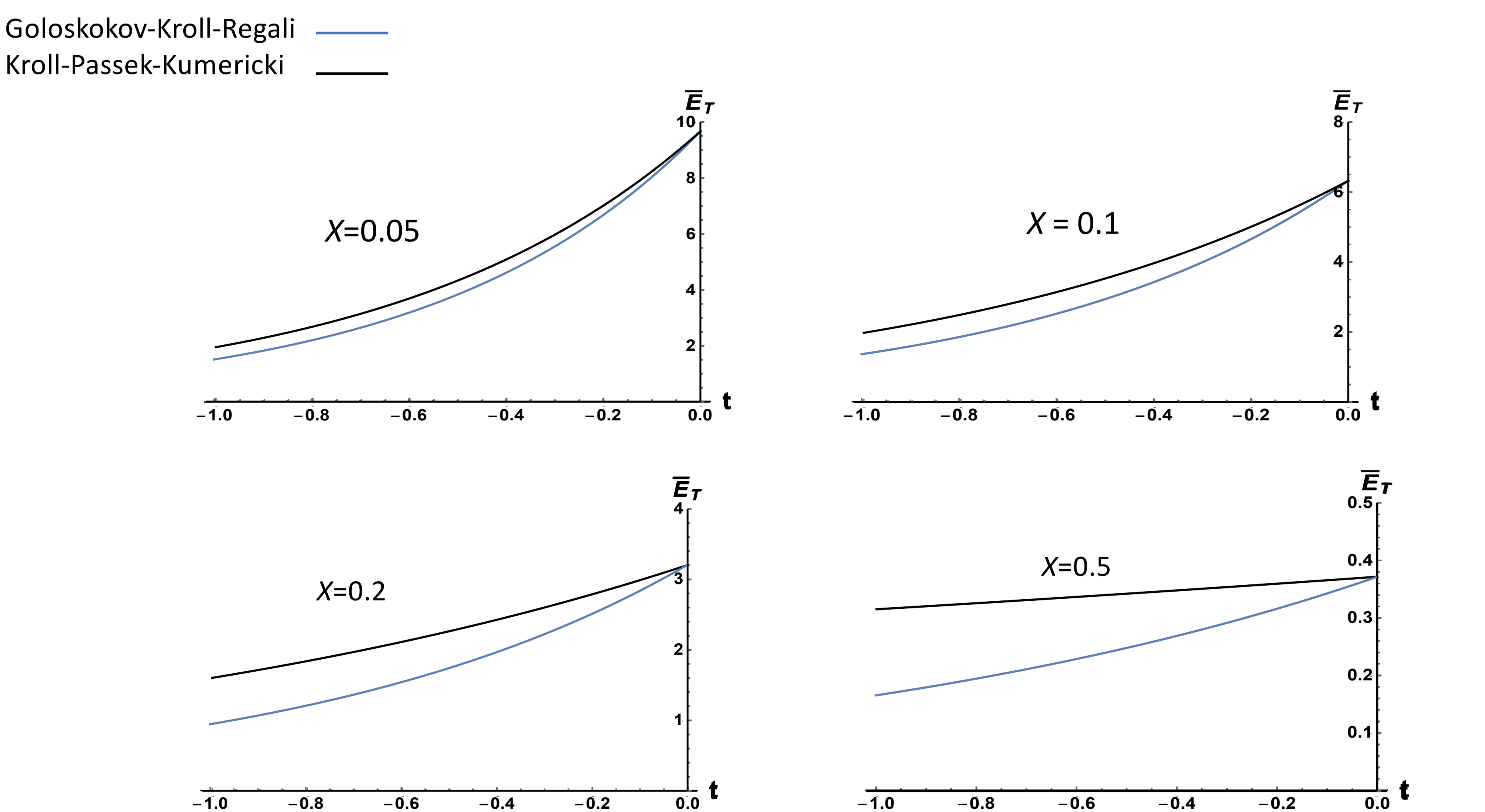
Valence quark (ξ=0) Parameterization
Kroll-Passek-Kumericki-1802.06597
M. Diehl and P. Kroll, -1302.4604





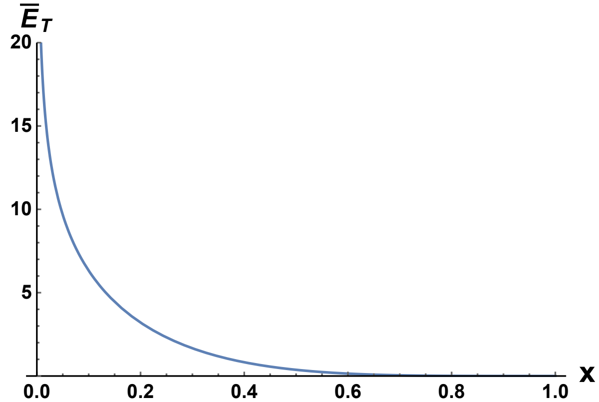




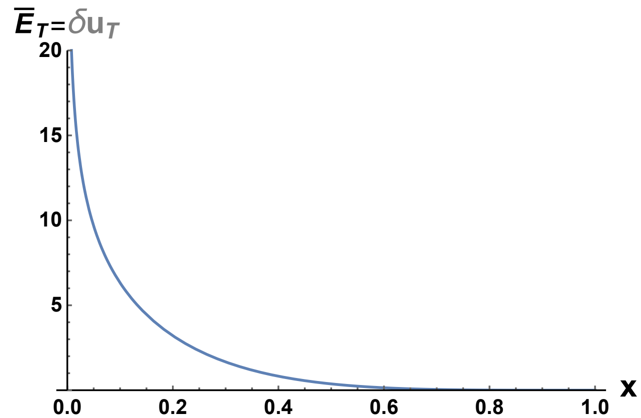

Goloskokov-Kroll-Regali
Kroll-Passek-Kumericki
X=0.05
X = 0.1
X=0.2
X=0.5
$\overline{E}_T$
t

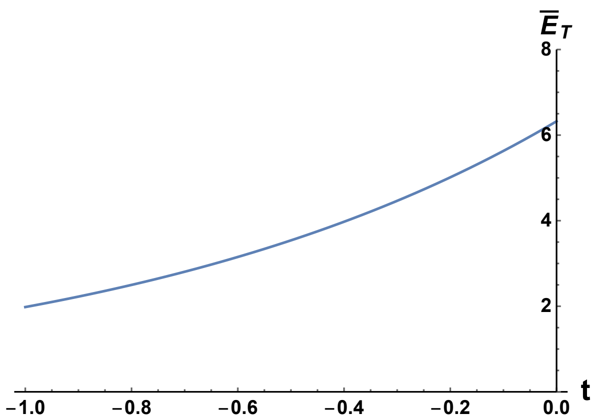
Valence quark ($\xi=0$) Parameterization
Kroll-Passek-Kumericki-1802.06597
from PK handout - 2018

Regali $\left(\text{consistent with GK } 2008\right)$
$\left(\text{Lim } \xi \to 0\right)$

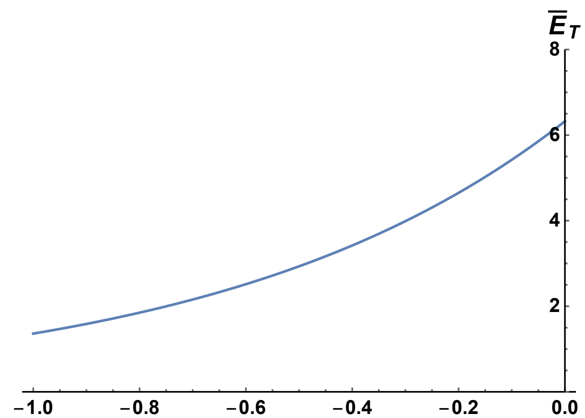


$t = 0$





$x = 0.1$



Regalli Parameters

$N_u = 4.83$ $N_d = 3.57$

$b_u = 0.5$ $b_d = 0.5$

$\alpha_{0u} = 0.3$ $\alpha_{0d} = 0.3$

$\alpha'_u = 0.45$ $\alpha'_d = 0.45$

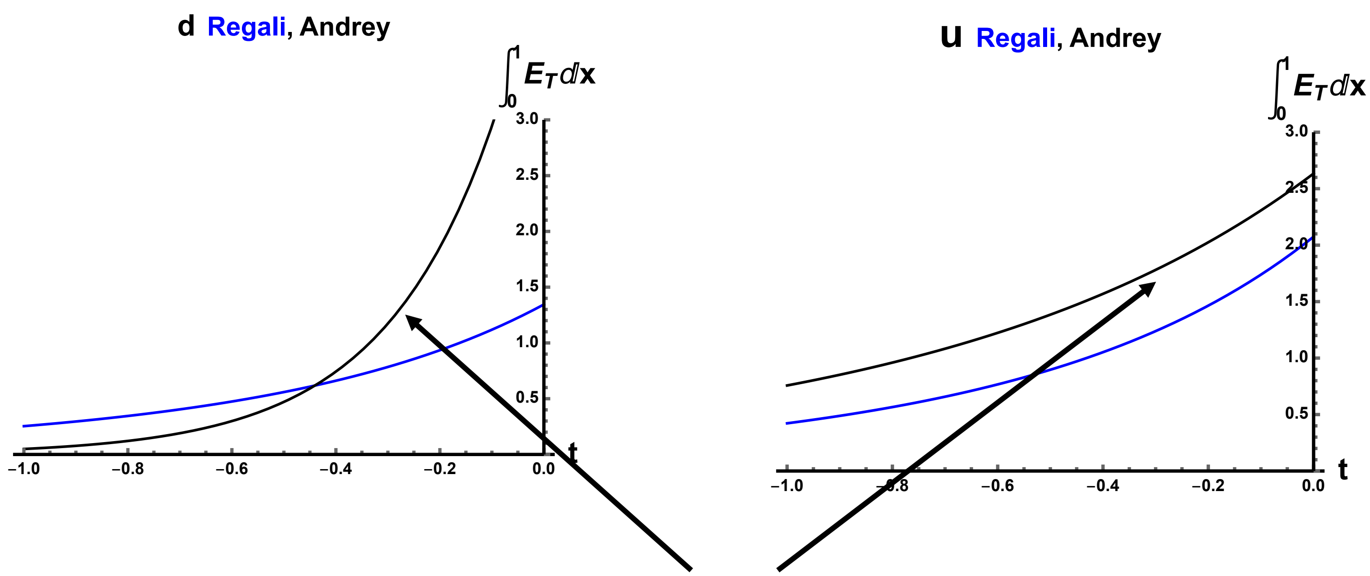
Andrey fit v2.p6

$N_u = 15.4$ $N_d = 33.2$

$b_u = 0.46$ $b_d = 3.7$

$\alpha_{0u} = 0.3$ $\alpha_{0d} = 0.3$

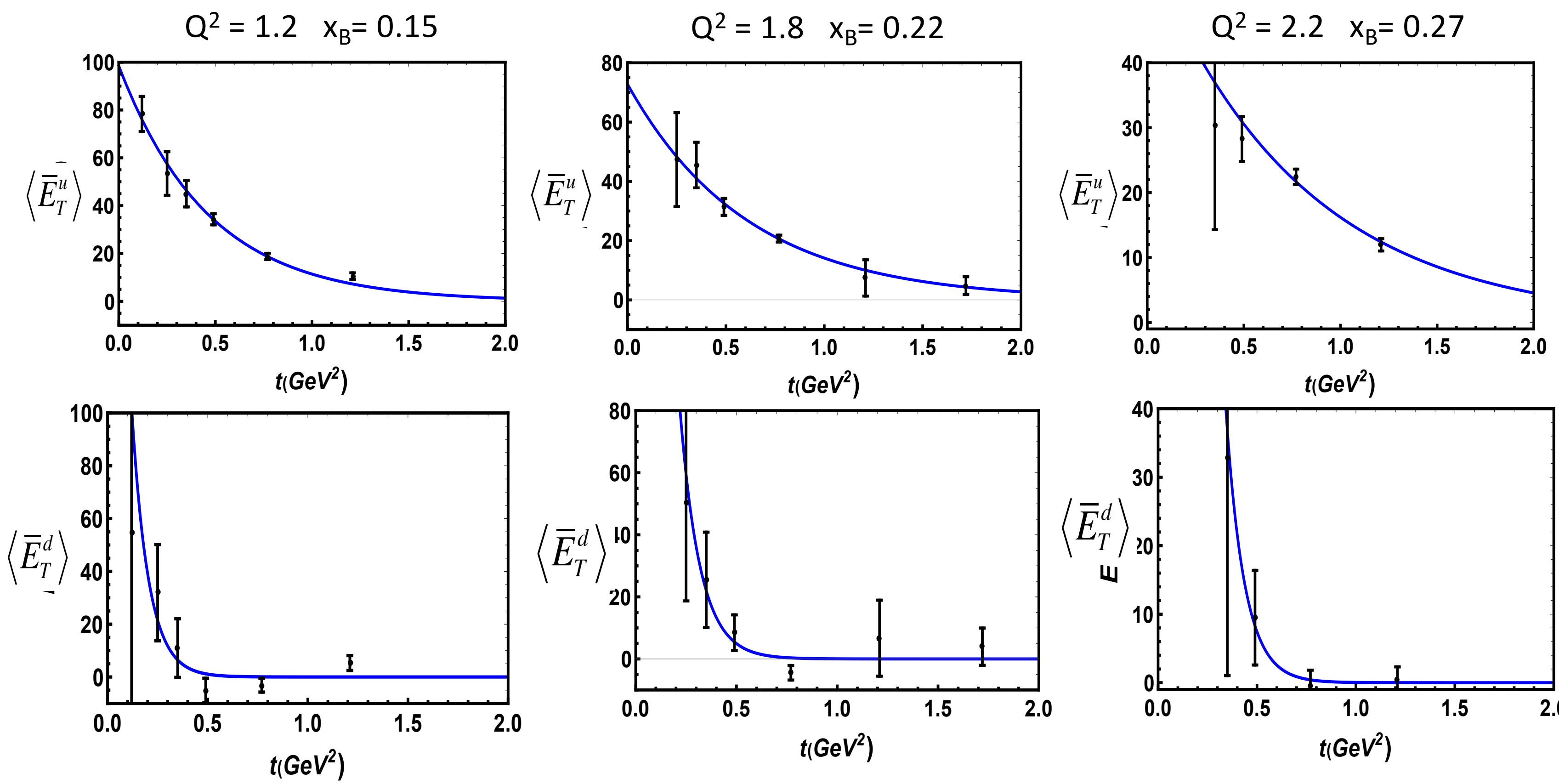
$\alpha'_u = -0.07$ $\alpha'_d = 0.40$



Andrey: $\langle r_d \rangle > \langle r_u \rangle$

V.Koubarovsky - Separated u and d GFFs from CLAS π^0 and η data

Clearly, $\langle r_d \rangle > \langle r_u \rangle$



Recalculate number density $q(\bar{E}_T)$

Rescale $f_u(x)$ and $f_d(x)$ based on GFF $\left\langle \bar{E}_T(t,x_B)\right\rangle$ fits.

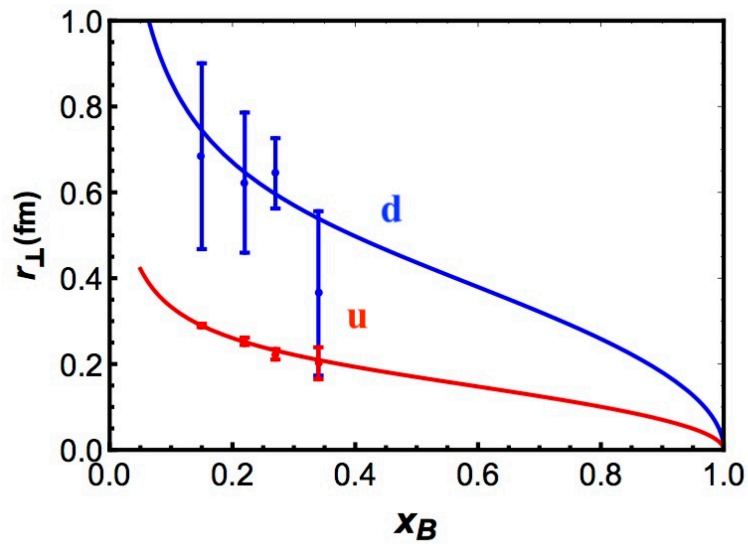
Fit to generalized form factor: assume simple exponential model at each x_B :

$$\left\langle \bar{E}_T(t,x_B)\right\rangle = A(x_B)\, e^{t\,f(x_B)} = A(x_B)\, e^{-\Delta^2\, f(x_B)} = \left\langle \bar{E}_T(b)\right\rangle = \frac{k(x_B)}{4\pi f_d(x_B)}\, e^{-\frac{b^2}{4f(x_B)}}$$

$$\left\langle b\right\rangle = \frac{\int b\,\left\langle \bar{E}_T(b)\right\rangle db}{\int \left\langle \bar{E}_T(b)\right\rangle db} \quad \left\langle r\right\rangle = \hbar c\left\langle\, b\right\rangle \sim \hbar c\sqrt{2f(x_B)}$$

$$\bar{E}_T = e(x)e^{-f(x_B)t} \rightarrow \frac{e(x)}{2f(x)}e^{-b^2/4f(x_B)}$$

$$r = \sqrt{\frac{b}{(1-x_B)}hc^2}$$



$$r \sim a\frac{\sqrt{1-x_B{}^2}}{\sqrt[3]{x_B}}$$

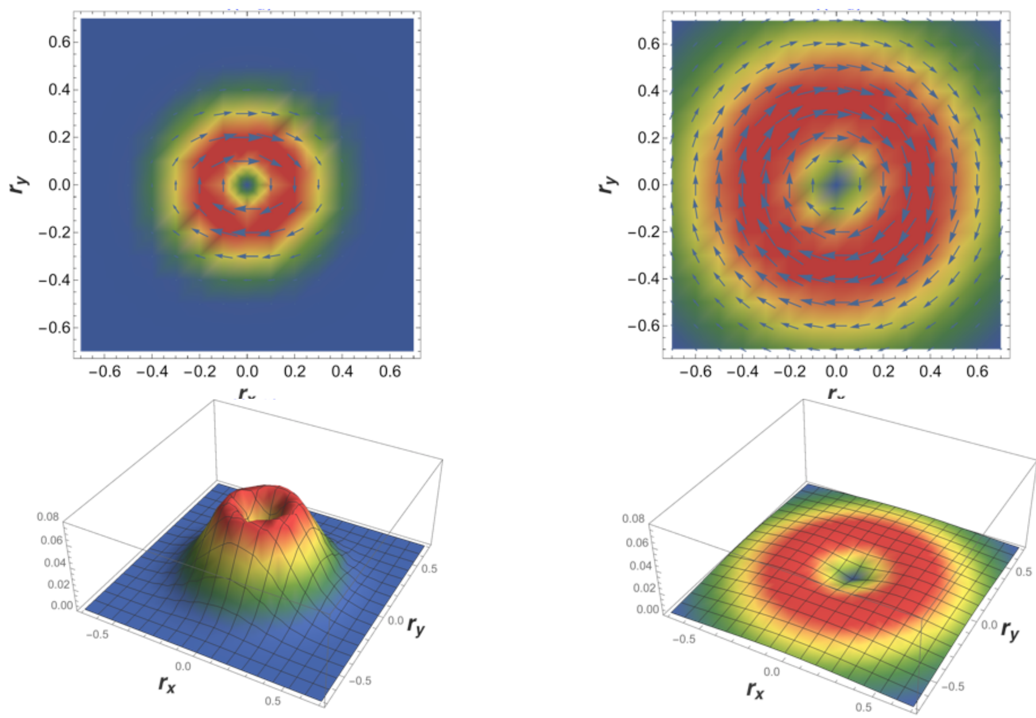
Transversely polarized of u and d quarks in an unpolarized nucleon.

(e.g. see Diel-Kroll (2004), Kroll Diehl-Hagler-05 figs. 2,5)

$$q_T(x,\vec{b}) \equiv \frac{1}{2}\ (b^x\hat{x} - b^y\hat{y})\ \frac{1}{m}\frac{\partial}{\partial \boldsymbol{b}^2}\bar{\mathcal{E}}_T$$

Rescale Kroll-Passek-Kumericki (2018) parameters such that $\langle b_d \rangle = 2\langle b_u \rangle$

$q\left(\bar{\mathcal{E}}_{T\,u}\right)$ $q\left(\bar{\mathcal{E}}_{T\,d}\right)$



$x = 0.2$