On the reconstruction of the twist-3 parton distribution function e(x)

Elser López

Master's student Institute of Physics National Autonomous University of Mexico (UNAM) Supervisor: Aurora Courtoy

06/14/2024





Dirección General de Asuntos del Personal Académico



Reconstruction of parton distribution functions

Hypothesis:

We can use the **Bézier Curves** to parametrize PDFs

[Kotz et al., Phys.Rev.D 109].

$$\mathcal{B}^{(n)}(t) = \sum_{l=0}^{n} c_l b_{n,l}(t) = \sum_{l=0}^{n} c_l \binom{n}{l} t^l (1-t)^{n-l},$$

The Mellin moments,

$$M_m[f_q(x)] = \int_0^1 \mathrm{d}x \ x^{m-1} f_q(x),$$

could give us geometrical information about the PDF.



Reconstruction of parton distribution functions

Known pion xPDF example

xPDF reconstructed

- -Varying the number of moments from 2 to 5
- -Black line \rightarrow phenomenological function.
- -Green bands \rightarrow error bands.
- -Dashed lines → reconstructed xPDFs,

- An absolute error around to ~10⁻⁷
- Satisfactory level of accuracy



х

3

The twist-3 parton distribution function e(x)

Accessed in various experiments through asymmetries, e.g. CLAS at JLab, it was listed as a key object to gather information about multiparton dynamics for the EIC

Higher-twist PDF, suppressed by a factor of M/Q which describes transversely polarized quarks in an unpolarized hadron, it's defined by

$$e^{q}(x) = \frac{1}{2M_{N}} \int \frac{\mathrm{d}\lambda}{2\pi} e^{i\lambda} \langle N | \bar{\psi}_{q}(0) [0, \lambda n] \psi_{q}(\lambda n) | N \rangle, \quad e^{\overline{q}}(x) = e^{q}(-x),$$



The twist-3 parton distribution function e(x)

Why are the moments important?

-Some of them relate known physical quantities -They potentially give us information about the curve's shape.

$$\mathcal{M}_1[e^q(x)] = \frac{1}{2M_N} \langle N | \bar{\psi}_q(0) \psi_q(0) | N \rangle = \sigma_q(Q^2),$$

$$\sigma_u(Q^2) + \sigma_d(Q^2) = \underbrace{\sigma_{\pi N}}_{(m_u(Q^2) + m_d(Q^2))/2} \text{Pion-nucleon sigma-term}$$

$$\mathcal{M}_2[e^q(x)] = \frac{m_q}{M_N}$$
 \checkmark Valence quark number



The twist-3 parton distribution function e(x)

Next step \rightarrow combine the countable data and information on the moments from the lattice



Thanks!





