SOFT PION THEOREM
FOR PARTON DISTRIBUTIONS

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The motivation of the work is to explore the relationships between hadronic matrix elements with pions in final and initial states, studying the limits of the function.

$$\langle \pi^k(q)\beta|O(0)|\alpha\rangle = i\int d^4x e^{iq\cdot x}(\Box + m_\pi^2)\langle\beta|T\{\pi^k(x)O(0)\}|\alpha\rangle$$

Matrix Element

[Donoghue et al. Cambridge University Press.]

LSZ Reduction Formula ✚

$$\pi^k = \frac{1}{F_\pi m_\pi^2}\partial^\mu A_\mu^k \qquad Q_5^k = \int d^3x A_0^k(x)$$

$$\lim_{q^\mu \longrightarrow 0}\langle \pi^k(q)\beta|O(0)|\alpha\rangle = -\frac{i}{F_\pi}\langle\beta|[Q_5^k(x), O(0)]|\alpha\rangle$$

For parton distribution we change :

$$\begin{cases} O(0) \to O(x,0) \\ \langle \pi_1\pi_2|O|0\rangle \to \langle\pi_1|\pi_2 O'|0\rangle \end{cases}$$

$$\lim_{p_2 \longrightarrow 0}\langle \pi^a(p_1)\pi^b(p_2)|\bar{\psi}(x)\hat{n}\frac{\tau^3}{2}\psi(0)|0\rangle = \frac{i\epsilon^{3bc}}{f_\pi}\langle\pi^a(P)|\bar{\psi}(x)\hat{n}\frac{\tau^c}{2}\psi(0)|0\rangle$$

[Polyakov. Nucl. Phys. B, 555:231.]