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Transverse-momentum dependent distribution functions for a pion with Minkowskian dynamics

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The unpolarized twist-2 (leading) and twist-3 (subleading), T-even, transverse-momentum dependent quark distributions in the pion are evaluated for the first time by using the actual solution of a dynamical equation in Minkowski space. The adopted theoretical framework is based on the homogeneous Bethe-Salpeter integral equation with an interaction kernel given by a ladder gluon exchange, featuring an extended quark-gluon vertex. The masses of quark and gluon as well as the interaction-vertex scale have been chosen in a range suggested by lattice-QCD calculations, and calibrated to reproduce both pion mass and decay constant.

The joint use of the Fock expansion of the pion state facilitates a more in-depth analysis of the content of the pion Bethe-Salpeter amplitude, allowing for the first time to determine the gluon contribution to the quark average longitudinal fraction, that results to be $\sim 6\%$.
The current analysis highlights the role of the gluon exchanges through quantitative analysis of collinear and transverse-momentum distributions, showing, e.g. for both leading and subleading-twists, an early departure from the widely adopted exponential fall-off, for $|\mathbf{k}_\perp|^2 > m^2$, with the quark mass $\sim \Lambda_{QCD}$.

Primary authors: YDREFORS, Emanuel (Instituto Tecnologico de Aeronautica); SALME', Giovanni (Istituto Nazionale di Fisica Nucleare - Roma); FREDERICO, Tobias (Instituto Tecnologico de Aeronautica); DE PAULA, Wayne (Instituto Tecnológico de Aeronáutica)

Presenter: SALME', Giovanni (Istituto Nazionale di Fisica Nucleare - Roma)

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