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Impact of Spin on Quark Wigner Distributions

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We study how the spin of quarks and the target affects the shape of Wigner distributions in the transverse impact parameter space ($\vec{b}_\perp$), which is conjugate to the transverse momentum transfer $D_\perp = \frac{\Delta_\perp}{1-\xi^2}$, within the framework of a light-front dressed quark model. This study considers the effect of nonzero longitudinal momentum transfer, called skewness, defined as $\xi = \frac{\Delta^+}{2P^+}$. By looking at different combinations of quark and target spin, we find that certain patterns like dipoles and quadrupoles, appear due to spin and orbital motion. These patterns become more noticeable as skewness increases, causing changes in how the quark is spread out in space. This shows that spin plays an important role in the 3D structure of hadrons. Our results provide deeper insight into the role of spin in shaping the multidimensional structure of hadrons and establish a link between polarization effects and partonic spatial correlations in non-forward regimes.

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