

# From Spin Structure to Transverse Momentum Distributions: A Lattice View of the Nucleon

Saturday, 10 October 2026 14:55 (15)

Understanding how the spin, flavor, and intrinsic transverse motion of quarks emerge from QCD is essential for building a complete picture of nucleon structure. Recent developments in large-momentum effective theory have made it possible to access increasingly detailed partonic information directly from lattice QCD.

In this talk, I will present two complementary lattice studies of nucleon structure. The first focuses on the spin-flavor structure encoded in ratios of helicity and unpolarized parton distribution functions, with particular emphasis on  $\Delta d(x)/d(x)$ . This ratio directly probes the polarization of the down quark inside a longitudinally polarized nucleon, especially in the valence region, while benefiting from partial cancellation of common systematic uncertainties between the helicity and unpolarized distributions.

The second study extends this picture from longitudinal spin structure to the transverse-momentum structure of the nucleon through calculations of isovector unpolarized and helicity TMD PDFs,  $f_1^{u-d}(x, b_T)$  and  $g_{1L}^{u-d}(x, b_T)$ . Using ensembles with multiple lattice spacings, pion masses, and nucleon momenta, together with nonperturbative Collins–Soper evolution and LaMET matching, we investigate their dependence on both the longitudinal momentum fraction  $x$  and the transverse separation  $b_T$ , as well as the associated systematic uncertainties.

Together, these studies illustrate how lattice QCD can connect the spin structure of the nucleon with its transverse-momentum structure, providing increasingly detailed first-principles information on nucleon partonic dynamics and complementary input for phenomenology and future Electron-Ion Collider measurements.

**Primary author(s) :** Mr 张, 杰 (Shanghai Jiao Tong University)

**Co-author(s) :** ZHANG, Qi-An (Beihang University); Prof. JI, Xiangdong (Tsung-Dao Lee Institute and School of Physics and Astronomy, Shanghai Jiao Tong University, Shanghai 201210, China); Prof. WANG, Wei (Shanghai Jiao Tong University)

**Presenter(s) :** Mr 张, 杰 (Shanghai Jiao Tong University)

**Session Classification :** Section 8