Contribution ID: **12** Type: **not specified**

Transverse Momentum Distributions from Lattice QCD without Wilson Lines

Tuesday 13 August 2024 09:20 (30 minutes)

The transverse-momentum-dependent distributions (TMDs), which are defined by gauge-invariant 3D parton correlators with staple-shaped lightlike Wilson lines, can be calculated from quark and gluon correlators fixed in the Coulomb gauge on a Euclidean lattice. These quantities can be expressed gauge-invariantly as the correlators of Coulomb-gauge-dressed fields, which reduce to the standard TMD correlators under principal-value prescription in the infinite boost limit. In the framework of Large-Momentum Effective Theory, a quasi-TMD defined from such correlators in a large-momentum hadron state can be matched to the TMD via a factorization formula, whose exact form is derived using Soft Collinear Effective Theory and verified at one-loop order. Compared to the currently used gauge-invariant correlators, this new method can substantially improve statistical precision and simplify renormalization for the time-reversal-even TMDs, which will greatly enhance the predicative power of lattice QCD in the non-perturbative region.

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Session Classification: Presentations