Theory and computation highlights in November, 2021
(Contribution to the Director's Monthly Report to JSABOD)
December 8, 2021

Parton distribution functions encode important nonperturbative information on hadron structure and strong interaction physics. A new paper by T. Rogers, N. Sato and collaborators [arXiv:2111.01170] addresses the question of whether parton distribution functions defined in the MS-bar renormalization scheme are required on general structural grounds to be positive. The paper argues that they are not, and points out a flaw in a recent claim of proof to the contrary in the literature. The positivity question is used to explain a misconception that often appears in discussions of factorization theorems, and to illustrate how it can lead to wrong conclusions regarding the properties of parton correlation functions.

Quantum corrections to higher-twist parton distribution functions (PDFs) suggest that they may have a peculiar property that a finite fraction of partons carries zero momentum -- referred to as "zero modes". It was proposed in the literature that the "gluon condensate" PDF, was one such distribution. New detailed calculations by A. Radyushkin and colleagues [arXiv:2111.00887] have demonstrated the absence of zero-mode terms in the gluon condensate PDF; however, they detected such a term in the corresponding generalized parton distribution at nonzero momentum transfer.

The first calculation of the transversity distribution of the nucleon using the pseudo-PDF framework developed at Jefferson Lab appeared in [arXiv:2111.01808]. The lattice computation was compared with global fits to data for transverse single-spin asymmetries, and further the intrinsic nucleon sea was found to be isospin symmetric with respect to transversity. In [arXiv:2111.06797], the short-distance structure of the matrix elements giving rise to the unpolarized gluon distribution was studied, enabling the gluon PDF to be extracted from a variety of lattice matrix elements thereby providing further control over the calculations. The work provides essential theoretical input to lattice calculations of hadron structure.

Tanjib Khan, a student at William and Mary and two-time recipient of a JSA graduate studentship, successfully defended his PhD thesis entitled "Calculation of Gluon PDF in the Nucleon using Pseudo-PDF Formalism with Wilson Flow Technique in LQCD", based on two papers that have now appeared in Physical Review D.