

Theoretical and Computational Physics highlights in March, 2024

A team of theorists at JLab and William & Mary have been awarded a renewal allocation of 1M node hours on the Frontera supercomputer at the University of Texas under the Leadership Resource Allocation (LRAC) program. Calculations performed on Frontera have been essential to the lattice studies of the internal structure of the nucleon, and this award will enable both the calculation of Generalized Parton Distributions, and the extension of structure studies to include the contribution of the sea quarks.

Resolution of the sign of gluon polarization in the proton

Recently, the possible existence of negative gluon helicity, Δg , has been observed to be compatible with existing empirical constraints, including from jet production in polarized proton-proton collisions at RHIC, and lattice QCD data on polarized gluon Ioffe time distributions. Dr. W. Melnitchouk and Dr. N. Sato, together with the JAM Collaboration, have performed [arXiv:2403.08117] a new global analysis of polarized parton distributions in the proton with new constraints from the high- x region of deep-inelastic scattering (DIS). A dramatic reduction in the quality of the fit for the negative Δg replicas compared to those with positive Δg suggests that the negative Δg solution cannot simultaneously account for high- x polarized DIS data along with lattice and polarized jet data.

Spin-orbit correlations in the nucleon in the large- N_c limit

The spin and orbital angular momentum degrees of freedom play an essential role in characterizing the internal motion of quarks and gluons in the nucleon. A recent theoretical study by Dr. J.-Y. Kim and Dr. C. Weiss [arXiv:2403.07186] explores the spin-orbit correlations of quarks in the nucleon, which connect the spin with the momentum of the orbital motion and attest to the interactions in the dynamical system. Using systematic methods based on the semiclassical limit of QCD ($1/N_c$ expansion), a mechanical interpretation of the spin-orbit correlations is developed, and quantitative predictions are provided.