Theoretical and Computational Physics highlights in September, 2023

NEW LDRD AWARD

"GPDs from polarization asymmetries with photoproduction in Hall D" (2024-LDRD-6) by Dr. Nobuo Sato (Principal Investigator) and Dr. Wally Melnitchouk (Co-Investigator).

NEW AWARD FOR COMPUTING TIME

The work of the Lattice Hadron Structure Group has been recognised through the award of 1,000,000 node hours on the Frontier supercomputer under the INCITE program following a proposal led by Kostas Orginos.

GLOBAL QCD ANALYSIS OF DIHADRON FRAGMENTATION FUNCTIONS AND TRANSVERSITY PDFS

A new paper [arXiv:2308.14857] by Dr. Sato and the JAM Collaboration explores the first simultaneous analysis of $\pi^+\pi^-$ dihadron fragmentation functions (DiFFs) and transversity PDFs using a comprehensive set of dihadron observables in electron-positron annihilation, DIS, and proton-proton collisions, including recent cross-section data from Belle and azimuthal asymmetries from STAR. A new definition of the DiFFs with a number density interpretation allows a calculation of the expectation values for the dihadron invariant mass and momentum fraction. The compatibility of the results with those from single-hadron fragmentation (in the transverse momentum dependent/collinear twist-3 framework) and the nucleon tensor charges computed in lattice QCD was studied, and a universal nature of the available information was obtained.

ACCELERATING MARKOV CHAIN MONTE CARLO SAMPLING WITH DIFFUSION MODELS

Global fits of physics models require efficient methods for exploring high-dimensional and multimodal posterior functions. Drs. Melnitchouk, Sato, and Ringer, together with collaborators from Adelaide University in Australia, propose a novel method [arXiv:2309.01454] for accelerating Markov Chain Monte Carlo sampling by pairing a Metropolis-Hastings algorithm with a diffusion model that can draw global samples with the aim of approximating the posterior. This approach leads to a significant reduction in the number of likelihood evaluations required to obtain an accurate representation of the Bayesian posterior across several analytic functions, as well as for a physical example based on a global analysis of parton distribution functions.

ON THE DEFINITION OF FRAGMENTATION FUNCTIONS AND VIOLATION OF SUM RULES

A new paper by Dr. Rogers et al. [arXiv:2309.03346] discusses a gap in the derivation of common sum rules for fragmentation functions and explains the corrections necessary for them to be absolutely valid. In particular, the paper introduces "deficit" fragmentation functions, which describe how quantum numbers may leak from a fragmentation function through small parton momentum fraction hadrons. The paper argues that studying these functions nonperturbatively can lead to improved understanding of the hadronization process in inclusive scattering.