Theoretical and Computational Physics highlights in August 2024

Dihadron azimuthal asymmetry and light-quark dipole moments at the EIC

The single transverse spin of a light quark produced at high-energy colliders, though suppressed in the Standard Model, can be highly sensitive to new physics dipole interactions. A recent paper [arXiv:2408.07255] explores this phenomenon at the EIC and demonstrates that it can be measured through an azimuthal asymmetry between pairs of hadrons fragmented by the transversely spinning quark. Using the global fit results of the dihadron fragmentation function from the JAM group, Dr. Zhite Yu and collaborators show that this new approach could improve current constraints on dipole interactions by an order of magnitude, thereby extending the EIC's capability to probe new physics.

Coulomb confinement in the Hamiltonian limit

The Gribov-Zwanziger scenario attributes the phenomenon of confinement to the instantaneous interaction term in the QCD Hamiltonian in the Coulomb gauge, which leads to a potential energy that increases linearly with the separation in a static quark-antiquark pair. Previous lattice studies of the SU(2) Yang-Mills theory determined the corresponding (Coulomb) string tension σ_C to be about three times larger than the Wilson loop string tension ?F far above Zwanziger's variational bound, $\sigma_C > \sigma_F$. New work by Drs. Arkaitz Rodas and Adam Szczepaniak [arXiv:2408.09007] examines the lattice definition of the instantaneous potential, and performs an improved determination in SU(2) lattice gauge theory, reporting a conservative estimate for the value of the Coulomb string tension as $\sigma_C/\sigma_F = 2.0 \pm 0.4$.

Two-loop QCD corrections to Higgs radiative decay to vector quarkonium

The exclusive production of J/ψ through Higgs boson radiative decay may serve a clean channel to extracting the charm quark Yukawa coupling. A new paper [arXiv:2408.17448] by Dr. Jia-Yue Zhang conducts the two-loop QCD corrections to $H \to J/\psi(\Upsilon) + \gamma$ using an optimized nonrelativistic QCD approach. Refined predictions for branching ratios $\mathrm{B}(H \to J/\psi + \gamma)$ and $\mathrm{B}(H \to \Upsilon + \gamma)$ are presented.

Longitudinal form factors of $A \leq 10$ nuclei in chiral effective field theory

In collaboration with Jefferson Lab and Argonne National Laboratory, the Washington University in St. Louis Quantum Monte Carlo Group's new publication presents the calculation of elastic electron scattering longitudinal form factors of light nuclei based on chiral effective field theory. Together with earlier publications, the work [arXiv:2408.16909] by Dr. Alex Gnech and collaborators is part of a comprehensive analysis of elastic electron scattering on light nuclei starting from first principles using the most recent chiral effective field theory combined with ab-initio approaches. These analyses permit the identification of new nuclei of interest for experiment that can be used to constrain models of the interaction of leptons with nuclei, which is part of the mission of Jefferson Lab and crucial for the future experimental effort of the Deep Underground Neutrino Experiment (DUNE)