Theory and computation highlights in February, 2021

(Contribution to the Director's Monthly Report to JSABOD)

March 7, 2021

The first calculation from QCD of the scattering amplitude of three particles was done by JLab theorists and their collaborators and published in Phys. Rev. Lett. [https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.126.012001], and was also selected as an Editor's suggestion. This progress is an important step for interpreting resonant properties of QCD states in the energy regime of the 12GeV upgrade.

An impact study was performed by Dr. Nobuo Sato and collaborators at JLab theory for the Collins effect in semi-inclusive deep-inelastic scattering at the EIC for the extraction of the nucleon's tensor charge [https://arxiv.org/abs/2101.06200]. In the framework of a QCD global analysis, a significant reduction in the uncertainties for the up, down and isovector tensor charges was found, which will make their extraction from EIC single-spin asymmetry data as or more precise than current lattice QCD calculations. The constraints placed by the future data from the proposed SoLID experiment at Jefferson Lab were also analyzed.

The JAM (Jefferson Lab Angular Momentum) collaboration, including Dr. Wally Melnitchouk and Dr. Nobuo Sato of the Theory Center, completed a Monte Carlo-based analysis of the combined world data on polarized lepton-nucleon deep-inelastic scattering at small Bjorken-x within the polarized quark-dipole formalism [https://arxiv.org/abs/2102.06159]. The analysis showed for the first time that double-spin asymmetries at $x < 0.1$ can be described using only small-x evolution, allowing predictions to be made for the g_1 structure function at much smaller x. Anticipating future data from the EIC, the paper also assessed the impact of electromagnetic and parity-violating polarization asymmetries on g_1, and demonstrated an extraction of the individual flavor helicity parton distributions at small x.

Under the LDRD with JLab and UVA, JLab has purchased equipment to help improve the laser generation for the UVA optics Quantum Computer prototype. In addition, JLab has assembled two fADC programmable digital signal analyzers that will be used to interpret the signal coming from measurements of the UVA single photon detectors. These are the first steps to constructing, in hardware, the interactions within a lattice-based QCD Hamiltonian. Separate theoretical work is continuing to develop the formalism for Hamiltonian based computations of QCD matrix elements.