Theory and computation highlights in February, 2020
(Contribution to the Director's Monthly Report to JSABOD)
March 6, 2020

Developing the physics program of the EIC is part of the mission of the JLab Theory Center. The basic physics program was defined in the 2012 EIC White Paper and the 2015 NSAC Long-Range Plan. A 7-week program at the Institute of Nuclear Theory in Seattle in 2018 reviewed possible "new" physics topics that could be explored for the EIC, suggested by recent developments in theory and on-going experiments, and assessed the feasibility of such measurements. The summary document of this program was compiled in 2019 and released in February 2020 [arXiv:2002.12333, https://arxiv.org/abs/2002.12333 , 330 pages, to be published by World Scientific]. Members of the Theory Center have played a leading role in this effort. C. Weiss acted as convener of Week 1 on Generalized Parton Distributions (GPDs) and contributed a summary of recent developments in GPD theory, experiment, and interpretation [JLAB-THY-20-3145, https://misportal.jlab.org/ul/publications/view_pub.cfm?pub_id=16236]. F. Aslan, J. Qiu, and N. Sato contributed articles about topics in QCD theory and EIC measurements. Beyond these contributions, the broader impact of the JLab Theory Center can be seen in the fact that several of the program organizers and contributers are former JLab Theory postdocs or bridge positions.

The Jefferson Lab Angular Momentum (JAM) Collaboration has performed the first global analysis [arXiv:2002.08384] of transverse-spin asymmetry data from semi-inclusive deep-inelastic scattering, Drell-Yan lepton-pair production, electron-positron annihilation into hadron pairs, and proton-proton collision experiments. The study suggests a common origin of these asymmetries, which can be described in terms of a universal set of nonperturbative, transverse-momentum dependent functions. In addition, the analysis was also able to achieve for the first time the phenomenological agreement with lattice QCD for the up- and down-quark tensor charges of the nucleon, which could be better tested by the proposed SoLID experiment at JLab in the future.

The proton's composite structure is expressed in the spatial distributions of electric charge and magnetic moment (or current), which can be measured in electron-proton elastic scattering experiments. A recent study by a collaboration of Jefferson Lab (JLab) experimentalists and theorists [https://arxiv.org/abs/2002.05167] has extracted the proton's magnetic radius from the high-precision electron-proton cross section data, using a new theoretical framework combining methods of dispersion analysis and chiral effective field theory that was developed in the JLab Theory Center. The proton's magnetic radius is found to be ~0.85 fm, very close to the electric radius determined earlier, revealing a close connection between the spatial distribution of charge and the internal motion in the system. The results will impact on the analysis and planning of future nucleon form factor measurements at JLab and other facilities, such as the JLab PRad experiment.