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

Members of the Theory Center took part in organizing the *A.I. for Nuclear Physics* workshop <https://www.jlab.org/conference/AI2020> at Jefferson Lab, whose aim was to explore ways in which AI and machine learning (ML) can be used to advance research in fundamental nuclear physics. In particular, Theory Center staff organized two working groups, on *Lattice QCD and Other Quantum Field Theories* and on *Bayesian Inference for Quantum Correlation Functions,* with participation of nuclear physicists and AI scientists from across many sub-fields. An important application of ML is to the "inverse problem" of inferring from experimental data the quantum correlation functions that characterize the 3-dimensional "tomographic" structure of hadrons in terms of the elementary quark and gluon (or parton) degrees of freedom of QCD. A summary report from the workshop is being prepared to highlight priority research directions to which AI can contribute, areas of commonality across the nuclear physics community and beyond, and workforce development.

The EIC User Group is presently conducting a program of "Yellow Report" studies aimed at specifying the detector requirements needed for the EIC physics program and quantifying the physics impact of the measurements. A remote workshop was taken place at Temple University on March 19-21 to summarize the current status of work done for the Yellow Report and plan for the next steps in this effort, https://indico.bnl.gov/event/7449/overview. Members of the JLab Theory Center are coordinating some of the Yellow Report studies and contributed prominently to the workshop: Nobuo Sato as convener of the Inclusive Processes Working Group; Christian Weiss as coordinator of the physics discussion in the Exclusive Processes Working Group, and through topical presentations.

Theory Center staff, Dr. Schiavilla and his collaborators reported the first *ab initio* calculation of neutrino and antineutrino charged-current inclusive scattering on 12C [arXiv:2003.07710]. It is based on a realistic treatment of nuclear dynamics based on two- and three-nucleon interactions and accompanying one- and two-body electroweak currents. The calculated neutrino flux-folded cross sections are found to be in good agreement with the MiniBooNE and T2K CCQE data. This success provides strong corroboration for the validity of the current theoretical framework, yielding a consistent picture of nuclei and their electroweak interactions across a wide regime of energy and momenta.

The CLAS collaboration has performed the first measurement of a2(1320) photoproduction cross-section at two different energies, and a paper has been submitted for a publication in Phys. Rev. Lett. The differential cross section, as function of the momentum transferred between the photon and the meson, displays a depletion at the same momentum transferred in both energies, characteristic of a diffractive production by Regge exchanges. JPAC provided a theoretical estimation of the cross section and an explanation of the dip mechanism. The dip originates from an exact zero in the coupling between the dominant vector isoscalar exchange and the nucleon target. It is conjectured that a similar dip will not be observed in the isospin-related photoproduction of the f2(1270) meson, currently under extraction by the CLAS and GlueX collaboration.