Theory and computation highlights in October, 2021
(Contribution to the Director's Monthly Report to JSABOD)
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Interpretation of recent experimental discoveries in hadron spectrum as exotic states is of utmost importance. These new observations can indicate existence of compact quark-gluon bound or other phenomena related to hadron-hadron interactions, opening a new widow to study QCD. For the first time, JPAC used neural networks to determine the nature of an exotic hadron [arXive:2110.13742], setting the path for a new way to study hadron resonances. This new approach was benchmarked against the $P_c(4312)$ reported by LHCb, confirming that it is most likely a virtual state.

The general structure of semi-inclusive polarized electron scattering from polarized spin-1/2 targets was recently developed by Dr. Van Orden and collaborators [arXiv:2109.08767] for use at all energy scales, from modest-energy nuclear physics applications to use in very high-energy particle physics. The leptonic and hadronic tensors that enter in the formalism were constructed in a general covariant way in terms of kinematic factors that are frame dependent but model independent, as well as invariant response functions containing the model-dependent dynamics. In the process of developing the general problem, the relationships to the conventional responses expressed in terms of the helicity components of the exchanged virtual photon was presented.

The JLab LDRD project the "EIC on a Table Top" was renewed for its second year, starting in October. A major activity this year is to evaluate and potentially expand a new system for photon measurements called Superconducting Nanowire Single Photon Detectors. JLab electronics personnel are working in cooperation with UVA project members to adapt the JLab f-ADC measurement systems to the signals from these detectors.

Hadrons composed of heavy quarks and antiquarks (so-called heavy quarkonia) play an important role as measures of the gluonic fields in Quantum Chromodynamics and probes of the hot and dense nuclear medium created in heavy-ion collisions. The EIC will enable a program of next-generation experiments aimed at producing heavy quarkonia in electron scattering processes and studying their interactions with hadrons and nuclei. A workshop at the Center for Frontiers in Nuclear Science at Stony Brook University on Oct. 25-27, co-organized by C. Weiss (JLab Theory Center & EIC Senior Team), highlighted recent developments in the physics of heavy quarkonia and assessed the requirements and prospects for the EIC experiments [https://indico.bnl.gov/event/12899/]. The workshop brought together >100 researchers in QCD theory, heavy-ion experiments (CERN LHC, BNL RHIC), and electron scattering (DESY HERA, JLab 12 GeV, EIC), including a large number of postdocs and students, and facilitated direct exchanges between the communities. One particular goal was to apply the lessons learned in heavy quarkonium experiments at RHIC, LHC, and HERA to the EIC physics and detector development.