Theory and computation highlights in October, 2019
(Contribution to the Director's Monthly Report to JSABOD)
November 20, 2019

"The Shape of the Light Antiquark Asymmetry" - Using data from a recent reanalysis of neutron structure functions from inclusive proton and deuteron DIS, the CJ (CTEQ-Jefferson Lab) collaboration re-examined the constraints on the shape of the light antiquark asymmetry in the proton at large parton momentum fractions x. A global analysis of the proton–neutron structure function difference from DIS measurements, combined with Drell-Yan lepton-pair production cross sections, suggests that existing data can be well described with dbar > ubar for all kinematics currently accessible. The new analysis [arXiv:1910.02931] compares the shape of the fitted dbar > ubar distributions with expectations from nonperturbative models based on chiral symmetry breaking, which can be tested by upcoming Drell-Yan data from the SeaQuest experiment at larger values of x.

JPAC submitted a paper [arXiv:1910.04566] that describes how to take into account binary interaction between pairs of pions that result from decays of resonances having arbitrary spin. We derived a set of integral equations, which incorporate these interactions to all orders and result in a set of reaction amplitudes that are manifestly Lorentz invariant, crossing symmetric and unitary. This is important because a vast majority of meson resonances, including the exotic, hybrid meson candidate, have large decay widths to three pions and a precise theoretical description of final state interactions is necessary for partial wave analysis and extraction of resonance properties. The next step is to solve (numerically) these equations in specific waves including the $J^{PC}=1^{++}$ wave that hosts the enigmatic a1 resonance and ultimately the exotic, $J^{PC}=1^{-+}$ wave.

Lattice gauge calculations have a vital role in nuclear and high-energy physics, both through providing an *ab initio* description of the quark and gluon structure of matter, and in the search for physics beyond the Standard Model of particle physics. The USQCD Collaboration, representing most of those working on lattice gauge theory across the US, wrote a series of seven white papers that identified the opportunities and tasks for lattice QCD in the advent of the exascale era. These white papers have now been published as a topical, refereed collection in European Physical Journal A, vol 55. Three of the those articles had Jefferson Lab members as one of the two editors: *Hadrons and Nuclei* (William Detmold, Robert Edwards *et al.*), *Status and future perspectives for lattice gauge theory calculations to the exascale and beyond* (Balint Joo, Chulwoo Jung, *et al.*), and *Lattice QCD and neutrino-nucleus scattering* (Andreas Kronfeld, David Richards *et al.*). The participation of the Jefferson Lab Theory Center as authors was wider still (Jo Dudek, Kostas Orginos, Raza Sufian). Together, these articles form an exciting manifesto for the US lattice community, and for Jefferson Labs role within it.

The ASCR Advisory Committee (ASCAC) has hosted two meetings to recommend on priorities for ASCR after the end of the Exascale Computing Project - set for 2023. After this date, the two Exascale machines, Aurora at ALCF (scheduled for deployment in FY21) and Frontier at OLCF (scheduled for FY23), should be in operation. R. Edwards was invited to attend the meetings and provide input on the priorities for Jefferson Lab and Nuclear Physics. A report and recommendation to ASCAC should be made available in a few months. Edwards also attend the

kickoff meeting for the Frontier computing system. The meeting held in Knoxville, brought together early developers as well as industry representatives from Cray and AMD.