Theory and computation highlights in May, 2022
(Contribution to the Director's Monthly Report to JSABOD)

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The paper, "Deep learning exotic hadrons" by JPAC, was published in Letters of Physical Review D [Phys. Rev. D105 (2022) L091501]. The first amplitude analysis of experimental data using deep neural networks to determine the nature of the pentaquark candidate, $P_c(4312)$ was reported. By studying its line shape as reported by the LHCb, it was found that it is most likely interpreted as that of a virtual state. This new method can be applied to other near-threshold resonance candidates.

The most basic information on the proton's finite spatial extent and composite internal structure comes from the distributions of electric charge and magnetic moment measured in elastic electron scattering experiments. In a recent paper [arXiv:2204.11863], C. Weiss and collaborators calculated the transverse electromagnetic densities in the proton and neutron from first principles, using a novel hadronic physics method combining chiral effective field theory and dispersion analysis. The method predicts the "peripheral" densities with controlled uncertainties and provides a robust theoretical framework for the analysis of low-energy electron scattering experiments at Jefferson Lab, Mainz, and other facilities.

An update of the JAM3D-20 QCD global analysis of single transverse-spin asymmetries is presented in a new paper [arXiv:2205.00999] by N. Sato and the JAM Collaboration. In the new analysis, referred to as JAM3D-22, the twist-3 chiral odd fragmentation function is extracted for the first time by incorporating the sin(φs) modulation data from semi-inclusive deep-inelastic scattering, along with its contribution to the single transverse-spin asymmetry in pion production from proton-proton collisions. The paper also explores the impact of lattice QCD tensor charge calculations and the Soffer bound on the global analysis.

Generalized parton distributions (GPDs) provide rich and fundamental information on spatial distributions of quarks and gluons inside a bound hadron, and opportunity to study QCD tomography of hadrons. In a new paper from Theory [arXiv:2205.07846], it was shown that exclusive production of a pair of high transverse momentum photons in pion-nucleon collisions and a class of similar exclusive processes can be systematically studied in QCD factorization approach if the photon's transverse momentum P_T with respect to the colliding pion is much greater than Λ_{QCD}. It was also demonstrated that this new type of exclusive processes is not only complementary to existing processes for extracting GPDs, but also capable of providing an enhanced sensitivity to the active parton's momentum fraction x-dependence of GPDs.