

Theory and computation highlights in June, 2019
(July 8, 2019)

The workshop “Lepton Interactions with Nucleons and Nuclei” held in Marciana Marina, Isola d'Elba, Italy, June 24-28, 2019, was the fifteenth meeting in a series started in 1988, meant to cover new developments in research areas ranging from nuclear astrophysics and neutrino physics to the physics of hadrons and nuclei at low and high energies. This year focus was on (i) hadron structure and spectroscopy, (ii) nuclear structure and reactions, (iii) gravitational waves, neutron star mergers, and the neutron matter equation of state, (iv) dark matter and prospects for future neutrino experiments/facilities, (v) neutrino physics, and (vi) neutrinoless double beta decay and BSM physics. Since 1992, R. Schiavilla, a Theory Center Staff joint with ODU, has co-organized many editions of this very well-attended and successful international workshop series, and leading the effort to set up the scientific programs (1) and (2) above while helping other sessions. This year, there was a large participation from the JLab community including five theorists from the Theory Center and seven experimental colleagues, and many new results from JLab were reported.

Researchers in the Theory Center, in collaboration with computer scientists at Old Dominion University and Davidson College, NC, received an award from the Center for Nuclear Femtography for a project on “*QCD Theory and Machine Learning*”. The goal of the project, led by Dr. Nobuo Sato as PI, who will be the Nathan Isgur Fellow starting in this fall, is to build the next generation of global QCD analysis tools using machine learning techniques to study the quantum probability distributions characterizing the internal structure of the nucleon. The project is multi-disciplinary in nature, requiring collaboration between nuclear physicists, computer scientists and information technology specialists. The resulting product will be an important new tool for the nuclear physics community, opening up new possibilities for collaboration with computer science in the exploration and visualization of the inner structure of hadrons and nuclei.

There have been different methods proposed for the analysis of semi-inclusive lepton-hadron/nuclei deep-inelastic scattering processes, in terms of Transverse Momentum Dependent parton distributions (or TMDs) at low and moderate values of Bjorken- x . I. Balitsky, a Theory Center Staff joint with ODU, completed a new paper attempting to reconcile the different approaches by first obtaining conformal leading-order evolution equations, in view of the urgency that the future Electron-Ion Collider will probe the intermediate- x region. The paper discusses the conformal properties of TMD operators and presents the results of the conformal rapidity evolution of TMD operators in the so called Sudakov region.

The JPAC collaboration has generalized the techniques of moment extraction for two-meson photoproduction to the case in which the incident photon beam is linearly polarized in a recent paper [arXiv:1906.04841]. This is particularly relevant at Jefferson Lab, and it is foreseen that the linearly polarized photon beam will play a fundamental role in the search for the exotic mesons. In particular, the GlueX collaboration in Hall D will soon start analyzing moments of the final state, for which our techniques will be used. This is an important example of the collaboration between the theory effort and experimentalists here at Jefferson Lab.