

Theory and computation highlights in April, 2020
(*Contribution to the Director's Monthly Report to JSABOD*)
May 4, 2020

JLab Theory, Rocco Schiavilla (joint staff with ODU) received the 2020 Gene W. Hirschfeld Faculty Excellence Award from the College of Science at Old Dominion University.

JLab Theory, organized by Robert Edwards, Jianwei Qiu, Kostas Orginos, and Rocco Schiavilla, hosted a Mini-lecture series on Quantum Information Science (QIS) with the aim to educate a new generation of Nuclear scientists. The series was funded under the Quantum Horizons FOA from DOE/NP. There were 9 experts in the field of QIS ranging from nuclear structure calculations to atomic and molecular systems experiments who each provided about 4 hours of lectures within their areas. About 90 people were registered for the meeting.

The pseudo-distribution approach for extraction of parton densities from lattice QCD calculation, which was pioneered at JLab, has been used to calculate the nucleon's valence quark distributions for ensembles with several different pion masses. Using factorization relations, the parton distributions and their moments have been determined on these ensembles and extrapolated to the physical limit [arXiv:2004.01687]. This calculation provides an important check of a systematic error in the determination of hadronic structure from the lattice matrix elements.

Short-range nucleon-nucleon correlations have been discussed recently as a possible explanation for the famous "nuclear EMC effect", or the differences between deep-inelastic structure functions of nucleons and nuclei. JLab Theory, Wally Melnitchouk and collaborators completed a new paper [arxiv:2004.03789] that examines the relative contributions to the nuclear EMC effect in deuterium from Fermi motion and nucleon off-shell effects, in models that have explicit Fermi motion, binding and off-shell contributions to the nuclear structure functions. The analysis finds that Fermi motion overwhelms the off-shell effects for nucleons inside short-range correlations (SRCs), calling into question the hypothesized causal connection between SRCs and the EMC effect. Suggestions are made for possible future experiments at JLab and the EIC that may further elucidate the microscopic origin of the nuclear EMC effect.

Rocco Schiavilla of Theory and collaborators has submitted a new paper [arXiv:2004.05263] on a comprehensive study of low energy weak transitions in light nuclei ($A=3-10$) fully within chiral effective transitions with quantum Monte Carlo methods.

Theorists at JPAC studied tensor meson photoproduction outside of the resonance region, at beam energies of few GeVs. They built a model based on Regge theory that includes the leading vector and axial exchanges. They considered two determinations of the unknown helicity couplings, and fit to the recent a_2 photoproduction data from CLAS. Both choices give a similar description of the a_2 cross section, but result in different predictions for the parity asymmetries and the f_2 photoproduction cross section. They concluded that new measurements of f_2 photoproduction in the forward region are needed to pin down the correct production mechanism. They also extend their predictions to the 8.5 GeV beam energy, where current experiments are running. A new paper summarizing their results was just submitted to arXiv. The f_2 measurements are expected soon from CLAS12 and GLueX.