Theory and computation highlights in February, 2019
(Jianwei Qiu, March 5, 2019)

Extracting the nucleon's generalized parton distributions (GPDs) from the JLab 12 GeV data in exclusive electron-nucleon scattering requires software tools for evaluating GPD physics models and experimental observables. To provide these tools, JLab is collaborating with the PARTONS project, a European-based development effort involving physicists and computer scientists, and JLab's effort is coordinated by Dr. Ch. Weiss, a Theory Center Senior Staff. A member of the PARTONS group, Dr. Pawel Sznajder (Center for Nuclear Studies, Warsaw, Poland) visited JLab in February 2019 to make practical arrangements for the use of the PARTONS software by JLab staff and users. During his visit, Dr. Sznajder gave a tutorial session about PARTONS, collected feedback regarding the computing practices and preferences of JLab users, and set up the use of PARTONS through modern platform-independent software "containers". He also participated in the planning of future joint development projects in the context of the planned Center for Nuclear Femtography.

Explaining the structure of hadrons in terms of quarks and gluons is of key importance to our understanding of strong interactions. Mapping hadron states with explicit gluonic degrees of freedom in the light sector has been a challenge, and has led to controversies in the past. Recently, COMPASS experiment reported two different hybrid candidates with spin-exotic signature, $\pi_1(1400)$ and $\pi_1(1600)$, which is not compatible with existing lattice QCD and phenomenological expectations. The JPAC collaboration published its new analysis results [A. Rodas et al., Phys. Rev. Lett. 122, 042002 (2019)] and shows no evidence for a second exotic state. Performing mass dependent analysis of the partial waves extracted by the COMPASS experiment for the first time they extracted resonance pole parameters of the exotic $\pi 1$ resonant pole, with mass and width $1564\pm24\pm86$MeV and $492\pm54\pm102$MeV, which couples to both $\eta(')\pi$ channels.

The parton distribution functions (PDFs) encode important nonperturbative information of hadron structure and strong interaction dynamics. Since parton distribution functions (PDF) cannot be directly calculated from lattice QCD, one must instead calculate quantities related to PDFs by integral equations. As the range of data available to lattice calculations is limited, the extraction of PDFs from lattice QCD calculations constitutes an ill-posed "inverse problem". The Theory Center joint staff, Dr. Orginos and collaborators in a new paper [arXiv:1901.05408] explored pros and cons three methods for solving this inverse problem: the Backus-Gilbert inverse method, parameterizing the PDF with a neural network, and finding the most probable PDF through a Bayesian inference. They found that the ill-posed incomplete Fourier transform underlying the reconstruction requires careful regularization, for which both the Bayesian approach as well as neural networks are efficient and flexible choices.