Theory and computation highlights in July, 2020
(Contribution to the Director's Monthly Report to JSABOD)
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Quantum Computing offers the opportunity to directly simulate field theories such as QCD with physical time evolution. Access to properties of the theory are possible that are not amenable to conventional lattice QCD techniques. In a new paper [arXiv:2007.01155], the Theory Center's Raul Briceno, Juan Guerrero and their collaborators explored the limitations for this formulation of QCD and suggested strategies for improving the extraction of physical scattering amplitudes important for the JLab and the broader Nuclear Physics program. This work provides the foundation for a recent proposal to the JLab's LDRD program.

Jet production in deep-inelastic scattering (DIS) provides an excellent tool for understanding the structure of nucleons and nuclei in terms of quark and gluons. Theory Center's N. Sato and collaborators proposed a new jet algorithm for DIS that accounts for the forward-backward asymmetry in the Breit frame [arXiv:2006.10751]. The algorithm is longitudinally invariant and can cluster jets with Born kinematics, enabling novel studies of transverse momentum dependent observables. The authors show that spherically-invariant algorithms in the Breit frame give access to low-energy jets from current fragmentation, and propose novel studies in unpolarized, polarized, and nuclear DIS at the future Electron-Ion Collider.

The Electron-Ion Collider (EIC) will be built as a new electron-hadron facility with capabilities that could improve our understanding of hadron spectrum. In a recent paper [arXiv:2008.01001], theorists at JPAC calculated the cross sections for exclusive photo-production of several XYZ states at the EIC as well as at a high luminosity and higher energy CEBAF. The observation of these XYZ states, which were shown to be measurable at these facilities, would provide a novel and independent confirmation of their existence, as well as new insights into the nature of these new hadronic states.

Several SuLI and REU students worked with members of the Theory Center over the summer, and presented their work in an online "poster session" at the end of the month. Zaki Panjsheeri worked with member of the HadStruc collaboration on investigating the impact of direct calculations of the moments of Parton Distribution Functions (PDFs) on parametrizations of x-dependent PDFs computed on the lattice. With the increasingly precise calculations of the isovector PDFs, the impact was somewhat small, but with the emergence of calculations of flavor-singlet PDFs, more prominent at small x, the constraints of low-moment calculations are likely to be more significant.