Theory and computation highlights in December, 2018
(Theory and computation to Drector's Monthly Report to JSABOD)
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Lattice QCD has made tremendous progresses in recent years and finite volume observables obtained numerically in lattice QCD calculations could be mapped onto infinite-volume physical quantities with a controllable accuracy, from which scattering processes could now be studied via lattice QCD approach. Theory Center joint staff, Dr. Raul Briceno, who is a 2018 DOE Early Career Award winner, and his collaborators presented the most general formalism to date to study three-hadron dynamics allowing for the presence of resonant subsystems. This is a necessary step to study, for example, the Roper resonance, which has a significant branching fraction to $\pi\Delta$ as well as to $N\sigma$ [arXiv.1810.01429].

Mapping states with explicit gluonic degrees of freedom in the light sector for the search of hybrid candidates is a challenge, and has led to controversies in the past. For example, the experiments have reported two different hybrid candidates with spin-exotic signature, pi1(1400) and pi1(1600), coupling separately to eta pi and eta' pi channels, which is not compatible with lattice QCD and phenomenological expectations and results into an outstanding puzzle. JPAC collaboration initiated a new analysis by fitting the intensities and phases of the $\eta\pi$-$\eta'\pi$ system extracted by COMPASS experiment with a coupled-channel amplitude [arXiv:1810.04171]. This analysis provides a robust extraction of a single exotic π_1 resonant pole, finding no evidence for a second exotic state, and thus reconciling the experimental data with the theoretical predictions.

Any reliable calculation in lattice QCD must confront excited-state contamination and statistical precision, where attempts to reduce excited-state effects are often handled with various "smearing" algorithms. Distillation, a particularly powerful form of smearing, has seen extensive use in spectroscopy calculations, yet has not seen use in calculations of hadronic structure. Staff and students at the Theory Center completed a new study finding that distillation applied to calculations of the scalar, axial and tensor isovector charges of the nucleon leads to a dramatic reduction in statistical uncertainty and excited-state contamination when compared to conventional methods [arXiv:1810.09991], which help make a strong case for the use of distillation in future, more elaborate, structure calculations.