Theory and computation highlights in December, 2022
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The years 2022-2023 mark the 50th anniversary of the emergence of Quantum Chromodynamics (QCD) as the fundamental theory of strong interactions. The formulation of this quantum field theory and its application to hadron structure and scattering processes have revolutionized our understanding of the subnuclear world and laid the foundation for present experimental and theoretical investigations, including the programs at JLab, RHIC BNL, EIC, and other facilities worldwide. A group of researchers, led by Franz Gross (Emeritus, JLab Theory) and Eberhard Klempt (Bonn U.), has compiled a review article "50 years of Quantum Chromodynamics" with 567 pages of text, 95 authors and almost 5000 references [arXiv:2212.11107], covering the history and present status of QCD (to appear in European Physics Journal). It includes contributions from J. Dudek, W. Melnitchouk, K. Orginos, J. Qiu, C. Weiss (JLab Theory Center) and V. Burkert, A. Deur, B. Grube, P. Rossi (JLab Physics). The article aims to provide a broad background for students and junior career researchers entering the field.

A new paper [arXiv:2212.00757] by Dr. Ted Rogers and colleagues makes transparent the steps of factorization in renormalizable quantum field theories, by illustrating them in a scalar Yukawa theory, where the dynamics of all spacetime scales are calculable in low-order perturbation theory. The exact, unapproximated calculations are compared in both inclusive and semi-inclusive deep-inelastic scattering with collinear and transverse momentum dependent factorization descriptions. The results highlight some of the subtleties of factorization and point to the need to address analogous issues in QCD.

New work by Dr. Felix Ringer and collaborators [arXiv:2212.02432] explores the potential of jet observables in charged-current deep-inelastic scattering events at the future Electron-Ion Collider (EIC). Tagging jets with a recoiling neutrino will allow for flavor-sensitive measurements of transverse momentum dependent parton distribution functions (TMD PDFs). Although charged current jet measurements are challenging in terms of luminosity requirements, they will complement the EIC experimental program to study the three-dimensional structure of the nucleon encoded in TMD PDFs.