

## Theoretical and Computational Physics highlights in January, 2024

### **Analytic Solutions of DGLAP Evolution and Theoretical Uncertainties**

Parton distribution functions have played a central role in the investigation of the strong force since the early days of QCD. It has long been understood that PDFs are solutions of a set of integro-differential equations, usually referred to as the DGLAP evolution equations, with proper boundary conditions. Analytic solutions of the DGLAP evolution equations for the singlet sector of PDFs inevitably require the introduction of approximations, differing in the treatment of the theoretical uncertainties. A new paper [arXiv:2401.13663] by Dr. Andrea Simonelli, joint postdoctoral appointment in the Theory Center and ODU, discusses a novel and more accurate analytic solution of the equations in Mellin space and compares that with previous results.

### **Extracting Transition GPDs with a Pion Beam**

Generalized parton distributions (GPDs) and transition GPDs are fundamental quantum correlation functions of partons inside confined hadrons, carrying rich information on tomographic images of the hadron. In a new paper [arXiv:2401.13207], Dr. Jianwei Qiu and Theory Center postdoc Dr. Zhite Yu proposed a new observable for extracting the transition GPDs at the J-PARC (in Japan) and AMBER (at CERN) with an energetic pion beam. This new diphoton process not only gives a higher production rate, but also complements other proposed observables (such as the dilepton process) by offering better sensitivity to extract the parton momentum fraction  $x$  dependence of GPDs.

### **Phenomenology of TMD Parton Distributions in Drell-Yan and Z0 Boson Production**

A new paper by Dr. Ted Rogers and collaborators [arXiv:2401.14266] performs a first implementation of a recently developed "Hadron Structure Oriented" approach to TMD phenomenology by comparing with Drell-Yan and Z boson production measurements. The results demonstrate how the predictive power contained within nonperturbative transverse momentum dependence can be exploited and used to test specific nonperturbative theoretical treatments. It also includes new extractions of the nonperturbative Collins-Soper evolution, and contrasts the methodology with that of the JAM and MAP collaborations.