Ben Assi – Special HEP seminar – February 24, 2025
University of Cincinnati

Title: Precision QCD and EFT for Next-Generation Collider Studies

Abstract:
In this talk, I present a research program that leverages precision QCD and effective field theory (EFT) methods to improve theoretical predictions for current and future collider experiments.
Monte-Carlo simulations in the form of parton shower algorithms are a leading source of systematic uncertainty in this context. I will discuss the development of a next-to-leading logarithmic accurate algorithm for both massless and massive parton evolution. I will then explain how to employ information theory and machine learning to improve generators in general and hadronization models in particular.
Despite computational advances, traditional lattice QCD continues to face significant challenges in studying exotic multi-quark states due to large excited state contamination. To address these issues, I discuss the development of an EFT for multi-hadron systems in the heavy quark limit, coupled with advanced quantum Monte-Carlo methods from nuclear theory. This framework enables the study of exotic bound states observed at colliders as well as strongly-coupled dark matter.
Lastly, I explain how exploiting the inherent geometric and energetic structure of EFTs in general simplifies higher-order calculations and permits a systematic identification of energy-enhanced operators in the Standard Model EFT (SMEFT), thereby refining predictions for high-energy processes.