T 2: QCD (Theorie) 1

Time: Monday 16:15–18:30 Location: T-H15

T 2.1 Mon 16:15 T-H15

Soft photon bremsstrahlung at Next-to-Leading Power — •Domenico Bonocore and Anna Kulesza — Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster

A long-standing discrepancy in the soft photon bremsstrahlung has attracted a renewed attention in view of the proposed measurements with a future upgrade of the ALICE detector in the upcoming runs of the LHC. In this talk I will discuss the possibility to implement techniques that have been recently developed for soft gluon resummation at Next-to-Leading-Power (NLP) to the soft photon spectrum.

T 2.2 Mon 16:30 T-H15

Leading-Color Two-Loop Amplitudes for Four Partons and a W-Boson in QCD — Samuel Abreu[1,2,3], Fernando Febres Cordero[4], Harald Ita[5], •Maximilian Klinkert[5], Benjamin Page[1], and Vasily Sotnikov[6] — [1]Theoretical Physics Department, CERN, Geneva — [2]Higgs Centre for Theoretical Physics, School of Physics and Astronomy,The University of Edinburgh — [3]Mani L. Bhaumik Institute for Theoretical Physics, Department of Physics and Astronomy, UCLA, Los Angeles — [4]Physics Department, Florida State University, Tallahassee — [5]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg — [6]Max Planck Institute for Physics (Werner Heisenberg Institute), München

Leading-Color Two-Loop Amplitudes for Four Partons and a W-Boson in QCD

I will present the leading-color two-loop QCD corrections for the scattering of four partons and a W boson, including its leptonic decay. The amplitudes are assembled from the planar two-loop helicity amplitudes for four partons and a vector boson decaying to a lepton pair. The analytic expressions are obtained by setting up a dedicated Ansatz and constraining the free parameters from numerical samples obtained within the framework of numerical unitarity. Our results are expressed in a basis of one-mass pentagon functions, which opens the possibility of their efficient numerical evaluation.

T 2.3 Mon 16:45 T-H15

Fast simulations with NNLO QCD accuracy — •Lucas Kunz — Karlsruhe Institute of Technology, Karlsruhe, Germany

The calculation of theoretical predictions for hadron colliders at higher orders in perturbation theory involves computing time expensive iterative procedures. The same is true for the extraction of parton distribution functions (PDFs) from measured data. Hence, to produce results in reasonable time, a very efficient and flexible setup is needed. The APPLfast project fulfills these requirements by linking the parton-level Monte Carlo program NNLOjet with both the APPLgrid and fastNLO grid libraries, thereby allowing for an a posteriori choice of a set of PDFs or value of the strong coupling constant. This talk will give an overview of the project, focusing on an explanation of the general logic and on possible applications rather than technical details.

T 2.4 Mon 17:00 T-H15

MiNNLO$_{PS}$ for dibosons: matching NNLO QCD with parton showers — •Daniele Lombardi[1], Marius Wiesemann[1], Giulia Zanderighi[1], Gabriël Koole[1], Luca Buonocore[2], and Luca Rottoli[2] — [1]Max-Planck-Institut für Physik, Munich, Germany — [2]University of Zurich, Zurich, Switzerland

The comparison of theory calculations against experimental measurements for many particle collider processes is nowadays one of the main roads towards the discovery of new physics. The tremendous amount of data collected and the great effort of the experimental collaborations have allowed us to reach an unprecedented accuracy in the measurements of many processes. To avoid that the theory uncertainties become the limiting factor of this comparison, a similar effort from the theory community is demanded. In this talk, I will first motivate why matching our best available fixed-order results with parton showers is a necessary step in this direction. Then I will focus on MiNNLO$_{PS}$, which is one of the latest methods that have been proposed to embed a next-to-next-to-leading order QCD calculation into a full-fledged Monte Carlo event generator. Originally formulated for single boson production, this method has been recently extended to general color-singlet final states and successfully applied to different diboson processes, such as $Z\gamma$, W^+W^- and ZZ. After a brief review of the underlying idea of MiNNLO$_{PS}$ and a presentation of the main results, I will conclude by highlighting the potential of the method for future applications.

T 2.5 Mon 17:15 T-H15

Automating the calculation of jet functions and beam functions in SCET — Guido Bell, •Kevin Brune, Goutam Das, and Marcel Wald — Center for Particle Physics Siegen, Theoretische Physik 1, Universität Siegen

In perturbative QCD large logarithms can arise in the computation of collider observables. These logarithms can be resummed via factorization theorems within Soft-Collinear Effective Theory(SCET). These factorization theorems include beam functions accounting for the initial-state collinear interactions and jet functions for the final-state collinear interactions. While these functions have been calculated case by case for different observables until now, we are investigating an automated approach for a general class of observables. For this, we study a general phase-space parameterization that factorizes the universal singularities of the functions. We have implemented this framework for different observables, by using the public code "pySecDec" to compute the next-to-next-to-leading order beam and jet function.

T 2.6 Mon 17:30 T-H15

Invertible Networks for the Matrix Element Method — Anja Butter[1], •Theo Heimel[1], Till Martini[2], Sascha Peitzsch[2], and Tilman Plehn[1] — [1]Institut für Theoretische Physik, Universität Heidelberg, Germany — [2]Institut für Physik, Humboldt-Universität zu Berlin, Germany

For many years, the matrix element method has been considered the perfect approach to LHC inference. We show how conditional neural networks can be used to unfold detector effects and initial-state QCD radiation, to provide the hard-scattering information for this method. We illustrate our approach for the CP-violating phase of the top Yukawa coupling in associated Higgs and single-top production.

T 2.7 Mon 17:45 T-H15

Targeting Multi-Loop Integrals with Neural Networks — •Ramon Winterhalder[1,2,3], Vitaly Magerya[4], Emilio Villa[4], Stephen P. Jones[5], Matthias Kerner[4,6,7], Anja Butter[1,2], Gudrun Heinrich[2,4], and Tilman Plehn[1,2] — [1]Institut für Theoretische Physik, Universität Heidelberg, Germany — [2]HEiKA - Heidelberg Karlsruhe Strategic Partnership, Heidelberg University, Karlsruhe Institute of Technology (KIT), Germany — [3]Centre for Cosmology, Particle Physics and Phenomenology (CP3), Université catholique de Louvain, Belgium — [4]Institut für Theoretische Physik, Karlsruher Institut für Technologie, Germany — [5]Institute for Particle Physics Phenomenology, Durham University, UK — [6]Institut für Astroteilchenphysik, Karlsruher Institut für Technologie, Germany — [7]Physik-Institut, Universität Zürich, Switzerland

Numerical evaluations of Feynman integrals often proceed via a deformation of the integration contour into the complex plane. While valid contours are easy to construct, the numerical precision reached for a multi-loop integral can depend critically on the chosen contour. We present methods to optimize this contour using a combination of machine-learned complex shifts and a normalizing flow. This can, potentially, lead to a very significant gain in precision.

T 2.8 Mon 18:00 T-H15

Generative Networks for Precision Enthusiasts — •Anja Butter, Theo Heimel, Sander Hummerich, Tobias Krebs, Tilman Plehn, Armand Rousselot, and Sophia Vent — U. Heidelberg, ITP

Generative networks are opening new avenues in fast event generation for the LHC. We show how generative flow networks can reach percent-level precision for kinematic distributions, how they can be trained jointly with a discriminator, and how this discriminator improves the generation. Our joint training relies on a novel coupling of the two networks which does not require a Nash equilibrium. We then estimate the generation uncertainties through a Bayesian network setup and through conditional data augmentation, while the discriminator ensures that there are no systematic inconsistencies compared to the training data.

T 2.9 Mon 18:15 T-H15

Development of transverse flow for small and large systems in conformal kinetic theory — •Clemens Werthmann[1], Sören Schlichting[1], and Victor Eugen Ambrus[2,3] — [1]Universität Bielefeld, Germany — [2]Goethe-Universität Frankfurt, Germany — [3]West University of Timisoara, Romania

We employ an effective kinetic description to study the space-time dynamics and development of transverse flow of small and large collision systems. By combining analytical insights in the few interactions limit with numerical simulations at higher opacity, we are able to describe the development of transverse flow from very small to very large opacities, realised in small and large collision systems. Surpisingly, we find that deviations between kinetic theory and hydrodynamics persist even in the limit of very large interaction rates, which can be attributed to the presence of the early pre-equilibrium phase. We discuss implications for the phenomenological description of heavy-ion collisions and the applicability of viscous hydrodynamics to describe small and large collision systems.

[1] V.Ambrus, S.Schlichting, C.Werthmann arXiv:2109.03290