Workshop summary

Nikhef hosted the workshop "Next-to-leading power corrections in particle physics" from November 5 to 7, 2018, as part of Working Group 2 of COST action ParticleFace. This was the second workshop dedicated to power corrections, with the first being held at the University of Edinburgh on 25-28 January 2016.

The calculation of next-to-leading power corrections is a necessary step towards precise predictions for scattering processes at modern colliders. The goal of the workshop was to bring together the groups working on this topic, and create an environment to facilitate discussions, to exchange ideas, and compare different methods. To achieve this, the workshop consisted of seminar sessions alternated with discussion sessions. Seminars consisted of 30 minutes presentation and 15 minutes of discussion time, which was enough to allow the speakers to discuss their research topic in depth, and provide technical details about methods and results.

The topics that were discussed fall into three main subjects, namely next-to-leading power (NLP) corrections in fixed-order calculations, resummation of NLP logarithms, and diagrammatic methods to study the factorization of amplitudes at NLP.

The first topic was covered during the first day of the workshop.

Andrea Isgro (Northwestern) discussed how power corrections can be used to improve the N-jettiness subtraction scheme. In this scheme, phase space is divided into two regions, defined as above or below a cut on the N-jettiness observable. At next-to-next-to-leading order (NNLO), the calculation in the phase-space region above the cut essentially reduces to a next-to-leading order calculation. The other region requires a true NNLO calculation, but can be approximated using a factorization theorem if the value of the cut is chosen to be small. In his talk Andrea discussed how the inclusion of power corrections in the factorization theorem improves the precision of this method, allowing for higher values of the cut, and making the numerical integration easier. He discussed results in the context of Higgs production through gluon fusion.

Frank Tackmann (DESY) also focused on the calculation of power corrections for N-jettiness. He presented a numerical analysis showing how the inclusion of power corrections is expected to improve fixed-order calculations, provided additional details on the structure of factorization in Soft-Collinear Effective Theory (SCET) beyond leading power. He presented a detailed numerical analysis for both Higgs production and Drell-Yan at NNLO.

The second topic, the resummation of threshold NLP logarithms, was the subject of several talks:

Jian Wang (TUM) discussed the calculation of anomalous dimensions of subleading power jet operators in SCET, which is a necessary ingredient for resummation of NLP threshold logarithms. In particular, the result presented in the talk will be relevant for the resummation of NLP logarithms up to next-to-leading logarithmic (NLL) accuracy.

Gherardo Vita (MIT) presented a talk discussing the factorization of event shape observables beyond leading power, leading to the first resummation of NLP logarithms at leading logarithmic (LL) accuracy.

Sebastian Jaskiewicz (TUM) discussed the factorization of Drell-Yan cross section in the threshold limit beyond leading power, showing how collinear radiation can be factorised into “collinear functions”, which contribute to NLP logarithms starting at NLL accuracy.

Robert Szafron (TUM), starting from the factorization theorem discussed in the previous talk, discussed the calculation of soft functions and the derivation of renormalization group evolution equation, which allowed them to achieve the resummation of NLP threshold logarithms in Drell-Yan at LL logarithmic accuracy.

The third day of the workshop was dedicated to the discussion of diagrammatic methods:

Chris White (QMUL) discussed the application of the method of regions to derive the Drell-Yan cross section to N^3LO in perturbation theory, up to NLP. He focused on the factorization structure of the Drell Yan amplitude with two soft gluon emissions, discussing a peculiar soft region involving soft quarks, which starts at N^3LO. Its presence would be problematic for the resummation of NLP logarithms, because its presence cannot be predicted from lower loop results. However, the explicit calculation shows that it actually contributes only at N^4LL.

Melissa van Beekveld (Radboud), presented an investigation of NLP logarithms in prompt photon production. Recently, it had been shown that NLP logarithms are universal at NLO in processes without colored particles in the final state. Her preliminary results indicate that this universality at NLO extends to processes with colored particles in the final state like prompt photon production.

The workshop has been very successful, both from the point of view of the presented results and the discussions that took place. Substantial progress has been achieved since the time of the first workshop in Edinburgh, and the relevance of NLP logarithms is now more widely appreciated by the community. The number of application of NLP logarithms has increased, and the first resummations have been achieved. At the same time, the number of possible applications and theoretical development necessary to (for example) achieve resummation at the NLL accuracy are still largely ahead of us, and the workshop has been an excellent occasion for the various groups to discuss future developments and trigger new ideas.