Description of master project
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Colour-Flow Evolution at Next-to-leading Order

In my master project, under supervision of Dr. Simon Plätzer, key quantities to perform soft gluon evolution at next-to-leading order (NLO) were determined. Soft gluon evolution is concerned with a perturbative expansion of scattering amplitudes by adding soft gluon corrections to a hard process. The soft gluon evolution equations then allow to resum large logarithms, which is necessary to make precise predictions for infrared sensitive observables, in particular also for non-global observables.
The main focus of the master project was the detailed analysis of the one-loop/one-emission and two-loop Feynman diagrams involving soft gluons. The analysis was separated into two parts - the QCD colour structure and the kinematical part.
The amplitudes were treated as vectors in colour-space, we have chosen to decompose them in terms the colour-flow basis. The determination of the colour structures in the colour-flow basis lead us to results for the general form of the soft anomalous dimension matrices at one-loop/one-emission and at two-loop order. In this study we found structures of special importance arising at two-loop order, extending the sum over two-parton correlations to include three-parton correlations as well.
The kinematical part of the amplitudes was treated with the so-called Feynman tree theorem (FTT), which allowed us to rewrite the loop-integrals in the form of phase-space type integrals. As a result the cancellation of infrared divergences at the integrand level of the considered cross-section could be demonstrated. Additionally, we extended the FTT in order to be able to apply it to two-loop integrals, eikonal propagators and propagators raised to higher power.
My master project thus provided some of the key ingredients when aiming to perform soft gluon evolution and the resummation of non-global logarithms at next-to-leading logarithmic level as well as beyond the large-N limit of QCD. The insights gained during the project also lead to a publication of a research paper about this work with the title “Towards Colour Flow Evolution at Two loops”.