T 13: QCD (Theorie) 3

Convenor: Steffen Schumann

Zeit: Donnerstag 16:45–19:00 Raum: VG 3.103

T 13.1 Do 16:45 VG 3.103

Numerical evaluation of multi-loop integrals — •Sophia Borowka[1], Jonathon Carter[2], and Gudrun Heinrich[1] — [1]Max-Planck Institute for Physics, Munich, Germany — [2]Institute for Particle Physics Phenomenology, University of Durham, UK

In this talk the new version of the public program SecDec 2.0 for the numerical evaluation of multi-loop integrals with several mass scales is presented. The program is based on sector decomposition to extract dimensionally regulated singularities. To deal with integrable singularities due to mass thresholds, the integration contour is deformed into the complex plane. As applications, numerical results for several two-loop integrals are given, including non-planar two-loop four-point functions entering heavy quark pair production at NNLO.

T 13.2 Do 17:00 VG 3.103

Two loop corrections for single top quark production — •Mohammad Assadsolimani, Philipp Kant, Bas Tausk, and Peter Uwer — Institut für Physik - AG PEP, Humboldt-Universität zu Berlin

Single-top-quark production enables us to study the nature of the weak interaction and to measure directly the Cabibbo-Kobayashi-Maskawa matrix element V_{tb}. For a detailed analysis of this process, precise theoretical predictions are required. The results available in the literature include the leading-order QCD corrections which are found to be small. Since in leading-order QCD no color exchange between the two incoming quarks is allowed, one can expect that higher-order QCD corrections may give a significant contribution. It is thus important to take these corrections into account. One important ingredient to extend the accuracy of the available predictions are the two-loop amplitudes. In this talk we discuss the methods used to assess the two-loop corrections and show first results for specific color configuration.

T 13.3 Do 17:15 VG 3.103

Integrating massive 3-loop diagrams with operator insertions — •Johannes Blümlein and Fabian Wissbrock — DESY

An extension of the method to integrate scalar finite massless Feynman integrals in $D = 4$ space-time dimensions [arXiv:0804.1660] is presented. We allow for the insertion of local operators, which leads to a dependence on the general operator spin variable N and calculate a series of 3-loop topologies containing a single massive line. These terms contribute to the heavy flavor corrections of the deep-inelastic structure functions at 3-loop order in the asymptotic region $Q^2 >> m^2$. The mathematical background of the computation relies on hyperlogarithms, generalizing the harmonic polylogarithms. Advanced summation methods are used in a final step to obtain compact results in terms of generalized harmonic sums. The method allows for the first computation of a series of diagrams and gives very compact expressions in intermediate and final results.

T 13.4 Do 17:30 VG 3.103

Simultaneous decoupling of bottom and charm quarks — Andrey Grozin[1], Maik Höschele[2], •Jens Hoff[2], and Matthias Steinhauser[2] — [1]Budker Institute of Nuclear Physics, Novosibirsk 630090, Russia — [2]Institut für Theoretische Teilchenphysik, Karlsruher Institut für Technologie, D-76128 Karlsruhe, Germany

We compute the decoupling relations for the strong coupling, the light quark masses, the gauge-fixing parameter, and the light fields in QCD with heavy charm and bottom quarks to three-loop accuracy taking into account the exact dependence on m_c/m_b. The application of a low-energy theorem allows the extraction of the three-loop effective Higgs-gluon coupling valid for extensions of the Standard Model with additional heavy quarks from the decoupling constant of α_s.

T 13.5 Do 17:45 VG 3.103

Running of α_s in a momentum subtraction scheme — •Maik Höschele and Matthias Steinhauser — Institut für Theoretische Teilchenphysik, Karlsruher Institut für Technologie, D-76128 Karlsruhe, Germany

In contrast to the $\overline{\rm MS}$ scheme the decoupling of heavy particles is automatically incorporated in momentum subtraction schemes. We consider the strong coupling constant and compute both, the beta function in a momentum subtraction (MOM) scheme and the relation of α_s in the MOM and $\overline{\rm MS}$ scheme to three-loop accuracy. We compare the running of α_s at various renormalization scales and find good numerical agreement, demonstrating the equivalence of both schemes.

T 13.6 Do 18:00 VG 3.103

Current Correlators and the Differential Equation Method — •Jonathan Grigo, Jens Hoff, Peter Marquard, and Matthias Steinhauser — Institut für Theoretische Teilchenphysik, Karlsruher Institut für Technologie

Moments of non-diagonal current correlators with two different non-vanishing quark masses are considered in QCD to three-loop order. We describe the calculation and discuss in detail the evaluation of the master integrals with the help of the differential equation method.

T 13.7 Do 18:15 VG 3.103

Three Loop Contributions to the Matrix Elements in the Variable Flavor Number Scheme — Johannes Blümlein[1], •Alexander Hasselhuhn[1], and Carsten Schneider[2] — [1]DESY — [2]RISC, JKU Linz

The variable flavor number scheme may be used to describe parton distributions in the transition region in which one heavy quark gradually becomes a light flavor. We present first three-loop results to the massive operator matrix elements A_{gg} and A_{gq} for the contributions due to bubble topologies $\propto T_F^2 n_f$ at general values of the Mellin variable N. The calculation has been performed using higher transcendental functions and by applying modern summation technologies encoded in the package `Sigma`. These massive operator matrix elements describe the universal contributions in the matching of different flavor sectors, which are the logarithmic and constant contributions in the ratio of m_H^2/Q^2, with Q^2 the virtuality and m_H the respective heavy quark mass. The framework allows to derive heavy quark parton distributions which are of relevance for calculating specific processes at hadron-hadron colliders.

T 13.8 Do 18:30 VG 3.103

Decay Rate of the Z-boson into hadrons at $\mathcal{O}(\alpha_s^4)$ — •Pavel Baikov[2], Konstantin Chetyrkin[1], Johann Kühn[1], and Jörg Rittinger[1] — [1]Institut für theoretische Teilchenphysik, KIT, Karlsruhe — [2]Institute of Nuclear Physics, Moscow State University, Moscow

To calculate the decay rate of the Z-boson into hadrons (Γ_Z), one has to do two steps. First the heavy top quark has to be decoupled, which leads to an effective massless 5-flavour QCD. Second the imaginary part of the Z-propagator, which is related to Γ_Z due to the optical theorem, has to be calculated in this effective theory. This was done up to $\mathcal{O}(\alpha_s^4)$, including the calculation of 5-loop propagators.

Since Γ_Z is related to one of the most precise determinations of α_s, our calculation will improve the existing 3 loop fit, resulting in a small shift in α_s and a reduction of the theory uncertainty.

T 13.9 Do 18:45 VG 3.103

OPE of the energy momentum tensor correlator in QCD — •Max Zoller — KIT, Karlsruhe, Germany

The operator product expansion (OPE) is a very usefull tool to separate the perturbative high energy physics from the low energy contributions in a controlled way. This is done by expanding the correlator of some current into a series of local operators with so-called Wilson coefficients. An important correlator is the one of the energy momentum tensor in QCD which plays an important role e.g. in sum rule approaches to glueballs and the transport and other properties of the quark gluon plasma. The focus of this talk will be on the general idea of an OPE and the presentation of the results for the leading Wilson coefficient and the coefficient in front of the gluon condensate for the energy momentum tensor correlator in higher orders.