T 12: QCD (Theorie) / Quantenfeldtheorie

Convenor: Michal Czakon / York Schröder

Zeit: Freitag 14:00–16:20 Raum: 30.23: 10-1

T 12.1 Fr 14:00 30.23: 10-1

Effects of Anisotropy in QED_3 — •Jacqueline A. Bonnet[1], Christian S. Fischer[1,2], and Richard Williams[3] — [1]Institut für Theoretische Physik, Universität Gießen, D-35392 Gießen, Germany — [2]Gesellschaft für Schwerionenforschung mbH, D-64291 Darmstadt, Germany — [3]Institut für Kernphysik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany

I investigate anisotropic QED in (2+1) dimensions in the framework of Dyson–Schwinger equations for the fermion and gauge boson propagator. Of particular interest is the critical number of fermions with respect to dynamical mass generation. I report on the findings of the effects of anisotropy obtained within different approximation schemes such as large-N_f and the minimal Ball-Chiu approximation.

This work has been supported by the Helmholtz-University Young Investigator Grant No. VH-NG-332.

Gruppenbericht T 12.2 Fr 14:15 30.23: 10-1

Dimensionally reduced QCD at high temperature — •Jan Möller — Universität Bielefeld, Bielefeld, Deutschland

QCD at high temperature T exhibits three different momentum scales T, gT and g^2T. Pertubation theory restricted to the momentum scale T can be treated with conventional methods. But at higher order in pertubation theory, the other scales enter the stage and can contribute to obervables.In contrast to the momentum scale T, these low momentum scales are only accessible through improved analytic methods or non-perturbatively via lattice simulations, as is especially the case for the g^2T scale.

At high temperature these momentum scales are clearly separated and allow to construct a sequence of two effective field theories by integrating out the gT and g^2T scale.

I will discuss recent progress in this framework in determining the different matching coefficients and point out the difficulties.

T 12.3 Fr 14:35 30.23: 10-1

Consistency of modified Maxwell theory: microcausality and unitarity — Frans Klinkhamer[1] and •Marco Schreck[2] — [1]Karlsruhe Institute of Technology (KIT), Karlsruhe — [2]Karlsruhe Institute of Technology (KIT), Karlsruhe

Recent prototypes of a unification of quantum theory and gravitation such as string theory or loop quantum gravity can, under certain assumptions, lead to Lorentz symmetry breaking. In the low energy limit violation of Lorentz invariance can be described in the framwork of an effective quantum field theory. Background fields are introduced that manifestly break Lorentz symmetry and lead to a deformation of the Standard Model of particle physics.

Modified Maxwell theory, which is a modification of the photon sector, will be presented. The Lorentz-violating part of the theory is described by 19 free parameters. In order to reduce the number of parameters, the theory will be restricted to physically interesting cases.

Theses cases have been examined with respect to consistency concerning microcausality and unitarity. The results of these examinations will be presented and conclusions made.

T 12.4 Fr 14:50 30.23: 10-1

Energy-Momentum Tensors with Worldline Numerics — •Marco Schäfer, Holger Gies, and Idrish Huet Hernandez — Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, D-07743 Jena, Germany

We apply the worldline formalism and its numerical Monte-Carlo approach to computations of fluctuation induced energy-momentum tensors.

In the case of a fluctuating Dirichlet scalar this formalism allows the computation of induced energy-momentum tensors in arbitrary Casimir configurations.

Our methods can straightforwardly be used to investigate potential violations of positive-energy conditions by quantum field theories. These energy conditions are of particular interest in General Relativity where they are imposed on the energy-momentum tensor in order to avoid exotic spacetime properties.

T 12.5 Fr 15:05 30.23: 10-1

The Duality Method: A Cutting Relation between Loops and Trees — •Isabella Bierenbaum[1], Stefano Catani[2], Petros Draggiotis[3], and Germán Rodrigo[3] — [1]RWTH Aachen — [2]INFN Florenz & Universität Florenz — [3]IFIC Valencia

After the start of the LHC, theoretical predictions for scattering processes are needed with a large number of particles in the final state and to a very high precision. In perturbative QCD, the former leads to Feynman diagrams with a large number of external legs, while the latter corresponds to higher loop orders. Both requirements, especially when combined together, lead to an increasing complexity of the calculation. In the last years, various unitarity and recursive methods have been successfully used to address this issue and to calculate scattering amplitudes for multi-particle processes up to next-to-leading order (NLO).

In this talk, I will present the Duality Method. It provides a cutting relation between loop and tree Feynman diagrams. As a modified extension of Feynman's Tree Theorem, it allows at one-loop order to calculate scattering amplitudes by a sum of single-cut phase-space integrals which are similar to the corresponding real-radiation phase-space integrals. I will discuss this method and show how it can be extended to higher loop orders beyond NLO and by doing this, which boundary conditions for the results can be maintained at higher orders.

T 12.6 Fr 15:20 30.23: 10-1

Numerical NLO QCD calculations - Contour deformation — •Sebastian Becker — Institut für Physik, Universität Mainz, D - 55099 Mainz,Germany

This talk reports on a previously published algorithm for the numerical calculation of one-loop QCD amplitudes. The algorithm consists of subtraction terms, approximating the soft, collinear and ultraviolet divergences of one-loop amplitudes and a method to deform the integration contour for the loop integration into the complex space. It is formulated at the amplitude level and does not rely on Feynman graphs. Therefore all required ingredients can be calculated efficiently using recurrence relations.

The Talk will present the algorithm for the contour deformation for the loop integration. Our starting point is an integrand of a finite one-loop QCD amplitude, i.e. a one-loop QCD amplitude where all the infrared and ultraviolet divergences are subtracted. It will discuss that such an integrand is still not numerical integrable in the real space and that we have to deform our integration region into the complex plane. The algorithm is based on the introduction of Feynman parameters, the deformation of the loop momentum and the Feynman parameters in the complex plane and the expansion of the true propagators around propagators where we have added a small mass μ_{IR}.

T 12.7 Fr 15:35 30.23: 10-1

Understanding and proving the expansion by regions — •Bernd Jantzen — Institut für Theoretische Teilchenphysik und Kosmologie, RWTH Aachen University, 52056 Aachen

When loop integrals involve many different scales from masses and kinematical parameters, it can be hard or even impossible to evaluate them exactly. The integrand may be simplified before integration by exploiting hierarchies of parameters and expanding in powers of small parameter ratios. Naive expansions of the integrand usually fail and generate new singularities, but there are sophisticated methods of asymptotic expansions to solve this problem. One of them is the so-called "strategy of regions" or "expansion by regions" developed by M. Beneke and V.A. Smirnov. It considers a set of regions in the integration domain, expands the integrand with respect to the small parameters in each region and integrates all expanded terms over the whole integration domain. The sum of these contributions yields the full, expanded result.

This method has successfully been applied to many complicated loop integrals, but a general proof for its correctness is still missing. This talk will show how the expansion by regions manages to correctly reproduce the exact result in an expanded form and clarify what are the conditions on the choice and completeness of the considered regions. A more general expression for the full result will be presented that involves additional overlap contributions. These extra pieces normally yield scaleless integrals which are consistently set to zero, but they may be needed when special regularization schemes are used.

T 12.8 Fr 15:50 30.23: 10-1

One-loop Gluon Amplitudes with Generalised Unitarity — •Benedikt Biedermann — Humboldt-Universität zu Berlin

The evaluation of colour-ordered n-gluon amplitudes at one-loop order in pure Yang-Mills theory is presented. Thereby the recently developed technique of generalised unitarity is used. Our program can handle arbitrary numbers of external gluons. Running in double precision one gets reliable results for up to 14 gluons with only a small fraction of events requiring a re-evaluation using extended floating point arithmetic. First applications of the program are shown.

T 12.9 Fr 16:05 30.23: 10-1

All tree-level amplitudes in massless QCD — Lance Dixon[1,2], Johannes Henn[3], Jan Plefka[3], and •Theodor Schuster[3] — [1]Theory Group, Physics Department, CERN, Ch-1211 Geneva 23, Switzerland — [2]SLAC National Accelerator Laboratory, Stanford University, Stanford, CA 94309, USA — [3]Institut für Physik, Humboldt-Universität zu Berlin, Newtonstraße 15, D-12489 Berlin, Germany

We derive compact analytical formulae for all tree-level color-ordered gauge theory amplitudes involving any number of external gluons and up to three massless quark-anti-quark pairs.

A general formula for all gluon-gluino tree amplitudes is presented, based on the combinatorics of paths along a rooted tree and associated determinants. Our results are obtained by projecting the previously-found expressions for the super-amplitudes of the maximally supersymmetric super Yang-Mills theory (N = 4 SYM) onto the relevant components.

We show how these results carry over to the corresponding QCD amplitudes, including massless quarks of different flavors as well as a single electroweak vector boson.

The public Mathematica package GGT is described, which encodes the results of this work and yields analytical formulae for all N = 4 SYM gluon-gluino trees. These in turn yield all QCD trees with up to four external arbitrary-flavored massless quark-anti-quark-pairs.