T 13: QCD (Theorie) IV / Quantenfeldtheorie II

Convenor: Peter Uwer / Christian Schwinn

Zeit: Donnerstag 16:45–18:55 Raum: HG XVI

Gruppenbericht T 13.1 Do 16:45 HG XVI

(De-) confinement in Yang-Mills theories — •Astrid Eichhorn — Theoretische-Physikalisches Institut, Friedrich-Schiller-Universität Jena

We discuss the (de-)confinement phase transition in Yang-Mills theories. For a phase transition of second order the thermodynamical quantities are governed by universal critical exponents which are determined by the center of the underlying gauge group, as is the case for SU(2). On the other hand one expects a first-order phase transition for gauge groups of higher rank as the number of gluons above the critical temperature strongly increases and therefore does not allow for a continuous change in thermodynamical quantities. Based on functional Renormalisation Group studies, we discuss the order parameter for deconfinement, namely the Polyakov loop, and the critical temperature for various Yang-Mills theories. Our approach allows for a continuum study of non-perturbative dynamics and provides an insight into the relation between infrared gluon dynamics and quark confinement. In particular, we show our results for the Polyakov loop for SU(N) (N=2,3,...,12), Sp(2)- and E(7).

T 13.2 Do 17:05 HG XVI

On the Infrared Behaviour of Landau Gauge Yang-Mills Theory with a Fundamentally Charged Scalar Field — •Leonard Fister — ITP, Heidelberg, Germany

Recently it has been shown that infrared singularities of Landau gauge QCD can confine static quarks via a linear potential. We show that the same mechanism also may confine fundamental scalar fields. This confirms that within this scenario static confinement is an universal property of the gauge sector even though it is formally represented in the functional equations of the matter sector. The simplifications compared to the fermionic case make the scalar system an ideal laboratory for a detailed analysis of the confinement mechanism in numerical studies of the functional equations as well as in gauge-fixed lattice simulations.

T 13.3 Do 17:20 HG XVI

The heavy quark deconfinement transition from strong coupling series for the Potts model — •Linus Feldkamp — Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster, D-48149 Münster

The critical points of the 3-dimensional Z(3)-Potts model are in the same universality class as those of QCD with heavy quarks. It is therefore a useful model to investigate finite density effects on the deconfinement transition. This has recently been done in Monte Carlo simulations. Here we demonstrate the application of strong-coupling techniques as an alternative to obtain the critical parameters.

Gruppenbericht T 13.4 Do 17:35 HG XVI

Dimensional 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 the $O(g^6)$ contribution to the electric screening mass mE^2 and $O(g^8)$ correction to the effective gauge coupling gE^2 appearing as matching coefficients in so-called EQCD, which acts as a large-distance effective theory for the theory of strong interactions at finite-temperature.

These corrections are necessary for the pressure of hot QCD at g^7. On the other hand, the effective gauge coupling can be used to determine the so-called spatial string tension.

T 13.5 Do 17:55 HG XVI

Screened perturbation theory for 3d Yang-Mills theory and hot QCD — •Daniel Bieletzki — Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster, D-48149 Münster

Perturbation theory for non-abelian gauge theories at finite temperature is plagued by infrared divergences which are caused by magnetic soft modes $\sim g^2T$, corresponding to gluon fields of a 3d Yang-Mills theory. While the divergences can be regulated by a dynamically generated magnetic mass on that scale, the gauge coupling drops out of the effective expansion parameter requiring summation of all loop orders for the calculation of observables. Some gauge invariant possibilities to implement such infrared-safe resummations are reviewed. We use a scheme based on the non-linear sigma model to estimate some of the contributions $\sim g^6$ of the soft magnetic modes to the QCD pressure through two loops.

T 13.6 Do 18:10 HG XVI

Gauge/string duality at zero and finite temperature — •Eugenio Megias, Kambis Veshgini, Jun Nian, Hans-Juergen Pirner, and E.-Michael Ilgenfritz — Institute for Theoretical Physics, University of Heidelberg, Philosophenweg 19, D-69120 Heidelberg, Germany

We explore some of the features of the Polyakov loop, heavy quark free energy and the thermodynamics of the confined and deconfined phases of QCD within the AdS/QCD formalism. Using a consistent treatment based on 5D Einstein-dilaton gravity with a dilaton potential, the computation of the Einstein equations leads to two solutions: the thermal graviton gas solution corresponding to a confined phase, and the black hole solution which is characterized by the existence of an horizon, corresponding to a deconfined phase. The first solution leads to a precise computation of the heavy qq free energy in the confined phase, with a estimation of T_c in very good agreement with lattice data. The second solution gives also very good results for the expectation value of the Polyakov loop and equation of state, when an ansatz for the breaking of conformal in variance is taken into account. This ansatz mimics the running of the coupling in QCD. This is a remarkable fact, because this means that the formalism incorporates in a natural way power corrections, and it allows for a perfectly invariant way to introduce condensates of dimension two. We extend this study also to compute the behavior of the shear and bulk viscosities in the gluon plasma, showing a good agreement with recent lattice data.

T 13.7 Do 18:25 HG XVI

Systematic approach to leptogenesis in nonequilibrium quantum field theory — Mathias Garny[2], Andreas Hohenegger[1], •Alexander Kartavtsev[1], and Manfred Lindner[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Deutschland — [2]Technische Universität München, James-Franck-Straß e, 85748 Garching, Deutschland

The generation of a baryon asymmetry via leptogenesis is usually studied by means of classical kinetic equations whose applicability to processes in the hot and expanding early universe is questionable. The approximations implied by the state of the art description can be tested in a first-principle approach based on nonequilibrium field theory techniques. We apply the Kadanoff-Baym formalism to a simple toy model of leptogenesis. We find that, within the toy model, medium effects increase the vertex contribution to the CP-violating parameter. At high temperatures it is a few times larger than in vacuum and asymptotically reaches the vacuum value as the temperature decreases. Contrary to the results obtained earlier in the framework of thermal field theory, the corrections are only linear in the particle number densities. An important feature of the Kadanoff-Baym formalism is that it is free of the double-counting problem, i.e. no need for Real Intermediate State subtraction arises. We show that in the resonant regime quantum corrections to the effective masses and decay widths lead to a modified expression for the self-energy CP-violating parameter. Most notably, in the maximal resonant regime the Boltzmann picture breaks down and an analysis in the full Kadanoff-Baym formalism is required.

T 13.8 Do 18:40 HG XVI

Stabilizing topologically nontrivial spacetimes with an $SO(3)$-Skyrme field — •Markus Schwarz — Institut für Theoretische

Physik, Universität Karlsruhe, KIT

One possible result of a theory of quantum gravity is that spacetime might have a "foamy" and topologically nontrivial structure on small scales. Since there is no complete theory of quantum gravity yet, we investigate classical models with nontrivial spacetime topology. One of these is an $SO(3)$-Skyrme model interacting with gravity on spacetimes of topology $\mathbb{R} \times SO(3)$.

This particular class of spacetimes can be realized by cutting a ball of radius b out of Minkowski spacetime and identifying antipodal points. To prevent a spacetime with such a defect from collapsing, an $SO(3)$-valued scalar field together with a Skyrme Lagrangian is added.

The resulting Einstein-$SO(3)$-Skyrme model admits classical solutions where the $SO(3)$-Skyrme field has integer winding number. For odd winding numbers there exists a nonzero radius b that minimizes the mass of the spacetime. This means that we have found a potentially stable spacetime with nontrivial topology. We briefly discuss similarities to and differences from the Einstein-$SU(2)$-Skyrme model.