# HK 49: Theorie

Zeit: Freitag 14:00–16:00 Raum: 2F

HK 49.1 Fr 14:00 2F

**Vector-axialvector mixing in dilepton production and dropping meson masses** — •Chihiro Sasaki[1], Masayasu Harada[2], and Wolfram Weise[1] — [1]Institut für Theoretische Physik T39, Physik-Department der TU München, D-85747 Garching — [2]Department of Physics, Nagoya University, Nagoya, 464-8602, Japan

Changes of hadron properties are expected to be indications of chiral symmetry restoration in hot and/or dense QCD. Dropping masses of hadrons can be one of the prominent candidates of the strong signal of melting quark condensate $\langle\bar{q}q\rangle$ which is an order parameter of spontaneous chiral symmetry breaking.

Due to the pion in a heat bath, the vector and axialvector current correlators are mixed. Thus axialvector mesons play an important role in exploring the critical properties associated with chiral symmetry restoration. Recently a chiral approach based on a systematic perturbation scheme including both vector and axialvector mesons as well as pions has been constructed. In this approach the dropping meson masses are inevitably achieved at chiral phase transition.

In this talk we discuss the importance of the axialvector meson in thermal dilepton productions assuming dropping masses. We show that there exists a significant change in structure above/below $\rho$ peak, which corresponds to the vector-axialvector mixing and has been missed in previous calculations with dropping $\rho$ scenarios.

HK 49.2 Fr 14:15 2F

**Modelling QCD-dynamics in and beyond mean field theory** — •Simon Rössner, Nino Bratovič, Thomas Hell, and Wolfram Weise — Physik Department, TU München, 85748 Garching, Germany

We present model calculations [1,2] featuring the two most important non-perturbative effects of QCD at temperatures below the 1 GeV-scale (spontaneous chiral symmetry breaking and confinement) which are in astonishingly good agreement with full lattice QCD calculations. The existing analysis has been extended by corrections accounting for the fermion sign problem. RPA is used to estimate pressure contributions generated by mesonic fluctuations of the two light meson modes, $\pi$ and $\sigma$. Qualitatively the overall picture drawn by the PNJL model remains, confirming preceeding conclusions.

Additionally, in the effort to extend the range of applicability of the PNJL model, non-local approaches are under investigation. In their construction special attention has been paid to the connection to QCD at high temperatures. We show that the non-local modifications to the PNJL model preserves the Nambu-Goldstone character of pions within the framework of this model. Furthermore the thermodynamic of this non-local PNJL model predicts a joint cross-over of chiral symmetry and deconfinement, similar to the situation in the original PNJL model.

Work supported in part by BMBF, GSI, the DFG Excellence Cluster "Origin and Structure of the Universe", and the Elitenetzwerk Bayern.

[1] C. Ratti, S. Rößner and W. Weise, Phys. Lett. B**649**, 57 (2007).
[2] S. Rößner, C. Ratti and W. Weise, Phys. Rev. D**75**, 034007 (2007).

HK 49.3 Fr 14:30 2F

**Thermodynamics of a non-local NJL-type model (was HK 34.68 before)** — •Thomas Hell, Simon Rössner, and Wolfram Weise — Physik Department, TU München, 85748 Garching, Germany

From hadron spectroscopy it follows that the SU(2) chiral symmetry of the QCD-Lagrangian is dynamically broken at low energies. Pions appear as the corresponding Goldstone bosons. A simple scheme including these properties is the Nambu–Jona-Lasinio (NJL) model, where the quark interaction is described by a local four fermion coupling. Due to this locality loop integrals are divergent and the model is non-confining. Asymptotic freedom is implemented crudely through a regularizing cut-off at approximately 1 GeV. This limits the applicability of the NJL model to a momentum range below that cut-off.

In our work we want to include asymptotic freedom in a more realistic way. For this reason we use a non-local Lagrangian including an effective momentum-dependent four-fermion vertex. This allows for the matching of the low-momentum region to perturbative QCD in the high-momentum regime.

We apply this model to QCD thermodynamics, incorporating couplings to a gluonic background field. The chiral condensate serves as an order parameter for the chiral phase transition while the confinement-deconfinement transition is described by the Polyakov loop. The resulting thermodynamic potential and related quantities are calculated and compared with results from lattice QCD.

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HK 49.4 Fr 14:45 2F

**In-Medium-Modifikation des $a_1$-Mesons als Konsequenz der Veränderung des $\rho$-Mesons** — •Stefan Leupold und Markus Wagner — Institut für Theoretische Physik, Universität Gießen

Der Isovektor-Vektor-Strom und der Isovektor-Axialvektor-Strom stellen chirale Partner dar. Die zugehörigen Spektren sind auf Grund der chiralen Symmetriebrechung im Vakuum nicht identisch. Vielmehr zeigt sich im Vektor-Spektrum das $\rho$-Meson und im Axialvektor-Spektrum das $a_1$. Im Vortrag von Markus Wagner bei dieser Tagung wird gezeigt, dass das $a_1$ im Wesentlichen ein Meson-Molekül ist, bestehend aus Pion und $\rho$-Meson. Darauf aufbauend wird hier untersucht, wie sich eine In-Medium-Veränderung des $\rho$-Mesons auf das $a_1$-Meson auswirkt. Der mögliche Zusammenhang der Ergebnisse zur chiralen Symmetrie-Restauration wird diskutiert.

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HK 49.5 Fr 15:00 2F

**In-medium chiral condensate beyond linear density approximation** — Norbert Kaiser, •Philip de Homont, and Wolfram Weise — Physik Department, Technische Universität München, D-85747 Garching, Germany

In-medium chiral perturbation theory is used to calculate the density dependence of the quark condensate $\langle\bar{q}q\rangle$. The corrections beyond the linear density approximation are obtained by differentiating the interaction contributions to the energy per particle of isospin-symmetric nuclear matter with respect to the pion mass. Our calculation treats systematically the effects from one-pion exchange (with $m_\pi$-dependent vertex corrections), iterated $1\pi$-exchange, and irreducible $2\pi$-exchange including intermediate $\Delta(1232)$-isobar excitations, with Pauli-blocking corrections up to three-loop order.

We find a strong and non-linear dependence of the "dropping" in-medium condensate on the actual value of the pion (or light quark) mass. In the chiral limit, $m_\pi = 0$, chiral restoration appears to be reached already at about 1.5 times normal nuclear matter density. By contrast, for the physical pion mass, $m_\pi = 135\,\mathrm{MeV}$, the in-medium condensate stabilizes at about 60% of its vacuum value above that same density. Effects from $2\pi$-exchange with virtual $\Delta(1232)$-isobar excitations turn out to be crucial in generating such pronounced deviations from the linear density approximation above $\rho_0$. The hindered tendency towards chiral symmetry restoration provides a justification for using pions and nucleons as effective low-energy degrees of freedom at least up to twice nuclear matter density.

HK 49.6 Fr 15:15 2F

**Polarized photon production in non-central heavy ion collisions** — •Andreas Ipp, Antonino Di Piazza, Jörg Evers, and Christoph H. Keitel — MPI für Kernphysik, Heidelberg

The strong angular momentum in non-central heavy-ion collisions can lead to global quark polarization in a quark gluon plasma (QGP) through spin-orbit coupling [1]. The global quark polarization can be transfered to a polarization of massive secondary particles like the $\Lambda$-hyperon. So far only an upper bound for the $\Lambda$-hyperon polarization $|P_{\Lambda,\bar{\Lambda}}| \leq 0.02$ has been found, but its result is affected by all stages of the collision to an unknown degree. Photons on the other hand are likely to leave the QGP without further interaction and thus provide a primary probe for thermodynamic properties of the QGP [2].

In this work we study the possibility to detect global quark polarization using photons emitted from the QGP through Compton scattering of quarks (antiquarks) and gluons, $qg \to q\gamma$ ($\bar{q}g \to \bar{q}\gamma$), and annihilation of quarks and antiquarks, $q\bar{q} \to g\gamma$ [3]. We calculate the visibility of the photon polarization for various degrees of momentum anisotropy of the QGP that naturally arise due to the anisotropic expansion of the QGP itself. We find that especially for anisotropies compressed along the beam axis and higher photon energies, global quark polarization is transfered efficiently to circular polarization of photons.

[1] Z.-T. Liang and X.-N. Wang, *Phys. Rev. Lett.* **94**, 102301 (2005)
[2] A. Ipp, K. Kajantie, A. Rebhan and A. Vuorinen, *Phys. Rev.* D **74**, 045016 (2006)
[3] A. Ipp, A. Di Piazza, J. Evers, and C. H. Keitel, arXiv:0710.5700

HK 49.7 Fr 15:30 2F

**Quark mass dependence of 1-loop and HTL self-energies** — •Daniel Seipt, Marcus Bluhm, and Burkhard Kämpfer — Forschungszentrum Dresden-Rossendorf, PF 510119, 01314 Dresden, Germany

1-loop and HTL self-energies in hot QCD are presented with emphasis on the quark mass dependence. These self-energies enter our quasi-particle model via quasi-particle dispersion relations, which allows to parameterize and extend lattice QCD results for the equation of state (EoS), susceptibilities etc. The primary goal is to handle the chiral extrapolation of lattice QCD data, provided often at finite quark mass parameters. We find that the HTL approximation of the self-energies, valid only for small quark masses, differs significantly from the 1-loop results for quark mass values used in lattice calculations. The EoS may serve as input in the hydrodynamical prescription of the expansion stage of heavy-ion collisions at FAIR energies and also for LHC.

HK 49.8 Fr 15:45 2F

**Effects of mesonic correlations in the QCD phase transition** — •Michael Buballa[1], David Blaschke[2,3], Andrey E. Radzhabov[3], and Mikhail K. Volkov[3] — [1]TU Darmstadt, Germany — [2]University of Wroclaw, Poland — [3]JINR Dubna, Russia

We study the finite temperature phase transition of strongly interacting matter within a nonlocal chiral quark model of the NJL type coupled to a Polyakov loop. In contrast to previous investigations which were restricted to the mean-field approximation, mesonic correlations are included by evaluating the quark-antiquark ring sum. For physical parameters, we find that the pions dominate the pressure below the phase transition. In this regime, the pressure is quite insensitive to the details of the interaction and agrees almost exactly with that of an ideal pion gas. At temperatures above $T_c$ the mesonic contributions die out and the pressure is well described by the mean-field result. Finally, we compare our results with the resonance gas model and with lattice simulations. If we take unphysically large quark masses, as used on the lattice, the meson effects are suppressed.