HK 16: Heavy-Ion Collisions and QCD Phases IV

Time: Tuesday 17:00–18:15 Location: J-HS G

Group Report HK 16.1 Tue 17:00 J-HS G

Cold, dense quark matter and quark-hadron continuity in neutron stars — •Yifan Song — Physics Department, Technical University of Munich, 85748 Garching b. Munich, James-Franck-Str. 1, Germany

Recent discoveries of record-breaking massive neutron stars indicate their core density could reach up to five times nuclear matter saturation density, where the matter could begin to be properly described by quark matter. State-of-the-art equation of state studies using phenomenological quark models constrained by neutron star observations strongly suggest a continuous, smooth crossover from hadronic matter to quark matter, possibly with no first-order phase transitions. In this talk I show how such quark-hadron continuity can be manifestly realized in several aspects: 1. the continuity of spectrum of low-lying Nambu-Goldstone modes resulting from spontaneous chiral symmetry breaking by coexisting chiral and diquark condensates can be demonstrated using a schematic Nambu-Jona-Lasinio type model; 2. the explicit mapping between fermion and boson degrees of freedom in hadronic and quark matter can be established by a gauge-invariant description of QCD via field redefinition in the presence of diquark pairing; 3. the massive diquark-dressed gluons could be used to explain the strong vector correlations (implied by equation of state studies) between quarks, potentially bridging the non-perturbative gluon dynamics to phenomenological vector boson exchanges in such models.

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HK 16.2 Tue 17:30 J-HS G

Λ hyperon production in collisions of relativistic ions at the CERN SPS and FAIR SIS100 energies — •Hamda CHERIF for the CBM-Collaboration — Goethe University Frankfurt am Main — GSI Helmholtzzentrum für Schwerionenforschung GmbH

For more than 30 years, the production of strangeness has been proposed as a sensitive signal to QGP formation. Strange particles are of particular interest in hadronic collisions since they carry a new quantum number not present in the colliding nuclei. In that respect, the study of the production of Λ hyperons is of particular interest as it allows one to study simultaneously strangeness production and the effect of net baryon density.

The NA61/SHINE experiment at the CERN/SPS and the CBM experiment at the future facility FAIR aim to investigate the QCD phase diagram of strongly interacting matter in the region of moderate temperatures and high net-baryon densities. A systematic study of the energy dependence of Λ production has been performed previously by NA49 for Pb+Pb collisions, and recently by NA61/SHINE in p+p collisions.

In this contribution, the status of the analysis of Λ hyperons with the NA61/SHINE experiment at CERN/SPS will be presented. The study of Λ production in CBM experiment at the future FAIR facility in Darmstadt will be also presented based on simulation of Au+Au collisions at various SIS100 energies.

HK 16.3 Tue 17:45 J-HS G

Inhomogeneous phases in the quark-meson model with explicit chiral-symmetry breaking — •Lennart Kurth and Michael Buballa — Theoriezentrum, IKP, TU Darmstadt

The conjectured existence of a critical endpoint of a first-order chiral phase boundary in the QCD phase diagram has triggered tremendous experimental and theoretical activities. Several QCD-inspired models suggest that instead of a first-order transition between homogeneous phases there is an inhomogeneous phase where the chiral condensate periodically varies in space. While in the chiral limit the existence of the inhomogeneous phase appears to be rather robust under model variations, the situation is less clear when chiral symmetry is explicitly broken.

In this talk we discuss the effect of explicit chiral-symmetry breaking on the existence and size of an inhomogeneous phase in the quark-meson model. To this end we perform a stability analysis of the homogeneous phase with respect to developing inhomogeneities. We find that the inhomogeneous region shrinks with increasing pion mass but still survives at the physical value of m_π. The instability of the homogeneous phase occurs in the scalar channel while pseudoscalar fluctuations or the popular chiral density wave are not favored.

HK 16.4 Tue 18:00 J-HS G

Self-consistent meson spectral functions from analytically continued FRG flow equations — •Jan-Hendrik Otto, Lorenz von Smekal, and Christopher Jung — Justus Liebig Universität Giessen

The Functional Renormalization Group (FRG) can be used to calculate spectral functions from analytically continued (aFRG) flow equations for two-point correlation functions. Of particular relevance for the electromagnetic spectral function and thus for thermal dilepton rates in the resonance region, are the vector and axial-vector meson spectral functions in the hot and dense medium. Because chiral symmetry restoration at finite temperature and/or density is reflected in these spectral functions, this can be exploited to search for experimental signatures, from heavy-ion collisions at HADES energies and later with CBM at FAIR, of a chiral first-order phase transition and the associated critical endpoint (CEP) in the phase diagram of QCD. While present calculations are thermodynamically consistent and symmetry preserving, fully self-consistent solutions are still a challenge. On the other hand, self-consistent calculations are particularly important for possible signatures of a CEP. In this contribution we therefore present a simplified scheme to calculate self-consistent spectral functions from aFRG flow equations, based on self-energy parametrisations inspired by one-loop structures, for π and σ mesons in the O(4)-model.