HK 30: Heavy-Ion Collisions and QCD Phases V

Time: Wednesday 15:45–17:15 Location: HS 3 Chemie

Group Report HK 30.1 Wed 15:45 HS 3 Chemie

Measurement of (anti)hypernuclei production in heavy-ion collisions at the LHC — •Michael Hartung for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe Universität Frankfurt

At the Large Hadron Collider (LHC) at CERN, light (anti)hypernuclei are produced abundantly in Pb–Pb collisions. Their study provides further insights on the formation mechanism and the nature of the hyperon-nucleon interaction. The most prominent example is the (anti)hypertriton, which is a bound state of a proton, a neutron and a Λ hyperon. It is often discussed as a bound state of a deuteron and a Λ. The Λ-separation energy is only about a few hundred keV, leading to an object size of about 10 fm. The size has consequences for its probability to be formed in a coalescence process, which is not expected from a statistical-thermal model approach. We will show the latest production measurements in different collision systems and a comparison to the production models. Furthermore, we will present a novel technique for the determination of the object size and the Λ-separation energy. Additionally, we were able to study the production and properties of heavier (anti)hypernuclei, namely $A = 4$ (anti)hypernuclei, which lead to the first evidence of the antihyperhelium-4 ever. The known excited states of the (anti)hyperhydrogen-4 and (anti)hyperhelium-4 enable the measurement of their production, mass and antiparticle-to-particle ratio in the available heavy-ion dataset of the LHC Run 2. Moreover, very first results of our (anti)hypernuclei analyses of the ongoing Run 3 heavy-ion dataset are presented.

HK 30.2 Wed 16:15 HS 3 Chemie

Statistical hadronization of hypertriton and other loosely bound nuclei — •Hjalmar Brunssen — Physikalisches Institut, Universität Heidelberg

While compact objects such as hadrons can be treated as point-like particles in the hadronization, this is not an adequate description for loosely bound (hyper-)nuclei. In these cases the spatial extension of the wavefunction matters when calculating production yields. Especially in the case of the hypertriton, where the rms radius is of similar size as the fireball, this effect leads to a major correction in the production yield.

This talk presents how the size of (hyper-)nuclei can be incorporated in a calculation of production yields. In particular, the effect of this correction due to the (hyper-)nucleus-size as a function of the fireball size is discussed. Results of the size-corrected production yield are compared to experimental data from the ALICE experiment for various collision systems. Production yield ratios of ${}^{3}_{\Lambda}\mathrm{H}/\Lambda$, ${}^{3}_{\Lambda}\mathrm{H}/{}^{3}\mathrm{He}$ as well as d/p as a function of $\mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta$ are presented.

HK 30.3 Wed 16:30 HS 3 Chemie

Kinetic Mixing in Parity Doublet Model — •Mattia Recchi[1], Lorenz Von Smekal[1], and Jochen Wambach[2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [2]Technische Universität Darmstadt, 64289 Darmstadt, Germany

The parity doublet model (PDM) is an effective hadronic theory with chiral symmetry suitable to describe nuclear matter and its phase transitions. Recently the thermodynamics of PDM has been widely investigated. Here we study the thermodynamics in a renormalization-group invariant mean-field calculation. Moreover, we explore an extension including derivative mixing terms to improve the axial charges for electroweak phenomenology in the PDM. We compare the resulting thermodynamics with that of standard PDM to show that this improvement can be implemented without breaking the phenomenologically successful description of nuclear and neutron matter in this effective hadronic theory for chiral symmetry breaking in presence of a chirally invariant baryon mass.

HK 30.4 Wed 16:45 HS 3 Chemie

Impact of Diquarks on the QCD Phase Structure and Spectral Functions — •Ugo Mire[1] and Bernd-Jochen Schaefer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Campus Gießen, 35392 Gießen, Germany

At sufficiently high densities quark matter is expected to become color superconducting through the formation of diquarks. We investigate the role of diquarks in the two-flavor QCD phase structure within a functional renormalization group framework. For sufficiently strong diquark couplings, we find that the onset of diquark condensation precedes the chiral phase transition. By examining the diquark spectral functions, we find that this effect is caused by the behavior of the diquark pole mass. Additionally, we discuss the behavior of the sigma, pion, and diquark spectral functions in the presence of a finite diquark condensate.

HK 30.5 Wed 17:00 HS 3 Chemie

Renormalized quark-meson-diquark model — •Hosein Gholami[1], Lennart Kurth[1], Ugo Mire[2], Michael Buballa[1], and Bernd-Jochen Schaefer[2] — [1]TU Darmstadt — [2]Justus Liebig University Giessen

The Quark-Meson-Diquark (QMD) model is a framework for investigating color superconductivity (CSC) in dense quark matter. Unlike the Nambu-Jona-Lasinio (NJL) model, the QMD models inherent renormalizability offers a more robust theoretical foundation. We previously employed RG-consistent treatments in the three-flavor NJL model, demonstrating how such methods eliminate cutoff artifacts. In this work, we use the QMD model to compare RG consistency and renormalization on firmer ground. This talk will focus on the renormalized QMD model, its interplay with RG-consistent approaches, and highlight their key differences. Finally, we introduce the three-flavor renormalized QMD model as an improved alternative to the NJL model for studying CSC and the physics of dense quark matter.