HK 47: Heavy Ion Collisions and QCD Phases X

Zeit: Donnerstag 16:45–19:00 Raum: F 1

Gruppenbericht HK 47.1 Do 16:45 F 1

Recent results on (anti-)(hyper-)nuclei production with ALICE at the LHC — •Esther Bartsch for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The high collision energies reached at the LHC lead to significant production yields of light anti- and hyper-nuclei in proton-proton and, in particular, Pb-Pb collisions. The excellent particle identification capabilities of the Time Projection Chamber, using the specific energy loss (dE/dx), and the time-of-flight measurement, allow for the detection of these rarely produced particles. Furthermore the Inner Tracking System gives the possibility to separate primary nuclei from those coming from the decay of heavier systems. This altogether offers the unique opportunity to search for exotica like the bound state of a Λ and a neutron which would decay into deuteron and pion, or the bound state of two Λs, and also allows for the topological identification of the hypertriton via its mesonic decay (${}^{3}_{\Lambda}\mathrm{H} \rightarrow {}^{3}\mathrm{He} + \pi^{-}$).

In this group report we will show results for (anti-)deuterons, (anti-)tritons, (anti-)^{3}He and (anti-)^{4}He and give an overview on the ongoing searches. The results will also be compared with the expectations from thermal and coalescence models.

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HK 47.2 Do 17:15 F 1

Multi-strange Hyperons and Hypernuclei reconstruction at the CBM experiment — •Iouri Vassiliev[1], Ivan Kisel[2], and Maksym Zyzak[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH — [2]FIAS Frankfurt Institute for Advanced Studies

The main goal of the CBM experiment at FAIR is to study the behavior of nuclear matter at very high baryonic density in which the transition to a deconfined and chirally restored phase is expected to happen. The promising signatures of this new state are the enhanced production of multi-strange particles, production of hypernuclei and dibaryons. Theoretical models predict that single and double hypernuclei, and heavy multi-strange short-lived objects are produced via coalescence in heavy-ion collisions with the maximum yield in the region of SIS100 energies. The discovery and investigation of new hypernuclei and of hyper-matter will shed light on the hyperon-nucleon and hyperon-hyperon interactions. Results of feasibility studies of the key CBM oservables in the CBM experiment are discussed.

HK 47.3 Do 17:30 F 1

Mechanisms of hypernuclei formation in relativistic ion collisions — •Alexander Botvina[1], Jan Steinheimer[1], Marcus Bleicher[1], and Josef Pochodzalla[2] — [1]FIAS and ITP J.W.Goethe University, D-60438 Frankfurt am Main, Germany — [2]HIM and IKP J.Gutenberg University, D-55099 Mainz Germany

The study of hypernuclei in relativistic ion collisions open new opportunities for nuclear and particle physics. The main processes leading to the production of hypernuclei in these reactions are (1) the disintegration of large excited hyper-residues (target- and projectile-like), and (2) the coalescence of hyperons with other baryons into light clusters. We use the transport, coalescence and statistical models to describe the whole process, and demonstrate the advantages over the traditional hypernuclear methods: A broad distribution of predicted hypernuclei in masses and isospin allows for investigating properties of exotic hypernuclei, as well as the hypermatter both at high and low temperatures. We point at the abundant production of multi-strange nuclei and new bound/unbound hypernuclear states. The realistic estimates of hypernuclei yields in various collisions are presented [1]. Also the processes well known in normal reactions: evaporation, fission, multifragmentation break-up are transformed in the case of hypermatter [2]. There is a saturation of the hypernuclei production at high energies [1], therefore, the optimal way to pursue this experimental research is to use the GSI/FAIR accelerator (Darmstadt).

[1] A.S. Botvina, et al., arXiv:1608.05680, in Phys. Rev. C (2016).
[2] A.S. Botvina, et al., Phys. Rev. C94, 054615 (2016).

HK 47.4 Do 17:45 F 1

Deuteron Distributions in Au+Au Collisions at 1.23A GeV — •Max Zuschke for the HADES-Collaboration — Goethe-Universität Frankfurt

In April 2012, the HADES collaboration collected data on Au+Au collisions at 1.23*A* GeV.
As light hadrons, such as pions, kaons and protons have successfully been analyzed, ongoing studies try to extend the set of identified particles towards light nuclei in order to improve the statistical model analysis. Here we present results on the measurement of deuterons.
After particle identification, based on a mass determination via time-of-flight and on a measurement of the energy loss in the MDC drift chambers, the transverse mass spectra of the deuteron candidates are extracted. Subsequently, they are corrected for acceptance and efficiency losses, which are determined using a UrQMD simulation, containing embedded deuterons that have passed a full detector simulation, provided by the HGeant framework.
The obtained yields are then compared to blast-wave-fits, in order to extract the radial expansion velocity (β) of the system and its kinetic freeze-out temperature T_{kin}. The latter one is compared to the chemical freeze-out temperature T_{chem} as extracted from statistical model fits to hadron yields.

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HK 47.5 Do 18:00 F 1

Production of deuterons in pp collisions at $\sqrt{s} = 13$ TeV with ALICE at the LHC — •Benedikt Krimphoff for the ALICE-Collaboration — Goethe-Universität, Institut für Kernphysik, Frankfurt am Main

The production of nuclei in high-energy collisions is commonly discussed within two different scenarios: the thermal-statistical model and the coalescence model. Both approaches are successful in describing the data when applied with certain parameters but they might exhibit more dependencies when used for a wider range of energies.
With the measurement of (anti-)deuterons in $\sqrt{s} = 13$ TeV pp collisions we want to shed light on the nature of light nuclei and their production mechanisms. In particular, the measurement of the production cross section at an unprecedented collision energy may reveal important constraints for the models.
In this presentation we describe the procedure to extract a deuteron spectrum and present the current status of the analysis.

HK 47.6 Do 18:15 F 1

Measurement of (anti-)hypertriton in Pb–Pb collisions with ALICE at the LHC — •Lukas Kreis for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt — Institut für Kernphysik Technische Universität Darmstadt, Schlossgartenstr. 9, 64289 Darmstadt

The ALICE experiment at the CERN LHC is dedicated to the study of nucleus–nucleus collisions at the highest energies ever reached in the laboratory. The excellent particle identification and decay vertex reconstruction capabilities allow the study of light (anti-)hypernuclei production in heavy-ion collisions. Hypernuclei are weakly-bound unstable nuclei, which contain at least one hyperon. This makes them interesting for gaining insight into the nucleon-hyperon interaction. The lifetime of hypertriton ${}^{3}_{\Lambda}\mathrm{H}$ has gathered particular interest. Recent heavy-ion experiments indicate a deviation from the lifetime of the free Λ baryon, but higher precision measurements are required. In this talk the methodology of the measurement of hypertriton and anti-hypertriton with ALICE is explained. First results obtained in Pb–Pb collisions are presented.

HK 47.7 Do 18:30 F 1

Exit flow, enter femto — •Ante Bilandzic for the ALICE-Collaboration — Technical University of Munich, James-Franck-Str. 1, 85748 Garching, Germany

Neutron stars are the densest stars observed in the Universe. Their mass can be as large as 2 solar masses while their radius is only about 10-15 km. Recent observations of these massive neutron stars are proving to be a serious challenge for our understanding of their fundamental properties, most notably of their chemical content. A neutron star composed only of neutrons cannot match the experimental data, instead the other particle species are nowadays suggested by the theorists to model the content of a neutron star. One popular candidate are hyperons.

The onset of hyperons in the core of neutron star have dramatic effect on its equation of state. The nature of both the two-body hyperon-nucleon and the three-body hyperon-nucleon-nucleon interactions are at the moment poorly understood by the theorists mostly due to lack of experimental constraints for the parameters entering the theoretical models. It was only recently argued that a strong repulsive interaction of hyperons with nucleons via three-body force could yield to equation of state of a neutron star which is stiff enough to support the recent experimental data.

In this talk with present the status of multiparticle correlation techniques for the study of genuine three-body interactions between hyperons and nucleons, in the context of multiparticle femtoscopic techniques utilized for the analysis of elementary collisions in ALICE.

HK 47.8 Do 18:45 F 1

Online reconstruction of multi-strange hyperons with the CBM experiment — •Hamda Cherif[1,2], Alberica Toia[1,2], and Iouri Vassiliev[2] for the CBM-Collaboration — [1]Goethe Universität Frankfurt am Main — [2]GSI Helmholtzzentrum für Schwerionenforschung

The Compressed Baryonic Matter (CBM) experiment at the future Facility for Antiproton and Ion Research in Darmstadt is a dedicated heavy ion experiment which will operate in fixed target mode at beam energies up to 11A GeV for ions delivered by the SIS100 accelerator. The CBM physics program is devoted to the exploration of the QCD phase diagram at high net-baryon densities. One of the main experimental challenges is the measurement of very rare probes, which requires an interaction rate of up to 10 MHz.

We study the production of multi-strange (anti)hyperons as one of the earliest proposed signatures for the formation of a Quark Gluon Plasma. The reconstruction of multi-strange hyperons in CBM is based on their weak decay topology, characterized by one or more displaced vertices, and reaches a reconstruction efficiency of about 20% for Λ, 8% for Ξ and 5% for Ω . In this presentation, we discuss the performance of the online event selection of multi-strange hyperons in Au+Au collisions at various SIS100 energies.