HK 35: Heavy-Ion Collisions and QCD Phases VII

Time: Wednesday 14:00–15:30 Location: HK-H1

Group Report HK 35.1 Wed 14:00 HK-H1

Creation of fragile anti- and hyper- matter at the LHC — •Janik Ditzel for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität, Frankfurt, Germany

At the Large Hadron Collider at CERN, copious production of light (anti-)(hyper-)nuclei has been measured in Pb–Pb collisions by the ALICE collaboration. The production of such (anti-)(hyper-)nuclei has recently become a topic of high interest, connecting for instance to the possible strangeness content in neutron stars. The most prominent example is the (anti-)hypertriton, which is a bound state of a proton, a neutron and a Λ hyperon. These (anti-)(hyper-)nuclei are reconstructed by their decay products, e.g. in the case for the charged two-body decay channel of the hypertriton: ${}^{3}_{\Lambda}\mathrm{H} \rightarrow {}^{3}\mathrm{He} + \pi^{-}$. The excellent performance of the ALICE apparatus provides a clear particle identification of the daughters and a perfect reconstruction of the decay vertex. Together with results on the production of light (anti-)nuclei, we will show the latest measurement of the Λ separation energy and lifetime of the (anti-)hypertriton and a comparison to different production models. Furthermore, we will show first results on the measurement of (anti-)hypernuclei within the A=4 mass region.

Supported by BMBF and the Helmholtz Association.

HK 35.2 Wed 14:30 HK-H1

Hypernuclei studies in heavy-ion collisions at CBM — •Susanne Glässel, Christoph Blume, and Enxhela Vardhami for the CBM-Collaboration — IKF, Frankfurt

Under the extreme conditions of relativistic heavy-ion-collisions the creation of exotic matter like hypernuclei is possible. Hypernuclei measurements provide insights into the equation-of-state of hadronic matter at high net-baryon densities, as well as into hyperon-nucleon and hyperon-hyperon-interactions. The Compressed Baryonic Matter (CBM) experiment at the future Facility for Anti-Proton and Ion Research (FAIR) in Darmstadt offers the perfect conditions to explore the production of hypernuclei. At beam energies of around 12A GeV, in combination with high interaction rates of up to 10 MHz, an exceptionally high amount of hypernuclei will be created, and even very rare double hypernuclei like ${}^{6}_{\Lambda\Lambda}\mathrm{He}$ are expected. The reconstruction of hypernuclei was implemented into the CBM software PFSimple, which is based on the KFParticleFinder package. The reconstruction algorithm and parameters were optimized for the identification of hypernuclei with respect to important performance indicators. Expected efficiencies and signal-to-background-ratios were calculated for a reliable estimation of the number of reconstructable hypernuclei. Rapidity dependencies of these performance indicators were analyzed to identify the detector areas with an high efficiency for hypernucei measurements. The experimental sensitivity to properties of hypernuclei, such as their lifetime, was evaluated. Results for ${}^{3}_{\Lambda}\mathrm{H}$ will be discussed as an example. DFG-grant BL 982/3-1, DFG-grant BR 4000/7-1.

HK 35.3 Wed 14:45 HK-H1

Studies on hypertriton reconstruction in heavy-ion collisions at CBM — •Enxhela Vardhami, Christoph Blume, and Susanne Glässel for the CBM-Collaboration — IKF, Frankfurt

Under the extreme conditions of relativistic heavy-ion-collisions the creation of exotic matter like hypernuclei is possible. Hypernuclei measurements provide insights into the equation-of-state of hadronic matter at high net-baryon densities, as well as into hyperon-nucleon and hyperon-hyperon-interactions. The Compressed Baryonic Matter (CBM) experiment at the future Facility for Anti-Proton and Ion Research (FAIR) in Darmstadt offers the perfect conditions to explore the production of hypernuclei. At beam energies of around 12A GeV, in combination with high interaction rates of up to 10 MHz, an exceptionally high amount of hypernuclei will be created. The reconstruction of hypertriton was studied with the CBM software PFSimple. Focus was placed on the most probable 3-body-decay ${}^{3}_{\Lambda}\mathrm{H}\rightarrow\mathrm{d}+\mathrm{p}+\pi^{-}$ (branching ratio = 40.2 %). Different cuts were evaluated with regards to their performance indicators like efficiency, signal-to-background-ratio and significance. To further improve the reconstruction performance and speed, the correlations between several cuts were analyzed. A systematic study of cut combinations was performed to prepare optimized sets of cuts for various study purposes, eg. high efficiency, high background suppression or for different particle identification approaches.

HK 35.4 Wed 15:00 HK-H1

Extending strong-interaction studies in ALICE to nuclei: measurement of proton-deuteron and Lambda-deuteron correlations — •Bhawani Singh[1] and Michael Jung[2] for the ALICE-Collaboration — [1]Technische Universität München — [2]Goethe-Universität Frankfurt am Main

In the endeavour to explore the strong interaction among hadrons, ALICE has for the first time extended its femtoscopic studies to nuclei. The large data sample of high-multiplicity pp collisions at $\sqrt{s} = 13\,\mathrm{TeV}$ allows us to measure both the proton–deuteron (p–d) and the Lambda–deuteron (Λ–d) momentum correlations.

In this contribution, the measured correlation functions for p–d and Λ–d are presented and compared to theoretical predictions. A large discrepancy between data and theory is observed in the case of p–d correlations, where the data show a depletion at low relative momenta, while the models predict a strong attractive signal. Possible explanations include a late formation of the deuterons and the formation of a bound state. The Λ–d correlation is in agreement with no observed interaction, supporting the findings in p–d, but the current data would also allow for a remaining strong-interaction signal. Future measurements by ALICE in the upcoming LHC Run 3 will help to shed more light on the sector of nuclei in femtoscopy.

HK 35.5 Wed 15:15 HK-H1

Measurement of the Λ separation energy in hypertriton with ALICE using machine learning techniques — •Regina Michel for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung — Technische Universität Darmstadt

Hypertritron ${}^{3}_{\Lambda}\mathrm{H}$ is the lightest hypernucleus, consisting of a Λ hyperon, a proton and a neutron. It is structured as a halo nucleus, where the Λ hyperon is very loosely bound to a "deuteron core". Measurements of the Λ separation energy can be used as a test for QCD, for some models of neutron stars and to constrain the difference of the lifetimes of ${}^{3}_{\Lambda}\mathrm{H}$ and Λ. The Λ separation energy can be measured via the invariant mass of the hypertriton decay products. The two-body-decay ${}^{3}_{\Lambda}\mathrm{H} \rightarrow {}^{3}\mathrm{He}+\pi$ is considered. Monte Carlo simulations are conducted to simulate the hypertriton interactions and decays while flying through the detector. A data sample from Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV recorded with ALICE at the LHC is analyzed using machine learning techniques.