HK 44: Heavy-Ion Collisions and QCD Phases IX

Time: Wednesday 15:45–17:15 Location: HBR 62: EG 03

HK 44.1 Wed 15:45 HBR 62: EG 03

Lambda hyperon polarization in heavy-ion collisions within a hybrid approach — •Nils Sass[1], David Wagner[1], Masoud Shokri[1], Dirk Rischke[1,4], and Hannah Elfner[1,2,3,4] — [1]Institute for Theoretical Physics, Goethe University, Max-von-Laue-Strasse 1, 60438 Frankfurt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt, Germany — [3]FIAS, Ruth-Moufang-Strasse 1, 60438 Frankfurt, Germany — [4]Helmholtz Research Academy Hesse for FAIR (HFHF), GSI Helmholtz Center, Max-von-Laue-Straße 12, 60438 Frankfurt, Germany

In 2017, the STAR collaboration at the Relativistic Heavy Ion Collider (RHIC) has emphasized the role of spin in heavy-ion collisions by the measurement of global polarization of Λ hyperons. This measurement revealed, for the first time, a high angular momentum of heavy ions in the quark-gluon plasma (QGP), providing experimental evidence for a strong vortical structure in the fireball, integral to the manifestation of Λ polarization. Current investigations focus on delineating the mechanisms governing angular momentum deposition and the consequent emergence of polarization observables. Within a framework of second-order relativistic spin hydrodynamics, recent studies by Weickgenannt et al. [PhysRevD.106.096014] have extended the Pauli-Lubanski vector, to include dissipative spin effects. Introducing this updated formulation of the Pauli-Lubanski vector into a full hybrid approach for the first time, our work facilitates the direct exploration of Lambda hyperon polarization from the particlization hypersurface.

HK 44.2 Wed 16:00 HBR 62: EG 03

CBM Performance for Λ Yield Analysis using Machine Learning Techniques — •Axel Puntke for the CBM-Collaboration — Universität Münster

The Compressed Baryonic Matter (CBM) experiment at FAIR will investigate the QCD phase diagram at high net-baryon densities ($\mu_B >$ 500 MeV) with heavy-ion collisions in the energy range of $\sqrt{s_{NN}} =$ 2.9 - 4.9 GeV. Precise determination of dense baryonic matter properties requires multi-differential measurements of strange hadron yields, both for the most copiously produced K^0_s and Λ as well as for rare (multi-)strange hyperons and their antiparticles.

In this talk, the analysis of the Λ baryon yield measurement is presented. The Λ hadrons are reconstructed using methods based on a Kalman Filter algorithm that has been developed for the reconstruction of particles via their weak decay topology. The large combinatorial background is suppressed by applying selection criteria tuned to the topology of the decay. This selection is optimized by training a machine learning model based on boosted decision trees with simulated samples from two heavy-ion event generators, UrQMD and DCM-QGSM-SMM. A routine is implemented to extract multi-differentially Λ yields corrected for detector acceptance and efficiency. This analysis chain is validated by the GEANT4 Monte Carlo simulations of particle transport through the CBM detector material.

HK 44.3 Wed 16:15 HBR 62: EG 03

CBM performance for the measurement of strange hadron and hypernuclei in 3 GeV Au+Au collisions at FAIR — •Yingjie Zhou for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The main goal of the CBM experiment at FAIR is to study the behavior of nuclear matter at very high baryonic density. This includes the exploration of the high-density equation of state (EoS), search for the transition to a deconfined and chirally restored phase and critical endpoint. The promising diagnostic probes for this new state are the enhanced production of multi-strange (anti-)particles. The CBM detector is designed to measure such rare diagnostic probes multi-differentially with unprecedented precision and statistics. Important key observables are the production of hypernuclei. The discovery and investigation of new (doubly strange-)hypernuclei and hyper-matter will shed light on the hyperon-nucleon and hyperon-hyperon interactions.

In this presentation, performance studies for strange hadron and hypernuclei production in 3 GeV Au+Au collisions with the CBM experiment at FAIR will be presented. The CBM performance is compared with that of the STAR experiment and projections for statistical uncertainties with high statistics data at CBM are presented.

HK 44.4 Wed 16:30 HBR 62: EG 03

Measurement of $A = 4$ (anti-)hypernuclei production in heavy-ion collisions at the LHC — •Janik Ditzel — Institut für Kernphysik, Goethe-Universität, Frankfurt, Germany

At the Large Hadron Collider at CERN, light (anti-)hypernuclei are produced abundantly in Pb-Pb collisions. The production of such (anti-)hypernuclei 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 and the main (anti-)hypernucleus to study at the LHC. Nevertheless, there are heavier (anti-)hypernuclei whose production yields are suppressed with respect to the (anti-)hypertriton. However, they could give further insights into the formation mechanism and the nature of the hyperon-nucleon or hyperon-hyperon interaction. The existence of excited states of the two A=4 (anti-)hypernuclei makes their measurement in heavy-ion collisions in the investigated dataset become feasible. These (anti-)hypernuclei decay weakly after a few centimeters into two or more daughter particles and are reconstructed by their decay products. With the excellent performance of the ALICE apparatus, a clear particle identification of the daughters and a precise reconstruction of the decay vertex is possible. We will present new results on the measurement of (anti-)hypernuclei within the $A = 4$ mass region, namely the (anti-)hyperhydrogen-4 and the (anti-)hyperhelium-4.

HK 44.5 Wed 16:45 HBR 62: EG 03

Constraining Strangeness Production with Machine Learning — •Carl Rosenkvist[2] and Hannah Elfner[1,2,3] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt, Germany — [2]Frankfurt Institute for Advanced Studies, Ruth-Moufang-Strasse 1, 60438 Frankfurt am Main, Germany — [3]Institute for Theoretical Physics, Goethe University, Max-von-Laue-Strasse 1, 60438 Frankfurt am Main, Germany

In heavy-ion collisions, strange particles, which are absent in normal matter, are produced during or shortly after the collision, making them vital probes for understanding the underlying physics.

This project focuses on investigating strangeness production using the SMASH (Simulating Many Accelerated Strongly-interacting Hadrons) model. At lower collision energies, SMASH incorporates short-lived particles, known as resonances, to describe the production of strange particles through resonance decay.

However, the properties of resonance particles have uncertainties from experimental measurements, affecting simulations of low-energy observables sensitive to strangeness production. To address this, we employ machine learning algorithms and emulators to fit numerous resonance parameters simultaneously to experimental data, mainly exclusive elementary cross-sections.

Additionally, a recent study comparing SMASH with experimental data on pion beams colliding with carbon and tungsten revealed significant deviations. To understand this observed discrepancy, we will also investigate strangeness production in pion-nuclei collisions.

HK 44.6 Wed 17:00 HBR 62: EG 03

Strangeness tracking with the upgraded ALICE Inner Tracking System in Run 3 at the LHC — •Carolina Reetz for the ALICE Germany-Collaboration — Physikalisches Institut Heidelberg

A precise reconstruction of particles containing strangeness in high energy proton-proton and heavy-ion collisions is crucial not only for measurements of (multi-)charm baryons via their decays into strange baryons but also for measurements of strange hypernuclei such as the hypertriton ${}^{3}_{\Lambda}$H.

A novel technique called *strangeness tracking* is introduced making use of the upgraded silicon tracker (ITS2) of the ALICE detector in LHC Run 3. The new reconstruction approach allows to directly track weakly decaying charged strange hadrons and hypernuclei in the silicon layers closest to the beam pipe before they decay. The combination of the daughter track information with the measured hits of the parent particle trajectory in the ITS2 layers leads to significant improvements in the reconstruction performance and specifically the impact parameter resolution.

The strangeness tracking performance for ALICE Run 3 proton-proton collisions and simulations is presented with an emphasis on the reconstruction of charged Ξ-baryons.