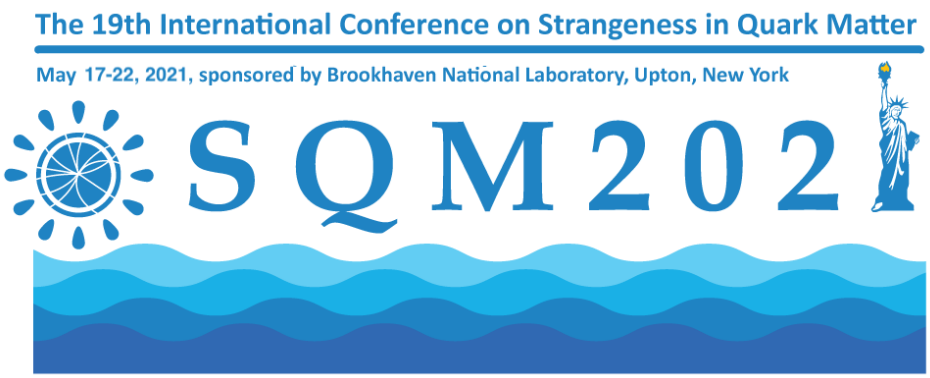
Online Strangeness in Quark Matter Conference 2021



Report of Contributions

https://indico.cern.ch/e/985652

Contribution ID: **4** Type: **Theory talk**

Interpretation of Λ hyperon spin polarization measurements

Thursday 20 May 2021 09:50 (20 minutes)

The physics interpretation of the recent measurements of the spin polarization of Λ hyperons produced in relativistic heavy-ion collisions is discussed. We suggest that the polarization measured in the Λ rest frame should be projected along the direction of the total angular momentum that is first transformed to the same frame, and only then averaged over Λ's with different momenta in the center-of-mass frame. As this improved procedure is not expected to significantly change the present results regarding the global spin polarization, it may affect the estimates of the magnitude of the polarization and its energy dependence. Such a treatment is also generally more appropriate whenever directions in the Λ rest frame and in the center-of-mass frame are compared. Throughout the paper we deliver explicit expressions for various boosts, rotations, and transformations of angular distributions, which may help to compare model predictions with the experimental results.

reference: e-Print: 2102.02890 [hep-ph]

Collaboration

Authors: Dr RYBLEWSKI, Radoslaw (Institute of Nuclear Physics PAN); FLORKOWSKI, Wojciech (Jagiellonian University)

Presenter: Dr RYBLEWSKI, Radoslaw (Institute of Nuclear Physics PAN)

Session Classification: Strangeness (Global Polarization)

Contribution ID: **5** Type: **Theory talk**

Strange baryons in nuclei and neutron stars

Thursday 20 May 2021 10:10 (20 minutes)

Understanding the dynamics of hadrons with strangeness has received a lot attention over the past decades in connection with the study of exotic atoms, the analysis of strangeness production and propagation in particle and nuclear research facilities, and the investigation of the possible strange phases in the interior of neutron stars. One venue of interest in the field of strangeness is the study of strange baryons, the so-called hyperons, and their dynamics with nucleons and nuclear matter. Theoretical studies have gone hand in hand with scattering experiments employing secondary hyperon beams or, more recently, using femtoscopy techniques. Also, the possible formation of nuclei with one or more hyperons inside the nucleus, the so-called hypernuclei, has triggered a lot of theoretical advances. Moreover, understanding the behaviour of hyperons in the presence of a surrounding dense medium is of particular interest to determine the features of the possible phases of dense matter in compact astrophysical objects, such as neutron stars. In this talk I will review the dynamics of hyperons with nucleons and nuclear matter, as presented in Ref. [1], paying a special attention to hypernuclei. I will also discuss the presence of hyperons in the inner core of neutron stars and the consequences for the structure of these compact stars.

[1] Laura Tolos and Laura Fabbietti, Prog. Part. Nucl. Phys. 112 (2020) 103770, 2002.09223 [nucl-ex]

Collaboration

Authors: Dr TOLOS, Laura; FABBIETTI, laura (Technische Universität München)

Presenter: Dr TOLOS, Laura

Session Classification: Astrophysics and Hadronic Interactions

Track Classification: Strangeness in astrophysics

Contribution ID: **6** Type: **Theory talk**

In-medium effects in strangeness production in heavy-ion collisions at (sub-)threshold energies

Tuesday 18 May 2021 10:30 (20 minutes)

We study the in-medium effects in strangeness production
in heavy-ion collisions at (sub-)\-threshold energies of 1 - 2 A GeV based on
the microscopic Parton-Hadron-String Dynamics (PHSD) transport approach.
The in-medium modifications of the antikaon ($\bar{K} = K^-, \bar{K}^0$) properties
are described via the self-consistent coupled-channel unitarized scheme
based on a SU(3) chiral Lagrangian which incorporates explicitly the $s-$ and
$p-$ waves of the kaon-nucleon interaction. This scheme provides the antikaon
potential, spectral functions and reaction cross sections as well as their dependence on baryon density, temperature and antikaon momentum in the nuclear medium, which are incorporated in the off-shell dynamics of the PHSD.
The in-medium modification of kaons ($K = K^+, K^0$) are accounted via
the kaon-nuclear potential, which is assumed to be proportional to the local baryon density. The manifestation of the medium effects in observables is investigated for the K and $\bar{K}$ rapidity distributions, p_T-spectra as well as the polar and azimuthal angular distributions, directed (v_1) and elliptic (v_2) flow in C+C, Ni+Ni, and Au+Au collisions.

We find - by comparison to experimental data from the KaoS, FOPI and HADES
Collaborations - that the modifications of (anti)kaon properties
in nuclear matter are necessary to explain the data in a consistent manner. Moreover, we demonstrate the sensitivity of kaon observables to the equation-of-state of nuclear matter.

Collaboration

Authors: SONG, Taesoo (GSI); TOLOS, Laura; WIRTH, Joana (Technische Universität München); AICHELIN, Joerg (Subatech/CNRS); BRATKOVSKAYA, Elena (GSI, Darmstadt)

Presenter: SONG, Taesoo (GSI)

Session Classification: Open and New (Electromagnetic)

Track Classification: Strangeness production in nuclear collisions and hadronic interactions

Contribution ID: **8** Type: **Theory talk**

Lattice QCD equation of state at finite chemical potential from an alternative expansion scheme

Thursday 20 May 2021 09:30 (20 minutes)

Taylor expansion of the equation of state of QCD
suffers from shortcomings at chemical potentials $\mu_B \geq (2-2.5)T$.
First, one faces difficulties inherent in performing such an expansion
with a limited number of coefficients; second,
higher order coefficients determined from
lattice calculations suffer from a poor signal-to-noise ratio.
We present a novel scheme for extrapolating
the equation of state of QCD to finite, real chemical
potential that can extend its reach further than previous methods.
We show continuum extrapolated lattice results for the new
expansion coefficients and for the thermodynamic observables up
to $\mu_B/T \leq 3.5$.

Collaboration

Authors: BORSANYI, Szabolcs (University of Wuppertal); FODOR, Zoltan; GUENTHER, Jana N. (University of Wuppertal); KARA, Ruben (University of Wuppertal); KATZ, Sandor (Eotvos University); PAROTTO, Paolo (University of Wuppertal); PASZTOR, Attila (Eötvös University); RATTI, Claudia (University of Houston); SZABO, Kalman (Forschungszentrum Jülich GmbH)

Presenter: PAROTTO, Paolo (University of Wuppertal)

Session Classification: Bulk (Lattice)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **10** Type: **not specified**

K_1/K^* enhancement as a signature of chiral symmetry restoration in heavy ion collisions

Tuesday 18 May 2021 10:50 (20 minutes)

Based on the fact that the mass difference between the chiral partners is an order parameter of chiral phase transition and that the chiral order parameter reduces substantially at the chemical freeze-out point in ultra-relativistic heavy ion collisions, we argue that the production ratio of K_1 over K^* in such collisions should be substantially larger than that predicted in the statistical hadronization model. We further show that while the enhancement effect might be contaminated by the relatively larger decrease of K_1 meson than K^* meson during the hadronic phase, the signal will be visible through a systematic study on centrality as the kinetic freeze-out temperature is higher and the hadronic life time shorter in peripheral collisions than in central collisions.

Collaboration

Authors: SUNG, Haesom (Yonsei University); CHO, Sungtae (Kangwon National University); HONG, Juhee (Yonsei University); LEE, Su Houng (Yonsei University); LIM, Sanghoon (Pusan National University (KR)); SONG, Taesoo (GSI)

Presenter: SUNG, Haesom (Yonsei University)

Session Classification: Open and New (Electromagnetic)

Contribution ID: **14** Type: **Theory talk**

Quarks and Antiquarks interacting in Electrodynamical Interactions

Tuesday 18 May 2021 10:10 (20 minutes)

Quarks and antiquarks carry electric charges and can interact in quantum electrodynamcal (QED) interactions. There appear no laws that forbid quarks and antiquarks to interact in QED interactions alone. Permitted on the basis of Gell-Mann's Totalitarian Principle that what is not forbidden is allowed and motivated by observations of low-mass anomalous particles in [1,2,3], we study the consequences of quarks and antiquarks in QED interactions alone [4,5,6]. We find that as the electrodynamical interactions between quarks and antiquarks with opposite signs of electric charges are attractive and quarks cannot be isolated, there can be stable composite light-quark states of neutral QED mesons and the QED neutron in the mass region of many tens of MeV [4,5,6]. Recent observations of the anomalous soft photons [1], the X17 particle [2], and the E38 particle [3] in the low-mass region provide positive experimental supports for the existence of some of the QED composite states. These anomalous particles may be produced during the deconfinement-to-cofinement phase transition of the quark-gluon plasma phase transition and may be used a signature for the quark-gluon plasma. The search for these states in high-energy heavy-ion collisions and the relevance of the QED neutron as a dark matter candidate particle will be examined and discussed.

[1] J. Abdallah *et al.* (DELPHI Collaboration),{Study of the dependence of direct soft photon production on the jet characteristics in hadronic Z0 decays}, Eur.Phys.J. C67, 343 (2010), [arXiv:1004.1587].
[2] A. J. Krasznahorkay *et al.*, {Observation of anomalous internal pair creation in 8Be: a possible indication of a light, neutral boson}, Phys. Rev. Lett. 116, 042501 (2016), [arXiv:1504.01527].
[3] K. Abraamyan, et.al, {Check of the structure in photon pairs spectra at the invariant mass of about 38 MeV}, EPJ Web of Conferences 204, 08004 (2019).
[4] C. Y. Wong, {Anomalous soft photons in hadron production}, Phys. Rev. C81, 064903 (2010), [arXiv:1001.1691].
[5] C. Y. Wong, {Open string QED meson description of the X17 particle and dark matter}, JHEP 08 (2020) 165, [arxiv:2001.04864].
[6] C. Y. Wong, {On the stability of the open-string QED neutron and dark matter}, [arxiv:2010.13948].

Collaboration

Author: WONG, Cheuk-Yin

Presenter: WONG, Cheuk-Yin

Session Classification: Open and New (Electromagnetic)

Track Classification: Open questions and new developments

Contribution ID: **15** Type: **Theory talk**

Temperature dependence of the properties of open heavy-flavor mesons

Wednesday 19 May 2021 10:10 (20 minutes)

Mesons carrying heavy flavor (charm and beauty) are valuable probes of the quark-gluon plasma (QGP) created in heavy-ion collisions. Therefore a proper theoretical understanding of their modification in a thermal medium is required for a better description of the experimental data collected at RHIC and LHC. The modification of open heavy-flavor mesons in a hot medium of light mesons can be investigated theoretically with effective theories. In particular our approach is built upon chiral and heavy-quark spin-flavor symmetries and the use of the imaginary-time formalism to introduce the non-zero temperature effects to the theory [1,2]. The unitarized scattering amplitudes, the ground-state self-energies and the corresponding spectral functions are calculated self-consistently. I will show that the heavy ground states acquire a width induced by the interactions with the light mesons and the in-medium masses drop with increasing temperatures, which also implies the thermal modification of the excited mesonic states generated dynamically in our heavy-light molecular model. The thermal ground-state spectral functions obtained with this methodology can be further used to calculate meson Euclidean correlators, which are the quantities directly accessible in lattice QCD simulations. I will show that the comparison of the Euclidean correlators resulting from the effective theory with recent open-charm lattice correlators is fairly good well below T_c [3].

[1] G. Montaña, A. Ramos, L. Tolos and J. M. Torres-Rincon, Phys. Lett. B 806 (2020), 135464 doi:10.1016/j.physletb.2020.
[2] G. Montaña, A. Ramos, L. Tolos and J. M. Torres-Rincon, Phys.Rev.D 102 (2020) 9, 096020 doi:10.1103/PhysRevD.102.096020
[3] G. Montaña, O. Kaczmarek, L. Tolos and A. Ramos, Eur.Phys.J.A 56 (2020) 11, 294 doi:10.1140/epja/s10050-020-00300-y

Collaboration

Authors: MONTAÑA, Gloria (Universitat de Barcelona); Prof. RAMOS, Àngels (University of Barcelona); TOLOS, Laura; Dr TORRES-RINCON, Juan M (Goethe University Frankfurt)

Presenter: MONTAÑA, Gloria (Universitat de Barcelona)

Session Classification: Heavy Flavor (Open charm)

Contribution ID: **18** Type: **Theory talk**

Estimating Compressibility by Maximal-mass Compact Star Observations

Thursday 20 May 2021 10:50 (20 minutes)

Recent observation data of pulsar masses led us to estimate nuclear parameters, however, these predictions are strongly uncertain due to the masquarade problem. To resolve this we introduced, te maximmal-mass compact star scenario, and took into account data satisfying this criteria. We tested our method, applying the extended σ-ω model in the mean-field approximation at zero temperature and finite chemical potential to investigate the recent observation data of pulsar masses of PSR J0740+6620, PSR J0348+0432, and PSR J1614–2230. During the analysis we assumed that these pulsars are maximal mass compact objects, which suggest that the core approximation can be applied. Most of the free parameters of this model are fitted based on the nuclear saturation data, except for the Landau mass and effective nucleon mass. We used the observation data to determine the optimal Landau mass, and used the value to determine the nuclear compressibility $m_L = 76.0^{+38.5}_{-84.9}$ MeV and $K = 42.7^{+57.2}_{-28.0}$, respectively [1,2], which was in agreement in a more sophisticated Bayesian analysis [3].

[1] Eur.Phys.J.ST 229 (2020) 22-23, 3605-3614
[2] arXiv:1710.05410 (submitted to PASA)
[3] Eur.Phys.J.ST 229, 22-23, 3615-3628 (2020)

Collaboration

Authors: SZIGETI, Balazs Endre (Wigner Research Centre for Physics (Wigner RCP) (HU)); BARNAFOLDI, Gergely (Hungarian Academy of Sciences (HU)); PÓSFAY, Péter (Wigner Research Centre for Physics); JAKOVAC, Antal (Eotvos University Budapest)

Presenter: SZIGETI, Balazs Endre (Wigner Research Centre for Physics (Wigner RCP) (HU))

Session Classification: Astrophysics and Hadronic Interactions

Track Classification: Strangeness in astrophysics

Contribution ID: **25** Type: **Theory talk**

Quarkonia and heavy quark diffusion in the hot gluonic medium

Wednesday 19 May 2021 10:30 (20 minutes)

We will discuss thermal modifications of charmonium and bottomonium spectral properties in a hot gluonic medium from continuum extrapolated lattice results. The dissociation temperatures of quarkonia as well as charm and bottom quark diffusion coefficients are presented in the temperature region from $1.1T_c$ to $2.25T_c$ in the quenched approximation with valence quarks tuned to physical J/ψ and Υ masses. The results are obtained by incorporating theoretically and perturbatively inspired models for the spectral functions compared to continuum extrapolated correlation functions measured on the lattice.

Collaboration

Author: Dr SHU, Hai-Tao (Bielefeld University)

Co-authors: KRUSE, Anna-Lena (Bielefeld University); Dr SANDMEYER, Hauke; Prof. DING, Heng-Tong (CCNU); Dr OHNO, Hiroshi (Center for Computational Sciences, University of Tsukuba); KACZMAREK, Olaf (University of Bielefeld); Dr LARSEN, Rasmus; MUKHERJEE, Swagato (Brookhaven National Laboratory)

Presenter: Dr SHU, Hai-Tao (Bielefeld University)

Session Classification: Heavy Flavor (Open charm)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **28** Type: **Theory talk**

Heavy-quark effects on cold quark matter and self-bound stars

Friday 21 May 2021 10:10 (20 minutes)

The heavy-quark effects on the equation of state for cold and dense quark matter are obtained from perturbative QCD, yielding observables parametrized only by the renormalization scale. In particular, we investigate the thermodynamics of charm quark matter under the constraints of β equilibrium and electric charge neutrality in a region of densities where perturbative QCD is, in principle, much more reliable. Finally, we analyze the stability of charm stars, which might be realized as a new branch of ultradense hybrid compact stars, and find that such self-bound stars are unstable under radial oscillations.

Collaboration

Author: JIMÉNEZ, José C.

Co-author: FRAGA, Eduardo (Federal University of Rio de Janeiro)

Presenter: JIMÉNEZ, José C.

Session Classification: Open and New (IV)

Contribution ID: **33** Type: **Theory talk**

Quark coalescence model for spin alignments of vector mesons ϕ and K^{*0}

Wednesday 19 May 2021 09:50 (20 minutes)

We propose an improved quark coalescence model with spin degrees of freedom for vector mesons by spin density matrix in phase space. This model allows us to estimate spin alignments of vector mesons using polarizations of quarks. We propose that a significant positive deviation from 1/3 of the spin density matrix element ρ_{00} for the ϕ meson may attribute to the electric part of the mean vector ϕ field generated in heavy ion collisions. Meanwhile, a negative deviation of ρ_{00} for the K^{*0} meson may come from the electric part of the vorticity tensor field. The difference between spin alignments of ϕ and K^{*0} is due to the large mass ratio of strange quarks to light quarks. These results should be tested by a detailed and comprehensive simulation of vorticity tensor fields and vector ϕ fields in heavy ion collisions.

Collaboration

Authors: Dr SHENG, Xin-Li (Central China Normal University); Prof. WANG, Qun (University of Science and Technology of China); OLIVA, Lucia (Institute for Theoretical Physics (ITP), Frankfurt am Main); Dr WANG, Xin-Nian (Lawrence Berkeley National Lab. (US))

Presenter: Dr SHENG, Xin-Li (Central China Normal University)

Session Classification: Resonances and Hypernuclei (I)

Contribution ID: **39** Type: **Theory talk**

Hyperon Global Polarization in Nucleus-Nucleus Collisions at sub-10-GeV Beam Energy

Thursday 20 May 2021 10:30 (20 minutes)

In a non-central nucleus-nucleus collision, the colliding system carries large orbital angular momentum, part of which remains within the hot dense matter created by the collision. This angular momentum turns into complex fluid vorticity structures in the rapidly expanding bulk fluid and eventually manifests itself through the global spin polarization of produced particles such as hyperons. The STAR Collaboration reported the experimental discovery of this novel phenomenon in 2017. A crucial feature in establishing the interpretation was the predicted beam energy dependence, specifically a strong increase of fluid vorticity (and thus the polarization) when the collision beam energy is decreased from O(100) GeV to O(10) GeV range. In the latest Beam Energy Scan II experiment, these measurements have been pushed toward sub-10-GeV range through e.g. fixed-target collisions. It is an important question of great interest as to whether the trend would continue into such low beam energy range. In this contribution, we report our latest (and perhaps the first systematic) theoretical analysis of the vorticity and polarization in the sub-10-GeV collisions and present predictions for relevant observables. Finally, we comment on the possible implications for strong magnetic fields and related phenomena in such collisions.

Collaboration

Author: LIAO, Jinfeng (Indiana University)

Presenter: LIAO, Jinfeng (Indiana University)

Session Classification: Strangeness (Global Polarization)

Contribution ID: **40** Type: **Theory talk**

Excited states of Bottomonia in QGP from lattice QCD

Thursday 20 May 2021 10:10 (20 minutes)

Using non-relativistic QCD techniques on finite temperature lattice configurations, we will present results pertaining to the fate of the Bottom and anti-Bottom quarkonium states of Y(1S), Y(2S) and Y(3S) in Quark-Gluon-Plasma (QGP). We will present results on how the mass and spectral width of these states change with temperature. We will also show new results on how the finite temperature potential between a quark and anti-quark corroborate the results obtained for the quarkonium states.

Collaboration

Author: LARSEN, Rasmus (University of Stavanger)

Co-authors: MUKHERJEE, Swagato (Brookhaven National Laboratory); PETRECZKY, Peter (BNL); Prof. MEINEL, Stefan (University of Arizona)

Presenter: LARSEN, Rasmus (University of Stavanger)

Session Classification: Bulk (Lattice)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **41** Type: **Experimental talk**

Indications for a non-monotonic pattern in the (T, μ_B)-dependence of the specific viscosity

Tuesday 18 May 2021 11:10 (20 minutes)

We present Azimuthal Anisotropy Scaling Functions for identified particle species spanning beam energies from RHIC to the LHC. The scaling functions, which clarify the respective influence of initial-state eccentricity, expansion dynamics, and the transport coefficients, indicate characteristic signatures for the transport coefficient's dependencies on the temperature (T) and the baryon (μ_B), strangeness (μ_S), and isospin (μ_I) chemical potentials. The extracted scaling coefficients indicate non-monotonic dependencies of the transport coefficients η/s and $\hat{q}$ on (T, μ_B), linked to the critical endpoint in the phase diagram for nuclear matter.

Collaboration

Author: LACEY, Roy (Stony Brook University)

Presenter: LACEY, Roy (Stony Brook University)

Session Classification: Open and New (Correlations)

Contribution ID: **42** Type: **not specified**

Building a testable shear viscosity across the QCD phase diagram

Tuesday 18 May 2021 11:50 (20 minutes)

Current experiments at the Relativistic Heavy Ion Collider (RHIC) are probing finite baryon densities where the shear viscosity to enthalpy ratio $\eta T/w$ of the Quark Gluon Plasma remains unknown. We use the Hadron Resonance Gas (HRG) model with the most up-to-date hadron list to calculate $\eta T/w$ at low temperatures and at finite baryon densities ρ_B. We then match $\eta T/w$ to a QCD-based shear viscosity calculation within the deconfined phase to create a table across $\{T, \mu_B\}$ for different cross-over and critical point scenarios at a specified location [1]. We find that these new $\eta T/w(T, \mu_B)$ values would require initial conditions at significantly larger ρ_B, compared to ideal hydrodynamic trajectories, in order to reach the same freeze-out point.
[1] E. McLaughlin, J. Rose, T. Dore, P. Parotto, C. Ratti, and J. Noronha-Hostler, arXiv:2103.02090

Collaboration

Author: MCLAUGHLIN, Emma (Columbia University)

Co-authors: DORE, Travis (University of Illinois at Urbana-Champaign); Prof. NORONHA-HOSTLER, Jacquelyn (University of Illinois Urbana Champaign); RATTI, Claudia (University of Houston); PAROTTO, Paolo (University of Wuppertal); ROSE, Jacob (Dr. Karl-Remeis Observatory - Astronomical Institute)

Presenter: MCLAUGHLIN, Emma (Columbia University)

Session Classification: Open and New (Correlations)

Contribution ID: **43** Type: **Theory talk**

Charmonium transition in electromagnetic and rotational elds

Friday 21 May 2021 09:30 (20 minutes)

We study charmonia in electromagnetic and rotational fields in the frame of a potential model. Different from the temperature field which is isotropic and leads to the well-known charmonium dissociation, the electromagnetic and rotational fields break down the radial symmetry, and the competition between strong interaction and electromagnetic and rotational interaction in the direction of Lorentz force makes the charmonia transit from an isotropic bound state of strong interaction with positive binding energy to an anisotropic bound state of electromagnetic and rotational interaction with negative binding energy. The transition seems possible to be realized in high energy nuclear collisions.

Collaboration

Author: ZHUANG, Pengfei (Tsinghua University)

Presenter: ZHAO, jiaxing (Tsinghua University)

Session Classification: Heavy Flavor (Charmonia)

Contribution ID: **45** Type: **Theory talk**

The role of the strange quasiquarks in transport properties of the QGP

Wednesday 19 May 2021 10:50 (20 minutes)

We study the role of dynamical strange quarks in transport properties of the QGP utilizing the quasiparticle approach based on the kinetic theory. The interactions with a hot medium are encoded in the quasiparticle excitations, with the temperature dependence of the dynamical masses specified by the effective coupling extracted from the lattice QCD thermodynamics.

Evaluation of the temperature and flavor profiles of the shear (bulk) viscosity to entropy density ratio illustrates how strange quark excitations modify the transport properties of the deconfined matter [1].
Further, computing the bulk to shear viscosity ratio and parameterizing it by the sound velocity, we show that the quasiparticle model adequately captures the weak and strong coupling regimes of QCD. In the vicinity of the crossover, the bulk to shear viscosity ratio behaves consistently to the scaling with the speed of sound derived in the AdS/CFT approach, while at high temperature, it obeys the same parametric dependence as in perturbation theory.

We also find that the presence of heavy quasiquarks in the system extends the temperature region where QCD is described nonperturbatively, and significantly delays the restoration of conformal invariance at high temperature [2]. The preliminary results including the charm quark will also be presented.

[1] V. M., M. Bluhm, K. Redlich, C. Sasaki, Phys.Rev.D 100 (2019) 3, 034002

[2] V. M., C. Sasaki, Phys.Rev.D 103 (2021) 1, 014007

Collaboration

Author: MYKHAYLOVA, Valeriya

Co-authors: SASAKI, Chihiro; REDLICH, Krzysztof (University of Wroclaw); Dr BLUHM, Marcus (University of Wroclaw)

Presenter: MYKHAYLOVA, Valeriya

Session Classification: Bulk (Transport)

Contribution ID: **47** Type: **Experimental talk**

Quarkonia excited state suppression in pp and p-Pb with ALICE

Tuesday 18 May 2021 11:30 (20 minutes)

Quarkonium production in small systems has been the subject of many theoretical and experimental studies. In proton-nucleus (p-A) collisions, their production is sensitive to cold nuclear matter effects such as nuclear modification of parton densities, parton energy loss via initial-state radiation and transverse momentum broadening due to multiple soft collisions. Furthermore, high-multiplicity proton-proton (pp) and p–A collisions have shown features reminiscent of those observed in heavy-ion collisions. Thus, quarkonium production as a function of event multiplicity can bring new insights on processes at the parton level and on the interplay between the hard and soft mechanisms in particle production. In particular, the role of Multiple Parton Interactions (MPI) which are expected to be relevant for the production of heavy quarks at the LHC energies, can be investigated. In this contribution the multiplicity dependence of self normalized yields measured in pp collisions at $\sqrt{s}$ = 13 TeV and $\sqrt{s}$ = 5 TeV will be presented for several quarkonium states, namely inclusive J/ψ at midrapidity as well as the corresponding results for J/ψ, ψ(2S), Υ(1S) and Υ(2S) at forward rapidity. The nuclear modification factor ($R_{\rm pPb}$) for J/ψ, ψ(2S), Υ(1S), Υ(2S) and Υ(3S), measured in p-Pb collisions at $\sqrt{s_{\rm NN}}$ = 8.16 TeV in forward and backward rapidities will also be presented, including the centrality dependence of J/ψ and ψ(2S) and the new results of the excited to ground state ratio for both charmonium and bottomonium. Furthermore, the $R_{\rm pPb}$ results at midrapidity will be shown at $\sqrt{s_{\rm NN}}$ = 5 TeV for both prompt and non-prompt J/ψ, the latter originating from the decay of beauty hadrons. The results are compared with several model calculations and the possible interpretation of the results will be discussed.

Collaboration

ALICE

Author: DING, Yanchun (Central China Normal University CCNU (CN))

Presenter: DING, Yanchun (Central China Normal University CCNU (CN))

Session Classification: Open and New (Correlations)

Track Classification: Heavy quark production in nuclear collisions and hadronic interactions

Contribution ID: **48** Type: **Experimental talk**

Quarkonia as probe of the QGP and of the initial stages of the heavy ion collision with ALICE

Friday 21 May 2021 09:50 (20 minutes)

The production of quarkonia is one of the first proposed probes of the QGP properties in heavy-ion collisions. Since heavy quarks are produced during the early hard partonic collisions, they experience the entire evolution of the fireball. The suppression of quarkonium bound states by the free color charges of the dense deconfined medium, as well as the charmonium regeneration by (re)combination of charm quarks at the QGP phase boundary or through the fireball evolution, are sensitive to the medium properties. Furthermore, a modification of the quarkonium vector states polarization in Pb-Pb collisions with respect to pp collisions may give insights on quarkonium suppression and regeneration mechanisms in the QGP. Quarkonia are also sensitive to the initial state of heavy-ion collisions and could help constraining the nuclear gluon distribution at low Bjorken-x, in photonuclear collisions. In this contribution, we will report on the recent ALICE measurements of the J/ψ $R_{\rm AA}$ as a function of centrality/$p_{\rm T}$, and on final J/ψ v_2 results, at both central and forward rapidity, using the full Run 2 Pb-Pb data sample. The final Υ(1S) $R_{\rm AA}$ and v_2, Υ(2S) $R_{\rm AA}$, and J/ψ v_3 measured at forward rapidity will also be shown. We will also report on the first measurement of the J/ψ polarization in Pb-Pb collisions as a function of centrality/$p_{\rm T}$ and provide prospects for measurements as a function of the event plane. Finally, the recent coherent J/ψ photoproduction cross section measurement in Pb–Pb collisions with nuclear overlap at $\sqrt{s_{\rm NN}}$ = 5.02 TeV, which extends previous measurements towards more central collisions, will be shown considering the full Run 2 data sample. The aforementioned results will be compared and confronted to theoretical model predictions.

Collaboration

ALICE

Author: LOFNES, Ingrid Mckibben (University of Bergen (NO))

Presenter: LOFNES, Ingrid Mckibben (University of Bergen (NO))

Session Classification: Heavy Flavor (Charmonia)

Contribution ID: **49** Type: **Theory talk**

Using DREENA framework to explore properties of QGP

Friday 21 May 2021 10:30 (20 minutes)

DREENA framework is based on our dynamical energy loss formalism, which takes into account finite size, finite temperature QCD medium consisting of dynamical (moving) partons. Both radiative and collisional energy losses are calculated under the same theoretical framework in the dynamical energy loss formalism, which is applicable to both light and heavy flavor observables. We generalized the formalism to the case of finite magnetic mass, running coupling, and towards removing widely used soft-gluon approximation. Importantly, DREENA provides a natural framework where temperature profile from any medium evolution can be straightforwardly implemented. We exploit this by implementing different state-of-the-art medium evolutions (both smooth and event-by-event hydrodynamics simulations) within DREENA framework. DREENA does not use free parameters, i.e. its only input is the temperature profile that comes directly from various QGP simulation models. This opens possibility to use DREENA on both light and heavy flavor to test and differentiate between different available QGP evolution models, including both large and smaller systems, making DREENA a multipurpose QGP tomography tool. Our results on these tests will be presented, which enables us to gain a better understanding of the bulk QGP medium created at RHIC and LHC. As a highlight, contrary to the existing models, which for full hydro evolution models lead to v_2 puzzle, with DREENA we surprisingly obtain a very good joint agreement between R_{AA} and v_2 data. This well known puzzle therefore appears to be a consequence of a simplified energy loss commonly used by other models –once a proper description of parton medium interactions is used, v_2 puzzle is abolished. While a widely accepted paradigm is that proper medium evolution description dominates in explaining high p_T data, this result strongly suggests that proper description of parton-medium interactions is much more important.

Collaboration

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Presenter: ZIGIC, Dusan (Institute of Physics Belgrade)

Session Classification: Open and New (IV)

Contribution ID: **50** Type: **Experimental talk**

Low-mass dielectron measurements with ALICE at the LHC

Tuesday 18 May 2021 09:30 (20 minutes)

Dileptons and photons are unique tools to study the space–time evolution of the hot and dense matter created in ultra-relativistic heavy-ion collisions. They are produced continuously by a variety of processes, in particular prompt and thermal photons and semi-leptonic heavy-flavour hadron decays, during the entire history of the collision and traverse the medium with negligible final state interaction. So they can carry undistorted information on early stages of the collision. In this contribution, we will present results from the recent measurements of e^+e^- pair production in pp and p–Pb collisions at the center-of-mass energy $\sqrt{s_{NN}}$ = 5.02 TeV. Charm and beauty cross sections are extracted to investigate possible cold nuclear matter effects such as shadowing by comparing estimates of the nuclear modification factor R_{pPb} obtained with different sets of nuclear parton distribution functions. Furthermore, our results on dielectrons at low $p_{T,ee}$ in pp collisions at $\sqrt{s}$ = 13 TeV and in Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV will be presented and compared to expectations from calculations including Bremsstrahlung (for pp collisions) and photoproduction (for Pb–Pb collisions).

Collaboration

ALICE

Author: BAILHACHE, Raphaelle (Goethe University Frankfurt (DE))

Presenter: BAILHACHE, Raphaelle (Goethe University Frankfurt (DE))

Session Classification: Open and New (Electromagnetic)

Track Classification: Strangeness production in nuclear collisions and hadronic interactions

Contribution ID: **51** Type: **Theory talk**

Deciphering the nature of X(3872) in heavy ion collisions

Tuesday 18 May 2021 10:30 (20 minutes)

Exploring the nature of exotic multiquark candidates such as the X(3872) plays a pivotal role in understanding quantum chromodynamics (QCD). Despite significant efforts, consensus on their internal structures is still lacking. As a prime example, it remains a pressing open question to decipher the X(3872) state between two popular exotic configurations: a loose hadronic molecule or a compact tetraquark. We demonstrate a novel approach to help address this problem by studying the X(3872) production in heavy ion collisions, where a hot fireball with ample light as well as charm (anti-)quarks is available for producing the exotics. Adopting a multiphase transport model (AMPT) for describing such collisions and implementing appropriate production mechanism of either molecule or tetraquark picture, we compute and compare a series of observables for X(3872) in Pb-Pb collisions at the Large Hadron Collider. We find the fireball volume plays a crucial role, leading to a 2-order-of-magnitude difference in the X(3872) yield and a markedly different centrality dependence between hadronic molecules and compact tetraquarks, thus offering a unique opportunity for distinguishing the two scenarios. We also make the first prediction of X(3872) elliptic flow coefficient to be tested by future experimental measurements.

Collaboration

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Presenter: Dr ZHANG, Hui (Institute of Quantum Matter, South China Normal University)

Session Classification: Charm Exotics

Contribution ID: **52** Type: **Theory talk**

Triple nuclear collisions –a new method to explore the matter properties under new extreme conditions

Friday 21 May 2021 09:30 (20 minutes)

We suggest to explore an entirely new method to experimentally and theoretically study the phase diagram of strongly interacting matter based on the triple nuclear collisions (TNC). The key element of such experiments is to use the superthin solid target operated in the core of two colliding beams [1]. Our approach is based on the successful data-taking in the LHCb experiment in which the colliding and fixed gaseous target modes are running simultaneously [2]. The estimates show that under the high luminosity LHC conditions the TNC rate might reach an observable level of 1 event over 1000 s.
We simulated the TNC using the UrQMD 3.4 model [3, 4] at the beam center-of-mass collision energies $\sqrt{s}$ = 200 GeV and $\sqrt{s}$ = 2.76 TeV. We found that in the most central and simultaneous TNC the initial baryonic charge density is about 3 times higher than the one achieved in the usual binary nuclear collisions at the same energies. As a consequence, a production of protons and Λ-hyperons is increased by 2 and 1.5 respectively, respectively, while a sizable suppression of their antiparticles is observed.
At the beam center-of-mass collision energies of 10-40 GeV, the production of protons as well as of Λ-hyperons is enhanced approximately by a factor of 2.2 compared to the binary collisions, while the positive kaons are enhanced by 1.5. Hence we conclude that in the TNC method it is possible to create substantially denser strange matter than in the binary collisions. We argue that this method at lower energies can be of principal importance for searching the (tri)critical endpoint of the QCD phase diagram.

References:
[1] V. Pugatch, International Conference "CERN-Ukraine co-operation: current state and prospects "Kharkiv. 15-May-2018; LHCb-TALK-2018-557.
[2] LHCb Collaboration. SMOG2.Tecnical Design Report. CERN-LHCC-2019-005l.
[3] S.A. Bass et al., Prog. Part. Nucl. Phys. 41 (1998), 225-370.
[4] M. Bleicher et al., J. Phys. G 25 (1999), 1859-1896.

Collaboration

Authors: Prof. BUGAEV, Kyrill (Bogolyubov Institute for Theoretical Physics, Kiev, Ukraine); Mr VITIUK, Oleksandr (Taras Shevchenko National University of Kyiv); Prof. PUGATCH, Valery (Institute for Nuclear Research, National Academy of Sciences of Ukraine,); Mr DOBISHUK, Vasyl (Institute for Nuclear Research, National Academy of Sciences of Ukraine); Mr CHERNYSHENKO, Sergiy (Institute for Nuclear Research, National Academy of Sciences of Ukraine); Dr GRINYUK, Boris (olyubov Institute for Theoretical Physics, National Academy of Sciences of Ukraine); Mr PANASIUK, Pavlo (Department of Physics, Taras Shevchenko National University of Kyiv); Mr YAKOVENKO, Nazar (Department of Physics, Taras Shevchenko National University of Kyiv); Ms ZHEREBTSOVA, Elizaveta (National Research Nuclear University "MEPhI"(Moscow Engineering Physics Institute)); Prof. BRAVINA, Larissa (University of Oslo); Dr TARANENKO, Arkadiy (National Research Nuclear University "MEPhI"(Moscow Engineering Physics Institute)); Dr ZABRODIN, Evgeny (University of Oslo); BLE-

ICHER, Marcus (Uni Frankfurt)

Presenters: Prof. BUGAEV, Kyrill (Bogolyubov Institute for Theoretical Physics, Kiev, Ukraine); Mr VITIUK, Oleksandr (Taras Shevchenko National University of Kyiv)

Session Classification: Open and New (IV)

Contribution ID: **53** Type: **Experimental talk**

Production of light nuclei in small collision systems with ALICE

Friday 21 May 2021 09:50 (20 minutes)

The energy densities reached in high-energy hadronic collisions at the LHC allow significant production of light (anti)nuclei. Their production yields have been measured as a function of p_{T} and charged-particle multiplicity in different collision systems and at different center-of-mass energies by ALICE. One of the most interesting results obtained from such a large variety of experimental data is that the dominant production mechanism of light (anti)nuclei seems to depend solely on the event charged-particle multiplicity. Evidence for this comes from the continuous evolution of the deuteron-to-proton and ^{3}He-to-proton ratios with the event multiplicity across different collision systems and energies. The characterization of the light nuclei production mechanism is complemented by measurements of their production yields in jets, where hard QCD processes are dominant, and in the underlying event, which is dominated by soft QCD processes.

In this contribution, recent results on light nuclei production in proton-proton and proton-lead collisions are shown and discussed in the context of the statistical hadronization and coalescence models. In addition, final results on the deuteron production in jets and new preliminary results on its production in the underlying event measured in proton-proton collisions at 13 TeV are shown.

Collaboration

ALICE

Author: PINTO, Chiara (INFN and University of Catania)

Presenter: PINTO, Chiara (INFN and University of Catania)

Session Classification: Bulk (Small systems)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **54** Type: **Experimental talk**

Prompt and non-prompt D_s^+ production in pp and Pb-Pb with ALICE

Thursday 20 May 2021 10:10 (20 minutes)

Measurements of D_s^+ mesons originating from the hadronisation of a charm quark (prompt) and from beauty-hadron decays (non-prompt) offer a unique tool to study the hadronisation of both charm a-proton and heavy-ion collisions.

In this contribution, the latest results of the ALICE Collaboration on the production of prompt and non-prompt D_s^+ in pp collisions at $\sqrt{s} = 5.02$ TeV will be presented. Measurements of their production in pp collisions represent an important test for perturbative QCD calculations and provide information about the fragmentation of heavy quarks to strange heavy-flavour hadrons relative to that of heavy-flavour hadrons without strange-quark content.

The nuclear modification factor ($R_{\rm AA}$) in Pb-Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV and azimuthal anisotropy of prompt D_s^+ will be also presented. The first measurement of D_s^+ $R_{\rm AA}$ will also compared to that of prompt D_s^+ and non-prompt D^0 mesons at central rapidity. The production of charm and beauty hadrons with strange-quark content is particularly interesting to study the hadronisation mechanisms of heavy-quarks in the QGP. In fact, if a fraction of heavy quarks hadronise via recombination with light-flavoured quarks in the medium, the production of charm and beauty hadrons with strange-quark content is expected to be enhanced with respect to that of non-strange hadrons, due to the abundant production of (anti)strange quarks in heavy-ion collisions compared to proton-proton (pp) collisions, where an extended QGP formation is not expected. In this context, the production of prompt D_s^+ allows the study of the hadronisation of charm quarks, while that of non-prompt D_s^+ mesons, of which about half originate from B_s^0-meson decays, is sensitive to the possible enhancement of beauty-strange meson production.

Finally, the expected performance for the measurement of non-prompt D_s^+ mesons and that of B_s^0 mesons with ALICE in the LHC Run 3 and Run 4 will be presented.

Collaboration

ALICE

Author: CATALANO, Fabio (Politecnico e INFN Torino (IT))

Presenter: CATALANO, Fabio (Politecnico e INFN Torino (IT))

Session Classification: Heavy Flavor (Beauty)

Contribution ID: **55** Type: **Experimental talk**

Open charm and beauty measurements from small to large systems with ALICE

Thursday 20 May 2021 09:30 (20 minutes)

In this contribution, measurements of open charm and beauty production via heavy-flavour hadron decay leptons, prompt and non prompt D^{+} and D^{0} in pp collisions are presented. In heavy-ion collisions, measurements of the production of leptons from heavy-flavour hadron decays and the modification of their spectra in different collision systems, like Xe–Xe and Pb–Pb, are discussed. The aforementioned measurements, together with the centrality-dependent measurements of the prompt D mesons, set new constraints to the modeling of the nature of parton energy loss and its dependence on the size of the QGP medium in transport-model calculations, highlighting that the collision geometry plays an important role in heavy-quark energy loss.The latest results on the centrality dependence of R_{AA} of beauty-decay electrons and non-prompt D^{0} in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV will also provide important constraint to the in-medium mass dependent energy loss. High precision measurements of elliptic flow (v_2) of heavy-flavour particles provide stringent information about the thermal degrees of freedom of charm and beauty quarks in the QGP, path-length dependence of heavy-quark in-medium energy loss and recombination effects. Measurements of higher flow harmonics, such as the triangular flow (v_3), provide further constraints on fluctuations in the initial state of the system and on the ratio of the shear viscosity to the entropy density of the QGP, η/s. The coupling of the charm quark to the light quarks in the underlying medium is further investigated with the application of the event-shape engineering (ESE) technique to the D-meson elliptic flow and p_{T}-differential yields. A strong correlation with the average bulk elliptic flow in both central and semicentral collisions is measured. Finally, the expected performance and projections of charm and beauty-hadron productions with ALICE in LHC Run 3 and Run 4 will be discussed.

Collaboration

ALICE

Author: PARK, Jonghan (Inha University (KR))

Presenter: PARK, Jonghan (Inha University (KR))

Session Classification: Heavy Flavor (Beauty)

Contribution ID: **56** Type: **Experimental talk**

Heavy-flavour production in small systems and evolution with multiplicity with ALICE

Wednesday 19 May 2021 10:50 (20 minutes)

Studies on the production of heavy-flavour in pp and p-Pb collisions are of primary importance as a baseline to characterise the QGP medium created in ultrarelativistic heavy-ion collisions, and as tests of perturbative QCD and cold-matter effects in the nuclear medium. Recent measurements performed in small collision systems have revealed unexpected features, as the enhancement of baryon-to-meson ratios and modification of spectra in a high-multiplicity pp and p-Pb collisions with respect to minimum bias collisions. These could be explained as signatures of quark recombination mechanisms, radial flow and collectivity, phenomena typically observed in Pb-Pb collisions, suggesting that similar mechanisms could have a role also in small systems and that a smooth evolution of the heavy-flavour production measurements versus multiplicity, going from pp to Pb-Pb collisions, is observed.

In this regards, a comprehensive study of multiplicity-dependent measurements at midrapidity will be discussed for Λ_c^+, strange and non-strange D mesons, and leptons from heavy-flavour hadron decays. In particular the baryon-to-meson ($^+_c/\mathrm{D}^0$) and strange-to-non-strange meson ($\mathrm{D_s}/\mathrm{D}$) production ratios, and the self-normalised yields in pp collisions at $\sqrt{s}$ = 13 TeV will be shown. Such measurements constitute also a valuable tool to investigate the role of the color reconnection in the hadronization mechanisms and characterize Multi-Parton Interactions. Moreover, the elliptic flow measurements in high-multiplicity events for heavy-flavour decay leptons at mid and forward rapidity, will be discussed. Measurement of jets containing heavy-flavour decay hadrons in pp and p-Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV will be presented. Such studies provide a more direct access to the heavy-quark kinematics, and allow for studying possible modifications of its fragmentation in different multiplicity environments, from pp to p-Pb. In a similar context, new measurements of azimuthal correlations of heavy-flavour decay electrons and charged hadrons in the same systems will be shown.

Collaboration

ALICE

Author: ACHARYA, Shreyasi (Department of Atomic Energy (IN))

Presenter: ACHARYA, Shreyasi (Department of Atomic Energy (IN))

Session Classification: Heavy Flavor (Open charm)

Contribution ID: **57** Type: **Experimental talk**

Charm-baryon enhancement in small systems measured with ALICE and implication on the charm fragmentation fractions

Wednesday 19 May 2021 09:30 (20 minutes)

In this contribution, we present the latest measurements of Λ_c^+, $\Xi_c^{0,+}$, $\Sigma_c^{0,++}$, and the first measurement of Ω_c^0 baryons performed with the ALICE detector at midrapidity in pp collisions at $\sqrt{s} = 5.02$ and 13 TeV. Recent measurements of charm-baryon production at midrapidity by the ALICE Collaboration in small systems show a baryon-over-meson ratio significantly higher than that in e^+e^- collisions, suggesting that the fragmentation of charm is not universal across different collision systems. Thus, measurements of charm-baryon production are crucial to study the charm quark hadronisation in proton–proton collisions and its difference with respect to e^+e^- collisions, which is relevant also for the description the heavy-flavour mesons. In fact, the production cross sections of open heavy-flavour mesons are typically described within the factorisation approach as the convolution of the parton distribution functions of the incoming protons, the perturbative QCD partonic cross section, and the fragmentation functions which are typically parametrised from measurements in e^+e^- collisions. The results will be compared to predictions from Monte Carlo event generators and theoretical calculations based on the statistical hadronisation model and on the hadronisation via coalescence.

Furthermore, the new Λ_c^+/D^0 ratio measured down to $p_T = 0$ in p-Pb collisions as well as the nuclear modification factor R_{pPb} will be discussed. The measurement of charm baryons in p-nucleus collisions provides important information about Cold Nuclear Matter (CNM) effects and to understand how the possible presence of collective effects could modify production of heavy-flavour hadrons and the similarities observed among pp, p-nucleus and nucleus-nucleus systems. The results will be compared to models including CNM effects as well as ones assuming the formation of a quark-gluon plasma in p-Pb collisions.

Collaboration

ALICE

Author: ZHU, Jianhui (Central China Normal University CCNU (CN))

Presenter: ZHU, Jianhui (Central China Normal University CCNU (CN))

Session Classification: Heavy Flavor (Open charm)

Track Classification: Heavy quark production in nuclear collisions and hadronic interactions

Contribution ID: **60** Type: **Theory talk**

Thermal-model-based characterization of heavy-ion-collision systems at chemical freeze-out

Tuesday 18 May 2021 11:30 (20 minutes)

We investigate the chemical freeze-out in heavy-ion collisions (HICs) and the impact of the hadronic spectrum on thermal model analyses [1, 2]. Detailed knowledge of the hadronic spectrum is still an open question, which has phenomenological consequences on the study of HICs. By varying the number of resonances included in Hadron Resonance Gas (HRG) Model calculations, we can shed light on which particles may be produced. Furthermore, we study the influence of the number of states on the so-called two flavor freeze-out scenario, in which strange and light particles can freeze-out separately. We consider results for the chemical freeze-out parameters obtained from thermal model fits and from calculating net-particle fluctuations. We will show the effect of using one global temperature to fit all particles and alternatively, allowing particles with and without strange quarks to freeze-out separately.

[1] P. Alba et al. Phys.Rev.C 101 054905 (2020)
[2] R. Bellwied et al. Phys.Rev.C 99 034912 (2019)

Collaboration

Authors: STAFFORD, Jamie (University of Houston); ALBA, Paolo Giuseppe; MANTOVANI-SARTI, Valentina (Technical University Munich); NORONHA-HOSTLER, Jaki (University of Illinois at Urbana-Champaign); PAROTTO, Paolo (University of Wuppertal); PORTILLO, Israel (University of Houston); RATTI, Claudia (University of Houston)

Presenter: STAFFORD, Jamie (University of Houston)

Session Classification: Strangeness (Freeze-out)

Contribution ID: **61** Type: **Experimental talk**

Studying strangeness and baryon production in small systems through Ξ–hadron correlations using the ALICE detector

Friday 21 May 2021 09:50 (20 minutes)

One of the remaining puzzles in heavy-ion physics is that enhanced yields of multistrange hadrons —believed to be a signature of the quark–gluon plasma —are not only observed in heavy-ion collisions, but also in high-multiplicity proton-proton and proton-nucleus collisions. Various phenomenological models have been developed to try to understand this, such as rope hadronisation (available in PYTHIA 8.230) and core-corona models (used in EPOS). A prediction of the string/rope model is that strangeness is produced through $s\bar{s}$ pair breakings in the hadronisation phase, resulting in close correlations in phase space between strange and anti-strange hadrons, whereas in a core-corona model, strange quarks are produced earlier in the collision than strange hadrons, resulting in much weaker correlations. Experimentally, this can be studied by triggering on a (multi)strange hadron and studying the distribution of particle pairs of opposite strangeness. Here the same-strangeness pairs provide an estimate for the combinatorial background, so by subtracting these, one can access the part which is due to balancing quantum numbers.

In this talk, we present results on the correlations between strange particles in pp collisions at $\sqrt{s} = 13$ TeV that are studied by triggering on Ξ^- or Ξ^+ baryons and measuring per-trigger yields of charged kaons, Λ and Ξ baryons for several multiplicity classes, using the ALICE detector. Similarly, charge and baryon correlations are studied by measuring also per-trigger yields of pions and protons. The results are compared to theoretical predictions by PYTHIA and EPOS, where for PYTHIA two extensions are included: rope hadronisation and string junctions. The latter provides an alternative mechanism for baryon production. These results allow one to learn more about the strangeness and baryon production mechanisms, and how they change with multiplicity.

Collaboration

ALICE

Author: ADOLFSSON, Jonatan (Lund University (SE))

Presenter: ADOLFSSON, Jonatan (Lund University (SE))

Session Classification: Open and New (IV)

Contribution ID: **62** Type: **Experimental talk**

Proton-ϕ and Λ-Ξ interactions studied in pp collisions with ALICE at the LHC

Wednesday 19 May 2021 10:10 (20 minutes)

In order to constrain the equation of state of dense objects like neutron stars (NS) and subsequently solve the puzzle about their content, it is fundamental to understand the interaction between their hypothetical constituents. Hyperons might be contained in the core of NS. When becoming sufficiently abundant, in addition to the hyperon-nucleon interaction also the self-interaction of hyperons becomes relevant. In this context, both the hyperon-hyperon interactions and the coupling of the ϕ vector meson to nucleons play an important role. At the moment, experimental data is limited to studies of Λ-Λ final states or measurements of the inclusive ϕ productions in several colliding systems.

The ALICE Collaboration can provide precise data on interactions such as the hyperon-hyperon and the nucleon-ϕ by means of the femtoscopy technique applied to small collision systems at the LHC. The small size of the particle-emitting source produced in collision systems such as pp and p-Pb makes it possible to study short-ranged strong potentials with unprecedented precision. We present here the first experimental observation of the strong interaction between proton and ϕ meson as well as a measurement of the interaction between Λ-Ξ using high-multiplicity pp collisions at $\sqrt{s} = 13$ TeV at the LHC. The proton-ϕ interaction is found to be attractive with a sizable influence of the so far neglected direct p-ϕ coupling. The Λ-Ξ interaction suggests a shallow potential of the strong interaction, in contradiction to calculations with Chiral Effective Field Theory.

Collaboration

ALICE

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Presenter: CHIZZALI, Emma Sophia (Technische Universitaet Muenchen (DE))

Session Classification: Resonances and Hypernuclei (I)

Track Classification: Strangeness in astrophysics

Contribution ID: **63** Type: **Experimental talk**

Study of kaon-proton interactions with ALICE at the LHC

Tuesday 18 May 2021 12:30 (20 minutes)

The precise knowledge of the strong interaction between kaons and nucleons is a key element needed for the chiral effective theories that describe the interaction between hadrons in the non–pertubative regime of QCD. Additionally, the knowledge of the interaction plays an important role in the study of the equation of state of dense baryonic matter, and hence has important implications for the modeling of neutron stars.

The first femtoscopy measurement of momentum correlations of $K^-p \oplus K^+p$ and $K^+p \oplus K^-p$ pairs in Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV and of $K^0_S p$ and $K^0_S p$ pairs in pp collisions at $\sqrt{s}$ = 13 TeV using the ALICE detector will be presented. In this study the scattering parameters of Kp pairs associated with strong final state interactions as well as the source radii of the kaon-proton pairs using the Lednický-Lyuboshitz model have been determined.

The pair source size for pp collisions is of the order of 1 fm whereas for Pb–Pb is between 5 and 9 fm for the head-on collisions. This has a direct influence on the form of the observed correlation functions and allows to carry out for the first time a distance-dependent study of the kaon-nucleon interaction. The interaction parameters obtained for the $K^-p \oplus K^+p$ are compared to those extracted from scattering and kaonic atom experiments and are found to be compatible within the uncertainties of the experiment. The interaction of neutral kaons with protons is studied by comparing the measured correlation to state-of-the-art theoretical calculations.

Collaboration

ALICE

Author: KORNAKOV, Georgy (Warsaw University of Technology (PL))

Presenter: KORNAKOV, Georgy (Warsaw University of Technology (PL))

Session Classification: Open and New (Correlations)

Contribution ID: **65** Type: **Experimental talk**

Study of global and local polarization of Λ and anti-Λ hyperons in Pb-Pb collisions with ALICE

Thursday 20 May 2021 09:30 (20 minutes)

The system created in relativistic nucleus-nucleus collisions may possess large orbital angular momentum leading to the global polarization of particles perpendicular to the reaction plane. The local asymmetries in the velocity fields due to anisotropic flow can also generate vorticity and particle polarization along the beam direction. In parity-violating weak decays of hyperons, the momentum direction of the decay baryon is correlated with the hyperon spin and can be used to measure the hyperon polarization and thus estimate the local and global vorticity of the system created in relativistic heavy-ion collisions.

In this talk, the recent experimental measurements of the local and global polarization of the lambda and anti-lambda hyperons in Pb-Pb collisions in ALICE will be presented. Also, a comparison of the ALICE results with the previous STAR measurements will be shown and the collision energy dependence of the local and global hyperon polarization will be discussed.

Collaboration

ALICE

Author: Mr SARKAR, Debojit (Wayne State University (US))

Presenter: Mr SARKAR, Debojit (Wayne State University (US))

Session Classification: Strangeness (Global Polarization)

Contribution ID: **66** Type: **not specified**

Off-of-equilibrium effects on Kurtosis Along Strangeness-Neutral Trajectories

Tuesday 18 May 2021 12:30 (20 minutes)

The Beam Energy Scan program at RHIC (Relativistic Heavy Ion Collider)
is searching for the QCD critical point or a first order phase transition. The main signal for the critical point is the kurtosis of the distribution of proton yields obtained on an event by event basis where one expects a peak at the critical point. However, its exact behavior is still an open question due to out-of-equilibrium effects and the current limitations of the equation of state at large densities. Here we
use a simplistic hydrodynamic model that enforces strangeness-neutrality, selecting on trajectories that pass close to the critical point. We vary the initial conditions (in terms of how far-from-equilibrium they begin)
in order to estimate the effect of out-of-equilibrium hydrodynamics on the kurtosis signal.

Collaboration

Authors: DORE, Travis (University of Illinois at Urbana-Champaign); STAFFORD, Jamie (University of Houston); NORONHA-HOSTLER, Jacquelyn (University of Illinois Urbana Champaign); RATTI, Claudia (University of Houston)

Presenter: DORE, Travis (University of Illinois at Urbana-Champaign)

Session Classification: Bulk (Fluctuation)

Contribution ID: **70** Type: **Theory talk**

Heavy quark transport in a magnetized quark-gluon plasma

Tuesday 18 May 2021 09:50 (20 minutes)

Heavy quarks (HQs) are mostly created in the very initial stages of the relativistic heavy-ion collisions and are identified as effective probes to study the properties of the quark-gluon plasma (QGP). It is believed that an intense magnetic field has been created in the early stages of non-central collisions. The interactions of the heavy quarks with the magnetized medium particles are embedded through the transport coefficients of the heavy quark. The drag and the momentum diffusion coefficients of the HQ in a strongly magnetized QGP are determined within the framework of Fokker-Planck dynamics while incorporating the thermal medium interactions through a quasiparticle model. The medium effects and the magnetic field are seen to have sizable effects on the temperature behaviour of the heavy quark transport coefficients in the magnetized medium. Further, the analysis has been extended to an expanding medium. The dependence of viscous effects has been explored in the heavy quark transport in the magnetized medium. The anisotropic transport coefficients of the heavy quark may have a visible impact on the measured observables associated with heavy quarks, such as flow coefficients and the nuclear suppression factor in the heavy-ion collisions at the RHIC and LHC.

Collaboration

Authors: Dr KURIAN , Manu (Indian Institute of Technology, Ganghinagar); Prof. CHANDRA, Vinod (IIT Gandhinagar, India); Prof. DAS, Santosh Kumar (School of Physical Science, Indian Institute of Technology Goa, India)

Presenter: Dr KURIAN , Manu (Indian Institute of Technology, Ganghinagar)

Session Classification: Charm Exotics

Contribution ID: **75** Type: **Experimental talk**

The heavy-ion program at the upgraded Baryonic Matter@Nuclotron Experiment at NICA

Tuesday 18 May 2021 12:10 (20 minutes)

In the coming years, the Nuclotron at JINR in Dubna will deliver gold beams with energies of up to 3.8A GeV and intensities of up to 2.5⊠106 ions/s. These beams are well suited for experiments devoted to the study of the equation of state of dense baryonic matter, and the exploration of microscopic degrees of freedom emerging at neutron star core densities. The relevant observables in heavy-ion collisions at these energies include the yields and multi-differential distributions of (multi-) strange particles, the collective flow of identified particles, fluctuation of conserved quantities, and hypernuclei. In order to measure these observables in Au+Au collisions with rates of up to 50 kHz, the existing BM@N setup in the Nuclotron target hall will be upgraded with a highly granulated and fast hybrid tracking system, and a forward calorimeter for event plane determination. The BM@N physics program, the detector upgrades, and physics performance studies will be presented.

Collaboration

BM@N collaboration

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Presenter: DEMENTEV, Dima (JINR)

Session Classification: Upgrades and New Experiments

Track Classification: Other

Contribution ID: **78** Type: **Experimental talk**

Measurement of the antinuclei nuclear inelastic cross sections with ALICE and implications for indirect Dark Matter searches

Thursday 20 May 2021 09:50 (20 minutes)

The measurement of low-energy cosmic antinuclei may reveal the existence of exotic processes such as dark-matter annihilation, since the production rate of these ions through ordinary secondary processes is very low. However, the lack of experimental data at low energies, where both the antinuclei production and inelastic cross sections are very poorly known, prevents precise predictions of antinuclei fluxes near Earth.

In ultrarelativistic pp, p-Pb and Pb-Pb collisions at the CERN LHC, matter and antimatter are produced in almost equal abundances at midrapidity. This allows us to study the production cross sections of (anti)nuclei with high precision as well as to measure the absorption process of produced (anti)nuclei in the detector material.

In this talk we present the first results on the antideuteron and absorption cross sections in the ALICE detector material and we discuss the implications of these results for indirect Dark Matter searches using cosmic antinuclei.

Collaboration

ALICE

Author: ŠERKŠNYTĖ, Laura (Technische Universitaet Muenchen (DE))

Presenter: ŠERKŠNYTĖ, Laura (Technische Universitaet Muenchen (DE))

Session Classification: Astrophysics and Hadronic Interactions

Contribution ID: **79** Type: **Experimental talk**

Recent measurements of hadronic resonances with ALICE at the LHC

Wednesday 19 May 2021 09:30 (20 minutes)

Hadronic resonances, thanks to their relatively short lifetimes, can be used to probe the properties of the hadronic phase in ultrarelativistic heavy-ion collisions. In particular they are exploited to investigate the interplay between particle re-scattering and regeneration after hadronization. Resonances can also be used to explore the various mechanisms that influence the shape of particle momentum spectra, strangeness production, and collective effects. In this contribution we present the latest results on $\rho(770)^0$, K*(892), $f_0(980)$, $\phi(1020)$, $\Sigma(1385)^{\pm}$, $\Lambda(1520)$, $\Xi(1530)^0$ and $\Xi(1820)$ production in pp, p–Pb, Pb–Pb and Xe–Xe collisions at different LHC energies. Results include system-size and collision-energy evolution of transverse momentum spectra, integrated yields, mean transverse momenta and particle ratios. These results will be compared to measurements from lower energy and discussed in the context of theoretical models.

Collaboration

ALICE

Author: SUMBERIA, Vikash (University of Jammu (IN))

Presenter: SUMBERIA, Vikash (University of Jammu (IN))

Session Classification: Resonances and Hypernuclei (I)

Track Classification: Production of strange/heavy-flavor hadron resonances and hypernuclei

Contribution ID: **81** Type: **Experimental talk**

Event-shape studies of strangeness production in $\sqrt{s}$ = 13 TeV pp collisions with ALICE

Wednesday 19 May 2021 09:30 (20 minutes)

Significant strangeness enhancement and radial flow have been observed in high-multiplicity pp collisions at LHC. The origin of these effects is still under debate. In this contribution, new and more differential measurements are presented, making use of event-shape techniques to study final-state topologies: (i) the transverse spherocity, which aims to classify events into jetty (back-to-back) and isotropic to isolate hard and soft effects, respectively; (ii) the self-normalized Underlying Event (UE) activity, RT, which allows the UE to be significantly suppressed or enhanced. Using observables that control the hard-to-soft ratio and the UE, one gains novel insights into the mechanism responsible for the QGP-like effects in small systems. The results will be presented for a large variety of strange and non-strange hadrons and resonances (π, K, K^{*0}, p, φ, and Ξ) and will be compared to calculations using both PYTHIA 8 and EPOS LHC event generators.

Collaboration

ALICE

Author: NASSIRPOUR, Adrian Fereydon (Lund University (SE))

Presenter: NASSIRPOUR, Adrian Fereydon (Lund University (SE))

Session Classification: Open and New (Charge and Flavor)

Track Classification: Strangeness production in nuclear collisions and hadronic interactions

Contribution ID: **82** Type: **Experimental talk**

First measurement of the Bc meson in PbPb collisions with CMS

Thursday 20 May 2021 09:50 (20 minutes)

In the quark-gluon plasma produced in high-energy heavy-ion collisions, mesons with heavy quarks can dissociate and recombine. The CMS measurements of the nuclear modification factor of prompt and non-prompt J/ψ mesons and of Upsilon mesons help understanding these processes. Furthermore, compared to their low yield in proton-proton collisions, Bc meson production could be dramatically enhanced by recombination of bottom quarks with the numerous charm quarks in the QGP, which would provide an unambiguous probe of the recombination mechanism. We present here the first observation of the Bc meson in nucleus-nucleus collisions, through partial reconstruction of the semi-leptonic decay Bc+ ⟶ (J/ψ ⟶ μ+μ−) μ+ νμ with CMS data. The signal is extracted via a template fit on the trimuon mass, performed simultaneously in the analysis bins and in bins of the discriminant variable. The Bc nuclear modification factor is measured in two bins of the visible transverse momentum, and in two ranges of centrality.

Collaboration

CMS

Author: PETRUSHANKO, Serguei (M.V. Lomonosov Moscow State University (RU))

Presenter: FALMAGNE, Guillaume

Session Classification: Heavy Flavor (Beauty)

Track Classification: Heavy quark production in nuclear collisions and hadronic interactions

Contribution ID: **84** Type: **Experimental talk**

Probing of initial and final state effects using Y mesons in pp, pPb, and PbPb collisions with the CMS detector

Thursday 20 May 2021 10:50 (20 minutes)

Bottomonia have played a key role to understand the dynamics in high-energy heavy-ion collisions. In PbPb collisions, the modification of bottomonium production provides a crucial input for thermal property of the hot QCD medium. On there other hand, in smaller collision systems, it also contains intensive interest subjects such as Cold Nuclear Matter (CNM) effects. In this talk, we report the recent results of elliptic flow measurements in PbPb collisions at $\sqrt(s_{NN}) = 5.02$ TeV. In addition, we present the final results of the nuclear modification factors in pPb collisions at $\sqrt(s_{NN}) = 5.02$ TeV. Finally we also report the event activity dependence of Y states in pp collisions at 7 TeV.

Collaboration

CMS

Author: PETRUSHANKO, Serguei (M.V. Lomonosov Moscow State University (RU))

Presenter: PARK, Jaebeom (Korea University (KR))

Session Classification: Heavy Flavor (Beauty)

Track Classification: Heavy quark production in nuclear collisions and hadronic interactions

Contribution ID: **85** Type: **Experimental talk**

Evidence for X(3872) Production in PbPb collisions and studies of its prompt production with CMS

Tuesday 18 May 2021 10:10 (20 minutes)

The first evidence for X(3872) production in relativistic heavy ion collisions is reported. The X(3872) hadron is studied in PbPb collisions at a center-of-mass energy of 5.02 TeV per nucleon pair, using the decay chain $X(3872) \rightarrow J/\psi\pi\pi \rightarrow \mu^+\mu^-\pi^+\pi^-$ decay chain. The data were recorded with the CMS detector in 2018 and correspond to an integrated luminosity of 1.7/nb. The measurement is performed in the rapidity and transverse momentum ranges |y|<1.6 and 15< pT < 50 GeV. The significance of the inclusive X(3872) signal is 4.2 standard deviations. The prompt X(3872) to psi(2S) yield ratio is found to be $\rho^{PbPb} = 1.08 \pm 0.49(stat) \pm 0.52(syst)$, in contrast to typical values of 0.1 for pp collisions. This result provides a unique experimental input to theoretical models of the production mechanism and the nature of the X(3872) state. Future plan to exploit the Run 3 data is also presented in this talk.

Collaboration

CMS

Author: PETRUSHANKO, Serguei (M.V. Lomonosov Moscow State University (RU))

Presenter: LEE, Yen-Jie (Massachusetts Inst. of Technology (US))

Session Classification: Charm Exotics

Contribution ID: **88** Type: **Experimental talk**

Strange particle collectivity in pPb and PbPb with CMS

Tuesday 18 May 2021 09:30 (20 minutes)

We present the elliptic azimuthal anisotropy coefficient (v_2) of the identified strange hadrons K^0_S and Λ using the scalar product and multi-particle cumulant methods in pPb collisions at 8.16 TeV and PbPb collisions at 5.02 TeV at mid-rapidity (|y|<1). The data samples were collected by the CMS experiment at the LHC. The scalar product and multi-particle v_2 values are measured as a function of p_T for different centralities in PbPb and event multiplicities in pPb collisions. The v_2 results are compared to the inclusive charged hadrons as well as the hydrodynamic model calculations with different initial state conditions. The identified multi-particle v_2 in such a small collision system is measured for the first time. The results shed light on the initial state effects of the strange quark in large and small collision systems.

Collaboration

CMS

Author: PETRUSHANKO, Serguei (M.V. Lomonosov Moscow State University (RU))

Presenter: WANG, Quan (The University of Kansas (US))

Session Classification: Bulk (Collectivity)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **92** Type: **Experimental talk**

Production of strange particles in jets and underlying events in pp and p-Pb collisions with ALICE

Friday 21 May 2021 09:30 (20 minutes)

Previously reported ALICE measurements have shown that the inclusive production rate of (multi-)strange particles varies smoothly as a function of the size of the collision system, as measured by charged-particle multiplicity in pp, p-Pb, and Pb-Pb collisions. However, more detailed investigation reveals an overall enhancement in the yield of strange baryons relative to mesons for systems larger than pp collisions, possibly due to the effects of collective flow and recombination of the bulk matter. Such effects may differ for strange hadrons generated in soft (low Q^2) interactions, compared to those originating from jet fragmentation (high Q^2). In order to explore this question, in this contribution we report final measurements of the baryon-to-meson yield ratios measured in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV for the inclusive population, and for hadrons within jets. We will also discuss the production of (multi-)strange hadrons (K^0_s, Λ ($\bar{\Lambda}$), $\Xi^{\pm}$ and $\Omega^{\pm}$) in jets and the underlying event for pp collisions at $\sqrt{s} = 13$ TeV and p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV.

Collaboration

ALICE

Author: CUI, Pengyao (Central China Normal University CCNU (CN))

Presenter: CUI, Pengyao (Central China Normal University CCNU (CN))

Session Classification: Bulk (Small systems)

Contribution ID: **96** Type: **Theory talk**

Conserved charge fluctuations at vanishing net-baryon density from Lattice QCD

Tuesday 18 May 2021 11:50 (20 minutes)

Cumulants of net charge fluctuations and their correlations at vanishing values of the conserved charge chemical potentials ($\mu_{B,Q,S} = 0$) provide the basis for Taylor expansions of various thermodynamic observables at non-zero values of the chemical potentials. At $\mu_{B,Q,S} = 0$ continuum extrapolated results for these cumulants can directly be compared with charge fluctuations and correlations currently being measured by the ALICE collaboration at the LHC.

We present here continuum extrapolated results for all second order cumulants of net baryon-number, strangeness and electric charge fluctuations as well as their cross-correlations using the most resent results obtained by the HotQCD collaboration in (2+1)-flavor QCD. From this we obtain their temperature derivatives and determine inflection points which are absent in hadron resonance gas (HRG) model calculations using a spectrum of point-like, non-interacting resonances. We present a detailed comparisons of our results with such HRG models based on different sets of hadron spectra as well as with S-matrix based model calculations. We update results on model parameters for three body and higher order S-matrix contributions to the correlation of net baryon-number and electric charge fluctuations that have been used to explain the so-called proton anomaly observed by ALICE at the LHC.

We furthermore compare our lattice QCD results for second order cumulants with models that parametrize repulsive interactions among baryons and anti-baryons in a hadron resonance gas through a single excluded volume parameter (EVHRG). We point out that such an approach is not sufficient to describe all second order cumulants simultaneously. At least independent excluded volume parameter for strange and non-strange baryons would be needed already for the description of second order cumulants.

Collaboration

HotQCD

Authors: GOSWAMI, Jishnu (Bielefeld University); Prof. KARSCH, Frithjof (Brookhaven National Laboratory); MUKHERJEE, Swagato (Brookhaven National Laboratory); PETRECZKY, Peter (BNL); SCHMIDT, Christian (University of Bielefeld)

Presenter: GOSWAMI, Jishnu (Bielefeld University)

Session Classification: Bulk (Fluctuation)

Contribution ID: **100** Type: **Theory talk**

Early Strangeness freeze-out from RHIC BES to LHC

Tuesday 18 May 2021 11:50 (20 minutes)

In this talk, we investigate the kinetic freeze-out properties in relativistic heavy ion collisions at different collision energies. We present a study of standard Boltzmann-Gibbs Blast-Wave (BGBW) fits and Tsallis Blast-Wave (TBW) fits performed on the transverse momentum spectra of identified hadrons produced in Au + Au collisions at collision energies of $\sqrt{s_{\rm NN}}$ = 7.7 - 200˜GeV at Relativistic Heavy Ion Collider (RHIC), and in Pb + Pb collisions at collision energies of $\sqrt{s_{\rm NN}}$ = 2.76 and 5.02˜TeV at the Large Hadron Collider (LHC). The behavior of strange and multi-strange particles is also investigated. We found that in TBW fits, the strange hadrons, with higher temperature,similar radial flow and smaller non-equilibrium degree, approach equilibrium more quickly from peripheral to central collisions than light hadrons. We also observed that in TBW fits for non-strange particles the kinetic freeze-out temperature of the central collisions decreases from RHIC to LHC energies in TBW model, while strangeness does not show this behavior.

Collaboration

Authors: CHEN, Jia; YI, Li (ShanDong University)

Presenter: CHEN, Jia

Session Classification: Strangeness (Freeze-out)

Contribution ID: **106** Type: **Theory talk**

Hyperon-type dependence of global polarization in heavy-ion collisions

Wednesday 19 May 2021 10:10 (20 minutes)

In heavy-ion collisions, the spin polarization of Λ hyperon is an important measure to probe the vorticity of the quark-gluon plasma. On the other hand, other hyperons such as Ξ^- and Ω^- should also possess the global polarization similar to Λ.

In this talk, I will show our recent theoretical results on the global polarization of Λ, Ξ^- and Ω^- hyperons in non-central Au+Au collisions in the energy range $\sqrt{s_{\rm NN}} = 7.7-200$ GeV. The effect of resonance decays on the global polarization of Λ and Ξ^- is also investigated. Our results provide a quantitative relation between the global polarization of Λ, Ξ^- and Ω^- hyperons. This provides us a means to further test the vorticity interpretation of the global polarization in experiments.

Collaboration

Authors: Prof. HUANG, Huan Zhong (Fudan university); LI, Hui (Fudan University); XIA, Xiao-Liang; HUANG, Xu-Guang (Fudan University)

Presenter: LI, Hui (Fudan University)

Session Classification: Open and New (Charge and Flavor)

Contribution ID: **110** Type: **Theory talk**

Charm and Bottom quarks dynamics in heavy-ion collisions: R_{AA}, anisotropic flows v_n and their correlations to the bulk.

Tuesday 18 May 2021 09:50 (20 minutes)

We describe the propagation of heavy quarks (HQs), charm and bottom, in the quark-gluon plasma by means of a full Boltzmann transport approach within a coalescence plus fragmentation hadronization and including event-by-event fluctuations. The non-perturbative dynamics and the interaction between HQs and light quarks have been taken into account through a Quasi-Particle Model (QPM). We show the D-mesons R_{AA} and v_2 at RHIC and LHC energies, furthermore we discuss the role of the initial state fluctuations on the development of high-order heavy-flavour flow harmonics ($v_n(p_T)$, $n = 3, 4$). The results presented include event-shape selected D-mesons spectra and v_n, correlations between different D-mesons flow harmonics at LHC energies in different range of centrality selections. The events in centrality class are divided according to magnitude of the second-order harmonic reduced flow vector q_2. Within this approach the extracted T-dependence of the space-diffusion coefficient D_s is in a agreement with lattice QCD results within the systematic uncertainties.
In the same scheme we show for the first time predictions for R_{AA}, v_2 and v_3 of B-mesons and electrons from semi-leptonic B-mesons decays at top LHC energies. Our results show a quite significant suppression al low p_T and allow a determination of D_s which is consistent with the lattice QCD calculations. These will provide novel and powerful constraints for heavy-flavour transport coefficients.

[1] S.Plumari, G.Coci, V.Minissale, S.K.Das, Y.Sun and V.Greco, Phys. Lett. B 805 (2020), 135460.

[2] F. Scardina, S. K. Das, V. Minissale, S. Plumari, V. Greco, Phys.Rev. C96 (2017) no.4, 044905.

[3] M.L.Sambataro, S.Plumari and V.Greco, Eur. Phys. J. C 80, no.12, 1140 (2020).

Collaboration

Authors: SAMBATARO, Maria Lucia (Università degli Studi di Catania); PLUMARI, Salvatore (University of Catania (Italy)); SUN, Yifeng (INFN-LNS); MINISSALE, Vincenzo; GRECO, Vincenzo (University of Catania)

Presenter: SAMBATARO, Maria Lucia (Università degli Studi di Catania)

Session Classification: Bulk (Collectivity)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **112** Type: **Theory talk**

Deep learning stochastic processes with QCD phase transition

Tuesday 18 May 2021 10:50 (20 minutes)

It is non-trivial to recognize phase transitions and track dynamics inside a stochastic process because of itsintrinsic stochasticity. In this paper, we employ the deep learning method to classify the phase orders and predict the damping coefficient of fluctuating systems under Langevin description. As a concrete set-up, we demonstrate this paradigm for the scalar condensation in QCD matter near critical point, in which the order parameter of chiral phase transition can be characterized in a 1+1-dimensional Langevin equation for sigma field. In a supervised learning manner, the Convolutional Neural Networks(CNNs) accurately classify the first-order phase transition and crossover based on sigma field configurations with fluctuations. Noise in the stochastic process does not significantly hinder the performance of the well-trained neural network for phase order recognition. For mixed dynamics with diverse dynamical parameters, we further devise and train the machine to predict the damping coefficients in a broad range. The results show that it is robust to extract the dynamics from the bumpy field configurations.

Collaboration

Author: Dr ZHOU, Kai (FIAS, Goethe-University Frankfurt am Main)

Co-authors: Dr LINGXIAO, Wang (FIAS); Dr LIJIA, Jiang (FIAS)

Presenter: Dr LINGXIAO, Wang (FIAS)

Session Classification: Bulk (Collectivity)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **113** Type: **Theory talk**

Heavy quark momentum diffusion from the lattice

Thursday 20 May 2021 10:50 (20 minutes)

Heavy quark transport coefficients calculated from first-principles QCD are a crucial input for transport models. Utilizing the heavy quark limit, we will discuss the results of a novel approach to nonperturbatively estimate the heavy quark momentum diffusion coefficient in a hot gluonic medium from gradient-flowed color-electric correlators on the lattice. Unlike others, this approach can be extended to a medium with dynamical fermions. The correlation functions are computed on fine isotropic lattices at $1.5\,T_{\mathrm{c}}$ and are extrapolated to yield continuum data at zero flow time that is fully renormalized. Through theoretically well-established model fits we estimate the corresponding spectral function and in turn the diffusion coefficient, which is consistent with previous studies.

Collaboration

Author: ALTENKORT, Luis (Bielefeld University)

Co-authors: Prof. MOORE, Guy (Technische Universität Darmstadt); Dr KACZMAREK, Olaf (Bielefeld University); Dr SHU, Hai-Tao (Bielefeld University); Mr MAZUR, Lukas (Bielefeld University); Dr ELLER, Alexander Max (Technische Universität Darmstadt)

Presenter: ALTENKORT, Luis (Bielefeld University)

Session Classification: Bulk (Lattice)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **116** Type: **Experimental talk**

Charm and multi-charm baryon measurements via strangeness tracking in the upgraded ALICE detectors

Tuesday 18 May 2021 11:10 (20 minutes)

A fundamental ingredient of the ALICE physics programme for the new decade is a comprehensive study of charm and multi-charm baryon production. Because charm is exclusively produced in initial hard scatterings, such measurements may provide unique insight into the QGP medium as well as hadronization from proton-proton to lead-lead collisions.

We will present a new method for detection of multiply charmed baryons via their decays into strange baryons, using 'strangeness tracking'. In this method, the state-of-the-art upgraded silicon detectors in ALICE during Runs 3, 4 and beyond will enable the novel possibility of tracking strange hadrons directly before they decay, leading to a very significant improvement in impact-parameter resolution. In this work, we will discuss how this new technique will be crucial to distinguish secondary strange baryons originating from charm decays from primary strange baryons. This is a particularly interesting possibility for the Ω^- baryon coming from $\Omega_c^0 \rightarrow \Omega\pi$ decays, since there is no other feeddown source for Ω^-. This, in turn, means that the main Ω^- background for the Ω_c measurement will point most accurately to the primary vertex, unlike pions or protons from other charmed baryon decays.

We will illustrate the achievable performance of strangeness tracking for the Run 3 configuration of ALICE with the upgraded Inner Tracking System, which is fully instrumented with silicon pixel detectors. Moreover, we will discuss the potential of this technique in a future experiment with an extensive silicon tracking detector with a first layer very close to the interaction point. Finally, we will also cover other potential major applications of strangeness tracking, including measurements of hypernuclei such as the ${}^{3}_{\Lambda}\mathrm{H}$.

Collaboration

ALICE

Author: DOBRIGKEIT CHINELLATO, David (University of Campinas UNICAMP (BR))

Presenter: DOBRIGKEIT CHINELLATO, David (University of Campinas UNICAMP (BR))

Session Classification: Upgrades and New Experiments

Track Classification: Open questions and new developments

Contribution ID: **117** Type: **Theory talk**

Extracting freeze-out parameters from cumulant ratios of electric charge and strangeness fluctuations

Thursday 20 May 2021 09:50 (20 minutes)

The determination of freeze-out parameters from experimental data on particle yields and higher order cumulants crucially relies on thermodynamic relations known to be valid in hadron resonance gas models. In particular, the determination of chemical potentials at the time of freeze-out, obtained from ratios of first and second order cumulants, relies on the assumption that particle fluctuations are well described by Skellam distributions. As is known from lattice QCD calculations such an assumption becomes worse with increasing values of the baryon chemical potential.

Using results from our most recent simulation campaign that used improved fermion discretization schemes on fine lattices, we provide new continuum extrapolations for mean, variance, skewness and kurtosis cumulants of electric charge and strangeness fluctuations along the pseudo-critical line, $T_{pc}(\mu_B)$, of the chiral transition. We use ratios of these cumulants to discuss deviations from Skellam distributions of conserved charge fluctuations and determine systematic differences between baryon and strangeness chemical potentials deduced from cumulant ratios when using QCD results on the one hand and relying on Skellam relations on the other hand.

Furthermore, we present first continuum estimates for hyper-skewness and hyper-kurtosis cumulant ratios for electric charge and strangeness fluctuations on the pseudo-critical line.

Collaboration

Authors: SCHMIDT, Christian (University of Bielefeld); Mr BOLLWEG, Dennis (Bielefeld University); KARSCH, Frithjof (Brookhaven National Laboratory); MUKHERJEE, Swagato (Brookhaven National Laboratory)

Presenter: Mr BOLLWEG, Dennis (Bielefeld University)

Session Classification: Bulk (Lattice)

Track Classification: Strangeness production in nuclear collisions and hadronic interactions

Contribution ID: **123** Type: **Theory talk**

Directed flow of D mesons at RHIC and LHC energy within a transport approach: non-perturbative dynamics, vorticity and electromagnetic fields

Wednesday 19 May 2021 09:50 (20 minutes)

Ultrarelativistic heavy-ion collision are characterized by the presence of very intense electromagnetic fields, which attain their maximal strength in the early stage and interplay with the strong vorticity induced in the plasma by the large angular momentum of the colliding nuclei. As a promising observable influenced by these phenomena we study the directed flow v_1 of neutral D mesons by means of a relativistic Boltzmann transport approach. Confirming recent theoretical and experimental studies, we find that the v_1 for D mesons is surprisingly much larger than that of light charged hadrons and we clarify its different origin with respect to the one of the bulk matter. We point out that the very large v_1 for D mesons can be generated only if there is a longitudinal asymmetry between the bulk matter and the charm quarks and if the latter have a large non-perturbative interaction in the QGP medium. It is moreover associated to the small heavy-quark formation time expected to be more sensitive to the initial high-temperature dependence of the charm diffusion coefficient. We discuss also the splitting of v_1 for D^0 and $\overline{D}^0$ due to the electromagnetic field that is again much larger than the one observed for charged particles. We find a v_1 splitting of D mesons in agreement with the data by STAR that have however still error bars comparable with the splitting itself. We highlight the role of the D-meson v_1 as a powerful observable connected to the transport properties of the hot QCD matter produced in high-energy collisions: the magnitude of the v_1 gives information on the heavy-quark diffusion coefficient whereas the v_1 splitting is associated to the electric conductivity of the QGP medium.

Collaboration

Authors: OLIVA, Lucia (Institute for Theoretical Physics (ITP), Frankfurt am Main); PLUMARI, Salvatore (University of Catania (Italy)); GRECO, Vincenzo (University of Catania)

Presenter: PLUMARI, Salvatore (University of Catania (Italy))

Session Classification: Open and New (Charge and Flavor)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **124** Type: **not specified**

Thermal model description of the particle spectra in the few-GeV energy regime.

Tuesday 18 May 2021 12:10 (20 minutes)

It has been demonstrated that Statistical Hadronization Model fits perfectly to particle yields at freeze-out in heavy-ion and hadron collisions at LHC, RHIC and SPS, where quark-gluon plasma is created. It is however entirely not clear if particles emitted in the few-GeV energy regime can be understood as emerging from thermalized hadronic medium. A recent work [1] suggests that this might be the case. By implementing appropriate fireball geometry and expansion pattern in the THERMINATOR (THERMal heavy IoN generaTOR) it was possible to describe not only yields, but also the spectra of most abundant particles measured at GSI SIS18. Most of the latter are pure prediction of the model.

In this contribution, details of the model and extended comparison with experimental data will be presented and further developments will be discussed.

References:
[1] S. Harabasz, W. Florkowski, T. Galatyuk *et al.*, Phys.Rev.C 102 (2020) 5, 054903

Collaboration

Authors: HARABASZ, Szymon; FLORKOWSKI, Wojciech (Jagiellonian University); RYBLEWSKI, Radoslaw (Institute of Nuclear Physics PAN); GALATYUK, Tetyana (TU Darmstadt / GSI); Dr GUMBERIDZE, Malgorzata; STROTH, Joachim (Goethe-University and GSI); SALABURA, Piotr (IFUJ)

Presenter: HARABASZ, Szymon

Session Classification: Strangeness (Freeze-out)

Contribution ID: **125** Type: **Theory talk**

Quarkonium dynamics inside the Quark-Gluon Plasma using open quantum systems

Tuesday 18 May 2021 09:30 (20 minutes)

In recent years, a significant theoretical effort has been made towards a dynamical description of quarkonia inside the Quark-Gluon Plasma (QGP), using the open quantum systems formalism. In this framework, one can get a real-time description of a quantum system (here the quarkonium) in interaction with a thermal bath (the QGP) by integrating out the bath degrees of freedom and studying the system reduced density matrix.

We investigate the real-time dynamics of a correlated heavy quark-antiquark pair inside the QGP using a quantum master equation previously derived from first QCD principles in [1]. The full equation is directly resolved in 1D to lessen computing costs and is used for the first time to gain insight on the dynamics in both a static and evolving medium following a Björken-like temperature evolution. The role of color degrees of freedom will be studied by comparing the case of a QED and QCD plasma. Several parametrizations will be explored, by modifying the initial state (color state of the pair, initial excited state...) or the complex potential used.

[1]-J. P. Blaizot and M. A. Escobedo, Quantum and classical dynamics of heavy quarks in a quark-gluon plasma, J. High Energy Phys. 06 (2018) 034.

Collaboration

Authors: DELORME, Stéphane (Subatech); GOSSIAUX, Pol Bernard (Subatch); Mr GOUSSET, Thierry (Subatech); Dr KATZ, Roland (Subatech, Nantes)

Presenter: DELORME, Stéphane (Subatech)

Session Classification: Charm Exotics

Contribution ID: **128** Type: **Experimental talk**

Quarkonium results from PHENIX

Friday 21 May 2021 10:30 (20 minutes)

Quarkonia are among the most important tools for studying Quantum Chromodynamics (QCD) in high energy hadronic collisions. Despite decades of extensive studies, we still have a limited knowledge of their production mechanism and hadronization; and carrying out as many measurements as possible in p+p collisions over a broad kinematic region at different energies is essential to understanding their production mechanisms. Quarkonia are very valuable probe in heavy-ion collisions to study the properties of the quark gluon plasma, and also an important probe in small collision systems to study cold nuclear matter effects, which are also present in large collision systems.
The PHENIX experiment has measured inclusive J/ψ production as well as its angular decay coefficients at mid ($|y| < 0.35$) and forward ($1.2 < |y| < 2.2$) rapidities in p+p collisions at 200 GeV and 510 GeV; and at forward ($1.2 < |y| < 2.2$) rapidity in a variety of small collision systems (p+Al, p+Au and ^{3}He+Au) at 200 GeV. Results from these measurements will be presented.

Collaboration

PHENIX

Author: SARSOUR, Murad (Georgia State University)

Presenter: SARSOUR, Murad (Georgia State University)

Session Classification: Heavy Flavor (Charmonia)

Contribution ID: **129** Type: **Experimental talk**

Studying hypertriton production, lifetime, and binding in different collision systems with ALICE

Friday 21 May 2021 09:50 (20 minutes)

The ${}^{3}_{\Lambda}\mathrm{H}$ is a bound state of proton (p), neutron (n) and Λ. Studying its characteristics provides insights about the strong interaction between the Λ and ordinary nucleons. In particular, the ${}^{3}_{\Lambda}\mathrm{H}$ is an extremely loosely bound object, with a large wave function. As a consequence, the measured (anti-)${}^{3}_{\Lambda}\mathrm{H}$ production yields in pp and p-Pb collisions are extremely sensitive to nucleosynthesis models. Thanks to the very large set of pp, p-Pb and Pb-Pb collisions collected during Run 2 of the LHC, the ALICE collaboration has performed systematic studies on the ${}^{3}_{\Lambda}\mathrm{H}$ lifetime, binding energy and production across different collision systems. The new ALICE results on hypertriton properties have a precision which is comparable with the current world average and they can be used to constrain the state-of-the-art calculations which describe the ${}^{3}_{\Lambda}\mathrm{H}$ internal structure. The precision of the presented measurements allows for tighter constraints to available theoretical models. In particular, some configurations of the Statistical Hadronisation and Coalescence models can be excluded.

Collaboration

ALICE

Author: FECCHIO, Pietro (Politecnico di Torino (IT))

Presenter: FECCHIO, Pietro (Politecnico di Torino (IT))

Session Classification: Resonances and Hypernuclei (II)

Track Classification: Production of strange/heavy-flavor hadron resonances and hypernuclei

Contribution ID: **131** Type: **Theory talk**

Early quark deconfinement in compact star astrophysics and upcoming experiments at NICA

Thursday 20 May 2021 09:30 (20 minutes)

We outline a theoretical approach supporting strong phase transitions from normal nuclear matter to the deconfined quark-gluon plasma, in the equation of state (EOS) for compact star matter, from vanishing to moderately high temperatures that are accessible for BM(a)N and MPD experiments at NICA. We study the connection of such hybrid EOS with the mass-radius relation of cold compact stars, including the intriguing possibility of additional families, as a consequence of the presence of an early and strong phase transition. Special emphasis is devoted to eventually detectable signatures which can be directly related with the occurrence of a sufficiently strong phase transition. Therefore dynamical scenarios are being considered, such as binary compact star mergers including the subsequent emission of gravitational waves and supernova explosions of massive supergiant stars where neutrinos play the role of messengers.

Collaboration

Author: BLASCHKE, David (University of Wroclaw)

Co-authors: Dr BAUSWEIN, Andreas (GSI Darmstadt); Prof. FISCHER, Tobias (University of Wroclaw)

Presenter: BLASCHKE, David (University of Wroclaw)

Session Classification: Astrophysics and Hadronic Interactions

Track Classification: Open questions and new developments

Contribution ID: **135** Type: **Experimental talk**

Heavy flavor production and modification in ATLAS

Tuesday 18 May 2021 10:30 (20 minutes)

Measurements of open heavy-flavor hadron and heavy-flavor jet production in heavy-ion collisions provide a powerful tool to study both initial-state effects on heavy-quark production and final-state interactions between heavy quarks and the Quark-Gluon Plasma (QGP).
These measurements are performed with the ATLAS detector at the LHC and capitalize on the large statistics of the Run 2 Pb+Pb dataset.
This talk presents published results on the azimuthal anisotropy (v_2 and v_3) of muons from heavy-flavor decays in Pb+Pb collisions, as well as new results on the nuclear modification factor (R_{AA}) for heavy-flavor muons, both in the region $p_{\mathrm{T}} > 4$ GeV.
In both measurements, muons from charm and bottom hadrons are statistically separated using the transverse impact parameter with respect to the primary collision vertex.
Muons from both charm and bottom hadrons are found to have significant azimuthal anisotropies in Pb+Pb collisions, with larger anisotropies for muons from charm hadrons than for muons from bottom hadrons.
Muons from both sources are also observed to be strongly suppressed with respect to the pp baseline, in a way that depends on the mass of the parent hadron at low to moderate muon p_{T}.
The simultaneous measurement of multiple observables (v_2, v_3, and R_{AA}) for both charm and bottom with the same detector and technique is particularly crucial in providing constraints on state of the art theoretical predictions.
Additionally, a new measurement of fully reconstructed b-jet suppression is presented.
b-jets are tagged by the presence of a muon within the jet cone, and are separated from charm jets and light jets based on the p_{T} of the muon relative to the jet axis.
This measurement, also performed in 2018 Pb+Pb data, provides a substantial statistical improvement over previous measurements.

Collaboration

ATLAS collaboration

Author: ENARI, Yuji (University of Tokyo (JP))

Presenter: NAGLE, James Lawrence (University of Colorado Boulder)

Session Classification: Bulk (Collectivity)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **136** Type: **Experimental talk**

Characterizing the collective behavior in small and large systems with ATLAS

Friday 21 May 2021 10:30 (20 minutes)

Measurements of open heavy-flavor hadron production in proton-proton collisions provide a crucial baseline for interpreting measurements in nucleus-nucleus collisions, and allow for the investigation of the origin and underlying mechanism of collective effects in small systems.
These measurements are performed with the ATLAS detector at the LHC and capitalize on the large Run 2 pp dataset at 5.02 TeV and 13 TeV.
This talk presents published results on the azimuthal anisotropy (v_2 and v_3) of muons from heavy-flavor decays in 13 TeV pp collisions, as well as new results on the heavy-flavor muon production cross-section in 5.02 TeV pp collisions.
In both measurements, muons from charm and bottom hadrons with $p_{\mathrm{T}} > 4$ GeV are statistically separated using the transverse impact parameter with respect to the primary collision vertex.
Muons from charm hadrons are found to have a significant azimuthal anisotropy in high-multiplicity pp collisions, with a magnitude and p_{T}-dependence similar to that for light hadrons.
On the other hand, the anisotropy for muons from bottom hadrons is significantly smaller, compatible with zero, demonstrating a strong mass dependence for collective effects in small systems.
Additionally, the differential cross-section for charm and bottom muon production in 5.02 TeV pp collisions is presented and compared to FONLL predictions.
We discuss this measurement in the context of similar data-theory comparisons in pp collisions at other experiments and collision energies.

Collaboration

ATLAS collaboration

Author: ENARI, Yuji (University of Tokyo (JP))

Presenter: YIN, Pengqi (Columbia University (US))

Session Classification: Bulk (Small systems)

Track Classification: Heavy quark production in nuclear collisions and hadronic interactions

Contribution ID: **141** Type: **Experimental talk**

Studying light-flavour hadrons produced in the collisions of different nuclei at the LHC with ALICE

Tuesday 18 May 2021 09:50 (20 minutes)

The study of identified particle production as a function of event multiplicity is a key tool for understanding the similarities and differences among different colliding systems. The multiplicity dependence of particle production has been previously studied as a function of center-of-mass energy in pp and Pb-Pb collisions. Now for the first time, we can investigate how particle production is affected by the collision geometry in heavy-ion collisions at the LHC.

In this talk, we report newly published ALICE results on charged and identified particle production in Pb-Pb and Xe-Xe collision at $\sqrt{s_{\rm NN}}$ = 5.02 TeV and $\sqrt{s_{\rm NN}}$ = 5.44 TeV, respectively, as a function of transverse momentum ($p_{\rm T}$) and collision centrality. Particle spectra and ratios are compared between two different colliding systems at similar charged-particle multiplicity densities (⟨d⊠ch/d⊠⟩), and different initial eccentricities. We find that in central collisions, spectral shapes of different particles are driven by their masses. The $p_{\rm T}$-integrated particle yield ratios follow the same trends with ⟨d⊠ch/d⊠⟩ as previously observed in other systems, further suggesting that at the LHC energies, event hadrochemistry is dominantly driven by the charged-particle multiplicity density and not the collision system, geometry, or center-of-mass energy. Finally, results are discussed in the context of statistical hadronization models as well as pQCD-inspired models.

Collaboration

ALICE

Author: JACAZIO, Nicolo (CERN)

Presenter: JACAZIO, Nicolo (CERN)

Session Classification: Strangeness (Yields)

Track Classification: Strangeness production in nuclear collisions and hadronic interactions

Contribution ID: **143** Type: **Experimental talk**

Investigating the origin of strangeness enhancement in small systems through multi-differential analyses with ALICE

Tuesday 18 May 2021 10:30 (20 minutes)

The main goal of the ALICE experiment is to study the physics of strongly interacting matter, including the properties of the quark-gluon plasma (QGP).The relative production of strange hadrons with respect to non-strange hadrons in heavy-ion collisions was historically considered as one of the signatures of QGP formation. However, recent measurements in proton-proton (pp) and proton-lead (p- Pb) collisions have shown features that are reminiscent of those observed in lead-lead (Pb-Pb) collisions, measuring an increase in the production of strange hadrons relative to pions with the charged particle multiplicity in the event. In this work we present midrapidity measurements of the transverse momentum spectra and yields of strange hadrons K^0_S, Λ, Ξ and Ω in pp collisions at $\sqrt{s}$ = 5, 7, and 13 TeV. In order to better understand the contribution of the event multiplicity to the observed enhancement in pp, two new complementary analyses have been performed. The first uses the concept of the effective energy available in the event for particle production which is estimated by an anticorrelation with the energy deposited in ALICE's Zero Degree Calorimeters. The second exploits the angular correlation between strange and high-p_{T} hadrons in an event to classify in-jet and out-of-jet strangeness production. This gives a local enhancement in the multiplicity. The Ξ-yield is separated into correlated and underlying-event parts, with the ratios to neutral kaons then being calculated and compared to those from the event ensemble.The results indicate that strangeness enhancement emerges from the growth of the underlying event and is not connected to initial state properties. Comparisons between data and expectations from commonly used Monte Carlo event generators will also be presented.

Collaboration

ALICE

Author: ERCOLESSI, Francesca (Universita e INFN, Bologna (IT))

Presenter: ERCOLESSI, Francesca (Universita e INFN, Bologna (IT))

Session Classification: Strangeness (Yields)

Contribution ID: **144** Type: **Theory talk**

Resonance production in PbPb collisions at 5.02 TeV and duration of hadronic rescattering stage

Wednesday 19 May 2021 10:10 (20 minutes)

We compute resonance (rho, K*(892), phi(1020), f2'(1252), Lambda(1520), Sigma(1775)) yields and spectra in PbPb collisions at 5.02 TeV using hydrodynamics with hadronic afterburner. The yields and <pT> agree with available experimental data. With the afterburner the yields are substantially suppressed and the mean transverse momenta are substantially enhanced compared to the case without afterburner. The only exception of this rule is phi(1020), which remains unaltered by the afterburner. First, we provide a simple qualitative explanation of this phenomenon. Second, the available measurements of Lambda(1520) by ALICE allow us to estimate the duration of hadronic rescattering stage after hadronization of the quark-gluon plasma.

Collaboration

Authors: Dr OLIINYCHENKO, Dmytro (INT, UW); KOCH, Volker (LBNL)

Presenter: Dr OLIINYCHENKO, Dmytro (INT, UW)

Session Classification: Bulk (Transport)

Contribution ID: **148** Type: **Theory talk**

Hadron production within a full transport approach with statistical hadronization mechanism at RHIC and LHC energies

Tuesday 18 May 2021 10:50 (20 minutes)

We present for the first time results on final hadron production, with and without strangeness content, in Ultrarelativistic Heavy Ion Collisions at RHIC and LHC center of mass energies obtained combining a full 3+1D relativistic Boltzmann transport approach with a statistical hadronization mechanism. The non-perturbative interaction between quarks and gluons is described by means of a quasi-particle approach that permits to have an Equation of State close to lattice QCD. The resulting framework naturally includes both shear and bulk viscous effects. The 3+1D full transport evolution is converted to hadrons by mean of a realistic freeze-out hypersurface considering all known hadron resonances and by performing resonance decays. In this talk we present results on charged-hadron multiplicity, identified-particle spectra, identified-particle average transverse momentum and identified-particle elliptic flow produced at RHIC and LHC energies for different centralities. We focus on π, K, p, Λ and Φ and their related baryon over meson ratios, from which we obtain further constrain on η/s of QGP. In the same transport framework we study the existence of far-fromequilibrium attractor in the momenta of the distribution function. We show that the resulting far-fromequilibrium evolution is insensitive to different initial conditions: the initial momentum-space anisotropy and initial occupancy. Finally we investigate the possible existence of attractors in the anisotropic flow coefficient.

[1] G. Galesi, S. Plumari, V. Greco in preparation

Collaboration

Authors: GALESI, Giuseppe (INFN - National Institute for Nuclear Physics); PLUMARI, Salvatore (University of Catania (Italy)); GRECO, Vincenzo (University of Catania)

Presenter: GALESI, Giuseppe (INFN - National Institute for Nuclear Physics)

Session Classification: Strangeness (Yields)

Contribution ID: **152** Type: **Theory talk**

The multiple-charm hierarchy in the Statistical Hadronization Model

Tuesday 18 May 2021 10:50 (20 minutes)

In relativistic nuclear collisions the production of hadrons with light (u,d,s) quarks is quantitatively described in the framework of the Statistical Hadronization Model (SHM). Since charm quarks are dominantly produced in initial hard collisions but interact strongly in the hot fireball, charmed hadrons can be incorporated into the SHM by treating charm quarks as 'impurities' with thermal distributions, with the total charm content of the fireball fixed by the measured open charm cross section. We demonstrate that this way the measured multiplicities of single charm hadrons in Pb-Pb collisions at LHC energies can be well described with the same thermal parameters as for (u,d,s) hadrons. Furthermore, transverse momentum distributions are computed in a hydrodynamic approach also incorporating resonance decays. The approach is extended to lighter collision systems down to O-O and includes doubly- and triply-charmed hadrons. We show predictions for production probabilities of such states exhibiting a characteristic and rather spectacular enhancement hierarchy.

Collaboration

Authors: MAZELIAUSKAS, Aleksas (CERN); ANDRONIC, Anton (Westfaelische Wilhelms-Universitaet Muenster (DE)); STACHEL, Johanna (Ruprecht Karls Universitaet Heidelberg (DE)); REDLICH, Krzysztof (University of Wroclaw); KOHLER, Markus (Ruprecht-Karls-Universitaet Heidelberg (DE)); BRAUN-MUNZINGER, Peter (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE)); Dr VISLAVICIUS, Vytautas (University of Copenhagen (DK))

Presenter: Dr VISLAVICIUS, Vytautas (University of Copenhagen (DK))

Session Classification: Charm Exotics

Contribution ID: **154** Type: **Theory talk**

Net-particle number fluctuations in a hydrodynamic description of heavy-ion collisions at RHIC and LHC

Tuesday 18 May 2021 11:10 (20 minutes)

We generalize the Cooper-Frye particlization routine to make it suitable for describing event-by-event fluctuations in heavy-ion collisions. This is achieved via a newly developed subensemble method, allowing to incorporate the effects of exact global conservation of multiple charges, thermal smearing, and resonance decays on fluctuations of various particle numbers. Utilizing viscous hydrodynamic simulations of heavy-ion collisions, we study the behavior of cumulants of net-proton, net-Lambda, net-pion and net-kaon distributions at RHIC and LHC energies. The experimental data on net-proton cumulants at $\sqrt{s_{\rm NN}} > 20$ GeV are consistent with simultaneous effects of global baryon conservation and repulsive interactions in baryon sector, the latter being in line with the behavior of baryon number susceptibilities observed in lattice QCD. The data at lower collision energies show possible indications for sizable attractive interactions among baryons.

Collaboration

Author: Dr VOVCHENKO, Volodymyr (Lawrence Berkeley National Laboratory)

Co-authors: KOCH, Volker (LBNL); SHEN, Chun (Wayne State University)

Presenter: Dr VOVCHENKO, Volodymyr (Lawrence Berkeley National Laboratory)

Session Classification: Bulk (Fluctuation)

Contribution ID: **161** Type: **Experimental talk**

Elliptic flow for ⊠-mesons measured by PHENIX

Tuesday 18 May 2021 11:10 (20 minutes)

The systematic study of hadronic elliptic flow in various relativistic heavy ion collisions is important for the investigation of the initial geometry influence on the quark gluon plasma characteristics. The ⊠-meson consists of strange and antistrange quarks and has a small interaction cross section with non-strange hadrons. Therefore, ⊠-mesons are barely affected by late hadronic stage and reflect detailed information about hot and dense matter properties. Additionally, the comparison of elliptic flow for ⊠-mesons to those of charged hadrons will provide additional research of the flow flavor dependence. PHENIX has measured second order azimuthal anisotropy coefficients for ⊠-mesons in Cu+Au collisions at √s_{NN} = 200 GeV and in U+U collisions at √s_{NN} = 193 GeV at midrapidity (|y|<0.35). The obtained data suggest scaling of elliptic flow for ⊠-mesons with eccentricity of participant nucleons in Cu+Au, U+U, and Au+Au collisions. For a more detailed study, the comparison of current results to azimuthal anisotropy for charged hadrons and to hydrodynamic and transport model predictions will be presented.

Collaboration

PHENIX

Author: Mr MITRANKOV, Iurii (Peter the Great St.Petersburg Polytechnic University (SPbPU))

Co-authors: Mrs MITRANKOVA, Mariia (Peter the Great St.Petersburg Polytechnic University (SPbPU)); Prof. BERDNIKOV, Yaroslav (Peter the Great St.Petersburg Polytechnic University (SPbPU)); KOTOV, Dmitry (PNPI NRC KI & SPbPU); Mr BORISOV, Vladislav (Peter the Great St.Petersburg Polytechnic University (SPbPU)); Ms LARIONOVA, Daria (Peter the Great St.Petersburg Polytechnic University (SPbPU)); Mr BERDNIKOV, Alexander (Peter the Great St.Petersburg Polytechnic University (SPbPU))

Presenter: Mr MITRANKOV, Iurii (Peter the Great St.Petersburg Polytechnic University (SPbPU))

Session Classification: Strangeness (Freeze-out)

Track Classification: Strangeness production in nuclear collisions and hadronic interactions

Contribution ID: **162** Type: **Experimental talk**

Multi-strange hadron production in p+p interactions at $\sqrt{s_{NN}}$=17.3 GeV

Tuesday 18 May 2021 10:10 (20 minutes)

The production of multi-strange hadrons in proton-proton interactions is recently studied with the NA61/SHINE experiment at the SPS. These particles are reconstructed via their weak decay topologies, exploiting the tracking and particle identification capabilities of NA61/SHINE. New measurements of rapidity and transverse momentum spectra of Ξ^-, Ω^- baryons, and Ξ resonances and their antiparticles will be presented. The recent results are compared to those observed in A+A collisions as well as to model predictions.

Collaboration

NA61/SHINE

Author: PULAWSKI, Szymon (University of Silesia (PL))

Presenter: PULAWSKI, Szymon (University of Silesia (PL))

Session Classification: Strangeness (Yields)

Track Classification: Strangeness production in nuclear collisions and hadronic interactions

Contribution ID: **163** Type: **Theory talk**

Is the chemical freeze-out connected to the phase transition? A transport study of freeze-out criteria

Wednesday 19 May 2021 09:30 (20 minutes)

The chemical freeze-out is often related to the phase transition to a deconfined state of matter, the Quark Gluon Plasma. We introduce a novel approach based on elastic and inelastic scattering rates to extract the hyper-surface of the chemical freeze-out from a hadronic transport simulation. We use the Ultra-relativistic Quantum Molecular Dynamics (UrQMD) model to extract the chemical freeze-out hyper-surface of pions and kaons in the energy range from E_{lab} = 1.23 AGeV to $\sqrt{s_{NN}}$ = 62.4 GeV. By employing a coarse-graining procedure, we can extract the local temperature and baryo-chemical potential and investigate the typical freeze-out criteria $\langle E \rangle / \langle N \rangle$ = 1 GeV, s/T^3 = 7 and $n_B + n_{\bar{B}}$ = 0.12 fm^{-3} on the chemical freeze-out surface and compare them to results from statistical model analysis. We find a great agreement leading to the conclusion that the chemical freeze-out can be well described by hadronic transport simulations. We do not observe a relation of the chemical freeze-out line and the phase-transition line. Instead we argue that the freeze-out line is defined by an interplay between elastic, inelastic and pseudo-elastic scattering rates and the expansion rate.

Collaboration

Authors: REICHERT, Tom (Institut für Theoretische Physik, Goethe Universität Frankfurt); BLEICHER, Marcus (Uni Frankfurt); Dr INGHIRAMI, Gabriele (GSI)

Presenter: REICHERT, Tom (Institut für Theoretische Physik, Goethe Universität Frankfurt)

Session Classification: Bulk (Transport)

Contribution ID: **171** Type: **Theory talk**

Dynamical cluster and hypernuclei production in heavy-ion collisions

Friday 21 May 2021 10:10 (20 minutes)

We study the cluster and hypernuclei production in heavy-ion collisions from SIS to RHIC energies based on the n-body dynamical transport approach PHQMD (Parton-Hadron-Quantum-Molecular-Dynamics). In PHQMD clusters are formed dynamically due to the interactions between baryons described on a basis of Quantum Molecular Dynamics (QMD) which allows to propagate the n-body Wigner density and n-body correlations in phase-space, essential for the cluster formation. The clusters are identified by the MST (Minimum Spanning Tree) or the SACA ('Simulated Annealing Cluster Algorithm') algorithm which finds the most bound configuration of nucleons and clusters. Collisions among hadrons as well as Quark-Gluon-Plasma formation and parton dynamics in PHQMD are treated in the same way as in the established PHSD (Parton-Hadron-String-Dynamics) transport approach. We study the time evolution of the cluster creation in the expanding medium and the stability of the clusters. We present the comparison of the PHQMD results for d, t, He^3 and heavy clusters as well as for the hypernuclei with experimental data.

Collaboration

Authors: BRATKOVSKAYA, Elena (GSI, Darmstadt); GLAESSEL, Susanne (Goethe Universtitaet Frankfurt); KIREYEU, Viktar (Joint Institute for Nuclear Research (RU)); AICHELIN, Joerg (Subatech/CNRS); VORONYUK, Vadim (JINR, Dubna); BLUME, Christoph (Goethe University Frankfurt (DE)); COCI, Gabriele (GSI - Hemohilzzentrum für Schwerionenforschung GmbH); KOLESNIKOV, Vadim (Joint Institute for Nuclear Research (RU))

Presenter: BRATKOVSKAYA, Elena (GSI, Darmstadt)

Session Classification: Resonances and Hypernuclei (II)

Contribution ID: **173** Type: **Experimental talk**

Azimuthal anisotropy measurement of multi-strange hadrons in Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 27 and 54.4 GeV at STAR

Tuesday 18 May 2021 10:10 (20 minutes)

One of the main goals of the STAR experiment is to study the properties of QCD matter at various temperatures and/or baryon densities. With this motivation, the STAR experiment has collected data in the nuclear collisions at centre-of-mass energies ($\sqrt{s_{\rm NN}}$) = 3.0-200 GeV. The azimuthal anisotropy of multi-strange hadrons plays an important role in characterizing the properties (particularly, the ratio of shear viscosity to entropy density η/s) of the QGP. Moreover, higher-order anisotropic flow coefficients (v_3, v_4 etc) are found to be more sensitive to η/s. Elliptic flow (v_2) of identified hadrons has been extensively measured at top RHIC energy and well as RHIC Beam energy scan program. However, measurement of azimuthal anisotropy of multi-strange hadrons is limited by the statistics at low RHIC energies, especially v_3 of multi-strange hadrons remains unexplored.

The STAR experiment recorded high statistics data for Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 54.4 GeV (˜600 million events) and 27 GeV (~350 million events). In this talk, we will present new results on the second-order flow coefficient (v_2) and the third-order flow coefficient (v_3) of multi-strange hadrons such as ϕ, Ξ, and Ω measured at midrapidity (|y| <1.0) as a function of transverse momentum ($p_{\rm T}$) and centrality at $\sqrt{s_{\rm NN}}$ = 27 and 54.4 GeV. The number of constituent quark scaling will be studied and ratios v_2/v_3 will be presented for all these particles. We will show the comparison of the new results with the existing data on other particle species ($\pi^{\pm}$, $K^{\pm}$, K^0_S, Λ) and energies from the Beam Energy Scan phase-I. Finally, the physics implications of these measurements in the context of the evolution of partonic collectivity with collision energy will be discussed. This new high statistics measurements, along with available measurement at 200 GeV, can help to understand the temperature dependence of η/s.

Collaboration

STAR Collaboration

Presenter: DIXIT, Prabhupada

Session Classification: Bulk (Collectivity)

Contribution ID: **183** Type: **Experimental talk**

NCQ scaling of $f_0(980)$ elliptic flow in 200 GeV Au+Au collisions by STAR and its constituent quark content

Wednesday 19 May 2021 09:50 (20 minutes)

Searching for exotic state particles and studying their properties have furthered our understanding of quantum chromodynamics (QCD). The $f_0(980)$ resonance is an exotic state with relatively higher production rate in relativistic heavy-ion collisions, decaying primarily into $\pi\pi$. Currently the structure and quark content of the $f_0(980)$ are unknown with several predictions from theory being a $q\bar{q}$ state, a $qq\bar{q}\bar{q}$ state, a $K\bar{K}$ molecule state, or a gluonium state. We report the first $f_0(980)$ elliptic flow (v_2) measurement from 200 GeV Au+Au collisions at STAR. The transverse momentum dependence of v_2 is examined and compared to those of other hadrons (baryons and mesons). The empirical number of constituent quark (NCQ) scaling is used to investigate the constituent quark content of $f_0(980)$ [1], which may potentially address an important question in QCD. We will report the findings of our investigation and discuss its implications.

[1] A. Gu, T. Edmonds, J. Zhao, F. Wang, Phys. Rev. C 101, 024908 (2020), arXiv:1902.07152

Collaboration

STAR Collaboration

Presenter: Dr ZHAO, Jie (Purdue University)

Session Classification: Bulk (Transport)

Contribution ID: **184** Type: **Experimental talk**

Measurement of global polarization of Λ hyperons in Au+Au $\sqrt{s_{\mathrm{NN}}}$ = 7.2 GeV Fixed-target collisions at RHIC-STAR experiment

Thursday 20 May 2021 10:10 (20 minutes)

Non-central heavy-ion collisions produce a large angular momentum that leads to vorticity of the created system. Due to the spin-orbit coupling, spin directions
of particles are aligned with the orbital angular momentum of the system. Global
polarization of Λ and $\bar{\Lambda}$ hyperons has been measured in Au+Au collisions from $\sqrt{s_{\mathrm{NN}}}$ = 7.7 GeV to 200 GeV[1][2]. The STAR fixed target program provides an opportunity to extend such measurements at even lower energies. Additionally, Λ global polarization is also influenced by magnetic field at the initial stage. It would be interesting to investigate such effects towards lower beam energies. In this talk, measurement of global polarization of Λ hyperons in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 7.2 GeV with the fixed-target configuration is reported.

[1] L.Adamczyk et al,(STAR) Nature 548 62 (2017).
[2] J.Adam et al.(STAR), Phys. Rev. C 98 14910 (2018)

Collaboration

STAR Collaboration

Presenter: OKUBO, Kosuke (University of Tsukuba)

Session Classification: Strangeness (Global Polarization)

Contribution ID: **186** Type: **Experimental talk**

Recent J/ψ results in p+p and Au+Au collisions from STAR

Friday 21 May 2021 10:10 (20 minutes)

Heavy quarkonia are ideal probes of the Quark-Gluon Plasma (QGP). The J/ψ suppression due to the color screening effect in heavy-ion collisions is a key experimental observable to study the QGP. At RHIC energies, charm quark recombination could also affect the J/ψ yield in the QGP. Measurements of J/ψ production in Au+Au collisions at different collision energies will help to understand the interplay of these mechanisms for J/ψ production in heavy-ion collisions. Additionally, measurements of J/ψ cross section, polarization and its production in jets in p+p collisions are important in understanding the J/ψ production mechanism in vacuum.

Suppression of the J/ψ production at mid-rapidity in the Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 39, 62.4 and 200 GeV from the STAR experiment showed no significant collision energy dependence within large uncertainties. In 2017, STAR collected a high statistics sample of 54.4 GeV Au+Au collisions which is more than ten times larger than the 39 and 62.4 GeV data. In this talk, we will present new measurements of inclusive J/ψ production in Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 54.4 GeV by the STAR experiment. The collision energy and transverse momentumdependences of the nuclear modification factor will be presented. We will also present the measurements of J/ψ cross section and polarization in p+p collisions, as well as the first measurement of the fraction of charged jet transverse momentum carried by the J/ψ meson at $\sqrt{s}$ = 500 GeV. Physics implications of these results will also be discussed.

Collaboration

STAR Collaboration

Presenter: SHEN, Kaifeng

Session Classification: Heavy Flavor (Charmonia)

Track Classification: Heavy quark production in nuclear collisions and hadronic interactions

Contribution ID: **187** Type: **Experimental talk**

Low-p_{T} $\mu^{+}\mu^{-}$ pair production in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV at STAR

Tuesday 18 May 2021 09:50 (20 minutes)

Recently, significant enhancements of $e^{+}e^{-}$ pairs at very low transverse momentum (p_{T}) were observed by the STAR collaboration in peripheral Au+Au collisions. The excess can be explained by photon-photon interactions induced by the extremely strong electromagnetic field produced by the fast moving heavy ions. While such photon-photon interactions were traditionally studied in ultra-peripheral collisions without any nuclear overlaps, they could provide a novel probe to the Quark Gluon Plasma (QGP) created in peripheral collisions since the very-low-p_{T} dileptons are produced in the early stage of the collisions. Furthermore, the photon-photon interactions could be used to probe the possible existence of strong magnetic field trapped in a conducting QGP medium. Measurements of $\mu^{+}\mu^{-}$ pairs provide a complementary channel to investigate these phenomena.

In 2014 and 2016, the STAR experiment at RHIC recorded large samples of Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV. In this talk, we will present new mea- surements of invariant mass and yield distributions for $\mu^{+}\mu^{-}$ pair production at $p_{\mathrm{T}} < 0.15$ GeV/c. The p_{T}^{2} distribution of the excess yields will also be shown. Physics implications will be discussed together with model comparisons.

Collaboration

STAR Collaboration

Presenter: ZHOU, Jian (USTC)

Session Classification: Open and New (Electromagnetic)

Contribution ID: **189** Type: **Experimental talk**

Measurements of electrons from heavy-flavor hadron decays in 27, 54.4, and 200 GeV Au+Au collisions in STAR

Wednesday 19 May 2021 09:50 (20 minutes)

Measurements of heavy-flavor hadron production and elliptic flow (v_2) are unique and indispensable probes to the properties of the Quark-Gluon Plasma (QGP). Measurements of the production of electrons from open charm and bottom hadron decays in Au+Au collisions serve as a valuable tool to investigate the mass hierarchy of the parton energy loss. Meanwhile, measuring v_2 of heavy flavor hadrons and their decay daughters at different collision energies provide important insights for understanding the temperature dependence of charm quark interactions with the QGP.

In this talk, we will present the latest measurements of the nuclear modification factor of heavy-flavor electrons in Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 200 GeV. Measurements of electrons from open charm- and bottom-hadron decays will be reported separately. The new results from STAR on the v_2 of heavy-flavor electrons at $\sqrt{s_{\rm NN}}$ = 27 and 54.4 GeV will be presented. The energy dependence of heavy-flavor electron v_2 will be compared with those of light hadrons. Physics implications of these results will be discussed by comparing to theoretical model calculations.

Collaboration

STAR Collaboration

Presenter: ZHANG, Shenghui (USTC)

Session Classification: Heavy Flavor (Open charm)

Track Classification: Strangeness production in nuclear collisions and hadronic interactions

Contribution ID: **190** Type: **Experimental talk**

Light and strange hadron production and anisotropic flow measurement in Au + Au collisions at $\sqrt{s_{\rm NN}}$ = 3 GeV from STAR

Tuesday 18 May 2021 12:30 (20 minutes)

Particle production and anisotropic flow measurements have been used to investigate the properties of the QCD matter produced in heavy ion collisions.The RHIC Beam Energy Scan program covers a wide range of energies, including the transition from a partonic dominated area to hadronic dominated area. Of particular interest is the high baryon density region which is accessible through production and collective flow measurements of particles including strange hadrons (kaons, ϕ, Λ etc) in the STAR fixed-target program.

In this talk, we will report on our first measurements of identified particle (π, K, p, K^0_s, Λ, ϕ) production and anisotropic flow (v_1, v_2) in Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 3 GeV. The data were taken in 2018 by the STAR experiment with the fixed target configuration. After correcting for the detector acceptance and tracking efficiencies, invariant yields and rapidity density distributions of π, K and ϕ-mesons as well as the directed/elliptic flow of π, K, p, K^0_s, Λ, ϕ will be presented. The charged particle (π, K) production is analyzed with a thermal model to study the temperature and potential at chemical freeze-out. The ϕ-meson production is compared to the thermal and transport model calculations to study the strangeness production, and particularly to test and constrain canonical ensemble calculations. In addition, the transverse momentum ($p_{\rm T}$), rapidity (y) and energy ($\sqrt{s_{\rm NN}}$) dependence of the v_1 and v_2 will be presented and compared to the UrQMD calculations. These results imply that the matter produced in the 3 GeV Au+Au collisions is considerably different from those at higher energies.

Collaboration

STAR Collaboration

Presenter: XIE, Guannan (Lawrence Berkeley National Laboratory)

Session Classification: Strangeness (Freeze-out)

Track Classification: Strangeness production in nuclear collisions and hadronic interactions

Contribution ID: **191** Type: **Experimental talk**

Measurements of Λ-Λ, Ξ-Ξ, and p-Ξ Correlations in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV and p-p Correlation in Au+Au FXT target collisions at $\sqrt{s_{\mathrm{NN}}}$ = 3 GeV at RHIC-STAR

Wednesday 19 May 2021 10:30 (20 minutes)

Understanding of baryon-baryon interactions is important to examine the existence of stranglets and various exotic hadrons, e.g. H-dibaryon, and to model of astronomical objects such as neutron stars. However hyperon-nucleon and hyperon-hyperon interactions are not fully understood yet. In high energy heavy-ion collisions, a large number of particles including (multi-)strangeness are produced, which may allows us to study those interactions via femtoscopic measurements with better precision. At low relative momentum, the correlations between two particles are influenced by the strong and Coulomb interactions as well as quantum statistical effect sensitive to the emission source size for identical pairs. Thus measuring correlations of two baryons is a useful probe to extract the scattering parameters between the baryons and the size of the particle emission.

In this talk, we present measurements of Λ-Λ correlations in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV with largely improved statistical precision compared to previous measurements for studying a possible Λ-Λ bound state. We will also present the first measurements of Ξ-Ξ and p-Ξ correlations in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV. New results of p-p correlation in FXT target mode Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 3 GeV will be also presented as a function of the collision centrality, transverse momenta, and rapidity, and will be compared with the calculations from UrQMD transport model. In addition, a systematic energy dependence of the p-p correlation functions will be discussed.

Collaboration

STAR Collaboration

Presenter: ISSHIKI, Moe (University of Tsukuba (JP))

Session Classification: Resonances and Hypernuclei (I)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **194** Type: **Experimental talk**

Study of Charge Symmetry Breaking in A = 4 hypernuclei in $\sqrt{s_{\rm NN}}$ = 3 GeV Au+Au collisions at RHIC

Friday 21 May 2021 09:30 (20 minutes)

The Λ binding energy difference, which is called the charge symmetry breaking in the ground states of a pair of A = 4 hypernuclei, ${}^{4}_{\Lambda}$H and ${}^{4}_{\Lambda}$He, was measured to be $\Delta B^{4}_{\Lambda}(0^{+}_{g.s.}) \approx 350$ keV in nuclear emulsion experiments in 1970s. In the 2015 experiment from J-PARC, the binding energy difference in excited states $\Delta B^{4}_{\Lambda}(1^{+}_{exc}) \approx 30$ keV was found to be much smaller than the ground states. In 2016, the A1 collaboration updated the values to $\Delta B^{4}_{\Lambda}(0^{+}_{g.s.}) \approx 233$ keV and $\Delta B^{4}_{\Lambda}(1^{+}_{exc}) \approx -83$ keV. These values are difficult to be reproduced in existing theoretical models. The full understanding of the charge symmetry breaking in A = 4 hypernuclei still remains an open question.
As part of the STAR fixed target program, the STAR detector took the data in Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 3 GeV in 2018. The high production yield of hypernuclei provides an opportunity to measure the binding energies of both A = 4 hypernuclei in ground states in the same experiment to address this charge symmetry breaking puzzle. In this talk, we will present the measurement of the charge symmetry breaking in A = 4 hypernuclei in Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 3 GeV. The signal reconstruction and binding energy measurement of ${}^{4}_{\Lambda}$H and ${}^{4}_{\Lambda}$He, including energy loss correction and systematic uncertainty evaluation, will be discussed. Our preliminary result for ground states is smaller than the old results. Combined with the energy levels of excited states, our preliminary result for excited states shows a negative value and is compareable to the value of ground states. These results will be compared to previous measurements and theoretical models.

Collaboration

STAR Collaboration

Presenter: SHAO, Tianhao (Shanghai Institute of Applied Physics)

Session Classification: Resonances and Hypernuclei (II)

Contribution ID: **195** Type: **Theory talk**

Hydrodynamic description of D meson production in high-energy heavy-ion collisions

Tuesday 18 May 2021 12:10 (20 minutes)

The large values and the constituent-quark-number (NCQ) scaling of the elliptic flow of low-p_T D mesons imply that charm quarks, initially produced through hard processes, might be partially thermalized through the strong interactions with the quark-gluon plasma (QGP) in high-energy heavy-ion collisions.
To quantify the degree of thermalization of low-p_T charm quarks, we compare the D^0 meson spectra and elliptic flow from a hydrodynamic model to the experimental data as well as transport model simulations.
We use an effective charm chemical potential at the freeze-out temperature to account for the initial charm quark production from hard processes and assume that they are thermalized in local comoving frame of the medium before freeze-out.
D^0 mesons are sampled statistically from the freeze-out hyper-surface of the expanding QGP as described by the event-by-event (3+1)D viscous hydrodynamic model CLVisc.
Both hydrodynamic and transport model can describe the elliptic flow of D^0 mesons at $p_T < 3$ GeV/c as measured in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV.
Though the experimental data on D^0 spectra are consistent with the hydrodynamic result at small $p_T \sim 1$ GeV/c, they deviate from the hydrodynamic model at high transverse momentum $p_T > 2$ GeV/c.
The diffusion and parton energy loss mechanisms in the transport model can describe the measured spectra reasonably well within the theoretical uncertainty.
Our comparative study indicates that charm quarks only approach to local thermal equilibrium at small p_T even though they acquire sizable elliptic flow that is comparable to light-quark hadrons at both small and intermediate p_T.

Collaboration

Authors: DING, Chi (Central China Normal University); PANG, LongGang (Lawrence Berkeley National Laboratory); KE, Weiyao (University of California, Berkeley; Lawrence-Berkeley National); WANG, Xin-Nian (Lawrence Berkeley National Lab. (US))

Presenter: DING, Chi (Central China Normal University)

Session Classification: Open and New (Correlations)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **196** Type: **Experimental talk**

Production of pions, kaons, (anti-) protons and (multi-) strange hadrons production in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 54.4 GeV using the STAR detector

Tuesday 18 May 2021 09:30 (20 minutes)

Exploring the QCD phase diagram and searching for the QCD critical point are some of the main goals of heavy-ion collision experiments. The yields of identified hadrons and (multi-) strange hadrons provide information about the phase diagram and particle production in these collisions. In 2017 the STAR experiment collected large dataset of Au+Au collisions at 54.4 GeV.

The production of identified hadrons ($\pi^{\pm}$, $K^{\pm}$, p, $\bar{p}$) and strange hadrons (K^0_S, Λ, Ξ, Ω, ϕ) at mid-rapidity is presented. The results for the transverse momentum spectra, particle yields dN/dy, average transverse momentum $\langle p_{\mathrm{T}} \rangle$ and particle ratios are presented for different centrality classes. The energy dependence of all these observables will be discussed. The freeze-out conditions in these collisions are obtained using the statistical thermal model. In particular, the strange-to-pion ratios versus charged hadron multiplicity are studied and will be compared to the measurements in heavy-ion collisions at other energies from the BES-I program at RHIC and the ALICE experiment at the LHC.

Collaboration

STAR Collaboration

Presenter: HUANG, Yan

Session Classification: Strangeness (Yields)

Contribution ID: **200** Type: **Theory talk**

Light-nuclei production in heavy-ion collisions at RHIC BES in updated Three-fluid Hydrodynamics-based Event Simulator (THESEUS).

Wednesday 19 May 2021 10:50 (20 minutes)

We present an updated event generator THESEUS, based on the three-fluid dynamics (3FD), complemented by UrQMD cascade for the late stage of the nuclear collision. The generator is extended to simulate light-nuclei production in relativistic heavy-ion collisions via thermal mechanism, on the same basis as hadrons.
We present the rapidity, transverse momentum spectra, first (v_1) and second (v_2) flow harmonics of deuterons, tritons, ^{3}He at different collision energies and impact parameters in the RHIC BES range. The results are compared with experimental data from NA49 and STAR.
We show that anti-deuteron spectra from THESEUS are in good agreement with STAR data.
We demonstrate the contributions from the excited states of Helium to the yields of deuteron, triton and ^{3}He. The reproduction is achieved without any extra parameters, while the original coalescence approach in 3FD requires a tuning of the coalescence coefficients for each light nucleus separately.

Collaboration

Authors: KOZHEVNIKOVA, Marina (Joint Institute for Nuclear Research, Dubna, Russia); IVANOV, Yuri (NRC Kurchatov Institute); KARPENKO, Iurii (SUBATECH Nantes); BLASCHKE, David (University of Wroclaw); Dr ROGACHEVSKY, Oleg (JINR)

Presenter: KARPENKO, Iurii (SUBATECH Nantes)

Session Classification: Resonances and Hypernuclei (I)

Contribution ID: **201** Type: **Experimental talk**

Prospects for the NA60+ experiment at the CERN SPS

Tuesday 18 May 2021 11:50 (20 minutes)

A new heavy-ion experiment on fixed target, NA60+, has been proposed at the CERN SPS for data taking in the next years. Its main goals will be focused on precision studies of thermal dimuons, heavy quark and strangeness production in Pb-Pb collisions at center-of-mass energies ranging from 5 to 17 GeV. The experiment will profit from the high-intensity beams provided by the CERN SPS, that will provide a unique opportunity to investigate the region of the QCD phase diagram at high baryochemical potential. The proposed experimental apparatus consists of a vertex telescope located close to the target and a muon spectrometer located downstream of a hadron absorber. The vertex telescope consists of several planes of monolithic active pixel sensors embedded in a dipole magnetic field. The muon spectrometer will utilize GEM detectors for muon tracking and a toroidal magnet based on a new light-weight and general-purpose concept.
This apparatus, based on state-of-the-art technologies, will allow a very broad and ambitious physics program which will be discussed during the talk. The competitiveness and complementarity of the NA60+ physics program in the
landscape of the experiments foreseen at other facilities in the next decade will also be discussed. The high-precision measurements of dimuon invariant mass distributions will open the possibility to investigate the order of the phase transition from the quark-gluon plasma to a hadron gas in the interval $\mu_B \sim$ 200-400 MeV via the first measurement of the caloric curve. Furthermore, the precision measurement of charmonium states, through dimuon decays, and open-charm hadrons, from their hadronic decays, will provide new insights into the transport properties of the QGP and into the threshold energy for the onset of deconfinement. Finally, perspectives for high precision measurements of strangeness production at different energies will be presented, focusing on kaon, ϕ and Λ production.

Collaboration

NA60+

Author: DE FALCO, Alessandro (Universita e INFN, Cagliari (IT))

Presenter: DE FALCO, Alessandro (Universita e INFN, Cagliari (IT))

Session Classification: Upgrades and New Experiments

Track Classification: Open questions and new developments

Contribution ID: **202** Type: **Theory talk**

D and B RAA(pT,eta) for sqrt(s) = 2.76 - 5.5 TeV from AdS/CFT

Thursday 20 May 2021 10:30 (20 minutes)

We present the latest predictions from AdS/CFT for D and B meson suppression $R_{AA}(p_T, \eta)$ and $v_2(p_T, \eta)$ in Pb+Pb collisions of various centrality classes at multiple LHC center-of-mass energies. Included in these predictions are systematic theoretical uncertainties due to the currently incomplete understanding of strongly-coupled energy loss and from mapping QCD onto N=4 SYM.
By comparing to baseline p+p data, we establish the inadequacy of current NLO schemes at describing the rapidity dependence of heavy flavor production. Using FONLL heavy flavor production, which does reproduce the rapidity dependence in p+p collisions, we then compare to current D and B meson measurements. Our results show good qualitative agreement with data, suggesting a consistent picture of strongly-coupled quark-gluon plasma formation from low-p_T observables to high-p_T observables.

Collaboration

Authors: HAMBROCK, Robert (University of Cape Town); HOROWITZ, William Alexander (University of Cape Town (ZA))

Presenter: HAMBROCK, Robert (University of Cape Town)

Session Classification: Heavy Flavor (Beauty)

Contribution ID: **203** Type: **Theory talk**

Repulsive properties of hadrons in lattice QCD data and neutron stars

Thursday 20 May 2021 10:30 (20 minutes)

Second order susceptibilities χ_{ij}^{11} of baryon, electric, and strangeness, B, Q, and S, charges, are calculated in the Chiral Mean Field (CMF) model and compared to available lattice QCD data. The susceptibilities are sensitive to the short range repulsive interactions between different hadron species, especially to the hardcore repulsion of hyperons. Decreasing the hyperons size, as compared to the size of the non-strange baryons, does improve significantly the agreement of the CMF model results with the Lattice QCD data. The electric charge-dependent susceptibilities are sensitive to the short range repulsive volume of mesons. The comparison with lattice QCD data suggests that strange baryons, non-strange mesons and strange mesons have significantly smaller excluded volumes than non-strange baryons.
The CMF model with these modified hadron volumes allows for a mainly hadronic description of the QCD susceptibilities significantly above the chiral pseudo-critical temperature.
This improved CMF model which is based on the lattice QCD data, has been used to study the properties of both cold QCD matter and neutron star matter.
The phase structure in both cases is essentially unchanged, i.e. a chiral first order phase transition occurs at low temperatures ($T_{\rm CP} \approx 17$ MeV), and hyperons survive deconfinement to higher densities than non-strange hadrons. The neutron star maximal mass remains close to $2.1 M_\odot$ and the mass-radius diagram is only modified slightly due to the appearance of hyperons and is in agreement with astrophysical observations.

[1] A. Motornenko, S. Pal, A. Bhattacharyya, J. Steinheimer and H. Stoecker,
arXiv:2009.10848 [hep-ph]
[2] A. Motornenko, J. Steinheimer, V. Vovchenko, S. Schramm and H. Stoecker,
Phys. Rev. C 101, no.3, 034904 (2020)

Collaboration

Author: Mr MOTORNENKO, Anton (Frankfurt Institute for Advanced Studies)

Co-authors: Mr PAL, Somenath (Department of Physics, University of Calcutta); Dr BHATTACHARYYA, Abhijit (University of Calcutta); Dr STEINHEIMER, Jan; STOECKER, Horst (GSI)

Presenter: Mr MOTORNENKO, Anton (Frankfurt Institute for Advanced Studies)

Session Classification: Bulk (Lattice)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **205** Type: **Theory talk**

Thermalization time constrained by high-pt QGP tomography

Friday 21 May 2021 10:10 (20 minutes)

We show that high-$p_\perp$ R_{AA} and v_2 are way more sensitive to the QGP thermalization time, τ_0, than the distributions of low-$p_\perp$ particles, and that the high-$p_\perp$ observables prefer relatively late thermalization at τ_0 ~ 1 fm/c. To calculate high-$p_\perp$ R_{AA} and v_2, we employ our newly developed DREENA-A formalism, which combines state-of-the-art dynamical energy loss model with 3+1 dimensional hydrodynamical simulations. The model applies to both light and heavy flavor, and we predict a larger sensitivity of heavy observables to the thermalization time. Elliptic flow parameter v_2 is also more sensitive to τ_0 than R_{AA} due to non-trivial differences in the evolution of in-plane and out-of-plane temperature profiles. This presents the first time when a parameter describing bulk QGP has been constrained by high-$p_\perp$ observables and related theory, i.e., by so-called QGP tomography.

Collaboration

Authors: Mr STOJKU, Stefan (Institute of Physics University of Belgrade); Dr AUVINEN, Jussi (Institute of Physics University of Belgrade); Prof. DJORDJEVIC, Marko (University of Belgrade Faculty of Biology); Dr HUOVINEN, Pasi (Institute of Physics University of Belgrade); Dr DJORDJEVIC, Magdalena (Institute of Physics University of Belgrade)

Presenter: Mr STOJKU, Stefan (Institute of Physics University of Belgrade)

Session Classification: Bulk (Small systems)

Track Classification: Other

Contribution ID: **206** Type: **Theory talk**

Coupled baryon, electric charge and strangeness fluctuations in heavy-ion collisions

Tuesday 18 May 2021 12:10 (20 minutes)

Fluctuation observables in heavy-ion collisions probe the constituents, the chemical freeze-out and the transport properties of strongly interacting matter, and signal phase transitions. We present results for second order fluctuations of the conserved charges in QCD from a stochastic diffusion model in a Bjorken-type expansion background. The impact of the cross couplings between the three different currents is included and phenomenological consequences for experimental observables which affect the determination of the freeze-out curve and the search for the QCD critical point are discussed.

Collaboration

Authors: PIHAN, Grégoire (CNRS); BLUHM, Marcus (Subatech); NAHRGANG, Marlene (Subatech)

Presenter: PIHAN, Grégoire (CNRS)

Session Classification: Bulk (Fluctuation)

Contribution ID: **207** Type: **Experimental talk**

Do we observe a maximum of the global polarization at HADES energies?

Thursday 20 May 2021 10:50 (20 minutes)

In non-central heavy-ion collisions the orbital angular momentum can reach high values up $10^4\hbar$. This might lead to a global spin polarization of the particles being produced. The STAR results, as measured during the beam energy scan phase I, show an enhancement of the global polarization towards lower beam energies. At a collision energy of $\sqrt{s_{NN}} = 7.7\,\text{GeV}$ a polarization of a few percent has been found. For higher collision energies of $\sqrt{s_{NN}} = 200\,\text{GeV}$ a significant global polarization has still been measured at the per-mille level. At even higher LHC energies of a few TeV the ALICE measurements, despite being consistent with zero, are following the decreasing trend of the global polarization with the collision energy.\\
Several models have been used to describe the trend of the polarization. However, there is very little discussion on how this polarization manifests itself in the low-energy region as measured with HADES.\\
To fuel this discussion from the experimental side, we will present multi-differential results in $p_t - y$ and centrality for the global polarization as measured with HADES. The high statistics Ag+Ag sample measured in 2019 at $\sqrt{s_{NN}} = 2.55\,\text{GeV}$ together with the Au+Au collisions at $\sqrt{s_{NN}} = 2.42\,\text{GeV}$ indicates that the trend measured by STAR continues. The global polarization has been measured by the self-analyzing weak decay of the Λ hyperon. The orientation of the orbital angular momentum is estimated via the reaction plane which is reconstructed from charged spectator fragments measured with the forward wall hodoscope. Furthermore, new results for the directed flow, v_1, of the Λ will be shown and compared to world data.

Collaboration

Authors: KORNAS, Frederic (TU Darmstadt); GALATYUK, Tetyana (TU Darmstadt / GSI); SELYUZHENKOV, Ilya (GSI, Darmstadt)

Presenter: KORNAS, Frederic (TU Darmstadt)

Session Classification: Strangeness (Global Polarization)

Track Classification: Bulk matter phenomena associated with strange and heavy quarks

Contribution ID: **210** Type: **Theory talk**

Shear-induced spin polarization and "strange memory" in heavy-ion collisions

Wednesday 19 May 2021 10:50 (20 minutes)

We analyze the spin polarization generated from the hydrodynamic gradients. In addition to the widely studied effects of thermal vorticity, we identify an undiscovered contribution, namely, shear-induced polarization (SIP). That is, shear strength $\sigma^{\mu\nu}$, the traceless and symmetric part of the flow gradient, will give rise to spin polarization in momentum space. SIP can be viewed as the fluid analog of strain-induced polarization observed in elastic and nematic materials in condensed matter physics, which converts anisotropy in fluid into eccentricity in spin space. The form of the SIP can be obtained either using the quantum kinetic equation or linear response theory and the form is identical in both approaches. Based on a realistic hydrodynamic model, we investigate the spin polarization on both beam direction (z) and out-plane direction (y), including SIP and thermal vorticity effects. We observe the azimuthal angle dependence of SIP always has the same trend comparing to the local lambda polarization observed in experiments in both z and y directions. Within the present study, we find that in the scenario that Λ inherits and memorizes the spin polarization of strange quark in the quark-gluon plasma phase, the total spin polarization shows an azimuthal angle dependence qualitatively agrees with the experimental data.

Collaboration

Author: Dr LIU, Shuai (Institute of Modern Physics (IMP))

Co-authors: FU, Baochi (PKU); SONG, Huichao (Peking University); PANG, LongGang (CCNU); YIN, Yi (IMP)

Presenter: Dr LIU, Shuai (Institute of Modern Physics (IMP))

Session Classification: Open and New (Charge and Flavor)

Contribution ID: **212** Type: **Experimental talk**

Fixed-target program upgrade and prospects at LHCb

Tuesday 18 May 2021 11:30 (20 minutes)

LHCb has the unique capability to operate in fixed-target mode to study collisions of the LHC beams on fixed targets. In Run3, the internal gas target is going to be upgraded to allow for a wider selection of target gas species and a significant increase of the rates of fixed target collisions by up to two orders of magnitude. Along with significant data acquisition and tracking upgrades, the SMOG 2 system greatly enhances the reach of LHCb's heavy ion program. The talk will present SMOG2, the upgraded fixed-target program of LHCb and discuss its prospects in Run 3.

Collaboration

LHCb

Authors: RICCIARDI, Stefania (Science and Technology Facilities Council STFC (GB)); LHCB COLLABORATION

Presenter: FRANZOSO, Edoardo (Universita e INFN, Ferrara (IT))

Session Classification: Upgrades and New Experiments

Track Classification: Open questions and new developments

Contribution ID: **218** Type: **Experimental talk**

Higher-Order Cumulants of Net-Proton Multiplicity Distributions from RHIC-STAR

Tuesday 18 May 2021 11:30 (20 minutes)

In the study of QCD phase structure and search of the QCD phase boundary and critical point, higher-order cumulants of conserved quantities are proposed as promising observables and have been studied extensively both experimentally and theoretically. For 4^{th}-order cumulants it is predicted that there will be a non-monotonic energy dependence trend. For 5^{th}- and 6^{th}-order cumulants results from Lattice calculations suggest that they are connected to the smooth crossover transition at μ_B = 0. At high baryon density region, on the other hand, the higher-order cumulants are also sensitive to the first-order phase boundary.

In this talk, we will present net-proton cumulants up to 6^{th}-order in Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 7.7 - 200 from STAR Beam Energy Scan phase I and $\sqrt{s}$ = 200 GeV p+p collisions. Analysis update on STAR fixed target energy $\sqrt{s_{\rm NN}}$ = 3 GeV will also be shown. Physics implication as well as comparisons with various models will be discussed.

Collaboration

STAR Collaboration

Presenter: Mr ZHANG, Yu (Central China Normal University)

Session Classification: Bulk (Fluctuation)

Contribution ID: **222** Type: **Theory talk**

Thermal abundance of hyperons from a coupled-channel model

Wednesday 19 May 2021 10:30 (20 minutes)

I shall present an analysis of the thermal composition of the S=-1 strange baryons using an S-matrix formulation of statistical mechanics. The thermal abundances are computed based on the density of states extracted from a coupled-channel model. The approach entails a consistent treatment of resonances and naturally incorporates nonresonant interactions and the contribution from some additional states beyond the listing of the PDG. Influences from beyond the elastic scatterings of elementary hadrons, i.e. quasi-two-body states and unitarity backgrounds will be examined. Lastly, constraints from thermal model analysis of the LHC hadron yields and the LQCD results on baryon strangeness correlations will be discussed.

Collaboration

Author: Dr LO, Pok Man (University of Wroclaw)

Presenter: Dr LO, Pok Man (University of Wroclaw)

Session Classification: Bulk (Transport)

Contribution ID: **223** Type: **Experimental talk**

Machine Learning Application for Λ Hyperon Reconstruction in CBM at FAIR

Tuesday 18 May 2021 12:30 (20 minutes)

The Compressed Baryonic Matter (CBM) experiment at FAIR will investigate the QCD phase diagram in the region of high net-baryon densities (μB > 500 MeV) in the collision energy range of √sNN = 2.7–4.9 GeV with high interaction rate, up to 10 MHz, provided by the SIS100 accelerator. Enhanced production of strange baryons can signal transition to a new phase of the QCD matter. Λ hyperons are the most abundantly produced strange baryons. They weakly decay, with a branching ratio of 64%, into a proton and a negatively charged pion (π-). To reconstruct the Λ⟶π-+p decay kinematics, Particle-Finder Simple (PFSimple) package is used. PFSimple interfaces the mathematics of the Kalman Filter Particle (KFParticle) package and provides a convenient interface to control the reconstruction parameters. For the reduction of combinatorial background specific selection criteria needs to be applied to the proton and π- tracks and Λ-candidates decay topology.

In this work, the performance for Λ hyperon reconstruction in CBM with Machine Learning (ML) algorithms such as XGBoost will be presented. The ML algorithms allow efficient, non-linear and multi-dimensional selection criteria to be implemented and achieve high signal to background ratio in the region around the Λ candidate invariant mass peak.

Collaboration

CBM at FAIR

Authors: KHAN, Shahid (University of Tuebingen); Dr KLOCHKOV, Viktor (Eberhard Karls University of Tübingen, Tübingen, Germany); Mr LUBYNETS, Oleksii (GSI, Darmstadt, Germany); Dr DUBLA, Andrea (GSI, Darmstadt, Germany); Dr SELYUZHENKOV, Ilya (GSI, Darmstadt, Germany)

Presenter: KHAN, Shahid (Eberhard Karls Universität Tübingen)

Session Classification: Upgrades and New Experiments

Contribution ID: **225** Type: **Experimental talk**

CME search at STAR

Wednesday 19 May 2021 10:30 (20 minutes)

The hot and dense medium produced in relativistic heavy-ion collisions has been conjectured to be accompanied by an axial charge asymmetry that may lead to a separation of electric charges in the direction of the extremely strong (10^{18} Gauss) magnetic field (B),also known as the Chiral Magnetic Effect (CME). The measurement of azimuthal correlator ($\Delta\gamma$) with respect to the spectator plane [1], estimated by the zero degree calorimeters with shower maximum detector, and the participant plane, estimated by the 2nd harmonic event plane determined using charged particles reconstructed by time projection chamber, will give us an opportunity to measure the possible CME fraction beyond the flow background. Preliminary results using this approach in Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 200 GeV and U+U at $\sqrt{s_{\rm NN}}$ = 193 GeV have been presented at Quark Matter 2019 [2]. In this talk, I will present the final results where the systematic uncertainties have been thoroughly investigated. Meanwhile, the observability of CME has been conjectured to be dependent on $\sqrt{s_{\rm NN}}$ due to changes in the lifetime of the magnetic field, the strengths of CME signal and non-CME background. At lower energies, the Event Plane Detector (EPD) installed in the year 2018 provides a unique capability for CME search. The EPD can measure the event plane associated with the spectators with good precision. This opens up new opportunities to revisit CME search at lower energies with the BES-II data recently collected by STAR. In this presentation, I'll present the CME search at STAR using the EPD and present the first measurements in Au+Au collisions at $\sqrt{s_{\rm NN}}$ = 27 GeV and discuss STAR's plan for blind analysis of the isobar data as outlined in Ref. [3].

References
[1] H.-J. Xu, J. Zhao, X.-B. Wang, H.-L. Li, Z.-W. Lin, C.-W. Shen, and F.-Q. Wang. Varying the chiral magnetic effect relative to flow in a single nucleus-nucleus collision. Chinese Physics C, 42(8):084103, jul 2018.
[2] J. Zhao. Search for CME in U+U and Au+Au collisions in STAR with different approaches of handling backgrounds. Nuclear Physics A, 1005:121766, 2021. The 28th International Conference on Ultra-relativistic Nucleus-Nucleus Collisions: Quark Matter 2019.
[3] J. Adam and others, STAR collaboration. Methods for a blind analysis of isobar data collected by the star collaboration. arXiv:1911.00596, 2019.

Collaboration

STAR Collaboration

Presenter: HU, YU (Fudan University)

Session Classification: Open and New (Charge and Flavor)

Contribution ID: **228** Type: **Experimental talk**

${}^{3}_{\Lambda}$H and ${}^{4}_{\Lambda}$H Lifetime, Yield, Directed Flow and 3-body Decay Measurements in Au+Au collisions at $\sqrt{s_{\rm NN}} = 3$ GeV with the STAR detector

Friday 21 May 2021 10:30 (20 minutes)

The study of hyperon-nucleon (Y-N) interactions is of great interest in recent years because of its relation to high-density matter systems. For example, the presence of hyperons inside neutron stars would soften the equation of state. Hypernuclei, bound states of nucleons and hyperons, serve as a probe to study the Y-N interaction.

In this talk, the lifetime of ${}^{3}_{\Lambda}$H and ${}^{4}_{\Lambda}$H, and the rapidity and centrality dependence of their yields in Au+Au collisions at $\sqrt{s_{\rm NN}} = 3$ GeV will be presented. The measured yield will be compared to measurements at other energies and to theoretical models, and the physics implications will be discussed. We also report the first observation of the ${}^{3}_{\Lambda}$H and ${}^{4}_{\Lambda}$H directed flow in $5-40\%$ centrality. The directed flow of ${}^{3}_{\Lambda}$H and ${}^{4}_{\Lambda}$H are compared with those of the copiously produced particles such as p, Λ, d, t, ^{3}He and ^{4}He. These results will shed light on light hypernuclei production in heavy-ion collisions in the high baryon density region. Finally, reconstructing hypernuclei using different decay channels allows us to measure their decay branching ratios. In particular, the three-body decay channels are sensitive to the quantum numbers of the hypernuclei ground state, which can be studied with the Dalitz plot technique. The observation of ${}^{3}_{\Lambda}\mathrm{H} \to d+p+\pi$, ${}^{4}_{\Lambda}\mathrm{He} \to {}^{3}\mathrm{He}+\mathrm{p}+\pi$ and ${}^{5}_{\Lambda}\mathrm{He} \to {}^{4}\mathrm{He}+\mathrm{p}+\pi$ will be presented and discussed.

Collaboration

STAR Collaboration

Presenter: CHENLU, Hu (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Resonances and Hypernuclei (II)

Track Classification: Production of strange/heavy-flavor hadron resonances and hypernuclei

Contribution ID: **232** Type: **Theory talk**

Strangeness freeze-out in early universe

Thursday 20 May 2021 10:30 (20 minutes)

In the primordial QGP filling the early Universe the abundant strangeness is in chemical equilibrium since the characteristic Hubble time constant $H^{-1} \simeq 1\mu s$. Upon hadronization near to $T = 150$ MeV one may think that relatively short lived massive strange hadrons decay rapidly and strangeness disappears. However, using detailed balance considerations for inverse decay reactions including hadronic, electromagnetic and weak interaction processes we show that the back reactions repopulate strangeness keeping it near to the chemical equilibrium – small deviations occur due to multiparticle decay processes which can fall out from detailed balance. For $T > 20\,\mathrm{MeV}$ strangeness abundance is predominantly found in strangeness containing mesons with $s = \bar{s}$. For $20 > T > 13$ MeV strangeness is predominantly present in hyperons, with anti-strangeness balance in kaons, keeping symmetric $s = \bar{s}$ abundances. Near to $T = 13$ MeV the reaction $\overline{K} + N \to \Lambda + \pi$ becomes slower than the strangeness decay $\Lambda \to N + \pi$. Now strangeness abundance becomes asymmetric $s > \bar{s}$. Finally, at $T_s = 7.3$ MeV all strange particle kinetic reaction rates drop below H^{-1}, hence also Λ disappear below this temperature. Considering this relatively low value of final chemical decoupling T_s one can wonder if strange matter clustering should in future be also considered.

Collaboration

Author: -YANG, -Cheng Tao (The University of Arizona)

Co-author: RAFELSKI, Johann (University of Arizona (US))

Presenter: -YANG, -Cheng Tao (The University of Arizona)

Session Classification: Astrophysics and Hadronic Interactions

Contribution ID: **235** Type: **Experimental talk**

Light flavor and strangeness production and correlations from ALICE

Monday 17 May 2021 09:30 (25 minutes)

Collaboration

Presenter: KNOSPE, Anders (Lehigh University)

Session Classification: Experiment Collaboration Overview (I)

Contribution ID: **236** Type: **Experimental talk**

HADES

Monday 17 May 2021 09:55 (25 minutes)

Presenter: SPIES, Simon (Johann-Wolfgang-Goethe Univ. (DE))

Session Classification: Experiment Collaboration Overview (I)

Contribution ID: **237** Type: **Experimental talk**

NA61/SHINE

Monday 17 May 2021 10:20 (25 minutes)

Presenter: KUICH, Magdalena (University of Warsaw (PL))

Session Classification: Experiment Collaboration Overview (I)

Contribution ID: **238** Type: **not specified**

Updates on flavor production from STAR

Monday 17 May 2021 10:45 (20 minutes)

Collaboration

Presenter: RADHAKRISHNAN, Sooraj Krishnan (Lawrence Berkeley National Laboratory)

Session Classification: Experiment Collaboration Overview (I)

Contribution ID: **239** Type: **Experimental talk**

PHENIX

Monday 17 May 2021 11:05 (25 minutes)

Collaboration

Presenter: TODOROKI, Takahito (University of Tsukuba)

Session Classification: Experiment Collaboration Overview (II)

Contribution ID: **240** Type: **Experimental talk**

Heavy ion results from LHCb

Monday 17 May 2021 11:30 (25 minutes)

Collaboration

Presenter: SUN, Jiayin (Universita e INFN, Cagliari)

Session Classification: Experiment Collaboration Overview (II)

Contribution ID: **241** Type: **Experimental talk**

ATLAS

Monday 17 May 2021 12:20 (25 minutes)

Collaboration

Presenter: PEREPELITSA, Dennis (University of Colorado Boulder)

Session Classification: Experiment Collaboration Overview (II)

Contribution ID: **242** Type: **Experimental talk**

CMS recent results on strange and heavy-flavour quarks in heavy -ion collisions

Monday 17 May 2021 11:55 (25 minutes)

Collaboration

Presenter: MURRAY, Michael (The University of Kansas (US))

Session Classification: Experiment Collaboration Overview (II)

Contribution ID: **243** Type: **Experimental talk**

Heavy flavor and quarkonia from ALICE

Monday 17 May 2021 13:30 (25 minutes)

Collaboration

Author: DUBLA, Andrea (GSI)

Presenter: DUBLA, Andrea (GSI)

Session Classification: Theory Overview

Contribution ID: **244** Type: **not specified**

Recent milestones from STAR: new developments and open questions

Monday 17 May 2021 14:25 (20 minutes)

Collaboration

Presenter: MA, Rongrong (BNL)

Session Classification: Theory Overview

Contribution ID: **245** Type: **Theory talk**

Recent lattice QCD results on strangeness and phase diagram

Monday 17 May 2021 13:55 (30 minutes)

Collaboration

Presenter: GUENTHER, Jana N. (University of Wuppertal)

Session Classification: Theory Overview

Contribution ID: **246** Type: **not specified**

Open Heavy-Flavor theory overview

Monday 17 May 2021 13:00 (30 minutes)

Presenter: HE, Min (Nanjing University of Science & Technology)

Session Classification: Theory Overview

Contribution ID: **247** Type: **Theory talk**

dynamic modelling for heavy-ion collisions

Tuesday 18 May 2021 13:05 (30 minutes)

Presenter: SHEN, Chun (Wayne State University)

Session Classification: Strangeness production in Quark Matter

Contribution ID: **249** Type: **Experimental talk**

Momentum and multiplicity dependence of strangeness/nuclei production

Tuesday 18 May 2021 13:35 (30 minutes)

Presenter: CALIVA, Alberto (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))

Session Classification: Strangeness production in Quark Matter

Contribution ID: **250** Type: **not specified**

Excitation function (beam energy dependence) of strangeness production

Tuesday 18 May 2021 14:05 (30 minutes)

Collaboration

Presenter: NASIM, Mohammad (IISER Berhampur)

Session Classification: Strangeness production in Quark Matter

Contribution ID: **251** Type: **Theory talk**

From lattice QCD to in-medium heavy-quark interactions via deep learning

Wednesday 19 May 2021 12:25 (30 minutes)

Presenter: SHI, Shuzhe (McGill University)

Session Classification: Heavy-Flavor in Quark Matter

Contribution ID: **252** Type: **Theory talk**

Quarkonium in heavy-ion collisions

Wednesday 19 May 2021 12:55 (30 minutes)

Presenter: Prof. STRICKLAND, Mike (Kent State University)

Session Classification: Heavy-Flavor in Quark Matter

Contribution ID: **253** Type: **Experimental talk**

Recent experimental open heavy-flavor results

Wednesday 19 May 2021 13:25 (30 minutes)

Presenter: INNOCENTI, Gian Michele (CERN)

Session Classification: Heavy-Flavor in Quark Matter

Contribution ID: **254** Type: **Experimental talk**

Heavy-Flavor hadronization in small and large systems

Wednesday 19 May 2021 13:55 (30 minutes)

Presenter: LUPARELLO, Grazia (Universita e INFN Trieste (IT))

Session Classification: Heavy-Flavor in Quark Matter

Contribution ID: **255** Type: **Theory talk**

QCD/Quark Matter equation of state for neutron stars

Thursday 20 May 2021 11:40 (30 minutes)

Presenter: FUKUSHIMA, Kenji (The University of Tokyo)

Session Classification: Strangeness in Equation of State and in astrophysics

Contribution ID: **256** Type: **Experimental talk**

Hyperon-nucleon femtoscopy, nuclear production, and bearing on astrophysics

Thursday 20 May 2021 12:10 (30 minutes)

Presenter: MANTOVANI SARTI, Valentina (Technische Universitaet Muenchen (DE))

Session Classification: Strangeness in Equation of State and in astrophysics

Contribution ID: **257** Type: **Theory talk**

Hadronic interactions from femtoscopic correlations

Session Classification: Strangeness in Equation of State and in astrophysics

Contribution ID: **258** Type: **Experimental talk**

Global polarization/spin alignment measurements

Thursday 20 May 2021 13:25 (30 minutes)

Collaboration

Presenter: Dr NIIDA, Takafumi (University of Tsukuba)

Session Classification: Polarization of strangeness and heavy-flavor in Quark Matter

Contribution ID: **259** Type: **Theory talk**

Global polarization theory overview

Thursday 20 May 2021 13:55 (30 minutes)

Presenter: Prof. GAO, Jian-hua (Shandong University (Weihai))

Session Classification: Polarization of strangeness and heavy-flavor in Quark Matter

Contribution ID: **260** Type: **Experimental talk**

Quarkonium production and polarization

Thursday 20 May 2021 14:25 (30 minutes)

Collaboration

Presenter: STAHL LEITON, Andre Govinda (Rice University (US))

Session Classification: Polarization of strangeness and heavy-flavor in Quark Matter

Contribution ID: **261** Type: **not specified**

Exact strangeness conservation and particle production in HIC from SIS to LHC

Friday 21 May 2021 10:50 (30 minutes)

Collaboration

Presenter: REDLICH, Krzysztof (University of Wroclaw)

Session Classification: Memorials for Jean Cleymans, Jean Letessier, Richard Majka and Jack Sandweiss

Contribution ID: **262** Type: **Theory talk**

Statistical hadronization of strangeness and charm

Friday 21 May 2021 11:20 (30 minutes)

Presenter: TORRIERI, Giorgio (IFGW, Unicamp)

Session Classification: Memorials for Jean Cleymans, Jean Letessier, Richard Majka and Jack Sandweiss

Contribution ID: **263** Type: **Experimental talk**

Recent development of TPC for Heavy-Ion experiments

Friday 21 May 2021 11:50 (30 minutes)

Collaboration

Presenter: Prof. HEMMICK, Thomas (Stony Brook University)

Session Classification: Memorials for Jean Cleymans, Jean Letessier, Richard Majka and Jack Sandweiss

Contribution ID: **264** Type: **not specified**

From nuggets of SQM to domains of broken symmetry

Friday 21 May 2021 12:20 (30 minutes)

Collaboration

Presenter: Prof. FINCH, Evan

Session Classification: Memorials for Jean Cleymans, Jean Letessier, Richard Majka and Jack Sandweiss

Contribution ID: **265** Type: **Experimental talk**

Resonance production from low to high energy

Friday 21 May 2021 13:35 (30 minutes)

Presenter: SONG, Jihye (University of Houston (US))

Session Classification: Resonances and Hypernuclei from Quark Matter

Contribution ID: **266** Type: **Theory talk**

Hadronic interactions from femtoscopic correlations

Friday 21 May 2021 13:05 (30 minutes)

Collaboration

Presenter: KAMIYA, Yuki

Session Classification: Resonances and Hypernuclei from Quark Matter

Contribution ID: **267** Type: **Experimental talk**

Hypernuclei and antihypernuclei production in heavy-ion collisions

Friday 21 May 2021 14:05 (30 minutes)

Presenter: LEUNG, Yue Hang (Lawrence Berkeley National Laboratory)

Session Classification: Resonances and Hypernuclei from Quark Matter

Contribution ID: **268** Type: **not specified**

Andre Mischke Young Scientist Award

Saturday 22 May 2021 09:30 (15 minutes)

Presenter: MARKERT, Christina (University of Texas at Austin (US))

Session Classification: Open Questions and Perspectives

Contribution ID: **269** Type: **Theory talk**

Open theory questions for the next SQMs

Saturday 22 May 2021 09:45 (35 minutes)

Presenter: SCHENKE, Bjoern (Brookhaven National Lab)

Session Classification: Open Questions and Perspectives

Contribution ID: **270** Type: **Experimental talk**

Open experiment questions for the next SQMs

Saturday 22 May 2021 10:20 (35 minutes)

Presenter: BELLINI, Francesca (Universita e INFN, Bologna (IT))

Session Classification: Open Questions and Perspectives

Contribution ID: **271** Type: **Experimental talk**

CBM

Saturday 22 May 2021 11:00 (20 minutes)

Collaboration

Presenters: HERRMANN, Norbert (Univ. Heidelberg); HERRMANN, Norbert Willi (Ruprecht Karls Universitaet Heidelberg (DE))

Session Classification: Future Experiments and Facilities

Contribution ID: **272** Type: **Experimental talk**

MPD

Saturday 22 May 2021 11:20 (20 minutes)

Presenter: KISIEL, Adam (Warsaw University of Technology (PL))

Session Classification: Future Experiments and Facilities

Contribution ID: **273** Type: **Experimental talk**

sPHENIX

Saturday 22 May 2021 11:40 (20 minutes)

Collaboration

Presenter: Dr CORRALES MORALES, Yasser (Los Alamos National Laboratory (US))

Session Classification: Future Experiments and Facilities

Contribution ID: **276** Type: **Experimental talk**

an overview of the expected physics output from Run 3 at the LHC

Saturday 22 May 2021 12:00 (30 minutes)

Presenter: VAN LEEUWEN, Marco (Nikhef National institute for subatomic physics (NL))

Session Classification: Future Experiments and Facilities

Contribution ID: **279** Type: **not specified**

SQM2022 updates

Saturday 22 May 2021 12:30 (10 minutes)

Presenter: YOO, In Kwon (Pusan National University (KR))

Session Classification: SQM2022 and Closing

Contribution ID: **280** Type: **not specified**

Closing

Saturday 22 May 2021 12:40 (5 minutes)

Presenter: XU, Zhangbu (Brookhaven National Laboratory)

Session Classification: SQM2022 and Closing

Contribution ID: **281** Type: **not specified**

Opening

Monday 17 May 2021 09:20 (10 minutes)

Collaboration

Session Classification: Experiment Collaboration Overview (I)

Contribution ID: **282** Type: **Theory talk**

Recent progress on few-body hypernuclei

Thursday 20 May 2021 11:10 (30 minutes)

In this talk I will briefly review recent progress on two problems in few-body hypernuclei:

(i) The Lambda-3H (hypertriton) lifetime puzzle [1,2,3].

(ii) The onset of binding in Lambda-Lambda hypernuclei [4,5].

References:

[1] A. Gal, H. Garcilazo,
Towards resolving the hypertriton lifetime puzzle,
Phys. Lett. B 791 (2019) 48.

[2] Lifetime of the hypertriton,
F. Hildenbrand, H.-W. Hammer,
Phys. Rev. C 102 (2020) 064002.

[3] Revisiting the hypertriton lifetime puzzle,
A. Perez-Obiol, D. Gazda, E. Friedman, A. Gal,
Phys. Lett. B 811 (2020) 135916.

[4] L. Contessi, M. Schaefer, N. Barnea, A. Gal, J. Mares,
The onset of Lambda-Lambda hypernuclear binding,
Phys. Lett. B 797 (2019) 134893.

[5] H. Le, J. Haidenbauer, U.-G. Meissner, A. Nogga,
S-shell Lambda-Lambda hypernuclei based on chiral interactions, arXiv:2103.08395 (submitted to EPJA).

Collaboration

Presenter: Prof. GAL, Avraham (Hebrew University of Jerusalem)

Session Classification: Strangeness in Equation of State and in astrophysics

Contribution ID: **283** Type: **Experimental talk**

ALICE upgrades

Wednesday 19 May 2021 14:25 (25 minutes)

Collaboration

Author: REIDT, Felix (CERN)

Presenter: REIDT, Felix (CERN)

Session Classification: Heavy-Flavor in Quark Matter

Contribution ID: **285** Type: **Experimental talk**

STAR Detector Upgrades

Friday 21 May 2021 14:35 (20 minutes)

Collaboration

Presenter: YANG, Chi (Shandong University)

Session Classification: Resonances and Hypernuclei from Quark Matter

Contribution ID: **286** Type: **not specified**

Strangeness in astrophysics: Theoretical developments

Thursday 20 May 2021 12:40 (30 minutes)

Collaboration

Presenter: DEXHEIMER, Veronica (Kent State University)

Session Classification: Strangeness in Equation of State and in astrophysics

Contribution ID: **287** Type: **not specified**

Photo

Wednesday 19 May 2021 12:10 (5 minutes)

Presenter: GARG, Prakhar (Stony Brook University)

Session Classification: Break + Conference Photo