WPCF 2024 - 17th Workshop on Particle Correlations and Femtoscopy

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Combinants and correlation functions in nuclear collisions: some intriguing properties of multiplicity distributions

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Multiplicity distributions in e+e- and proton-proton collisions analyzed via the combinants method exhibit oscillatory behavior of the modified combinants. The possible sources of these oscillations and their impact on our understanding of the multiparticle production mechanism were discussed [1-5]. The set of combinants, Cj provides a similar measure of fluctuations as the set of cumulant factorial moments, Kq, which are very sensitive to the details of the multiplicity distribution and were frequently used in phenomenological data analyses. However, while cumulants are best suited to studying the densely populated region of phase space, combinants are better suited for studying sparsely populated regions because the calculation of Cj requires only a finite number of probabilities P(N<j). The observed oscillations of the modified combinants are of physical origin and are not experimental artifacts. Modified combinants evaluated from models exhibit oscillatory behavior, though the oscillation period differs from experimental data [6].

In this presentation, we discuss how this approach can be used in nuclear collisions. We demonstrate how correlation functions can be related to combinants and illustrate how the information about just the sign of these correlation functions can be used in analyses of multiplicity distributions in nuclear collisions. It is argued that measuring couplings of the genuine multi-particle correlation functions could provide cleaner information on possible non-trivial dynamics in heavy-ion collisions.

[1] M. Rybczyński, G. Wilk, and Z. Włodarczyk, PR D 99 (2019) 094045
[2] H.W. Ang, M. Ghaffar, A.H. Chan, M. Rybczyński, Z. Włodarczyk, G. Wilk, MPL A 34 (2019) 1950324
[3] H.W. Ang, A.H. Chan, M. Ghaffar, M. Rybczyński, G. Wilk, Z. Włodarczyk, EPJ A 56 (2020) 117
[4] M. Rybczyński, G. Wilk, Z. Włodarczyk PR D 103 (2021) 114026
[5] H. W. Ang, M. Rybczyński, G. Wilk, and Z. Włodarczyk, PR D 105 (2022) 054003
[6] V. Z. Reyna Ortiz, M. Rybczyński, Z. Włodarczyk, PR D 108 (2023) 074009

3

Extracting source function from two-particle correlation function through entropy-regularized Richardson-Lucy algorithm

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Recently, the Richardson-Lucy (RL) algorithm has been successfully applied to extract the source function from the deuteron-α correlation function using the Koonin-Pratt (KP) equation as the forward model. To avoid overfitting to the noise in the data, the total-variation (TV) regularization method was employed. Similarly to Lasso regularization, it is derived from introducing L1-norm penality to the objective function.
For 1D image, it reduces to applying a small multiplicative factor to the update rule, smoothing the image in the entire domain at each iteration. Despite of its simplicity and effectiveness in ordinary

image restoration, such correction destroys the conservation of image intensity, especially after prolong iterations. In the context of KP equation, this amounts to the violation of the normalization of the source function, leading to unphysical features or even divergence of the algorithm. We propose to regularize the RL algorithm with the maximum-entropy method (MEM-RL) which naturally preserves the total intensity of the source function. We first present the formalism of the MEM-RL algorithm and illustrate the optimization strategy designed specifically for Koonin-Pratt equation. To demonstrate the effectiveness of the algorithm, we apply the MEM-RL algorithm to restore the source function from the two-proton correlation function associated with the Gaussian source function. Application to the experimental data shows the agreement between source sizes and purity parameter obtained from the Bayesian imaging and fitting to the Gaussian source. Finally, we examine the algorithm to extract the source function from the d-α correlation functions obtained from a recent experiment.

4

Clocking the particle production and tracking quantum numbers balance and radial flow effects at top LHC energy with ALICE

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Balance functions have been used extensively to elucidate the time evolution of quark production in heavy-ion collisions. Early models predicted two stages of quark production, one for light quarks and one for the heavier strange quark, separated by a period of isentropic expansion. This led to the notion of clocking particle production and tracking radial flow effects, which drive the expansion of the system.

In this talk, balance functions of identified particles in different multiplicity classes of pp collisions at $\sqrt{s} = 13.6$ TeV recorded by ALICE in Run 3 are reported. The results are compared with different models as well as with previously published results on pp and Pb-Pb collisions at different energies. The results enable tracking the balancing of electric charge and strangeness by measuring how the widths and integrals of the charge and strangeness balance functions evolve across multiplicity classes.

5

Femtoscopic correlations at LHCb

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A study of the Bose–Einstein correlations for same-sign charged pions originating from proton-proton and proton-lead collisions recorded in the LHCb experiment at √s = 7 TeV centre-of-mass energy and √sNN = 5.02 TeV centre-of-mass energy per nucleon will be presented. Both measurements are the first of this type performed in the forward region at LHC energies and are complementary to studies from other experiments at the LHC in the central rapidity region. In particular, the measured correlation radii scale linearly with a cube root of the reconstructed charged-particle multiplicity, which is a tendency compatible with predictions of hydrodynamic models on the system evolution. The pPb system is investigated both in the forward and the backward direction due to asymmetric beams and hints for a potential sensitivity of the correlation radii to pseudorapidity are observed. The preliminary results on three-pion Bose-Einstein correlations measured with the sample of proton-proton collisions recorded at the centre-of-mass energy of √s = 7 TeV will also be presented, being the first study of three-particle Bose-Einstein correlations measured in the forward region provided by the LHCb detector. The results are interpreted within the core-halo model for the first time in proton-proton collisions.

6

The Cross-talk problem for a neutron correlator: preliminary results on the CROSSTEST@LNL experiment for NArCoS

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The advent of new facilities for radioactive ion beams mainly rich in neutrons, SPES @ LNL, FRAISE @ LNS and FAIR @ GSI only to give some examples, imposes the joint detection and discrimination of neutrons and charged particles in Heavy radioactive Ion collisions, with high angular and energy resolutions. The construction of novel detection systems suitable for this experimental task is both a scientific and a technological challenge.
The contribution will illustrate the results of recent tests performed on a new plastic scintillator material, the EJ276, both in the "green-shifted" and in the base version, coupled with SiPMs. The contribution will also present preliminary results on the CROSSTEST experiment performed at LNL-INFN in November 2023. The goal of the experiment was the study of the crosstalk issue among the elementary cells of NArCoS (Neutron Array for Correlation Studies), a novel detector for neutrons and charged particles with high energy and angular resolution, based on a 3D cluster of scintillation units. This project is also funded by the Italian Project PRIN ANCHISE (2020H8YFRE) and the INFN experiment CHIRONE.

7

Novel constraints for the multi-strange meson-baryon interaction using correlation measurements

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This talk presents recent correlation measurements involving Λ, Ξ, kaons and pions created in nucleus-nucleus collisions. Such measurements have been made available in the past few years, constituting new experimental constraints on the S = −1, −2 meson-baryon interactions and the nature of exotic states. The strong interactions involving mesons and baryons with strangeness content deliver a rather broad spectrum of interesting states, arising from the rich interplay between the elastic and inelastic QCD dynamics. The Λ(1405) in the S = −1 sector is an example of such molecular state, but in order to build a solid description of its inner structure more data are needed, particularly below the K⁻ N energy threshold. Much less experimental data are currently available on another potential molecular state, the Ξ(1620), predicted and observed in the S = −2 meson-baryon sector. The presented correlation data put new constraints on these sectors and deliver a better understanding on such states.

8

Investigating the nature of the K*0(700) state with pi+- K0s correlations with ALICE at the LHC.

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The first measurements of femtoscopic correlations with the particle-pair combinations $\pi^{\pm}\ K^0_S$ in pp collisions at $\sqrt{s}$ = 13 TeV are reported by ALICE. It is shown that it is possible to study the elusive $K^*_0(700)$ particle that has been considered a tetraquark candidate for over forty years. Boson source parameters and final-state interaction parameters are extracted by fitting a model assuming a Gaussian source to the experimentally measured two-particle correlation functions. The final-state interaction is modeled through a resonant scattering amplitude, defined in terms of a mass and a coupling parameter, decaying into a $\pi^{\pm}\ K^0_S$ pair. The extracted mass and Breit-Wigner width, derived from the coupling parameter of the final-state interaction are found to be consistent with previous measurements of the $K^*_0(700)$. The small value and increasing behavior of the correlation strength with increasing source size support the hypothesis that the $K^*_0(700)$ is a tetraquark state. This latter trend is also confirmed via a simple geometric model that assumes a tetraquark structure of the $K^*_0(700)$ resonance.

9

Recent results on Baryon Correlations at RHIC-STAR

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In high-energy nuclear collisions, the measurements of two-particle femtoscopy is a powerful and unique method for extracting information about the femtoscopic spatio-temporal properties of the source and characterising the final state interactions (FSI). However, measurements of baryon correlations are scarce. Understanding the strong interactions between baryons, especially nucleon-nucleon (N-N), hyperon-nucleon (Y-N) and hyperon-hyperon (Y-Y) interactions, are crucial for comprehending the equation-of-state (EoS) of the nuclear matter and inner structure of neutron star. Furthermore, baryon correlations involving light nuclei, which are loosely bound objects, are critical for understanding many-body interactions and the production mechanisms of light nuclei.

In this talk, we will present recent results on baryon correlations measured with RHIC-STAR experiment, including p-p, p-d, d-d, p-Λ, p-Ξ^-, and d-Λ. Extracted source size parameters, driven by collision dynamics, and FSI parameterization, determined by the nature of the particle pairs under study, will be discussed within the framework of lattice calculations (interaction potentials) and hadronic transport model calculations.

10

The measurement and analysis of neutron-neutron correlation function in the heavy ion experiment.

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The isospin-dependent equation of state of nuclear matter, i.e. symmetry energy $E_{sym}(\rho)$ plays an important role in the study of nuclear physics and astrophysics. The calculation of transport model has shown the $E_{sym}(\rho)$ affects significantly the nucleon emission times in HIC, leading to significant variation of two-nucleon correlation functions.

Recent years, a compact spectrometer for heavy ion experiment（CSHINE）has been built, which has the ability to measure light charged particles, and the two charged particle correlation functions have been obtained. In this year, a neutron array with 212ps time resolution has been mounted on CSHINE[arXiv:2406.18605], and the neutron-neutron correlation function is measured in $25MeV/u^{124}Sn+^{124}Sn$. The effect of cross talk event on n-n correlation function has been analyzed. Finally, the scattering length, effective range, source size and timescale are obtained by Lednicky-Lyuboshitz model.

11

Lévy walk of pions in heavy-ion collisions

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The process of Lévy walk, i.e., movement patterns described by heavy-tailed random walks, play a role in many different phenomena, from chemical and microbiological systems through marine predators to climate change. Recent experiments have suggested that this phenomenon also appears in heavy-ion collisions. However, the theoretical background is not yet well understood. In high-energy collisions of heavy nuclei, the strongly interacting Quark Gluon Plasma is created, which, similarly to the early Universe, undergoes a rapid expansion and transition back to normal hadronic matter. In the subsequent expanding hadron gas, particles interact until kinetic freeze-out, when their momenta become fixed, and they freely transition toward the detectors. Measuring spatial freeze-out distributions is a crucial tool in understanding the dynamics of the created matter as well

as the interactions among its constituents. In this talk, we present a novel three-dimensional analysis of the spatial freeze-out distribution of pions (the most abundant particles in such collisions). Utilizing Monte-Carlo simulations of high-energy collisions, we show that the chain of processes ending in a final state pion has a step length distribution leading to Lévy-stable distributions. Subsequently, we show that pion freeze-out distributions indeed exhibit heavy tails and can be described by a three-dimensional elliptically contoured symmetric Lévy-stable distribution.

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FARCOS correlator in the CHIFAR exp.: latest results from particle correlation studies

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The study of the reaction mechanisms and of the emission probability of Intermediate Mass Fragments (IMFs) in non-central Heavy Ion collisions was the main aim of the CHIFAR experiment,

carried out at LNS-INFN. The CHIMERA collaboration investigated nuclear reactions at the incident beam energy of 20 AMeV using different combination of three beams: ^{124}Sn, ^{112}Sn and ^{124}Xe, and three targets: ^{64}Ni, ^{58}Ni and ^{64}Zn, in order to study combinations of neutron rich and neutron poor systems. These systems were selected to highlight the role of the isospin degree of freedom of the colliding nuclei.
The experimental setup was composed by the coupling, for the first time, of ten telescopes of the FARCOS (Femtoscope ARray for COrrelation and Spectroscopy) correlator with the 4π CHIMERA multi-detector. This coupling allowed the study of the correlations between IMFs and light charged particles generated in a nuclear reaction.
Two stages of Double Sided Silicon Strip Detectors (DSSSDs), 300 μm and 1500 μm thick respectively, and a third stage of 4 CsI(Tl) crystals, 6 cm thick, were used to compose each FARCOS telescope. The energy and angular high resolutions of FARCOS guarantees the measurement of the energy and of the position of the detected particles with very high precision.
The latest results of FARCOS in term of energy calibration for DSSSDs and CsI(Tl), identification and pixelation procedures and preliminary result of the physics (including energy, velocity and angular particle correlations) will be presented.

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Non-identical particle femtoscopy of pairs containing (anti)deuteron in relativistic heavy-ion collisions with ALICE at the LHC.

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Femtoscopy studies of pion radiation in heavy-ion collisions have been conducted extensively at all available collider energies, both theoretically and experimentally. In all these studies a special interest is given to m_T dependency of pion femtoscopy radii, usually approximated by a power-law function at transverse momenta above 200~MeV/c. However, the radii behaviour has been much less explored for the ultra-soft pions, possessing the transverse momentum comparable to or lower than the pion mass. For many experimental setups this region is difficult to measure. This work presents theoretical calculations of pion emission in the ultra-soft region in the two hybrid models — iHKM and LHYQUID+THERMINATOR2. Along with the particle transverse momentum spectra, the femtoscopy radii are calculated, both in one-dimensional and three-dimensional representations. The radii dependence on pair m_T shows, in particular, a departure from the power-law behaviour at ultra-soft momenta, potentially reflecting a decoupling of such slow pions from the rest of collectively expanding system.

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The FAZIA apparatus: status and perspectives

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FAZIA is a detector array designed to detect and identify charged fragments produced in heavy-ion collisions in the Fermi energy domain. It is the result of a R&D activity aimed at improving the (Z, A) identification capabilities, which are crucial for investigating the nuclear equation of state (EOS). Since 2019, FAZIA has been performing experiments at GANIL, coupled with the INDRA array, to study reaction mechanisms at Fermi energies. The setup is particularly well-suited for investigating isospin transport phenomena and has already produced significant results.
Looking ahead, the FAZIA collaboration plans to extend its research to investigate the EOS in density

regions above the nuclear saturation. To achieve this, the collaboration is exploring new programs at high-energy facilities such as FRIB and RAON, which will utilize both stable and radioactive beams. It is expected that these future studies will provide more stringent constraints on EOS parameters in density regions where experimental data are scarce.

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Investigating the excitation function of HBT radii for Lévy-stable sources

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One of the main goals of today's heavy-ion physics research is to explore the phase diagram of strongly interacting matter and search for signs of the possible critical endpoint on the QCD phase diagram. Femtoscopy is among the important tools used for this endeavor; there have been indications that combinations of femtoscopic radii parameters (referred to as HBT radii for identical boson pairs) can be related to the system's emission duration. An apparent non-monotonic behavior in their excitation function thus might signal the location of the critical point. In this paper, we show that conclusions drawn from the results obtained with a Gaussian approximation for the pion source shape might be altered if one utilizes a more general Lévy-stable source description. We find that the characteristic size of the pion source function is strongly connected to the shape of the source and its possible power-law behavior. Taking this into account properly changes the observed behavior of the excitation function.

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Femtoscopy measurements of the d-Λ system as a tool for studying the strong interaction parameters

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Relativistic heavy-ion collisions provide a way to study the properties of nuclear matter under extreme conditions. One method for investigating the characteristics of bulk matter is the femtoscopy technique. This method allows for the extraction of the space-time characteristics of the expanding fireball produced in heavy-ion collisions and to collect information on the interaction between particles. The correlation between two particles due to the strong interaction can be described by the Lednicky-Lyuboshitz equation, which takes into account two key parameters: the scattering length (f_0) and the effective range (d_0). Systems of particular interest are those where this interaction involves not just one, but two spin states, resulting in a larger set of parameters f_0 and d_0. Examples of such systems include p-Λ (singlet and triplet states) and d-Λ (doublet and quartet states).
This talk will present the first results of the d-Λ correlation functions in silver ion collisions at 1.58 AGeV measured by the HADES experiment.

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Event-by-event investigation of the two-particle source function with EPOS

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In high-energy collisions, by measuring the two-particle Bose–Einstein correlation function and considering its relationship with the phase-space density of the particle-emitting source, we can obtain information about the source function. While a Gaussian shape is commonly assumed, anomalous diffusion suggests Lévy-stable distributions, as observed in the PHENIX experiment for kaon-kaon pair-source functions. Event generators like EPOS allow direct investigation of freeze-out coordinates, facilitating the analysis of the source function. EPOS, a Monte Carlo-based model, simulates high-energy nuclear and particle collisions, integrating Parton-Based Gribov-Regge theory for initial evolution, subsequent hydrodynamic evolution, and hadronization. In this talk, I will present an event-by-event analysis of the kaon-kaon source function in $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV Au+Au collisions using the EPOS model.

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Protons femtoscopy with 3D source in Au +Au collisions at $\sqrt{s_{NN}} = 2.4$ GeV

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The availability of multidimensional and multivariate data on femtoscopic radii in heavy-ion collisions (HIC) is marginal at centre-of-mass energies of a few GeV. It impairs the development of theoretical models that describe the particle dynamics of HIC at those energies. The currently available femtoscopic radii were primarily extracted from the measurement of identically charged pions, which are limited in statistics at these energies. Proton-proton correlations are more promising at these low energies. The high nuclear stopping in the few-GeV collisions implies a high abundance of protons and extends the possibilities of investigating particle production mechanisms. Aside from primordial and decay protons, we can expect participants to contribute significantly to the final correlation function.
In this work, we introduce the measurements of proton-proton femtoscopic correlations for $\sqrt{s_{NN}} = 2.4$ GeV Au+Au collisions as measured by the HADES collaboration. We present the one-dimensional femtoscopic radii's dependence on transverse pair momentum and rapidity. Moreover, we introduce three-dimensional correlation functions with their dependence on the transverse momentum of a pair, pair rapidity, and pair azimuthal angle w.r.t. the event plane.

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Angular correlations of strange baryons in proton-proton collisions at $\sqrt{s_{\mathrm{NN}}}$=13.6 TeV

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The analysis of two-particle angular correlation(s) is a state-of-the-art method developed to probe hadron production mechanisms in the pp collisions at ultra-relativistic energies. It characterizes the likelihood of observing a pair of particles emerging from the collision as a function of their relative emission angle and provides new insight(s) into the underlying physical mechanisms. Two-particle angular correlations were measured for all baryon/anti-baryon combinations of identified protons

and lambdas in pp collisions at $\sqrt{s} = 13.6$ TeV. The results show a significant anti-correlation structure at the near-side region for all baryon-baryon and anti-baryon—anti-baryon pairs instead of a peak. The findings agree with an earlier measurement performed by ALICE with Run 1 data in pp collisions at $\sqrt{s} = 7$ TeV and hint at an unidentified mechanism suppressing the production of more than one baryon–anti-baryon pair during the mini-jet fragmentation process. Its origin remains an open question and requires further investigation into the role of particle flavor in the baryon production mechanism.

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Exploring the baryon correlation puzzle via multiplicity-dependent two-particle angular correlations in pp, p–Pb, and Pb–Pb collisions at the LHC energies

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One of the most effective techniques for investigating the mechanism of baryon production is the study of angular correlations between two particles. Angular correlations represent a convolution of various physical processes, such as mini-jets, Bose-Einstein quantum statistics, conservation of momentum, resonances, and other phenomena that contribute to the unique behavior observed for different particle species.
Experimental results from proton-proton collisions at 7 TeV have revealed a pronounced anticorrelation, a phenomenon that had not been replicated by any Monte Carlo model. This triggered a series of studies that helped create what is called the "baryon correlation puzzle".

In this work, the first ALICE measurements of the angular correlation functions for identical particles (such as $\pi^{\pm}$, $\mathrm{K}^{\pm}$, and pp) in pp, p–Pb and Pb–Pb collisions at LHC energies in various multiplicity/centrality classes are presented.
This new piece of the puzzle enhances the understanding of anticorrelation and raises new questions. This will prompt theorists to implement and improve existing theoretical models in search of new answers.

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Production of ϕ(1020) meson in nucleus-nucleus collisions at the CERN SPS

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The ϕ meson is a resonance particle and the lightest particle with hidden strangeness, containing both s and $\bar{\mathrm{s}}$ quarks. Strangeness enhancement is considered to be related to Quark-Gluon Plasma formation, making the ϕ meson a valuable probe due to its "double strangeness" in a partonic and zero net strangeness in a hadronic medium. Previous studies, such as EPJC 80 (2020) 199, demonstrated that the rapidity distribution widths for various particles produced in p+p and Pb+Pb collisions follow similar linear trends with increasing beam rapidity. Interestingly, while ϕ mesons from p+p collisions conform to this trend, those from Pb+Pb collisions exhibit a markedly faster increase, a phenomenon that remains unexplained. To explore this problem, we present the first-ever measurements of ϕ meson production in Ar+Sc collisions at three beam momenta: 150A, 75A, and 40A GeV/c, recently released as preliminary data by the NA61/SHINE collaboration. Utilizing the primary decay channel $\phi \rightarrow K^+K^-$, invariant mass analysis, and the tag-and-probe method, we provide detailed double differential (y, pT) spectra, rapidity distributions, and total yields. These results are compared to previous ϕ meson production measurements in p+p and Pb+Pb collisions by NA61/SHINE and NA49, respectively. Special emphasis is placed on the rapidity spectra widths, offering new insights into the puzzling behaviour observed in heavy-ion collisions. This study advances our understanding of strangeness enhancement and the dynamics of ϕ meson production in nuclear collisions.

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pT – pT Correlators at High Baryon Density Region from the STAR Experiment

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The study of event-by-event transverse momentum (p_T) fluctuations and p_T correlations between particles provide insight into the properties of the hot and dense matter created
in Au+Au collisions at the Relativistic Heavy-Ion Collier (RHIC) spanning a wide range of collision energies. These measures have been proposed as tools to understand the initial state geometry and subsequent evolution of the system as well as quantify some of the thermodynamic properties. As the < p_T > fluctuation is related to the specific heat of the system, its study as a function of collision energy and centrality may help probe the onset of phase transition and the QCD critical point.

In this talk, we present the first results on the 2-particle p_T correlations as measured by the STAR collaboration in the STAR-FXT program. The results from central Au+Au collisions at $\sqrt{s_{NN}}$ = 3.0 GeV and 3.2 GeV are compared to previous STAR BES-I measurements and measurements from ALICE at the Large Hadron Collider. The comparison of the experimental results with transport model calculations and the effect of primordial protons on the results will also be presented

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Demystifying the interior of neutron stars with femtoscopy at ALICE

Auteur: Marcel Markus Lesch[1]

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The study of the nuclear equation of state (EoS) plays a pivotal role in the quest of understanding the core of neutron stars. For this, a comprehensive knowledge of the strong interaction among hadrons is crucial, especially those which contain strange quarks. Indeed, recent model calculations show that both two-body and three-body forces between hyperons and nucleons are important for the study of the nuclear EoS under extreme conditions. However, probing these interactions in scattering experiments is challenging due to the unstable nature of hyperon beams and thus, the available experimental data is scarce.
In recent years, the study of hadronic interactions has been greatly extended with ALICE at the LHC by utilizing the femtoscopy technique. With this, it became feasible to probe the interactions of unstable hadrons in vacuum at short distances (of a few femtometers) and down to zero relative momenta. In this talk, recent results from the ALICE Collaboration for two-body and three-body interactions between hyperons and nucleons in pp collisions at $\sqrt{s} = 13$ TeV are presented. Among the presented results are the p–Λ, p–p–p and p–p–Λ correlations together with their implications

on state-of-the-art theoretical models. Included are the most recent results from the ongoing LHC Run 3 data taking campaign.

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Energy scan results with Lévy type femtoscopy at NA61/SHINE

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In the recent decades of high-energy physics research, it was demonstrated that strongly interacting quark-gluon plasma (sQGP) is created in ultra-relativistic nucleus-nucleus collisions. Investigation and understanding of the properties of the hadronic matter are among the important goals of the NA61/SHINE Collaboration at CERN SPS. Mapping of the phase diagram is achieved by varying the collision energy (5 GeV < \sqrt{s_{NN}} < 17 GeV) and by changing the collision system (p+p, p+Pb, Be+Be, Ar+Sc, Xe+La, Pb+Pb). Femtoscopic correlations reveal the space-time structure of the hadron emitting source.

In this talk, we report on the measurement of femtoscopic correlations in the whole available energy range of NA61/SHINE in intermediate collision systems. Comparing the measurements to calculations based on symmetric L\'evy sources, we discuss the results on L\'evy source parameters as a function of average pair transverse mass. One of the physical parameters is particularly important, the L\'evy exponent α, which describes the shape of the source and may be related to the critical exponent η in the proximity of the critical point. Therefore, measuring it may shed light on the location of the critical endpoint of the QCD phase diagram as well as the shape of the particle emitting source.

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Recent studies on heavy-flavor femtoscopy in Au+Au collisions by STAR

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Heavy quarks are produced in hard partonic scatterings at the very early stage of heavy-ion collisions and they experience the whole evolution of the Quark-Gluon Plasma medium. Femtoscopic correlations, i.e. two-particle correlations at low relative momentum, are sensitive to the final-state interactions as well as to the extent of the region from which the correlated particles are emitted. A study of correlations between heavy-flavor mesons and identified charged hadrons could shed light on their interactions in the hadronic phase.
STAR has performed the first measurement of femtoscopic correlation between D^0-hadron pairs at mid-rapidity in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV. D^0 mesons are reconstructed via the $K^{\mp} - \pi^{\pm}$ decay channel using topological criteria enabled by the Heavy Flavor Tracker with excellent track pointing resolution. We will present the femtoscopic correlation functions between $D^0/\overline{D^0}$-$\pi^{\pm}$, $D^0/\overline{D^0}$-$K^{\pm}$ and $D^0/\overline{D^0}$-$p^{\pm}$ pairs for $D^0/\overline{D^0}$ with transverse momentum above 1 GeV/c in the $0 - 80\%$ centrality range. STAR results will be compared with existing theory predictions and its physics implications will also be discussed.

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Three-Dimensional measurements of pion HBT correlations and their Lévy parameters in $\sqrt{s_{NN}} = 200$ GeV Au+Au collisions at STAR

Auteur: Sneha Bhosale[1]

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In this work, we present new results on the three-dimensional pion-pion femtoscopic correlation measurements and their Lévy parameters in heavy-ion collisions, utilizing data from the STAR experiment at RHIC in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. These measurements aim to deepen our understanding on the space-time structure of hadron emission sources and their role in the behavior of the strongly interacting quark-gluon plasma. The three-dimensional approach enables a more comprehensive investigation of the emission source properties. We focus on analyzing the transverse mass (m_T) dependence of the Lévy source parameters, including the Lévy scale parameters in the Bertsch-Pratt frame, R_{out}, R_{side}, R_{long}, the correlation strength parameter λ, and the Lévy exponent α. The Lévy scale parameters provide insights into the homogeneity structure of the source, while the parameters λ and α offer information about the correlation strength and source shape, respectively. In this talk, our 3D results are compared with previous one-dimensional studies, highlighting the differences and potential implications for understanding the space-time evolution of the system.

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Measurements of (anti)(hyper)nuclei with ALICE

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The formation of light (anti)(hyper)nuclei in heavy-ion collisions and hadron collisions has been studied experimentally and theoretically for several decades. Two competing (anti)nucleosynthesis models are typically used to describe light (anti)nuclei yields and their ratios to other hadrons in heavy-ion collisions: the statistical hadronization model (SHM) and the nucleon coalescence model.

The ALICE Collaboration has significantly contributed to this specific field of research with systematic measurements of the production of (anti)(hyper)nuclei in different collision systems and center-of-mass energies provided by the Large Hadron Collider.

Recent results on the production of (anti)nuclei conducted within the ALICE Collaboration, up to A=4, are shown in this contribution. These measurements are compared to predictions from the state-of-the-art statistical hadronization and coalescence models. We show how (anti)nuclei can be used to measure both the chemical freezeout temperature and the baryon chemical potential of the system created in the collision with high precision.

Further insights into the hadronization process can be obtained by investigating the production of exotic bound states, such as hypernuclei (multi-baryon states with hyperons). The production measurements of ^{3}H from pp to the most central Pb-Pb collisions are presented and compared to the state-of-the-art models.

28

Towards more precise correlation studies with machine-learning-based particle identification with missing data

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Identifying products of ultrarelativisitc collisions, such as the ones delivered by the LHC and RHIC, is one of the crucial objectives of experiments such as ALICE and STAR, which are spedicifally dedicated to this task with a number of detectors allowing particle identification (PID) over a broad momentum range. In the case of correlation studies, high purity of the sample is frequently needed, which usually results in quite low efficiency and, consequently, available statistics of the studied particles under consideration.

Recently, as a team of physicists and computer scientists at Warsaw University of Technology, we have introduced a novel method for Particle Identification (PID) method, tested within the framework of the ALICE experiment [1,2]. Typically employed PID methods rely on hand-crafted selections, which compare experimental data to theoretical simulations. To improve the performance of the baseline methods, novel approaches use machine learning models that learn the proper assignment in a classification task. However, because of the various detection techniques used by different subdetectors, as well as the limited detector efficiency and acceptance, produced particles do not always yield signals in all of the ALICE components. This results in data with missing values. Out of the box machine learning solutions cannot be trained with such examples without either modifying the training dataset or re-designing the model architecture.

In the presented work, we propose the new method for PID that addresses these issues and can be trained with all of the available data examples, including incomplete ones. Our approach improves the PID purity and efficiency of the selected sample for all investigated particle species.

[1] Miłosz Kasak, Kamil Deja, Maja Karwowska, Monika Jakubowska, Łukasz Graczykowski & Małgorzata Janik, "Machine-learning-based particle identification with missing data",Eur.Phys.J.C 84 (2024) 7, 691
[2] Maja Karwowska, Łukasz Graczykowski, Kamil Deja, Miłosz Kasak, and Małgorzata Janik on behalf of the ALICE Collaboration, "Particle identification with machine learning from incomplete data in the ALICE experiment", JINST 19 (2024) 07, C07013

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Exploration of Nuclear Clustering via Compound Decay Pathways

Auteur: Bryan Harvey[1]

Co-auteurs: Travis Hankins [1]; Alan McIntosh [1]; Kris Hagel [1]; Sherry Yennello [1]

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In recent years, experimental efforts have been dedicated to exploring the extent of clustering in excited nuclei. Of these, a particular emphasis in α-clustering has been fostered due to its various influences, such as those in astrophysical processes. A series of measurements of every α-conjugate nucleus in the mass range $16 \leq A \leq 36$ impinged on ^{12}C at 35 MeV/u was recently conducted with the Forward Array Using Silicon Technology (FAUST) at the Texas A&M University Cyclotron Institute with the intent of exploring decay pathways of various nuclei produced through charged particle emission.
FAUST possesses excellent position resolution and therefore angular resolution. In this talk I will present preliminary results of multi-particle correlations probing resonant states and decay pathways.

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Femtoscopic Coulomb and strong final state interactions in Fourier space

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Femtoscopy provides a means to explore the space-time structure of the particle emitting source in heavy-ion collisions, and had a fundamental role in the discovery of the Quark-Gluon-Plasma (QGP) created in such collisions. Work continues on the ever-increasing data sets to infer more and more details about the source function. In the past years a novel method was developed that enables the fast and reliable calculation of the effect of Coulomb final-state interaction on Bose-Einstein correlation functions. It relies on the Fourier transform of the assumed source function, and is mathematically interesting on its own, as well as faster and more robust than a direct calculation. In this talk a development of the method will be presented that is applicable to three-dimensional (i.e. not spherically symmetric) sources as well as to s-wave strong interaction wave functions. In this way, the new method will augment measurements that utilize three dimensional source functions. A pivotal application is Levy-type source functions; such ones have recently been increasingly successful in the description of correlation functions, as well as opened up interesting new physics questions. The new method (and the opportunity it offers to reliably use a broad range of source functions) will also help ongoing investigations of the strong interaction between various particle types using identical and non-identical correlations.

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Three-dimensional source sizes and shapes of hadron emis- sion in EPOS

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Femtoscopic measurements explore the strongly interacting Quark-Gluon-Plasma (sQGP) via examining the space-time characteristics of heavy-ion collisions using correlation functions of observed particles. This talk reports on an investigation of the space-time geometry of heavy-ion collisions based on the EPOS model, a state-of-the-art event generator. Based on its success with reliably reproducing many observables, we utilize it to investigate source geometry, and to explore the reason of the appearance of non-Gaussian, Lévy-type source distributions observed recently in multiple experiments. We show that such non-Gaussian, and in particular Lévy-stable source distributions arise on an event-by-event level, even if a three-dimensional distribution is assumed. We compare the event-averaged source parameters to experimentally obtained values.

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Investigating the influence of the mass on the baryon correlation puzzle using pϕ angular correlation functions at LHC energies

Auteur: Zuzanna Chochulska[1]

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The angular correlation function is a powerful tool for exploring hadronization mechanisms. The effects contributing to the angular correlation functions include quantum statistics, nuclear force, energy and momentum conservation, resonance decays, and Coulomb interactions. The angular correlation function can take different forms depending on the quark composition.

The results obtained by the ALICE Collaboration for Runs 1 and 2 indicate the presence of an anti-correlation in the vicinity of $(\Delta\eta, \Delta\varphi)$ = (0,0) for like-sign pairs of baryons, specifically pp + $\bar{p}\bar{p}$ and pΛ + $\bar{p}\bar{\Lambda}$. This is not yet described by any simulations and has remained a puzzle since 1980s.

This work studies the proton-ϕ angular correlation functions from pp collisions at $\sqrt{s} = 13.6\,\mathrm{TeV}$ recorded at the ALICE experiment at CERN. By correlating a meson (ϕ) with a mass similar to that of the lightest baryon, the proton, the aim is to determine whether the anticorrelation observed for like-sign baryon pairs can be attributed to the mass. A direct comparison of proton-proton and proton-ϕ angular correlations serves to verify whether the observed effect is purely baryonic.

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Probing emission dynamics with non-identical particle femtoscopy

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Femtoscopy is traditionally used to determine the size of the particle emitting region in heavy-ion collisions. The non-identical particle femtoscopy is additionally able to measure the difference in average emission points (so-called emission asymmetry) between two types of particles. This asymmetry is sensitive to details of the dynamics of the system created in the collision, and depends on the interplay of collective flow, thermal velocity and details of hadronic resonance production, propagation and decay. The sensitivity of the technique to those phenomena will be presented.

The correlations between charged pions and kaons have been the fist measurement of collision dynamics and emission asymmetry at several heavy-ion collision experiments. They provide unique insight into emission asymmetry as well as an interplay between hadronic rescattering and resonance production and decay. These processes naturally strongly depend on the momenta of the particles, as, especially for pions, resonance decays preferably populate the low-p_T part of the spectrum. In this talk we present the first theoretical investigation of the pion-kaon emission asymmetry done deferentially versus pair total transverse momentum. We investigate the interplay between spatial and temporal components of the asymmetry, as well as the dependence of the total system size on this variable. We show how this new type of measurement can shed new light on the understanding of particle production in the soft regime.

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Overview of Femtoscopic Studies in Small Collision Systems

Auteur: Dimitar Lubomirov Mihaylov[1]

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Femtoscopy is a technique that connects measured particle correlation functions to the properties of hadron emission and final-state interaction. Recent advancements in modelling the emission source function in pp collisions have revealed a common hadron source for primordial particles. This discovery has been instrumental in achieving a better understanding of the source function, leading to more precise studies of the strong interaction - an essential ingredient in developing a realistic nuclear equation of state.

This talk will provide an overview of femtoscopy studies in pp collisions, highlighting the latest developments in constraining the source function. Additionally, a newly explored link between source properties and deuteron momentum spectra, assuming a coalescence formation mechanism, will be presented and discussed. This relationship has been investigated using a toy Monte Carlo model, demonstrating that the coalescence mechanism in pp collisions depends on event multiplicity, not on the collision energy. This finding can be utilised to study anti-nuclei formation at lower centre-of-mass collision energies, relevant for indirect dark matter searches.

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Search for the X_{17} QCD Axion in the $\eta \to \pi^+\pi^-e^+e^-$ decay with the HADES Detector

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The High-Acceptance Di-Electron Spectrometer (HADES) operates at the GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt with pion, proton and heavy-ion beams provided by the synchrotron SIS-18 [1]. In February 2022, the HADES Collaboration measured proton-proton collisions at 4.5 GeV momenta using the upgraded setup within the FAIR-Phase0 programme. One of the goals of the physics program of HADES is to test validity of Standard Model predictions and search for hints of new phenomena escaping know schemes. In particular using η meson decays into channels with dileptons (e^+e^- pairs) we are investigating the possible existence of X_{17} boson which is a candidate to be an axion-like particle (ALP) [2,3]. In this scenario an intermediate state of η decay could involve an existence of QCD axion through the sequence $\eta \to \pi^+\pi^-X_{17}(\to e^+e^-)$. The X_{17} particle is suspected to be an axial-vector gauge boson, which may mediate a fifth force with some coupling to SM particles. The conducted studies are moreover stimulated by recently observed anomalies in the invariant mass distribution of e^+e^- in the isoscalar magnetic nuclear transitions of ^8Be and ^4He nuclei [4-6], which have been interpreted as the creation and decay of an intermediate particle X_{17} with mass of about 17 MeV/c^2 which have suppressed mixing with the neutral pion.

In this talk, we introduce general motivations for studies of a X_{17}, present analysis methodology and preliminary results from the data collected with high-resolution HADES spectrometer.

Bibliography:
[1] G. Agakichiev et al. (HADES), Eur. Phys. J. A 41, 243 (2009).
[2] D. S. M. Alves, Phys. Rev. D 103, 055018 (2021).
[3] D. S. M. Alves, S. Gonzàlez-Solís, J. High Energ. Phys. 2024, 264 (2024).
[4] A. J. Krasznahorkay et al., Phys. Rev. Lett. 116, 042501 (2016).
[5] A. J. Krasznahorkay et al., arXiv:1910.10459 (2019).
[6] A. J. Krasznahorkay et al., Phys. Rev. C 104, 044003 (2021).

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Angular correlations at LHCb.

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The LHCb experiment was originally designed to perform flavour physics observations, however over the years proved to be also an excellent general purpose detector with unique forward acceptance of pseudorapidity from 2.0 to 5.0. One of the areas of interest are the two-particle angular correlations studied in proton-lead collisions at a nucleon-nucleon centre-of-mass energy of $\sqrt{S_{NN}} = 5$ TeV. Data was collected in 2013 with two opposing beam configurations, allowing analysis in the direction of proton and in the direction of led ion. This is the first time that a long-range correlations on the near side in proton-lead collisions were measured in the forward region, extending previous observations in the central region.

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Compressed Baryonic Matter experiment at FAIR

Auteur: Hanna Zbroszczyk[1]

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The Compressed Baryonic Matter (CBM) experiment is currently under construction at the Facility for Antiproton and Ion Research (FAIR). Its goal is to explore the phase structure of strongly interacting (QCD) matter at high net-baryon densities and moderate temperatures through heavy-ion and hadron collisions in the energy range of \sqrt{s_{NN}} = 2.9 - 4.9 GeV using the SIS100 beams. As a fixed-target experiment, CBM is equipped with fast, radiation-hard detector systems and an advanced trigger-less data acquisition scheme. CBM will operate at interaction rates of up to 10 MHz by performing online space-time reconstruction and event selection, enabling the measurement of rare probes such as multi-strange hadrons and their antiparticles, multi-strange hypernuclei, and dileptons, which have not been extensively studied so far. This presentation will provide an overview of the CBM physics goals, including the investigation of the equation-of-state of compressed nuclear matter, the potential phase transition from the hadronic to the partonic phase, and chiral symmetry restoration. The discussion will cover CBM's physics performance in areas such as (multi-)strange particle production, di-lepton spectroscopy, collective phenomena, and with the special focus on femtoscopy. Additionally, the status of preparations for CBM's construction will be reviewed, including performance evaluations of CBM components in FAIR Phase-0 experiments and the latest results from a CBM demonstrator test setup operating with SIS18 beams (mCBM).

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Studying the proton source in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.36 TeV

Auteur: Gleb Romanenko[None]

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Space–time properties of particle–emitting sources created in heavy-ion collisions can be studied with femtoscopic techniques using momentum correlations based on quantum statistics, Coulomb and strong interactions. In this talk, we present the most recent results of femtoscopic analysis of identical proton pairs in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.36 TeV based on data collected by ALICE during the ongoing Run 3. Experimental correlation functions were obtained for several centrality ranges

and one-dimensional proton source sizes were extracted by using a modified Lednicky's model. The radii exhibit a k_T-dependence that is similar to the one observed with pion and kaon femtoscopy and typical for heavy-ion collisions. These results extend the study of the dynamics of the particle–emitting sources in heavy-ion collisions providing more details about the baryon source.

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Theoretical description of proton-deuteron interactions (online)

Auteur: Maria Stefaniak[1]

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Strong interactions between particles are fundamental to understanding the properties of matter. One way to study these interactions is through femtoscopic correlation measurements of particle pairs, extracting information using available theoretical models. In this work, we examine two approaches for describing proton-deuteron (*p*-*d*) correlations: the Lednicky-Luboshyts formalism and full numerical solutions of the Schrödinger equation. Our results show that the differences between these methods are significant. Furthermore, we demonstrate that incorporating higher-order partial waves—particularly the p-wave—is essential for accurately capturing the dynamics of *p*-*d* interactions and the full potential of the strong force.

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From Source Imaging to Balance Functions, Research Projects with Scott Pratt

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Shared interest in heavy-ion collisions has driven our joint research projects with Scott Pratt. Our projects have ranged from those focused on low relative-velocity correlations through time delays in interactions to balance functions testing correlations induced by pair production. Projects discussed in detail will include imaging of emission sources and the development and growth in popularity of balance functions. Scott's research is practical and focused on what has or can be measured for the sake of learning about Nature.

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Strange particles femtoscopy in PbPb collisions at 5.02 TeV with the CMS detector

Auteur: Raghunath Pradhan[1]

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Particle correlations have traditionally been used to study collective phenomena in hadronic and heavy ion collisions through azimuthal distributions. In contrast, femtoscopic correlations offer valuable insights into quantum statistical effects and final-state interactions. This talk presents the first results from the CMS experiment on femtoscopic correlations of strange particles ($\mathrm{K^0_S}$, $\Lambda/\bar{\Lambda}$) in lead-lead (PbPb) collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV, using Run 2 data. The source size has been determined from $\mathrm{K^0_S K^0_S}$ correlations across various centrality ranges, offering complementary insights compared to those from charge pion and kaon correlations. Additionally, strong interaction scattering parameters, such as scattering length and effective range, have been extracted from $\Lambda\Lambda$ and $\Lambda\mathrm{K^0_S}$ correlations using the Lednický-Lyuboshitz model and compared with other experimental and theoretical results. This includes the first determination of scattering parameters from $\Lambda\Lambda$ correlations in PbPb collisions at the LHC.

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Femtoscopic correlations of light nuclei

Auteur: Stanislaw Mrowczynski[1]

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Femtoscopic correlations of light nuclei, such as proton-deuteron or deuteron-deuteron, are sensitive to a production mechanism of the nuclei. Therefore, one can distinguish whether nuclei are directly emitted from a fireball, as one assumes within the thermodynamic approach, or whether nuclei are formed later on due to final-state interactions, as the coalescence model assumes. The correlation function takes a different form in the two cases and the results may differ qualitatively. The whole problem will be discussed in the context of recent experimental data from RHIC and LHC, in particular those on proton-deuteron correlations. Suggestions for future studies will be presented.

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Transport theory and deblurring to Analyze Secondary Decay Emissions in Correlations measurements (online)

Auteur: Pierre Nzabahimana[1]

Co-auteurs: Giuseppe Verde [2]; Pawel Danielewicz [3]

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Two-particle correlations play a pivotal role in understanding the space-time characteristics of particle emission in Heavy-ion collisions. These characteristics are typically represented by a relative emission source and can be obtained using transport model simulations such as the Boltzmann-Uehling-Uhlenbeck (BUU) transport model. We utilize the BUU transport model to simulate the p-p source. Subsequently, we employe the Koonin-Pratt formula to calculate the correlations. By comparing the correlations obtained from the BUU simulation with those obtained using imaging methods, such as the deblurring method, we aim to gain a deeper understanding of the impact of fast and slow emissions on the measured correlations. Specifically, this comparison is used as a tool to determine a function (tail) that represents the relative distribution of the particle pair from secondary decay emissions. Thus, we correct the BUU source function by incorporating a tail to

account for the contribution of secondary decay emissions, which cannot be accurately captured by BUU simulations. Resulting source function reproduce the features in the measured correlations. To illustrate our approach, we examine p-p correlations measured in Ar + Sc reactions at E/A = 80 MeV.

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Probing QGP formation in pp collisions with Balance Functions

Auteurs: Alexandru Dobrin[1]; Alexandru Manea[1]; Claude Pruneau[2]; Sumit Basu[3]; Victor Gonzalez[2]

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Two particle correlations have shown the presence of long-range rapidity correlations in small collision systems. Several other measurements provided insight into the unexpected collective beahviour similar to the one exhibited in heavy-ion collisions. These properties can be explained by several models, which consider a microscopic description like PYTHIA 8 and a macroscopic treatment as EPOS4. Balance functions have been regarded in the past as a method of investigationg the late-stage hadronization found in the presence of a strongly-coupled medium. We present balance functions confronting EPOS 4 and PYTHIA 8 in pp collisions at $\sqrt{s} = 13.6$ TeV to distinguish between these models.

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Event-by-event mean transverse momentum fluctuations in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE

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Event-by-event fluctuations of mean transverse momentum (p_T) of relativistic charged particles are studied in terms of two-particle correlator, $\sqrt{C_m}/M(p_T)_m$. High-multiplicity triggered pp data at $\sqrt{s}$ = 13 TeV, collected by the ALICE detector, are being analyzed for this intended purpose. The main motivation behind such studies is to search for the fluctuations of dynamical origin which can be associated to the QGP droplet formation in small systems, like pp, the traces of which have been reported in earlier investigations. The values of the correlator are observed to decrease with increasing charged particle density and follow a power-law behavior similar to those observed for small and large systems at lower energies. In order to look for effects of thermal (jets/minijets) and non-thermal (radial flow), dependence of $\sqrt{C_m}/M(p_T)_m$ on the charged particle multiplicities is examined in p_T windows of varying widths and positions. The findings based on the data are also compared with the predictions of various Monte Carlo models, e.g., PYTHIA and EPOS.

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Precise determination of the n-17B scattering length

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The s-wave neutron-nucleus scattering length a_s characterizes the low-energy neutron scattering off nuclei. In the effective-range approximation, the neutron-nucleus scattering cross-section at very low energies tends to $4a_s^2$, giving to the scattering length a sense of nuclear apparent size experienced by a neutron approaching at low energy. Its specific value is the result of a complex balance between the attractive individual neutron-nucleon potential and the repulsion generated by the Pauli principle with respect to the other neutrons in the nucleus. As such, it oscillates between positive and negative values (respectively for bound and virtual states) with increasing nuclear mass, with absolute values ranging from the about 20 fm of the n-N systems to the few fm for light nuclei. However, in ^{18}B the peculiar balance between attraction and repulsion leads to a spectacular increase in absolute value, with an upper limit of a_s<-50 fm provided by the only existing measurement [1]. Letting aside the anomalous value in itself, the fact that adding an extra neutron to the system leads to the weakly-bound two-neutron halo nucleus ^{19}B may have strong physics implications. The three-body system ^{17}B+n+n would be thus built from two scattering lengths, a large one of about 20 fm and a potentially huge one of tens, hundreds or even thousands of fm, opening the debate about possible Efimov states in ^{19}B and the description of nuclei at the unitary limit [2].
We have determined this essential observable by using a series of nuclear reactions leading to the ^{17}B+n final state. The experiments were performed at the RIKEN Nishina Center as part of the SAMURAI Day1 campaign (for experimental details see for example [3]). A series of secondary beams (^{19}B, ^{18,19,20}C, ^{20,21,22}N) at about 250 MeV/N were tracked onto a carbon target. The reaction products of interest, ^{17}B and neutrons, were detected respectively by the SAMURAI spectrometer and the NEBULA array, and the energy of the ^{17}B+n system was reconstructed by invariant mass. With respect to the previous measurement [1], the large acceptance of the SAMURAI+NEBULA setup has allowed for a complete observation of the virtual state, and the better resolution coupled to the high intensity of the secondary beams has led to a precise characterization of its line shape.
The (^{19}C,^{17}B+n) reaction is found to populate exclusively the virtual state, as expected by the s-wave neutron halo character of ^{19}C, and has been used for the determination of a n-^{17}B scattering length of the order of a thousand fm, taking into account the structure of the initial state. Moreover, the high acceptance and resolution has allowed for the first measurement of the n-^{17}B effective range, governing the second term of the effective-range expansion, and for an exploration of the next term, related to the shape of the potential. The (^{19}B,^{17}B+n) reaction populates the virtual state but also two additional resonances. While the latter represents the first spectroscopy of ^{18}B, the line shape of the former is found to be very sensitive to the neutron separation energy S_n of ^{19}B. We will discuss how these results constrain the value of S_n(^{19}B), and as a consequence S_{2n} and the mass of ^{19}B.

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Photon-photon femtoscopy in Ag+Ag collisions at √sNN = 2.55 GeV

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The study of femtoscopic correlations between photon pairs, although challenging from an experimental standpoint, can serve as a complemen- tary approach to traditional hadron femtoscopy. Owing to the penetrative nature of photons, which are unaffected by strong or electromagnetic interactions, such measurements can be used to probe the early stages of heavy-ion collisions, prior to freeze-out. Furthermore, since femtoscopy is sensitive to the emission sequence of particles, it may provide the poten- tial to distinguish between the femtoscopic signals of direct photons and decay photons, thus enabling the estimation of direct photon yields.
As part of the FAIR/GSI scientific complex, the HADES experiment focuses on detecting light vector mesons through dielectron (e±) channels produced in high-energy heavy-ion collisions at energies of approximately 1–2 A GeV. With the presence of electromagnetic calorimeters, HADES is also capable of direct photon detection, facilitating femtoscopic mea- surements.
√

Preliminary results from Ag+Ag collision data at will be presented.
Keywords: HADES, femtoscopy, photons

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Measurement of pseudorapidity distributions with the STAR EPD at BES-II energies

Auteur: Balazs Korodi[1]

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The measurement of charged particle pseudorapidity distributions using the STAR Event Plane Detector (EPD) in gold-gold collisions at Beam Energy Scan II energies is presented. Charged particles are detected by the EPD in the $2.15 < |\eta| < 5.09$ pseudorapidity interval. To account for the detector's response to primary particles, directly measured pseudorapidity distributions are unfolded using response matrices that are determined via Monte Carlo simulations. The centrality and energy dependence of the unfolded distributions are investigated.

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Inside the tetraneutron: correlations within the 4n system

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Light multineutron systems represent a severe test for our understanding of nuclei. They are composed of only one type of particle, connected by only one (nuclear) force, and can be calculated by ab-initio exact models. As such, the observation of events in the dissociation of 14Be consistent with the detection at the 2 sigma level of a weakly bound or unbound tetraneutron [1,2] led not only to a theoretical reappraisal of the 4n system [3], but also motivated renewed experimental efforts. In particular, work at RIKEN in two experiments using 8He beams and the missing-mass technique, first with double-charge exchange [4] and later with alpha knockout [5], exhibited a relatively narrow structure near threshold (respectively with 4.9 and »5 sigma significance) at about 2.4 MeV in the 4n continuum [5]. There is, however, no clear consensus on the interpretation of this near-threshold structure [6], in particular whether it is a true resonance or rather a correlated system that reflects the character of the 4n in the initial state [7]. We will discuss the next steps in this field, involving the direct meassurement of the multineutron invariant mass and the exploration of internal correlations in the system.

[1] F.M. Marqués et al., Phys. Rev. C 65, 044006 (2002).
[2] F.M. Marqués et al., arXiv:nucl-ex/0504009.
[3] F.M. Marqués and J. Carbonell, Eur. Phys. J. A 57, 105 (2021).
[4] K. Kisamori et al., Phys. Rev. Lett. 116, 052501 (2016).
[5] M. Duer et al., Nature 606, 678 (2022).
[6] L.G. Sobotka and M. Piarulli, Nature 606, 656 (2022).
[7] R. Lazauskas et al., Phys. Rev. Lett. 130, 102501 (2023).

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Search for Toroidal Nuclear Resonances in the Cluster Disassembly of ^{28}Si

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Wheeler and Wong predicted the possibility of toroidally-deformed nuclear configurations in the 1960s and 1970s. In the last decade, renewed interest has spurred further calculations exploring the possible structure, energetics, and disassembly of these nuclear configurations. Analysis of experimental data obtained with NIMROD at Texas A&M University showed hints that such structures may exist and may be observable in the 7-alpha decay channel from an excited 28Si, though that data set was not obtained with this study in mind. Using the same beam, energy, and target (28Si + 12C at 35 MeV/u), we conducted a subsequent experiment with FAUST at Texas A&M University to search for these possible toroidal states. The good angular resolution and energy resolution of FAUST, as well as the large number of measured events, allow for stronger statements to be made regarding the existence and properties of these possible states. Our analysis of the FAUST data indicated no statistically significant peaks in the 7-alpha relative energy distribution, and we set upper limits for the cross section as a function of the intrinsic width of the candidate state. These upper limits exclude the candidate states suggested by the previous NIMROD measurement.

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Whispers of Baryons: A Femtoscopic Journey to High Baryonic Chemical Potential

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Studying the matter's properties in high-baryonic density is essential to understanding the conditions in neutron stars and during heavy ion collisions at low collision energies. Femtoscopy might play a crucial role in the exploration of the phase diagram of strongly interacting matter. In the domain of the low collision experiments, the matter becomes baryon-dominant, in contrast to experiments at high energy collisions where mesons are the most abundant particles. Therefore, baryon femtoscopy is a very promising tool for studying the collision's dynamics and the interactions between particles.
In this presentation, I will briefly discuss the latest experimental measurements and techniques that might be useful for probing matter under extreme conditions. I will also briefly describe the future facilities that allow us to extend the current measurements. The challenges in exploring this physics in terms of developing new tools (like those for fitting data) will be discussed.

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Charge balance function and fluctuation with CMS at the LHC

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We present the first studies of charge-balance functions using the broad rapidity coverage of the CMS experiment. This larger phase space region is essential for studying the system time evolution. The width of the balance function, both in relative $|\eta|$ and relative azimuthal angle, is found to decrease with multiplicity for low particle transverse momentum ($p_T < 2$ GeV/c). The effect is observed for both collision systems, and it is consistent with a late hadronization scenario, where particles are produced at a later stage during the system evolution. The multiplicity dependence is weaker for higher p_T, which signifies that the balancing charge partners are strongly correlated compared to the low-p_T region. Model comparisons cannot reproduce the multiplicity dependence of the width in $\Delta\eta$, albeit a model which incorporates collective effects can reproduce the narrowing of the width.

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Dynamical attractors of distribution function and v_n from pp to AA systems in full kinetic theory: role of system size and interaction strength

Auteurs: VINCENZO NUGARA[1]; Salvatore Plumari[2]; Vincenzo Greco[3]

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We investigate the appearance of dynamical attractors in 3+1D systems by means of a Relativistic Full Boltzmann Transport approach. We look at the distribution function and its momentum moments and at the anisotropic flows v_n and at how they lose memory about their initial conditions. Our analysis is performed in a wide range of system size and interaction strength, starting from typical pp setup and going to pA up to AA collisions. We study how the emergence of universality is related to these parameters, and in particular to the interplay between the transverse system size R and the mean free path λ_{mfp}, relating the ratio R/λ_{mfp} to the opacity parameter $\hat{\gamma}$, previously introduced in literature. We also investigate how initial azimuthal correlations in momentum space affect final observables, delving in particular in the system size dependence.

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Equation-of-state (EOS) of Dense Nuclear Matter with CBM-FAIR and STAR-RHIC

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Our current understanding of the dense QCD matter EOS at supra-saturation densities ($> 2\rho_0$) is currently dominated by valuable yet statistically limited astrophysical observations. This density range is particularly interesting, with evidence suggesting the emergence of deconfined quark matter phases, supported by effective QCD models (ChEFT and pQCD calculations) and astrophysical data. Complementary information from heavy-ion collisions and transport codes provides a means to study EOS inside the laboratory in controlled conditions, therefore offering another crucial source of information.

Heavy-ion collisions at CBM-FAIR at the operating Relativistic Heavy Ion Collider (RHIC) and forthcoming Facility for Antiproton and Ion Research (FAIR), offer a complementary source to study the nuclear EOS at intermediate high energies ($\sqrt{s_{NN}} \approx 2.5 - 6$ GeV; Au-Au collisions), which have been touted as optimal for detecting signs of deconfinement. This contribution will talk about the EOS perspectives with the flagship heavy-ion collision experiments at aforementioned facilities, namely the Solenoidal Tracker at RHIC (STAR) and Compressed Baryonic Matter (CBM) at FAIR.

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Imaging nuclei with relativistic ion collisions

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The geometry of an ultra-relativistic heavy-ion collision is shaped by interactions of nucleons within the colliding nuclei, whose spatial coordinates are "frozen" during the ultra-short time duration of the collision process. As the quark-gluon plasma created in the collision expands hydrodynamically to the final state, the details of the spatial distribution of these nucleons and their correlations (clustering, deformations, skin diffuseness) leave specific imprints in the the collective flow of the produced hadrons, becoming thus accessible experimentally from established multi-particle correlation measurement techniques. In this contribution, I review the progress made in the use and the understanding of this method for imaging nuclear ground states. I discuss recent efforts aimed at the quantitative extractions of fundamental properties of nuclei from collider data, and what prospects lie ahead for this new frontier in nuclear research.

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Net-proton fluctuations influenced by baryon stopping and quark deconfinement

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Preliminary data from the Beam-Energy Scan II measurements by the STAR Collaboration at the Relativistic Heavy Ion Collider suggest a dip in the fourth-to-second-order cumulant ratio when plotted vs. beam energy. At the same energy range where the structure appears, a transition from hadrons to quarks is expected, the deconfinement transition. In this paper, the role of quark deconfinement in establishing fluctuaitions in the early stages of the collision is considered. Two models are compared: one with stopping occurring on a baryon-by-baryon basis, and a second where stopping proceeds through quark degrees of freedom. In the latter model, the fluctuation of baryon number is significantly reduced and this signal is found to survive recombination into hadrons and the subsequent diffusion. The transformation from baryon to quark stopping thus produces a dip in the fourth-to-second-order cumulant ratio when plotted vs. beam energy, consistent with observations.

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Particles correlations in 2-proton radioactivity

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The ground-state 2-proton radioactivity is a rare decay mode that can occur for few nuclei, beyond the proton drip-line and with an even number of protons. The phenomenon is possible due to the pairing interaction that lowers the mass and to the Coulomb and centrifugal barrier, which keeps the last proton pair inside the nucleus, until its tunneling through this barrier. The emission of a single proton being forbidden from energy conservation, the nucleus can only decay only decay by a direct emission of the 2 protons. While the *p-p* sub-system is necessarily correlated in the nucleus, it is unbound after the emission, which makes this decay mode a unique case of quantum 3-body process.
In order to reach a theoretical description of such a process, several aspects must be considered: the nuclear structure, the emission dynamics, and the asymptotic behavior. This decay mode has been observed experimentally for 4 nuclei: ^{45}Fe, ^{48}Ni, ^{54}Zn and ^{67}Kr. The results obtained with Time Projection Chamber devices, that allow to measure the angular and energy correlations between the emitted protons, are compared to recent theoretical descriptions. This work indicates that the process is not fully understood.

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Resolving Accretion Disks around Black-Holes

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Accretion flows around black-holes, neutron stars or white dwarfs are studied since almost 60 years. Although they are ubiquitous and somewhat similar over scales reaching billions in mass and size, their study has been limited because they remain unresolved point like sources in the optical/ultraviolet and X-rays, where they emit. Two main modes of accretion have been identified in Active Galactic Nuclei. In most sources the accretion rate is low and a high pressure, low density, low collision rate, optically thin, radiatively inefficient, two temperature plasma can form (Shapiro 1976; Narayan & Yi 1994,1995). This solution is stable only for low luminosities (<1% LEDD). The Event Horizon Telescope has recently resolved such flows in Sgr A and M87, confirmed several aspects of the model and could detect particles accelerated close to the horizon of Sgr A (Wielgus, 2022) a likely signature of the Blandford-Znajek (1977) process. When the accretion rate is higher, momentum can be dissipated by viscosity and the flow proceeds via geometrically thin disk-shaped structures. These accretion disks provide feedback to their environment by accelerating winds and launching jets in their central regions. The apparent size of accretion disks are of the order of 1-40µarcsec in nearby quasars, Seyfert galaxies and galactic cataclysmic variables and of 0.1-1µarcsec in of low mass X-ray binaries in our Galaxy. Accretion disks have never been resolved.

The signal-to-noise achievable using photon arrival time correlation (or intensity interferometry) depends on the telescopes sizes, detector time resolution, and the number of spectral channels observed simultaneously. Extremely large telescope and 10ps resolution single photon detectors bring the key improvements to reach in the optical angular resolutions better than these achieved in the radio by the Event Horizon Telescope and to obtain the first images of accretion disks around galactic and extragalactic compact objects, a breakthrough.

I will present the goals and the status of the QUASAR project, which started one year ago, aiming at bringing 10ps resolution optical spectrometers on very large telescopes.

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Extraction of the speed of sound in hot QCD matter at the LHC

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In this presentation recent extractions of the speed of sound in hot QCD matter are discussed. The measurements are performed using two different analysis techniques, which are applied in PbPb collisions at the LHC with center-of-mass energy per nucleon pair of 2.76 and 5.02 TeV. Special focus to the experimental techniques and prospects for future measurements will be given.

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The X17 search with the MEG-II apparatus

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The MEG-II experiment, at the Paul Scherrer Institute in Switzerland, is searching for the charged lepton flavour violating (CLFV) μ+ ⟶ e+γ decay. After its second year of data taking only, it can reach the world's best sensitivity on the branching ratio of the decay, below 10^(−13). Beyond its primary objective, MEG-II's adaptability enables it to probe the recent Atomki anomalies. These kinematically consistent excesses observed in the angular correlation spectra of electron-positron pairs emitted by 8Be, 4He and 12C excited nuclei could be interpreted by the decay of a circa 17 MeV/c2 neutral boson, X(17). Employing a Cockroft-Walton accelerator, a 2 μm-thin lithium target and advanced detectors, MEG-II aims to independently study the 7Li(p,e+e−)8Be reaction. The charged particles are tracked through a magnetic spectrometer equipped with a new-generation drift chamber and arrays of fast scintillators. At the same time, the associated photons are absorbed within a xenon calorimeter. With an improved resolution and extended acceptance with respect to the original Atomki experiment, MEG-II can provide further insights into the anomaly and its interpretation. A month-long data taking was conducted in 2023. We report on the data acquisition, analysis status and related prospects.

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Probing the X17 existence and properties using proton and neutron beams

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Three significant anomalies have been observed in the emission of electron- positron pairs in the 7Li(p,e+e−)8Be, 3H(p,e+e−)4He and 11B(p,e+e−)12C nuclear reactions [1-3]. These anomalies have been interpreted as the signature of the existence of a boson (hereafter referred to as X17) of mass MX17 = 16.8 MeV/c2 that could be a mediator of a fifth force, characterised by a strong coupling suppression of protons compared to neutrons (protophobic force).
In this talk is presented a new experimental approach to clarify the present scenario, by searching for the X17 boson in the decay of excited A=3,4 (Tritium, helium-3, helium-4) nuclei through reactions induced by protons or neutrons. The study of the 3He(n,e+e−)4He and 3H(p,e+e−)4He reaction, in a wide energy window and using a detector with a large acceptance, would probe the X17 existence and, if the anomaly is confirmed, it allows for the determination of its quantic numbers. In the case

of a positive result, the analysis of the 2H(n,e+e−)3He and 2H(p,e+e−)3H cross section ratio oWers a unique opportunity to shed light on the isospin dependence of the X17- nucleon coupling. The achievable results are discussed on the base of ab- initio calculations, in which the existence of a 17 MeV boson is considered [4,5].

[1] A. J. Krasznahorkay et al., Phys. Rev. Lett. 116, (2016) 042501.
[2] A. J. Krasznahorkay et al., Phys. Rev. C 104, (2021) 044003.
[3] A. J. Krasznahorkay et al., Phys. Rev. C 106, (2022) 061601.
[4] M. Viviani et al., Phys. Rev. C 105, 014001 (2022), arXiv:2104.07808 [nucl- th].
[5] M. Viviani et al., submitted to Phys. Rev. C. arXiv:2408.16744.

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Delta resonance mass distribution in AA collisions

Auteur: Szymon Harabasz[1]

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The statistical hadronization model is known to describe very well the yields of particles produced in heavy-ion collisions at LHC, RHIC, and SPS over many orders of magnitude. Recently, we have shown [1,2] that at lower energies, not just yields but also spectra of the most abundant particles containing u and d quarks can be reproduced in the thermal model.

Strangeness, heavy compared to the temperature and rarely produced, is not expected to thermalize at low energies. Instead, further insights can be gained by studying baryonic resonances, which are excited in large amounts in the system at high net-baryon density (high baryochemical potential).

In this talk, we will discuss Delta(1232) production using the thermal Monte Carlo event generator THERMINATOR 2, where we have implemented a finite width of the resonance based on the S-matrix theory [3]. Model predictions will be confronted with the unique set of experimental results published by the HADES collaboration [4]. Perspectives on continuing the study with other HADES measurements and the forthcoming CBM at FAIR will also be discussed.

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Accessing the strong interaction in three-hadron systems via proton-deuteron femtoscopy

Auteur: Bhawani Singh[1]

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Understanding the structure of light nuclei and the interactions among their constituents has been a long-standing goal in nuclear physics. Nuclear systems composed of three hadrons, such as unbound ensembles formed by a deuteron and a third nucleon, serve as fundamental references in nuclear physics for constraining nuclear interactions and understanding the properties of nuclei.

In this talk, I will present hadron-deuteron femtoscopic correlations measured by the ALICE Collaboration in proton-proton (pp) collisions at $\sqrt{s} = 13$ TeV at the Large Hadron Collider (LHC). These momentum-space correlations between deuterons and kaons or protons provide insights into three-hadron systems at distances comparable to the proton radius. The K^+–d correlation analysis shows that the relative distances at which deuterons and protons/kaons are produced are around 2 fm. The analysis of the p–d correlation demonstrates that only a full three-body calculation that accounts for the internal structure of the deuteron can explain the data. Specifically, the sensitivity of the observable to the short-range part of the interaction is emphasized. Additionally, the measured p–d correlation function is sensitive to the inclusion of higher-order partial waves. This study opens an avenue for strong interaction studies in three-body systems, including Λ/Σ–d or Λ_c–d, to investigate three-baryon systems in the strange and charm sectors, which are otherwise inaccessible.

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Tilted geometry in the heavy-ion collisions (online)

Auteur: Yevheniia Khyzhniak[1]

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The focus of this work is the tilt of the pion emission source in Au+Au collisions at $\sqrt{s_{NN}}$ = 7.7 to 27 GeV, based on data from the STAR experiment. The tilt is known to originate from the 3D structure of the initial collision geometry, such as the geometric overlap of two nuclei, and is important for understanding phenomena such as directed flow and polarization.

Using azimuthally-sensitive femtoscopy method of identical pion pairs we are going to show correspondence between the obtained tilt parameter and the actual tilt of the freeze-out coordinates predicted by the UrQMD model. Although one might expect the tilt to depend primarily on the collision centrality, we found that it actually depends much more strongly on the momentum of the particle pairs. We will discuss the reasons behind this result and compare the results obtained in the model with those from the experiment.

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Probing Short-Range NN Correlations via Nuclear Structure and Reaction Studies at GSI energies

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Nucleon-nucleon correlations are essential for understanding the structure of nuclei. They are responsible for the depletion of quantum states below the Fermi level and population of the states above it, that is a characteristic feature of dense many-body systems of strongly interacting fermions. The NN correlations are often distinguished into long- and short-range types depending on their spatial separation and the sensitive range of the NN potential. In particular short-range correlation (SRC) in light and heavy stable nuclei are known to be dominated by deuteron-like n-p pairs with spin S=1, while their presence and role in unstable nuclei still remains an open question. The radioactive-ion beam facility at GSI provides a unique opportunity to investigate the SRC component of isospin-asymmetric unstable nuclei. This can be achieved due to the available secondary-beam energies in GeV per nucleon range, and a possibility to perform inverse-kinematics studies. In this talk, an overview will be given for the recent experimental program on SRC physics at the R3B setup at GSI.

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Bayesian Analysis of Charge Balance Functions: Quantitatively extracting the chemical evolution and diffusivity of the matter created at RHIC and the LHC

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TBA

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Scaling Analysis of Proton Cumulants and the QCD Critical Point

Auteur: Agnieszka Sorensen[1]

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We perform a finite-size scaling analysis of net-proton number cumulants in Au+Au collisions at center-of-mass energies between 2.4 GeV and 54.4 GeV to search for evidence of a critical point in the QCD phase diagram. We show that for 7.7 GeV and above, the data as a function of rapidity bin width exhibits scale invariance, satisfying the conditions for a finite-size scaling analysis. We use model simulations to verify the applicability of this approach, then apply it to data and find evidence for a critical point near the baryon chemical potential of μB ≈ 625 MeV. This is the first analysis of experimental data to locate the critical point in a range consistent with recent theoretical predictions.

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Centrality dependence of Lévy-stable two-pion Bose-Einstein correlations in 200 GeV Au++Au collisions at PHENIX

Auteur: Sandor Lokos[1]

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The PHENIX experiment measured the centrality dependence of two-pion Bose-Einstein correlation functions in $\sqrt{s_{NN}} = 200$ GeV Au
+
+Au collisions at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory. The data are well represented by Lévy-stable source distributions. The extracted source parameters are the correlation-strength parameter λ
, the Lévy index of stability α, and the Lévy-scale parameter R as a function of transverse mass m_T and centrality. The $\lambda(m_T)$ parameter is constant at larger values of m_T, but decreases as m_T decreases. The Lévy scale parameter $R(m_T)$ decreases with m_T and exhibits proportionality to the length scale of the nuclear overlap region. The Lévy exponent m_T is independent of m_T within uncertainties in each investigated centrality bin, but shows a clear centrality dependence. At all centralities, the Lévy exponent α
is significantly different from that of Gaussian ($\alpha = 2$) or Cauchy ($\alpha = 1$) source distributions. Comparisons to the predictions of Monte-Carlo simulations of resonance-decay chains show that in

all but the most peripheral centrality class (50\%-60\%), the obtained results are inconsistent with the measurements, unless a significant reduction of the in-medium mass of the η' meson is included. In each centrality class, the best value of the in-medium η' mass is compared to the mass of the η meson, as well as to several theoretical predictions that consider restoration of $U_A(1)$ symmetry in hot hadronic matter.

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Stellar Intensity Interferometry with Cherenkov telescope arrays: the forthcoming ASTRI-SI3 and prospects for the CTAO

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Stellar Intensity Interferometry (SII) is a second observing mode of Imaging Atmospheric Cherenkov telescopes (IACTs), where the large collecting area and ultra-fast data acquisition electronics of these instruments can be used to reconstruct images of stars at optical blue wavelengths. IACTs composed of several telescopes distributed over an area of hundreds of meters, such as the ASTRI Mini-Array and the Cherenkov Telescope Array Observatory (CTAO), will also have unique capabilities in terms of angular resolution and coverage of the U-V plane, making them complementary and competitive with the current generation of long-baseline optical interferometers. In this talk I will first present the ASTRI Stellar Intensity Interferometry Instrument (SI3). The instrument is designed to make accurate measurements of single photon arrival times (1 ns) in a very-narrow optical bandwidth (1-3 nm) centred on a wavelength in the range 420-500 nm. The 36 simultaneous baselines over distances between 100 m and 700 m provided by the ASTRI mini-array will allow angular resolutions of less than 100 microarcseconds. I will then summarize the potential scientific prospects of SII on the CTAO.

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New insight into the structure of 4He nuclei

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Until recently, 4He's transition from its ground state to 0+ first excited state was seen as a what we may term as a breathing mode [1]. This mode, known as monopole excitation, involves the nucleus expanding and contracting symmetrically, like a balloon inflating and deflating. During this motion, the spherical shape of the nucleus remains intact.
More recent calculations using NCGSM (No Core Gamow Shell Model), which treats the 4He nucleus as an open quantum system, contradict the previous explanation. This new approach takes into account different reaction channels, such as [1H+ 3H], [3He + n] , and [2H + 2H]. This
makes it possible to solve the N-body problem more accurately, and to predict the excitation function of 4He decay in all three channels. We therefore decided to perform correlation functions of the [1H + 3H] and [2H + 2H] channels in Ni+Ni reactions measured at two incident energies, 32 and 52 MeV/A with the FAZIA+INDRA apparatus, to give an insight into the structure of 4He. We will show the limitations of the apparatus, as well as limitations of correlation function methods. We also give an alternative experimental method for extracting the branching ratio of the three decay channels of 4He nuclei as a function of excitation energy.

References:
[1] S. Kegel et al., Measurement of the -particle monopole transition form factor challenges theory: A lowenergy puzzle for nuclear forces, Phys. Rev. Lett., 131, (2021).
[2] Michel, N. and Nazarewicz,W. and Pøoszajczak, M., Description of the Proton-Decaying 0+2 Resonance of the Particle, Phys. Rev. Lett., 130, (2023).

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Search for alpha-condensed states in ^{20}Ne and ^{24}Mg

Auteur: Takahiro Kawabata[1]

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Alpha clustering is a crucial concept to understand nuclear structures. Alpha particles, which are tightly bound with no excited states up to Ex ~ 20 MeV, often behave as well established subunits in nuclei, forming what are known as alpha cluster states.

Of particular interest are alpha condensed states where all alpha clusters are condensed into the lowest s orbit. Due to this unique property, these states exhibit very sharp momentum distribution around zero. As a result, their density distributions spatially expand, becoming as dilute as about 1/5 compared to normal nuclei.

In our research, we searched for the 5alpha condensed state by measuring alpha-particle decays from excited states in ^{20}Ne populated by inelastic alpha scattering at zero degrees, and found its candidate states. Additionally, we recently reported candidates for the 6-alpha condensed state and its excited states with their spin and parity of 2+ and 4+ observed in the ^{12}C + ^{12}C resonance scattering.

In the present talk, we will report our experimental findings in the search for the alpha condensed states in ^{20}Ne and ^{24}Mg.

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Searching for the Anomalous Internal Pair Creation in ^{8}Be (online)

Auteurs: Benito Gongora Servin[1]; Tommaso Marchi[2]; Diego Tagnani[3]; Andrea Calentano[4]; Alain Goasduff[5]; Jose Javier Valiente Dobon[6]

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Since the Rose model was published in 1949 [1,2], several laboratories worldwide have started experimental campaigns to measure the angular distribution of the Internal Pair Creation (IPC) process in light nuclei to study electromagnetic multipole transitions. In the 1950s, Devons et al. reported the experiments' results in ^{16}O, ^{8}Be, and ^{8}Be [3,4]. The angular correlations obtained were consistent with the Model of Rose (adding an anisotropy due to Coulomb field effects). But in 2016, Krasznahorkay et al. reported the breakthrough of an anomaly in the IPC of ^{8}Be~[5]. An unexpected angular correlation distribution in the emission of the pair e^+e^- was found in the isoscalar magnetic dipole transition (18.15 MeV state ($J^\pi = 1^+$, T=0) $\rightarrow$ ground state ($J^\pi = 0^+$, T=0)). According to theoretical calculations performed with the Rose model, the angular correlation distribution drops quickly with the relative separation angle of the leptons. In contrast, the Hungarian group reported a peak-like behavior at large angles~[5]. This result has been interpreted as the signature of the emission of a previously unknown neutral isoscalar particle, named X17, with a mass of 16.70$\pm$0.35(stat)$\pm$0.5(syst) MeV/c^2 and J^π=1^+.
The present talk describes the historical events of the efforts to study this phenomenon and provides an overview of the experimental facilities that have been built up to now. As a particular case, the design and construction of a dedicated array to study this anomaly at the Laboratori Nazionale di Legnaro (Istituto Nazionale di Fisica Nucleare, Italy)~[6] are presented. The project aims to measure the angular correlation distribution of the emission of the pair e^+e^- from the transition studied in ^{8}Be at the Atomki Laboratories. The detector unit is a telescope manufactured with the plastic scintillator EJ-200. The in-beam commissioning of the setup demonstrated that the array could measure the lepton pairs in coincidence and reconstruct the energy of the electromagnetic transition.
Furthermore, the ΔE layer consists of a system of a double layer of 10-bars designed to detect the incident position of the particles. The IPC of the transition $0^+ \rightarrow 0^+$ in ^{16}O has been studied as a first case. This transition is used as a calibration point of the detectors since the cross-section is orders of magnitudes higher than the one in ^{8}Be. In November 2023 and May 2024, the former experiments were carried out at the AN2000 Accelerator. LiF targets from 50-950 μm/cm^2 have been irradiated with a 0.440-1.09 MeV proton beam and a $\sim$500 nA current. The population of the state of interest and the integrity of the target were monitored with a 3$\times$3 in^2 $LaBr_3$ detector.

References
[1] E. Rose, Phys. Rev. 76 (1949) 678.
[2] E. Rose, Phys. Rev. 78 (1950) 184.
[3] S.~Devons et al. Proc. Phys. Soc. A 67 (1954) 134.
[4] S.~Devons et al. Proc. Phys. Soc. A 67 (1956) 173.
[5] J. Krasznahorkay et al., Phys. Rev. Let. 116 (2016) 7.
[6] B. Gongora-Servin et al., LNL-INFN Annual Report 2022, (2023) 49.

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Femtoscopy and phenomenology of strong interactions

Auteur: Isabela Maietto Silvério[None]

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Femtoscopic two-particle correlations have traditionally been used to determine the size and shape of the particle-emitting region in high-energy collisions. This method is also sensitive to final state interactions, in particular, to strong interactions experienced by pairs of hadrons. In this presentation, phenomenological results on femtoscopy involving correlations of D^0D^0 and $\bar{D}^0\bar{D}^0$ pairs are discussed. These studies explore the strong interactions between these particle pairs, allowing us to extract scattering observables from their correlation functions and gain deeper insights into the short-range interactions in the repulsive sector.

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The quenching of nucleon knockout in nuclei far from stability and the role of nucleon correlations

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The increase in the relative fraction of high-momentum protons in short-range correlated NN pairs with the neutron excess in the nucleus, measured by the CLAS collaboration at the Thomas Jefferson National Accelerator Facility, has stimulated interest in investigating the presence of SRC NN pairs in nuclei far from stability. The GSI/FAIR facility, as the only worldwide facility providing beams of unstable nuclei at relativistic energies, offers unique opportunities to address this issue. In this talk I will present some previous inclusive experiments showing indications for the presence of SRC NN pairs in nuclei far from stability, as well as preliminary results obtained in new exclusive experiments.

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First measurement of a non-round photosphere with Stellar Intensity Interferometry: VERITAS observations of gamma Cassiopeia

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The VERITAS array consists of four Air Imaging Cherenkov Telescopes, measuring showers generated by extremely high-energy cosmic rays. During full-moon intervals, VERITAS is used for Stellar Intensity Interferometry (SII). This technique, pioneered by Hanbury Brown in the 1950s, probes the spatial distribution of intensity at the sub-milliarcsecond scale. Quite recently, groups around the world have been developing SII technology for future deployment, and a first round of measurements of stellar radii have been published in just the past year. In the early days, subatomic femtoscopy, based on Hanbury Brown's technique, measured only one-dimensional source radii (Rinv). With better statistics, extended phasespace coverage, and more complete detectors, femtoscopy has measured subatomic source shapes and orientations, proving much more insight on the evolution and dynamics of heavy ion collisions. I will present VERITAS-SII measurements of gamma Cassiopeia, a Be-type rapid rotator. With more complete baseline-vector coverage, we are able to measure not only the size of the photosphere, but its equatorial bulge and orientation of angular momentum. Fitting this data with a stellar model reveals that this star rotates at 99.6% of its breakup velocity.

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New Insights from CMS pPb Data at $\sqrt{s_{NN}}$ = 8.16 TeV

Auteur: Sandra Padula[1]

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Multiparticle correlation measurements at the LHC have revealed striking evidence of collective behavior in small collision systems, such as pp and pPb, mirroring phenomena typically observed in heavy-ion (AA) collisions. However, conclusive evidence for jet quenching in pPb collisions remains elusive. This presents a puzzling scenario where the medium described by hydrodynamics, which significantly alters the distribution of final-state hadrons, seemingly leaves high-pT particles unaffected. To explore this further, two extensive analyses were conducted using a large sample of

pPb collision data at $\sqrt{s_{\mathrm{NN}}} = 8.16$ TeV, recorded by CMS in 2016. The first analysis investigates jet imbalance over a wide range of multiplicities and pseudorapidities, aiming to detect potential medium-induced modifications to jets at high p_T. The second focuses on a detailed study of differential Fourier coefficients (v_n), including measurements of p_T-differential multiparticle cumulants calculated with the subevent method, probing an extended region of multiplicities, up to high particle p_T. This analysis also compares pPb results with PbPb collisions in similar multiplicity ranges, highlighting similarities and differences in behavior between these systems. This presentation will discuss the key findings from these two comprehensive studies, shedding new light on the dynamics of pPb collisions at $\sqrt{s_{\mathrm{NN}}} = 8.16$ TeV.

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Advances in Balance Function Measurements

Auteur: Claude Pruneau[1]

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easurements of Balance Functions were proposed more than two decades ago to probe the evolution of particle production in relativistic heavy ion collisions by Pratt et al.. It subsequently emerged that Balance Functions can also be used to probe the susceptibility of QCD matter near the phase transition and the light quark diffusivity. I will briefly review the theoretical work done in the last two decades and summarize measurements reported by the STAR and ALICE collaborations. I will finally describe recent advances and ideas towards measurements of strange, baryon, and charm balance functions.

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The MUonE experiment at SPS

Auteur: Izabela Juszczak[1]

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The current theoretical prediction of the anomalous magnetic moment of the muon (aμ) in the Standard Model reveals ~5σ discrepancy when compared to experimental results. The primary source of uncertainty in the muon anomaly lies in the leading hadronic contribution to the theoretical prediction of aμ and is expected to be the main limitation in any potential discovery. The MUonE experiment proposes a novel approach to precisely evaluate this hadronic contribution, aiming to increase the significance of the observed discrepancy. The experimental method relies on precisely measuring the of hadronic contribution to aμ in the space-like momentum region through the μe ⟶ μe elastic scattering process.

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Magicity vs Superfluidity: Neutron correlations in the heavy F isotopes (online)

Auteur: Julian Kahlbow[1]

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Nuclear structure evolves dramatically in asymmetric systems, particularly near the drip lines. A notable example is the "Island of Inversion", where the magic neutron number N=20 breaks down, as established for proton number Z=10-13. We study the structure of the most neutron-rich Fluorine (Z=9) isotopes around N=20 using the SAMURAI spectrometer at RIBF/RIKEN. Measurements were performed in inverse and complete kinematics with radioactive-ion beams at ~250 MeV/u incident on a LH2 target. The first measurement of the neutron-unbound 30F isotope via the invariant mass method confirms the breakdown of the N=20 magic number, thus extending the "Island of Inversion", with significant consequences for the F and O iostopes. Large-scale shell model calculations suggest that ^{29}F and ^{28}O are superfluid nuclei where neutron pairs scatter between shells, potentially transitioning into a BEC-like regime with small size pairs. Future experiments are being developed to further investigate these correlations.

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Chiral symmetry restoration studies with Femtoscopy

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Disoriented isospin condensates in high energy heavy ion collisions (online)

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Fluctuations between charged and neutral kaons measured by the ALICE Collaboration in Pb-Pb collisions at the LHC exceed conventional explanations. Previously it was shown that if the scalar condensate is accompanied by an electrically neutral isospin–1 field then the combination can produce large equilibrium fluctuations where $\langle \overline{u}u \rangle \neq \langle \overline{d}d \rangle$. Hadronizing strange and anti-strange quarks might then strongly fluctuate between charged ($u\overline{s}$ or $s\overline{u}$) and neutral ($d\overline{s}$ or $s\overline{d}$) kaons. Here we estimate the times for the condensates to achieve their equilibrium probability distributions within causal volumes in high energy heavy ion collisions. This is achieved by modeling the temperature dependence of the condensates, mesonic collective excitations, decay rates of the associated fields, and employing the Langevin and Fokker-Planck equations. We find that the equilibration times are short compared with the expan- sion time, and therefore disoriented isospin condensates are a viable explanation for the anomalous fluctuations observed at the LHC.

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Concluding remarks

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Commemoration of Angelo Pagano

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Practicalities

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