ACHT 2021: Perspectives in Particle, Cosmo- and Astroparticle Theory

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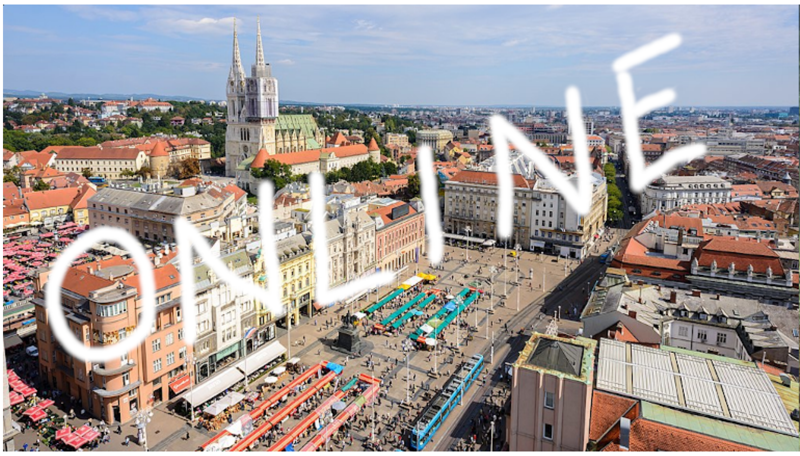

Book of Abstracts

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The effect of intermediate resonances in the quark interaction kernel on the time-like electromagnetic pion form factor

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An exploratory study of the time-like pion electromagnetic form factor in a Poincaré-covariant bound state formalism in the isospin symmetric limit is presented. Starting from a quark interaction kernel representing gluon-intermediated interactions for valence-type quarks, non-valence effects are included by introducing pions as explicit degrees of freedom. The two most important qualitative aspects are, in view of the presented study, the opening of the dominant rho-meson decay channel and the presence of a multi-particle branch cut setting in when the two-pion threshold is crossed. Based on a recent respective computation of the quark-photon vertex, the pion electromagnetic form factor for space-like and time-like kinematics is calculated. The obtained results for its absolute value and its phase compare favourably to the available experimental data, and they are analysed in detail by confronting them to the expectations based on an isospin-symmetric version of a vector-meson dominance model.

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Transverse single spin asymmetry at two loops

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Single spin asymmetry (SSA) is a high energy QCD phenomena associated with production of particles in collisions off a transversely polarized proton. There are several potential contributions that generate SSA at the leading, one-loop, order that originate from different soft parts of the cross section. The main focus of this talk will be on our recent work where we explicitly demonstrate that a genuienly new contribution coming from the gT(x) distribution function is first seen at two loops. I will provide the most important details of this calculation as well as explain the final formula. I will also explain what is needed for a non-zero SSA in general and also make remarks on the current status and different factorization frameworks used.

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Gintropy and the LGGR model for income and particle spectra

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On the coalescence phenomenology in heavy ion collisions

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Central nucleus-nucleus collisions produce many new baryons and the nuclear clusters can be formed from these species. The phenomenological coalescence models were used extensively for description of light nuclei from these baryons in a very broad range of collision energies. We suggest that the coalescence nucleation process can be effectively considered as 1) the formation of low density baryon matter which can be subdivided into primary diluted clusters with the limited excitation energy, and 2) the following statistical decay of such clusters leading to the final cold nuclei production. We argue that the nuclei formation from the interacting baryons is a natural consequence of the nuclear interaction at subnuclear densities resulting in the nuclear liquid-gas type phase transition in finite systems. In this way one can provide a consistent interpretation of the experimental fragment yields (FOPI data) including the important collision energy dependence of He isotope production in relativistic ion reactions. We investigate the regularities of this new kind of fragment production, for example, their yield, isospin, and kinetic energy characteristics.

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BRST-restoring 1-loop Counterterms for the Standard Model in Dimensional Regularization and Renormalization

Author: Hermès Bélusca-Maïto[1]

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I present the calculation of the BRST-restoring counterterms at 1-loop order for the Standard Model, necessary for restoring the BRST symmetry and the consistency of the model in the dimensional regularization and renormalization scheme. This talk is based on our recent publication: arXiv:2004.14398 (published in JHEP 08 (2020) 08, 024).

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Evidence for Odderon exchange from scaling properties of elastic collisions at the TeV scale

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We study the scaling properties of the differential cross section of elastic proton–proton (pp) and proton–antiproton (p\bar{p}p p ̄) collisions at high energies. We introduce a new scaling function, that scales –within the experimental errors –all the ISR data on elastic pp scattering from \sqrt{s} = 23.5 s =23.5–62.5 GeV to the same universal curve. We explore the scaling properties of the differential cross-sections of the elastic pp and p\bar{p}p p ̄ collisions in a limited TeV energy range. Rescaling the TOTEM pp data from \sqrt{s} = 7 s =7 TeV to 2.76 and 1.96 TeV, and comparing it to D0 p\bar{p}p p ̄ data at 1.96 TeV, our results provide an evidence for a t-channel Odderon exchange at TeV energies, with a significance of at least 6.26 σ. We complete this work with a model-dependent evaluation of the domain of validity of the new scaling and its violations. We find that the H(x)

scaling is valid, model dependently, within 200~\hbox {GeV}\le \sqrt{s} \le 8 TeV, with a -t−t range gradually narrowing with decreasing colliding energies.

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Renormalization vs Causality in Finite-Time-Path Out of Equilibrium

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We formulate the perturbative renormalization for the out-of-equilibrium gφ3 , gφ4 , QED … quantum field theory in the formalism with the finite time path. We use the retarded/advanced (R/A) basis of out-of-equilibrium Green functions, in which time ordering plays a role.
We use the dimensional regularization method and find the correspondence of diverging contributions in the Feynman diagrams and their counterparts in R/A basis. We find that the Dimensional Renormalization works exactly the way it does within the S-matrix field theories with the same number of subtraction. Although we reveal a number of problems related to energy (non-)conservation and causality, they are kept under control thanks to the D < 4 sector.
(This talk is based on collaboration with D. Klabučar and D. Kuić.)

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Topological susceptibility of pure gauge theory using Density of States

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The topological susceptibility of the SU(3) pure gauge theory is calculated in the deconfined phase at temperatures up to 10Tc. At such large temperatures the susceptibility is suppressed, topologically non-trivial configurations are extremely rare. Thus, direct lattice simulations are not feasible. The density of states (DoS) method is designed to simulate rare events, we present an application of the DoS method to the problem of high temperature topological susceptibility. We reconstruct the histogram of the charge sectors that one could have obtained in a naive importance sampling. Our findings are perfectly consistent with a free instanton gas.

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Renormalization group flows of field dependent couplings

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I will discuss the importance of considering field dependent couplings in low energy effective theories of the strong interaction. Particular emphasis will be put on the renormalization group flows of the Yukawa coupling and that of the axial anomaly in the three flavor quark meson model.

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Azimuthal correlations of D mesons with charged particles with the ALICE experiment at the LHC

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The ALICE experiment at the LHC at CERN investigates the fundamental nature of the strong interaction in collisions of protons or heavy-ions. In these high-energy collisions, heavy quarks are created in the early stages of the reaction and their numbers are conserved during the evolution of the system created in the collision. Understanding their production features in pp collisions is relevant in the frame of QCD studies, and they also represent an ideal probe of the strongly interacting hot and dense medium produced in heavy-ion collisions. In particular, the comparison of angular correlations between charmed mesons and charged hadrons produced in pp and p–Pb collisions can help to understand the production and fragmentation mechanisms of charm quarks.

In this talk we will present D-h correlation results from pp collisions at 5.02 and 13 TeV as well as p–Pb collisions at 5.02 TeV. We will also show detailed comparisons between data and several Monte Carlo simulations, which can give insight into the flavour-dependence of the hard production and radiation of partons, as well as fragmentation processes, and thus help in the interpretation of the charm-quark production and fragmentation.

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Di-Higgs production ($\gamma\gamma \rightarrow hh$) in Composite Models

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In Standard Model (SM) Higgs Boson pair production initiated by photons ($\gamma\gamma \rightarrow hh$) is loop-generated process and thereby is very sensitive to any new couplings and particles that may come in loops. Composite Higgs Models (CHMs) provide an alternate mechanism to address the hierarchy problem of SM where Higgs could be a bound state of a strongly interacting sector instead of being an elementary field. These set of models apart from modifying the SM Higgs couplings could also introduce new effective couplings that can have substantial impact on the loop processes. In this work we have studied the impact of Composite Higgs models in $\gamma\gamma \rightarrow hh$ (Di-Higgs) production process.

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On the mass spectrum of glueballs with even charge parity

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Results for the ground states and excited states of glueballs in Yang-Mills theory with $J^{\pm +}$, J=0,1,2,3,4 from Bethe-Salpeter equations are presented. The input comes from parameter-free Dyson-Schwinger calculations of the propagators and vertices. We compare with the corresponding lattice results and add some excited states to the known spectrum.

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New, multipole solutions of relativistic, viscous hydrodynamics

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We present a new class of exact fireball solutions of relativistic dissipative hydrodynamics. We describe new exact solutions both for the relativistic Navier-Stokes and for the Israel-Stewart theory, for arbitrary shear and bulk viscosities, as well as for other dissipative coefficients. The common property of these solutions is the presence of the relativistic Hubble flow. Our results generalize the recently found first solution in these classes, for an arbitrary temperature dependent speed of sound, shear and bulk viscosity, heat conduction and fluctuating initial temperature profiles. These solutions are causal and not only stable but also asymptotically perfect. A strong and narrow peak in the kinematic bulk viscosity is shown to imitate the effects of a first order phase transition. The new class of asymptotically perfect solutions is thus found to be very rich, but at the same time mostly academic as the solutions are limited by the spherical symmetry of the Hubble flow field.

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Large N_c behavior of thermodynamical quantities from the (axial)vector meson extended PQM model

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As t'Hooft has already pointed out in 1974 a systematic expansion in $1/N_c$ can be very useful in the investigation of certain properties of QCD. This kind of expansion can be carried out also in effective field theories of QCD like in the linear sigma model. For instance it is expected that the pseudocritical temperature T_c scales with N_c^0. This scaling and scaling of other interesting points of the chiral phase boundary such as the critical endpoint (CEP) can be investigated directly in the framework of the extended PQM model. During my talk I would like to address such questions.

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One-loop self-energy and curvature masses for (axial) vector mesons in ELSM

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The effective models play an important role in the investigation of the phase structure of the strongly interacting matter. The (axial) vector meson extended linear sigma model (ELSM) was already analysed at finite temperature and gave predictions to thermodynamical quantities and the critical end point. To improve this model with including an (axial) vector-fermion interaction and take into account mesonic one-loop corrections one needs to investigate the one-loop self-energy for (axial) vector mesons at finite temperature and understand its properties. These quantities and the curvature masses of the different modes were determined in a Nf=2+1 ELSM.

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Insights into hadron structure from deeply virtual Compton scattering

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The three-dimensional distribution of quarks and gluons is encoded in terms of the so called generalized parton distributions (GPDs), and the most promising access to these functions is via the process of deeply virtual Compton scattering (DVCS).
To overcome the problem of model bias, which is particularly dangerous in this context, we use the method of neural networks. As two applications, we discus the possibility of measurement of pressure inside the proton, and demonstrate separation of up and down quark distributions, when using both neutron and proton DVCS data.

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Nontopological solitons in Abelian gauge theories coupled to U(1)×U(1) symmetric scalar fields

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In a series of recent works, Ishihara and Ogawa have investigated nontopological solitons (Q-balls) in a spontaneously broken Abelian gauge theory coupled to two complex scalar fields. The present paper extends their investigations to the most general U(1)×U(1) symmetric quartic potential. Also, a new class of charged Q-ball solutions with vanishing self-interaction terms is investigated and some of their remarkable properties are exhibited.

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The spectrum of grand-unified theories

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It has been argued that the spectrum of observable particles in GUTs could be qualitatively different than the one expected in perturbation theory if manifest non-perturbative gauge invariance is required. After reviewing the underlying arguments lattice results in various channels in simplified GUT setups will be presented, which support these claims. This strongly suggest that criteria for selection of candidate GUTs need to be revised.

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Role of inhomogeneities in the flattening of the quantum effective potential

Author: Gergely Marko[1]

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We investigate the role of inhomogeneous field configurations in systems with a spontaneously broken continuous global symmetry. Textbooks tell us that the quantum effective potential of the system is flat in the thermodynamic limit. At the same time, spontaneous breaking is defined through the double limit, infinite volume at finite explicit breaking
sources, which then approach zero. This defining procedure leads to a flat potential by construction, however it is incapable of accessing the flat region itself. We argue that the flatness results from inhomogeneities and demonstrate it by carrying out constrained lattice simulations in the three dimensional O(2) model.

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Chiral U(1) model and restauration of symmetry at the 2-loop level

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Dimensional Regularization is one of the most commonly employed schemes for practical calculations in perturbative quantum field theories. In this scheme, however, the γ5 Dirac matrix needs to remain purely 4-dimensional in order to be able to describe theories with chiral anomalies, which are
necessary due to the fact that the existence of chiral fermions is a fundamental fact of nature. It is possible either to introduce
inconsistencies or to keep the mathematical rigor with Breitenlohner -Maison -'t-Hooft - Veltman scheme, with the consequence of breaking gauge and BRST symmetry. However, it is possible to restore symmetries with a choice of proper local counterterms, which will be shown in the U(1) example up to the two-loop level.

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Two-pole structures in QCD

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The two-pole structure refers to the fact that particular single states in the spectrum as listed in the PDG tables are often two states. In this talk, I will review the status of this emerging field and its consequences for our understanding of bound states in QCD.

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Effects of random phase shifts from multi-particle Coulomb-interactions on Bose-Einstein correlations

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Quantum-statistical correlation measurements in high-energy physics represent an important tool to obtain information about the space-time structure of the particle-emitting source. There are several final state effects which may modify the measured femtoscopic correlation functions. One of these may be the interaction of the investigated particles with the expanding hadron gas, consisting of the other final state particles. This may cause the trajectories – and hence the phases – of the quantum-correlated pairs to be modified, when compared to free streaming. The resulting effect could be interpreted as an Aharonov–Bohm-like phenomenon, in the sense that the possible paths of a quantum-correlated pair represent a closed loop, with an internally present field caused by the hadron gas. In this paper, the possible role of the effect in heavy-ion experiments is presented with analytical calculations and a simple numerical model. The modification of the strength of multi-particle Bose-Einstein correlation functions is investigated and it is found that, in case of sufficiently large source density, this effect may play a non-negligible role.

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Neutron Stars from the Functional Renormalization Group

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Neutron star physics provides the unique opportunity to directly connect the theory of cold and dense matter with experimental observations. Despite the recent progress in particular on the experimental side, many theoretical questions still remain open, such as the possible existence of quark matter or the occurrence of strangeness in neutron star cores. To answer these questions one essential ingredient is the precise knowledge of the equation of state (EoS) of cold and dense, beta-equilibrated matter. Very often the EoS is evaluated in mean-field approximated models where important nonperturbative fluctuations are simply ignored. We improve on these issues by applying a nonperturbative functional renormalization group (FRG) approach on a two- and three-flavor quark-meson truncation of low-energy QCD. In this talk we discuss the impact of (quantum) fluctuations on macroscopic astrophysical properties such as mass-radius relations. Furthermore, we construct a hybrid star EoS and consider additional vector meson interactions.

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The QCD phase diagram from analytic continuation

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I will discuss what is known about the QCD transition at small baryon densities from the analytic continuation of lattice QCD simulation results at purely imaginary baryochemical potentials.

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Inclusive photon production in high energy pA collisions from the Color Glass Condensate

Author: Anton Perkov[1]

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We compute a formula for the inclusive photon production cross section for high energy p+A collisions in the the q ->q gamma and g -> q qbar gamma channels (in the background field of the nucleus) using the Color Glass Condensate (CGC) formalism. We successfully demonstrate that the cross section has only factorizable final-state collinear divergences. The latter are isolated thus contributing to the photon fragmentation contribution in the MS-bar scheme and in both channels. Combined with the direct photon contribution, the obtained result is suitable for comparison with the data from RHIC and the LHC at mid rapidities and photon transverse momenta of a few GeV.

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Scaling properties of direct photons in heavy ion collisions

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Recently PHENIX Collaboration has shown that direct photon spectra, appropriately scaled by charged hadron density show universal behaviour known as multiplicity scaling. On the other hand the same data exhibit so called geometrical scaling, which follows from the non-linear nature of QCD. We show how these two scaling laws are connected.

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Constraining extended scalar sectors at current and future colliders

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After the discovery of a particle that complies with the properties of the SM Higgs boson, particle physics has entered an exciting era. A crucial question is whether the discovered particle is indeed the SM Higgs, or whether it is part of a new physics model featuring additional matter states. I will discuss a few examples to test such models at current and future colliders.

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Analogies between Lattice QCD and Truncated Nambu–Jona-Lasinio Model

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A modified Nambu–Jona-Lasinio Model with lattice structure is very instructive since it shows several similar problems and their solutions as the Lattice QCD. We study the limits of the large box size, small cell size and realistic pion mass. In particular, we study the relation of the discrete (bound state) solutions to the physical scattering states, for example the pion-pion scattering.

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Gauge-invariant description of the Higgs resonance

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In this talk, I will discuss the phenomenological consequences of a strict gauge-invariant formulation of the Brout-Englert-Higgs mechanism. This requires a description of physical observables in terms of bound state structures. Although this seems to be at odds with the common treatment of electroweak particle physics at first glance, the properties of the bound states can be described in a perturbative fashion due to the Fröhlich-Morchio-Strocchi (FMS) framework. In particular a relation between the bound states and the elementary fields is obtained within $R\xi$ gauges such that the main quantitative properties of the conventional description reappear at leading order of the FMS expansion. However, slight deviations of off-shell properties can be caused by the internal bound state structure. Further, I will show that the FMS approach provides a gauge-invariant Higgs spectral function which is not plagued by positivity violations or unphysical thresholds.

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Using a strongly intense observable to study the formation of quark-gluon string clusters in pp collisions at LHC energies

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The using of strongly intensive observables are considered as a way to suppress the contribution of trivial "volume"fluctuations in experimental studies of the correlation and fluctuation phenomena [1]. In this regard, we study the properties of the strongly intensive variable Σ characterizing correlations between the number of particles produced in two observation windows separated by a rapidity interval in pp interactions at LHC energies in the model with quark-gluon strings (color flux tubes) as sources [2,3].
It is shown that in the version of model with independent identical strings this variable really depends only on the individual characteristics of a string and is independent of both the mean number of strings and its fluctuation, which reflects its strongly intensive character.
In the version of the model when the string fusion processes are taken into account, and a formation of string clusters of a few different types takes place, it was found that the observable Σ is proved to be equal to a weighted average of its values for different string clusters, with weight factors, depending on details of the collision - its energy and centrality [4].
The analytical calculations are supplemented by the MC simulations permitting to take into account the experimental conditions of pp collisions at LHC energies. We perform the MC simulations of string distributions in the impact parameter plane and take into account the string fusion processes, leading to the formation of string clusters, using a finite lattice (a grid) in the impact parameter plane [4,5].
As a result, the dependences of this variable both on the width of the observation windows and on the value of the gap between them were calculated for several initial energies. Analyzing these dependencies we see that in pp collisions at LHC energies the string fusion effects have a significant impact on the behavior of this observable and their role is increasing with the initial energy and centrality of collisions. In particular, we found that the increase of this variable with initial energy and collision centrality takes place due to the growth of the portion of the dense string clusters in string configurations arising in pp interactions.
We show that the comparison of our model results with the preliminary experimental values of the strongly intensive variable obtained by the analysis of the ALICE data on pp collisions at 0.9 and 7 TeV enables to extract information on the parameters characterizing clusters with different numbers of merged strings, in particular, to find their two-particle correlation functions and the average multiplicity of charged particles from cluster decays [5].

This work was supported by the project of St. Petersburg State University, ID: 75252679.

References:
1. M.I. Gorenstein, M. Gazdzicki, Strongly intensive quantities, Phys. Rev. C 84 (2011) 014904.
2. V. Vechernin, Eur. Phys. J.: Web of Conf. 191 (2018) 04011. 3. E. Andronov, V. Vechernin, Strongly intensive observable between multiplicities in two acceptance windows in a string model, Eur. Phys. J. A 55 (2019) 14.
4. S.N. Belokurova, V.V. Vechernin, Strongly intensive variables and long-range correlations in the model with a lattice in the transverse plane, Theor. Math. Phys. 200 (2019) 1094.
5. V.V. Vechernin, S.N. Belokurova, The strongly intensive observable in pp collisions at LHC energies in the string fusion model, J. Phys.: Conf. Ser. 1690 (2020) 012088.

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Scaling properties of jets in high-energy pp collisions

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Measurements of jet profiles in high-energy collisions are sensitive probes of QCD parton splitting and showering. Precise understanding of the jet structures are essential for setting the baseline not only for nuclear modification of jets in heavy-ion collisions, but also for possible cold QCD effects that may modify jets in high-multiplicity proton-proton collisions. In this talk we demonstrate that the radial jet profiles in proton-proton collisions exhibit scaling properties with charged-hadron event multiplicity over a broad transverse-momentum range. Based on this we propose that the scaling behavior stems from fundamental statistical properties of jet fragmentation. We also study the multiplicity distributions of events with hard jets and show that the charged-hadron multiplicity distributions scale with jet momentum. This suggests that the Koba–Nielsen–Olesen (KNO) scaling holds within a jet. The in-jet scaling is fulfilled without multiple-parton interactions (MPI), but breaks down in case MPI is present without color reconnection. Our findings imply that KNO scaling is violated by parton shower or multiple-parton interactions in higher-energy collisions.

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The role of small hard-core radius of (anti-)Lambda-hyperons in (anti-)hyper-triton production puzzle

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We present a summary of the results obtained with the novel hadron resonance gas model based on the induced surface tension equation of state [1] with the multicomponent hard-core repulsion. This model is used to resolve the long-standing problem to describe the light nuclear cluster multiplicities including the hyper-triton nucleus measured by the STAR Collaboration, known as the hyper-triton chemical freeze-out puzzle [2]. Here we discuss an entirely new strategy to analyze the experimental data on light nuclear clusters and employing it in the analysis of hadronic and light (anti-)(hyper-)nuclei multiplicities measured by the STAR Collaboration at the center-of-mass collision energy $\sqrt{s_{NN}} = 200$ GeV and by the ALICE Collaboration at $\sqrt{s_{NN}} = 2.76$ TeV. We got rid of the existing ambiguity in the description of light (anti-)(hyper-)nuclei data and determined the chemical freeze-out parameters of nuclei with high accuracy and confidence. This success is achieved by taking into account the correct excluded volumes of light nuclei in hadronic medium and by using the small value of the hard-core radius of the (anti-)lambda hyperons found in earlier work [1]. One of the most striking results is that for the most probable scenario of chemical freeze-out for the STAR energy the obtained parameters allow us to reproduce the multiplicities of hadrons and light (anti-)(hyper-)nuclei and, for the first time, to simultaneously describe the values of the experimental ratios S_3 and anti-S_3 which were not included in the fit. Our results show that the multiplicities of light nuclear clusters may be frozen prior to the hadrons at temperatures about $170 - 175$ MeV. The new presented strategy allows one to determine the hard-core radii of other hyperons with high accuracy, if the yields of their hyper-nuclei are known. [1] K. A. Bugaev et al., Nucl. Phys. A 970, (2018) 133-155. [2] O. V. Vitiuk et al., Eur. Phys. J. A 57, (2021) 74 1-12.

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Charmonium properties in hadron-nucleus reactions

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We study the excitation function of the low-lying charmonium states: J/Ψ, Ψ(3686) in p, π and p¯, Au collisions taking into account their in-medium propagation. The time evolution of the spectral functions of the charmonium state is studied with a BUU type transport model. We calculated the charmonium contribution to the dilepton spectrum. We study how the short range correlations in nuclei effect the excitation function of J/Ψ and show that for Ψ(3686) production there is a good chance to observe its in-medium modification with good resolution detectors. The energy regime will be available in JPARC, PANDA and CBM.

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Topological origin of hadronic mass

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A strong influence of weak decays on chemical freeze-out parameters of hadrons measured in high energy nuclear collisions found within the advanced Hadron Resonance Gas Model

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The advanced Hadron Resonance Gas Model (HRGM) which correctly accounts for the sequential-strong and weak decays is developed. Our analysis of the STAR experiment data on hadronicmultiplicities demonstrates that taking into account for the weak decays is extremely important tohave a model that can describe the data with very high accuracy.
We report our results on fitting the particle yields measured at midrapidity in central nuclearcollisions by the STAR Collaboration during the Beam Energy Scan I (BES) program for the centerof-mass collision energies √sNN = 7.7 – 200 GeV using an advanced HRGM based on the inducedsurface tension equation of state [1, 2] with the multicomponent hard-core repulsion.
Two fitting schemes are used: with and without weak decays. The chemical freeze-out (CFO)parameters extracted from the fit show a significant influence of weak decays on the fit quality.Moreover, their inclusion into the analysis of BES I data leads to decreasing the CFO temperatureof hadrons by about 10–15 MeV. For the highest RHIC energies of collision the new CFOtemperatures of hadrons, for the first time, are in complete agreement with the ones obtained earlierfor the ALICE energy √sNN = 2.76 TeV [2, 3]. Furthermore, it is found that the new CFOtemperatures of hadrons practically coincide with the lattice QCD results on pseudocriticaltemperatures at small values of baryonic chemical potential. Remarkably, it is shown that the CFOparameters of light (anti-, hyper-) nuclei obtained in [3] are not affected by these modifications.

References:
[1] K. A. Bugaev et al., Nucl. Phys. A 970, (2018) 133–155.
[2] K. A. Bugaev et al., Eur. Phys. J. A 56, (2020) 293–1-15.
[3] O. V. Vitiuk et al., Eur. Phys. J. A 57, (2021) 74 1-12.