XXXVII International Workshop on High Energy Physics “Diffraction of hadrons: Experiment, Theory, Phenomenology”

вторник, 22 июля 2025 г. - четверг, 24 июля 2025 г.

Тезисы

Contents

Morning session 5 / **1**

Precise determination of the Pomeron intercept via a scaling entropy analysis

Author: Lucas Moriggi[1]

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(ONLINE)
Recent high-energy scattering data reveal that entropy-based observables offer a powerful new lens on the dynamics of hadron structure and particle production. In this talk, I present a unified framework in which **scaling entropy** derived from charged hadron multiplicity distributions and partonic transverse momentum fluctuations exposes a universal behavior across deep inelastic scattering and proton–proton collisions at the LHC. By analyzing entropy as a function of Bjorken-x, we determine the growth rate parameter λ, which is directly linked to the **Pomeron intercept** in Regge-inspired QCD evolution. This approach not only provides a precise extraction of the intercept but also demonstrates the breakdown of traditional KNO scaling in favor of a more fundamental **diffusion scaling** associated with gluon dynamics. We find that the entropy growth is consistent across experiments and energy scales, supporting its interpretation as a robust initial-state observable.

Afternoon session / **2**

Multiplicity distribution and the reflective scattering

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(OFFLINE)
Transition to the reflective scattering mode which has emerged at the highest LHC energy of $\sqrt{s} = 13$ TeV results in a relative shrinkage with the energy of the impact parameter region responsible for the inelastic hadron collisions. Respective increasing role of the multiplicity fluctuations of quantum origin is emphasized.

Afternoon session / **3**

Increase of the Coalescence Coefficient in Diffraction Processes

Author: Vladimir Vechernin[1]

[1] *Saint-Petersburg State University*

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(ONLINE)
We study the formation of high-energy deuterons by the coalescence mechanism in ultrarelativistic heavy-ion collisions. We find the coalescence coefficient by calculating the corresponding Feynman diagrams taking into account the coherent nature of the process. We show that the probability of neutron and proton fusion into a high-energy deuteron is higher in the diffraction region than in the central rapidity region. We also present the physical interpretation of this phenomenon.

Morning session 5 / **4**

Regge traijectories in QCD

Author: Victor Kim[1]

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(OFFLINE)
Various QCD approaches to the Regge traijectories are briefly reviewed. Nonperturbative and perturbative aspects of the QCD-based approaches to the Regge trajectories are discussed.

Morning session / **5**

Pomeron weights in QCD processes at high energy and the S-matrix unitarity constraint

Author: Rami Oueslati[1]

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(ONLINE)
In this talk, I explore the fundamental nature of pomeron exchanges in high-energy hadronic collisions. Although various unitarization schemes of the elastic scattering amplitude satisfy the S-matrix unitarity constraint, I will argue that rational unitarization—such as the U-matrix, is more optimum for describing QCD processes at high energies than eikonal-like schemes. I will present results showing that the U-matrix scheme leads to enhanced fluctuations and stronger higher-order pomeron correlations, with a significant impact on multi-parton interactions, particularly double parton scattering. These features contrast with the more independent pomeron exchanges observed in the eikonal case. Crucially, I will show that the pomeron distribution is determined by the unitarization scheme used, and that this choice is not arbitrary if one seeks to model hadronic observables realistically at high and ultra-high energy.

Afternoon session 6 / **6**

Pomeron- and photon- exchange contributions in proton-nuclear collisions with large rapidity gaps at the LHC energies

Authors: Dmitry Sosnov[1]; Victor Kim[2]; Ekaterina Kuznetsova[None]

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(OFFLINE)
Recent results of proton-Pb collisions with large forward rapidity gap events at the LHC show a dominant role of photon exchange over pomeron one.
A comparison of LHC proton-proton, proton-nuclear forward rapidity gap events provides an opportunity for the estimation of
A- and Z- dependencies of pomeron- and photon- exchange contributions, respectively.

Morning session 3 / 7

Unified Description of Elastic Hadron Scattering at Low and High Energies

Author: Oleg Selyugin[1]

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(OFFLINE)
A brief analysis of the development of elastic scattering models in the LHC era is presented and short overview of the results of the model
based on the analyticity of the scattering amplitude with taking into account the hadron structure for high energy hadron elastic scattering
{\rm $pp, p\bar{p}, pn, p\pi$ ($\sqrt{s} = 3.6$ GeV up to $\sqrt{s} = 13$ TeV)}. The main features of the model are: a unique energy dependence of the basic asymptotic terms of the Born amplitude (all Born terms have one fixed intercept); the real part of the hadronic elastic scattering amplitude is determined only through the complex Mandelstam variable S satisfying the dispersion relations; the use of two fixed forms of factors determined by different momenta of the same Generalized Parton Distribution (GPDs). We have examined the new form of the momentum transfer dependence of GPDs of hadrons to obtain different form factors, including Compton form factors, electromagnetic form factors, transition form factor, and gravitomagnetic form factors.
The negligible contributions of the hard Pomeron and the non-small contributions of the maximal Odderon were obtained. The non-dying form of the spin-flip amplitude is examined as well. The structure of the Born term and unitarized scattering amplitude are analysed. It is shown that the Black Disk Limit for the elastic scatering amplitude is not reached at LHC energies.

Afternoon session / 8

Multiplicity Distributions and Modified Combinants in the Multipomeron Model of pp Interaction at High Energies

Authors: Vladimir Kovalenko[1]; Vladimir Vechernin[1]; Evgeny Andronov[1]; Andrei Puchkov[1]

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(OFFLINE)
The multiplicity distributions of charged particles and their combinants for pp collisions at LHC energies are studied within the Multipomeron Exchange Model (MEM) that takes into account the phenomenon of string fusion. It is shown that the use of Gaussian-type distributions for multiplicity distributions at a fixed number of pomerons allows, within the MEM framework, the reproduction of the resulting multiplicity distributions and the oscillatory behavior of combinants, found in the ALICE and CMS pp collision data at LHC energies. It is important that in the proposed approach, the parameters of these Gaussian-type distributions are not considered free, but are calculated from the two-particle correlation function of a single string. The role of diffraction processes in the behavior of combinants is discussed.
The authors acknowledge Saint-Petersburg State University for a research project 103821868.

Morning session / 9

Introductory greeting

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(offline)

Morning session / **10**

Modern status of diffractive studies

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(ONLINE)
The main properties of high energy diffraction are considered. Plan: 1.Definition Diffraction = elastic scattering caused by the distortion of incoming wave function V.N. Gribov – “High energy diffraction may be related to confinement since here we deal with the amplitude of high energy particles interaction.” Diffractive events is a good place to search for the new physics (glueballs, QCD instanton, etc.) in a good experimental environment (i.e. low secondaries multiplicity) 2. Pomeron (multiperipheral models, QED, BFKL) Diffractive cone shrinkage 3. AGK-rules, space-time picture U-matrix or eikonal unitarization 4. Weak vs. strong Pomeron-Pomeron interaction 5. TOTEM-ALFA σ_{tot} tension

Morning session / **11**

Unitarity effects in high-energy elastic scattering

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(ONLINE)
e-Print: 2402.11385 [hep-ph]
Abstract We investigate the high-energy behavior of the elastic scattering amplitude within two distinct unitarization frameworks: the eikonal and the U-matrix schemes. Our analysis begins with a purely Pomeron-based formalism, incorporating pion-loop insertions in the Pomeron trajectory to account for the nearest singularity imposed by t-channel unitarity. We then extend the framework to include the contribution of an Odderon. Particular attention is given to the existing tension between TOTEM and ATLAS measurements of the total cross section $\sigma_{tot}(s)$ and the differential cross section $d\sigma/dt$ at 7, 8, and 13 TeV. We explore the implications of these discrepancies for the structure and properties of both the Pomeron and the Odderon.

Morning session / **12**

Elastic proton-proton and pion-proton scattering in holographic QCD

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(ONLINE)
https://journals.aps.org/prd/abstract/10.1103/PhysRevD.107.014018 https://journals.aps.org/prd/abstract/10.1103/Phys
https://journals.aps.org/prd/abstract/10.1103/PhysRevD.108.066001 https://journals.aps.org/prd/abstract/10.1103/Phys
Abstract The total and differential cross sections of elastic proton-proton and pion-proton scattering processes are studied in the framework of holographic QCD, considering the Pomeron and Reggeon exchange in the Regge regime. In our model setup, the Pomeron and Reggeon exchange are described

by the Reggeized spin-2 glueball and vector meson propagator, respectively. For the differential cross sections, contributions of the Coulomb interaction are also taken into account. Adjustable parameters involved in the model are determined with the experimental data, and it is presented that the resulting cross sections are consistent with the data in a wide kinematic region.

Afternoon session / **13**

General discussion 1: Discussion leader: Sergey Troshin

Morning session 3 / **14**

Ultra peripheral collisions at ALICE

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(ONLINE)
Ultra-peripheral collisions at the LHC provide a unique opportunity to study photon-hadron interactions in the new kinematic regime. Recent ALICE results from Run 2 on J/psi photoproduction in ultra-peripheral p-Pb and Pb-Pb collisions provide stringent constraints on gluon saturation effects. ALICE measurements on the coherent rho photoproduction allow for the studies of QCD in the black-disc limit and reveal signatures of quantum interference at femtoscopic scales. New ALICE data from Run 3 provide an opportunity to study inclusive photonuclear processes and perform high-precision vector meson photoproduction measurements. In this talk, an overview of recent ALICE results on ultra-peripheral collisions will be presented.

Morning session 3 / **15**

Coherent photoproduction of light vector mesons off nuclear targets in the dipole picture

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(ONLINE)
https://doi.org/10.1016/j.nuclphysa.2025.123018
Abstract We investigate coherent photoproduction of light vector mesons in Pb–Pb ultraperipheral collisions using the color dipole approach. Our analysis incorporates the Glauber–Gribov formalism with a gluon shadowing correction modeled via an effective suppression factor RG. This factor is fitted to match experimental data from the deep inelastic structure function F2 (E665) and ρ meson photoproduction (ALICE), yielding optimal agreement with RG=0.85 at scale Mρ2/4=0.15 GeV2. Based on this framework, we provide predictions for coherent photoproduction of ground and excited states, including ρ(2S), ω(1S,2S), and ϕ(1S,2S), employing holographic wave functions for the vector mesons.

Morning session 3 / **16**

J/Ψ -meson photoproduction off the nucleon in a dynamical model

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(ONLINE)
Physical Review C.104.045202 2. arXiv: 2503.09995
Abstract The photoproduction of Φ and J/ψ meson off the nucleon is investigated within a dynamical model approach based on a Hamiltonian which describes the reaction mechanisms of the Pomeron exchange, meson exchange, and direct Φ- or J/ψ-radiation terms. The final state interaction is described by the gluon-exchange and direct Φ- or J/ψ-N coupling terms. The parameters of the Hamiltonian are determined by the latest experiments at the Jefferson Laboratory (JLab). We have found that the t-channel light mesons play a crucial role to describe the available JLab data in the low-energy region.

Afternoon session 4 / 17

Azimuthal modulation in diffractive vector meson/di-jet production in ultra-peripheral collisions

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(ONLINE)
https://inspirehep.net/literature/1800744 https://inspirehep.net/literature/1971682 https://inspirehep.net/literature/275
Abstract The photons in ultra-peripheral collisions (UPCs) are highly linearly polarized and can be used as probes to test QCD phenomenology, such as nucleon structure. We studied the cos 2ϕ and cos 4ϕ modulations in diffractive vector meson and dijet production in UPCs. A theoretical description based on Fermi-scale double-slit interference was established, and the results for the cos 2ϕ asymmetry are consistent with experimental measurements from STAR and ALICE. Both the elliptic gluon Wigner distribution and final-state soft photon radiation can give rise to a cos 4ϕ azimuthal asymmetry in ρ-meson production. Additionally, we revisited diffractive dijet production in UPCs, incorporating the effects of both initial- and final-state soft gluon radiation, and obtained results that align more closely with experimental data.

Afternoon session 4 / 18

Single and double diffractive production of dilepton and photon at LHC

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(ONLINE)
This study investigates the single and double diffractive production of dileptons and photons in ultra-peripheral collisions at the Large Hadron Collider (LHC). Utilizing advanced theoretical models that integrate quantum electrodynamics (QED) and Quantum Chromodynamics (QCD) frameworks, we analyze the differential cross sections of these processes, with particular emphasis on the role of the Pomeron and resolved Pomeron structures. Our research employs semi-coherent two-photon production mechanisms to predict dilepton production rates under various LHC energy scenarios. Our results demonstrate distinct production patterns for single and double diffractive processes, highlighting their potential as probes for studying the electromagnetic structure of heavy ions and the dynamics of soft interactions in high-energy collisions. This paper provides new insights into the photon-mediated and Pomeron-mediated production mechanisms and sets the stage for future experimental investigations at collider facilities. Key words: Dileptons, Photon, Diffractive processes, Ultraperipheral collisions, LHC (Large Hadron Collider). PACS: 12.39.St, 13.85.Dz, 25.75.Cj

Afternoon session 4 / 19

Higgs bosons production and scattering processes beyond the perturbation theory

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(ONLINE)
To study the Higgs boson decay into a proton-antiproton,-boson, -boson, quarks et al pairs with large momenta, analytical preparation is performed based on the study of the asymptotic expression for the Higgs-boson at arbitrary angles scattering amplitude in the ladder approximation. To formulate the computational model in the ladder approximation, the Bethe-Salpeter equation with a minimum perturbative kernel has been used and the solution in the Regge asymptotical form is found.

Afternoon session 4 / 20

Chiral symmetry, Conformal breaking, and transport coefficients in the two-flavour PNJL theory.

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(ONLINE)
[1] J. Wu, Y. Yin, and J. Shi, Joint simulation study of chiral symmetry recovery and transport response in QCD at finite temperature and chemical potentials, arXiv:2504.18567 [hep-ph] (2025). [2]K. Fukushima, Chiral effective model with the Polyakov loop, Phys. Lett. B 591, 277 (2004). [3]C. Ratti, M. A. Thaler, and W. Weise, Phases of QCD: Lattice thermodynamics and a field-theoretical model, Phys. Rev. D 73, 014019 (2006). [4]P. Kovtun, D. T. Son, and A. O. Starinets, Viscosity in strongly interacting quantum field theories from black hole physics, Phys. Rev. Lett. 94, 111601 (2005). [5]M. A. Stephanov, Non-Gaussian fluctuations near the QCD critical point, Phys. Rev. Lett. 102, 032301 (2009).
Abstract We develop a theoretical framework for analyzing transport phenomena in QCD matter using the two-flavor PNJL model. Within the relaxation-time approximation and Kubo formalism, we compute the shear and bulk viscosities and reveal their intrinsic connection to chiral symmetry restoration and conformal symmetry breaking. The η/s minimum tracks the vanishing quark condensate, while the ζ/s peak correlates with the trace anomaly and sound velocity suppression. These transport extrema reflect the structure of the effective potential and energy-momentum tensor correlators, providing a microscopic realization of critical dynamics in strongly interacting matter.

Afternoon session 4 / 21

General discussion 2: Discussion leader: Vladimir Petrov

Morning session 5 / 22

Energy dependence of cross sections in proton-proton and antiproton-proton collisions

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(ONLINE)
Energy dependence of cross sections, mostly total and elastic, is studied for proton-proton and antiproton-proton collisions. Particularly, the range of very high collision energies larger or about 10 TeV is considered. The interest to that energy domain is driven by the following reasons. The large-scale projects of hadronic colliders of next generation assume the measurements for proton-proton interactions at collision energies about 100 TeV in order to magnitude. Phenomenological study of cross sections as one the most important global quantities for (anti)proton-proton scattering at very high collision energies can be helpful for search for the onset of the asymptotic regime in energy dependence of cross sections and related parameters as well as for the establish of more precision and mathematically rigorous criteria for asymptotic domain. Exploration of discussed dependence is promising tool for future developments in the physics of cosmic rays. Data samples included all available high-energy measurements up to date are analyzed for (anti)proton-proton collisions in order to derive analytic forms of energy dependence for total cross section as well as for the ratio of the elastic-to-total cross sections within various models. In the case of total cross section the set of approximation functions under consideration consists of equations within axiomatic quantum field theory [1], model with multiple reggeon exchange [2] and semiclassical approach with saturation [3], which admits the phenomenon of bosonic condensation. Also analytic functions [4] are used for approximation of the experimental energy dependence of the ratio of the elastic-to-total cross sections in (anti)proton-proton interactions. Most of model dependencies of total cross section on collision energy show the behavior close to the Froissart–Martin limit in functional sense. On the basis of the resulting approximations, the total cross section and the ratio of the elastic-to-total cross sections for proton-proton collisions are estimated at various collision energies up to an ultra high values about of 10 PeV in order of magnitude. In general, Bose–Einstein condensation (BEC) can provide the noticeable growth of multiplicity of secondary pions at sufficiently high energies [5] which can affect the behavior of cross sections. Thus, perhaps, BEC can be suggested as one of the possible dynamical mechanisms which may lead to some novel feature in energy dependence of cross sections. The investigation of bosonic condensation will shed new light on the nature of superfluidity of strongly interacting matter which can influence on the ratio of cross sections mentioned above. Studying the possible BEC effect on the pion yield may be one of the perspective research directions for better understanding of the muon enhancement in ultra-high energy cosmic ray (UHECR) measurements [5]. Therefore phenomenological studies of energy behavior of cross sections for (anti)proton-proton interactions, in particular, in collision energy domain of 100 TeV and even up to 10 PeV in order of magnitude are important for various fields of fundamental physics and these investigations have large interdisciplinary value. References [1] S. D. Campos, V. A. Okorokov, Int. J. Mod. Phys. A 25, 5333 (2010); V. A. Okorokov, S. D. Campos, ibid 32, 1750175 (2017). [2] V. A. Petrov, V. A. Okorokov, Int. J. Mod. Phys. A 33, 1850077 (2018). [3] V. A. Okorokov, Phys. At. Nucl. 81, 508 (2018). [4] V. A. Okorokov, Phys. At. Nucl. 82, 134 (2019). [5] V. A. Okorokov, Phys. At. Nucl. 87, 172 (2024).

Morning session 5 / **23**

Covariant reggeization framework for diffraction

(OFFLINE)
We consider the general structure of irreducible tensor representations of the Poincare group of arbitrary dimension with multiple sets of Lorentz indices and different ways to construct them from basic elements. Then we apply the same methods to obtain the expansion of general hadronic tensors in terms of these irreducible tensor representations. We propose to use an effective approach in hadronic diffraction, which was usually called covariant reggeization, and obtain basic functions to calculate all the diffractive cross-sections.

Afternoon session 6 / 24

Recent experimental results on charge exchange reactions with VES setup

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(OFFLINE)
Two topics on charge exchange (ChEx) production of exclusive systems of light mesons by pions on nuclei will be presented. The first one is the completed study of the omega(782) phi(1020) channel with the dominance of the scalar isoscalar resonance f0(1710), which characteristics point to its glueball-like nature. The second one is a preliminary report on the first observation of the eta’(958) pi+pi- system in the ChEx, with somewhat speculative consideration of rho(2150) as its possible origin.

Afternoon session 6 / 25

Light vector meson photoproduction in ultraperipheral heavy ion collisions at the LHC within the Reggeometric Pomeron approach

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(ONLINE)
László Jenkovszky, Érison S. Rocha, Magno V. T. Machado - Light vector meson photoproduction in ultraperipheral heavy-ion collisions at the LHC within the Reggeometric Pomeron approach - https://doi.org/10.1002/asna.20220117
Abstract By using the Reggeometric Pomeron model for vector meson production which successfully describes the high energy lepton-nucleon data, we analyze the light meson production in ultraperipheral heavy-ion collisions at the Large Hadron Collider (LHC). The rapidity distributions for rho and phi photoproduction in lead–lead, xenon–xenon and oxygen–oxygen collisions are investigated.

Afternoon session 6 / 26

On sizes of hadrons

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(OFFLINE)

Afternoon session 6 / 27

General discussion 3: Discussion leader: Viktor Kim