Conference
"Frontiers of Holographic Duality-6 "

Program
Titles & Abstracts

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Steklov Mathematical Institute of Russian Academy of Sciences, Moscow, Russia

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All times here are given in Moscow time (UTC+3).

Monday 17.11.2025

11:00 -12:00
Mihailo Čubrović (Belgrade, Inst. Phys.)
Chaos, averaging and holography in LLM geometries
We consider the dynamics of geodesics in Lin-Lunin-Maldacena (LLM) bubbling AdS solutions. The LLM solutions can be characterized by black and white patterns in a plane, which become gray upon ensemble averaging or coarse-graining. We find that the geodesics in black and white geometries exhibit complicated behavior with both chaos and trapping, corresponding to complex structure of the coherent states of long single-trace operators in dual CFT. For short times, this behavior is self-averaging and the average over geodesics is well-approximated by the geodesics in averaged (grayscale) backgrounds; at long times, the self-averaging breaks down completely. We discuss how this might correspond to thermal features of the CFT correlators, and more generally what is the holographic dictionary entry for bulk chaos."

12:05-13:05
Dimitrios Giataganas(NSYSU, Taiwan and NCTS, Taipei)
Black Holes, Photon Rings and Holography: A Unified View via the Penrose Limit
We study the physics of photon rings in a wide range of axisymmetric black holes admitting a separable Hamilton-Jacobi equation for the geodesics. Utilizing the Killing-Yano tensor, we derive the Penrose limit of the black holes, which describes the physics near the photon ring. The obtained plane wave geometry is directly linked to the frequency matrix of the massless wave equation, as well as the instabilities and Lyapunov exponents of the null geodesics. Consequently, the Lyapunov exponents and frequencies of the photon geodesics, along with the quasinormal modes, can be all extracted from a Hamiltonian in the Penrose limit plane wave metric. Additionally, we explore potential bounds on the Lyapunov exponent, the orbital and precession frequencies, in connection with the corresponding inverted harmonic oscillators and we discuss the possibility of photon rings serving as effective holographic horizons in a holographic duality framework for astrophysical black holes. Our formalism is applicable to spacetimes encompassing various types of black holes, including stationary ones like Kerr, Kerr-Newman, as well as static black holes such as Schwarzschild, Reissner-Nordström, among others.

13:30-14:30
Andrei Starinets (Oxford U., Theor. Phys.)
Hydrodynamic stability of black branes and holography
We establish the connection between thermodynamic and dynamical instabilities in relativistic hydrodynamics with multiple flavours of conserved U(1) charges. In theories with positive hydrodynamic entropy production, where the underlying perfect fluid has a positive speed of sound squared and satisfies the null energy condition, we show that hydrodynamic instabilities can arise only through negative diffusion coefficients associated with the U(1) charges. The onset of such instabilities is governed by the eigenvalues of the thermodynamic Hessian matrix, while the flavour-space polarisations of the unstable diffusion modes are determined by the corresponding eigenvectors. We illustrate this connection using strongly coupled N=4 supersymmetric Yang-Mills theory at finite densities of the three U(1) R-charges. In the dual holographic description, the five-dimensional STU black brane exhibits unstable quasinormal modes precisely at the onset of thermodynamic instability. We derive analytic expressions for the R-charge diffusion coefficients in several representative cases, including the configuration with three equal chemical potentials.

14:35-15:35
Mei Huang (UCAS, Beijing)
Dynamical Holographic QCD Meets the Data
Based on a machine learning holographic QCD model, we construct a systematical framework to investigate the properties of the scalar glueballs continuously from zero temperature to finite temperature. By using both the quasinormal frequencies and the spectral functions, we extract the pole masses, thermal widths, screening masses and dispersion relation of the scalar glueballs in hot medium. It is shown that the pole masses almost remain the vacuum values at temperatures far below the critical temperature, and then decrease with the increasing of temperature until a temperature lower than. This result qualitatively agrees with earlier lattice simulations. While the pole masses increase monotonically above the critical temperature, which agrees with recent lattice calculation. Meanwhile, it is shown that the thermal widths increase monotonically with temperature, which also agrees with the near
lattice simulations. The screening mass exhibits a similar temperature-dependent behavior to the pole mass, while the dispersion relation increasingly deviates from the relativistic one as the temperature rises. It is interesting to note that we obtain the imaginary corrections in the thermal correlators, which contains both the temperal and spatial information and might be helpful for the four-dimensional calculations. Furthermore, by comparing the quasinormal modes and the spectral functions, we note that it requires more careful analysis when applying the spectral functions in studying thermal hadrons from holography, since there could be other types of quasinormal modes which are not related with bound states while they may contribute to the peaks of the spectral functions.

16:00-16:30
Anastasia Golubtsova (BLTP JINR)
Irrelevant deformations in 3d gauged supergravity with periodic potential
In this talk I will discuss solutions with AdS/dS asymptotics for D=3 truncated gauged supergravity with a periodic scalar potential. From a holographic perspective, these solutions describe deformations of two-dimensional conformal field theories (CFTs). We demonstrate that assuming Dirichlet boundary conditions these deformations are driven by non-zero vacuum expectation values of irrelevant operators and can be considered as exotic RG flows. Generalizing the flows to finite temperature we find that the corresponding geometries are singular, but contain horizon.

16:30-17:00
Sergei Ovchinnikov (ITMP, Moscow)
Holographic drag force from charged rotating black holes in AdS5
he realistic description of a quark-gluon plasma produced by colliding ultrarelativistic heavy nuclei should account for non-central collisions characterised by large angular momentum. We construct a holographic dual of this process by submerging a string, which models a heavy quark, into a 5d bulk described by a charged rotating asymptotically AdS5 black hole, thus accounting for QGP anisotropy. We study the effects of rotation on the drag force experienced by the quark and evaluate the jet-quenching parameter. Furthermore, we discuss a toy model that allows for analytic drag force calculation beyond the slow-rotating regime.

Tuesday 18.11.2025

11:00-12:00
Igor Volovich (MIRAS)
Generalized holography and quantization of thermodynamics
In this talk I will discuss the possibility of microscopic description of black hole entropy using Black Hole/Bose gas duality approach.

12:05-13:05
Mikhail Khramtsov (MIRAS)
Semiclassical Hilbert space of AdS black holes: factorization and fluctuations

In this talk I will discuss the microscopic interpretation of the Hilbert space of AdS black hole according to the semiclassical gravity. I will review the construction of the corresponding microstates and explain how these states help resolve the AdS/CFT Hilbert space factorization puzzle. I will also discuss the extension of the formalism to describe microstates of out-of-equilibrium fluctuations of black holes, represented by infalling shells.

13:30-14:30
Alexey Koshelev (ShanghaiTech U.)
Black holes in SFT inspired gravity
As Einstein's gravity is a non-renormalizable theory, it can be a good description of physics only at the scales of energy or spacetime curvature below the Planck mass. Moreover, it requires the presence of an infinite tower of higher-derivative corrections, as required in the framework of effective field theory (EFT). Black holes, known to be vacuum solutions in Einstein's gravity, necessarily have singularities in the center, where both Einstein's gravity and low-energy EFT expansions break down. In this work, we address the question of whether, in the presence of matter, regular solutions looking like black holes from outside do exist. We show that the matter distribution supporting the regular black hole solution in the presence of Riemann tensor cube and Riemann tensor to the fourth power EFT corrections satisfies positivity of energy (also called weak energy condition, WEC) and null energy condition (NEC) everywhere outside the horizon. Unlike the case of singular solutions, the EFT description is also valid in the interior of such an object, given that the maximal curvature is bounded and does not exceed the cut-off scale. We found that in a wide range of parameters, WEC is satisfied inside the horizon, but NEC is violated inside the horizon in all cases.

14:35-15:35
Song He (Ningbo University, China)
Unify the QGP transports and equations of state in a data-based holographic QCD model
We construct a nonperturbative holographic QCD model that simultaneously reproduces the lattice equation of state and the temperature dependence of transport coefficients across the deconfinement crossover. Embedding a Gauss–Bonnet term nonminimally coupled to a dilaton within an Einstein–Maxwell–dilaton framework, we calibrate all potentials at zero chemical potential to lattice thermodynamics and compute the shear viscosity–to–entropy ratio η/s and bulk viscosity–to–entropy ratio ζ/s without small-coupling expansions. The model exhibits a high-temperature plateau in η/s above critical temperature T_c, a pronounced minimum of η/s, and a peak in ζ/s near the pseudo-critical temperature, in agreement with expectations from critical dynamics. This unified holographic construction shows that higher-curvature corrections tied to scalar dynamics capture both equilibrium and real-time properties of the quark–gluon plasma.

16:00-16:30
Jia-Zhou Liu (Lanzhou U.)
Exact Black Hole Solutions and Their Thermodynamics in Bumblebee Gravity with Lightlike or Spacelike VEVs
Motivated by recent developments in Lorentz-violating theories of gravity, we obtain new black hole solutions within the framework of bumblebee gravity, where the bumblebee vector field possesses two independent nonzero components and acquires either a lightlike or spacelike vacuum expectation value. Within this framework, we derive new Schwarzschild-like and Schwarzschild-(A)dS-like black hole solutions. By further incorporating a nonminimally coupled electromagnetic field, we generalize these to new charged black hole solutions. These solutions extend previous results by including additional Lorentz-violating parameters. A key finding is that even for lightlike vacuum expectation values, the black hole solutions exhibit distinct corrections from Lorentz violation. Furthermore, we present a preliminary analysis of their thermodynamic properties. Similar to previous studies that reported a discrepancy between the black hole entropy and the Wald entropy in bumblebee gravity with spacelike vacuum expectation values, our solutions in the spacelike case exhibit the same behavior. In contrast, for the lightlike case considered here, the two entropies coincide.

16:35-16:55
Daniil Stepanenko (MIRAS)
Black Hole/Bose gase duality
In this talk we propose generalization of black hole/Bose-gas duality for anistropic for a wide class of Lifshitz black hole solutions in Einstein-Maxwell-Dilaton model with electric and magnetic fields.

17:10-18:10
Jonah Kudler-Flam (Princeton, Inst. Advanced Study)
Emergent mixed stares for baby Universes and Black Holes
We examine the behavior of sequences of states in the large N limit of AdS/CFT duality in cases in which the bulk duals involve baby universes or black holes. Such sequences generally fail to converge as pure states. Under suitable conditions, such as diverging coarse-grained entropy, they can converge to mixed states for the large N algebra, as in the case of black holes. For Euclidean preparations that produce baby universes, the sequences do not converge, due to wormhole contributions, and so these states cannot admit large N limits. Nevertheless, appropriate averaging over N can lead to convergence to a mixed state. The associated algebras have nontrivial commutants, which can possibly be interpreted as operators in the baby universe.

Wednesday 19.11.2025

11:00-12:00
Jacob Sonnenschein (Tel Aviv U.)
Chaotic processes, erratic functions and random matrix theory
We analyze the dynamics of a first order confinement-deconfinement phase transition in an expanding medium using an effective boundary description fitted to the holographic Witten model. We observe and analyze hot plasma remnants, which do not cool down or nucleate bubbles despite the expansion of the system. The appearance of the hot remnants, the dynamics of their shrinking, and subsequent dissolution and further heating up is very robust and persists in such diverse scenarios as boost-invariant expansion with a flat Minkowski metric and cosmological expansion in a Friedmann-Robertson-Walker spacetime.

12:05-13:05
Oleg Andreev (Munich U., ASC)
The tetraquark system and string interactions
We continue our investigation of the effective string model for the triply heavy quark system, mimicking that in pure $SU(3)$ gauge theory. We present analytical and numerical studies of the three-quark potential for isosceles and collinear geometries. In the general case, we derive the asymptotic expression of the potential in the infrared limit. Here we also demonstrate the universality of the string tension and interpret the transition between two distinct regimes, occurring when one of the triangle's angles formed by the quarks is equal to $\frac{2}{3}\pi$, as a breaking of permutational symmetry. This symmetry breaking implies the emergence of a heavy quark dressed by gluons, transforming in the two-index antisymmetric representation. Additionally, we discuss various aspects of the Y- and Δ-laws, diquarks, and connections to lattice QCD.

14:00-14:30
Rene Meyer (Wurzburg U.)
PT Symmetric Non-Hermiticity in AdS/CFT
A transition matrix can be constructed through the partial contraction of two given quantum states. We analyze and compare four different definitions of entropy for transition matrices, including (modified) pseudo entropy, SVD entropy, and ABB entropy. We examine the probabilistic interpretation of each entropy measure and show that only the distillation

interpretation of ABB entropy corresponds to the joint success probability of distilling entanglement between the two quantum states used to construct the transition matrix. Combining the transition matrix with preceding measurements and subsequent non-unitary operations, the ABB entropy either decreases or remains unchanged, whereas the pseudo-entropy and SVD entropy may increase or decrease. We further apply these entropy measures to transition matrices constructed from several ensembles: (i) pairs of independent Haar-random states; (ii) bi-orthogonal eigenstates of non-Hermitian random systems; and (iii) bi-orthogonal states in PT-symmetric systems near their exceptional points. Across all cases considered, the SVD and ABB entropies of the transition matrix closely mirror the behavior of the subsystem entanglement entropy of a single random state, in contrast to the (modified) pseudo entropy, which can exceed the bound of subsystem size, fail to scale with system size, or even take complex values.

14:30-15:00
Behnam Pourhassan (Damghan U.)
Thermodynamics of an Enhanced Charged AdS Black Hole and Quantum Information
In this talk, I consider an $\alpha^{\prime}$ corrected Reissner-Nordstr\"{o}m AdS black hole to study thermodynamics. I present the $P-V$ criticality and thermodynamical stability of black hole. I discuss a first-order phase transition which may be interpreted as the large/small black hole phase transition. Then, I discuss about a van der Waals behavior and critical points. Finally, I conclude quantum work which is used to resolve the information loss paradox.

15:00-15:30
Diego Cirilo-Lombardo (U. Buenos Aires)
Quantum-SpacetimeSymmetries: A Principle of Minimum Group Representation
We show that, as in the case of the principle of minimum action in classical and quantum mechanics, there exists an even more general principle in the very fundamental structure of quantumspacetime: this is the principle of minimal group representation, which allows us to consistently and simultaneously obtain a natural description of spacetime's dynamics and the physical states admissible in it. The theoretical construction is based on the physical states that are average values of the generators of the metaplectic group Mp(n), the double covering of SL(2C) in a vector representation, with respect to the coherent states carrying the spin weight.

16:00-16:30
Prokopii Anempodistov (LPENS, Paris)
Study of protected BPS operators in N=4 SYM via complex matrix models

We propose and study a family of complex matrix models computing the protected two- and three-point correlation functions in $\mathcal{N}=4$ SYM. Our description allows us to directly relate the eigenvalue density of the matrix model for ``Huge" operators with $ \Delta \sim N^2$ to the shape of droplets in the dual Lin-Lunin-Maldacena (LLM) geometry. We show how this description allows to calculate various three-point functions involving huge operators. The talk is based on arXiv:2508.20094

16:35-17:05

Ali Hajilou (IPM, Tehran)

Running coupling for heavy and light quarks in Isotropic holographic QCD model

We consider the running coupling constant in holographic models supported by Einstein-dilaton-Maxwell action for heavy and light quarks. To obtain the dependence of the running coupling constant on temperature and chemical potential we impose boundary conditions on the dilaton field that depend on the position of the horizon. We use two types of boundary conditions: a simple boundary condition with the dilaton field vanishing at the horizon and a boundary condition that ensures an agreement with lattice calculations of string tension between quarks at zero chemical potential. The location of the first order phase transitions does not depend on the dilaton boundary conditions for light and heavy quarks. At these phase transitions, the function undergoes jumps depending on temperature and chemical potential. We also show that for the second boundary conditions the running coupling decreases with a temperature increase, and the dependence on temperature and chemical potential both for light and heavy quarks is actually specified in quark-gluon plasma (QGP) phase by functions of one variable, demonstrating in this sense automodel behavior.

17:10-18:10

Leopoldo Pando Zayas (Michigan U., LCTP)

Quantum corrections in Near-Extremal Black Holes: Thermodynamics, Dynamics and Applications

Attempts to construct a low-temperature version of the fluid/gravity correspondence have faced obstacles manifested in the form of logarithmic terms in the frequency, leading to non-local in time constitutive relations for the stress tensor and the charge current. These difficulties can be broadly presented as a breakdown of the hydrodynamic description due to additional infrared modes. We employ new quantum insights into the physics of near-extremal black holes, brought about in the context of Jackiw-Teitelboim gravity, as an effective description of quantum fluctuations in the throat, to revisit the fluid/gravity correspondence at very low temperatures. The quantum corrections naturally include a new length scale and an effective action that parametrizes the breaking of near-horizon symmetries. We show that with an appropriate choice of order of limits in the derivative expansion within the low-temperature regime, the infrared divergence can be resolved. By quantum averaging the infrared Schwarzian modes as an effective extra contribution to the long-wavelength fluid modes, the resulting low-temperature effective fluid description is consistent. We present the dispersion relations for all the relevant hydrodynamic modes. We also revisit the shear viscosity to entropy density ratio and find that at very low temperatures the universal bound is violated due to quantum correction.

Thursday 20.11.2025

11:00-12:00
Giuseppe Policastro (Ecole Normale Supérieure, Paris
Energy transport in 2D holographic interfaces: away from conformality
Defects and interfaces are the subjects of intense study in different contexts, as they provide useful probes quantum field theory and condensed-matter systems. In the case of two-dimensional conformal interfaces, universal properties are encoded in the flux of energy transmitted and reflected for an excitation scattered on the interface. I will recall the property of energy trasport across conformal interfaces. I will then discuss the extension to a class of non-conformal defects obtained by turning on a TTbar-deformation of the CFT, as well as a class of defects obtained by allowing a time-reparametrization at the interface, corresponding to solutions of Nambu-Goto equation in the limit of a small tension brane. The latter setup can also be further generalized to multi-way junctions between CFTs.

12:05-12:35
Sergio Aguilar-Gutierrez (Okinawa Inst. Sci. Tech.)
Cosmological Entanglement Entropy and Edge Modes from Double-Scaled SYK
We investigate entanglement entropy in the double-scaled SYK (DSSYK) model, its holographic interpretation in terms of edge modes (acting as quantum reference frames); particularly its de Sitter (dS) space limit; and its connection with Krylov complexity. We define subsystems relative to a particle insertion in the boundary theory. This leads to a natural notion of partial trace and reduced density matrices. The corresponding entanglement entropy takes the form of a generalized horizon entropy in the bulk dual, revealing the emergence of edge modes in the entangling surfaces. We match the entanglement entropy of the DSSYK in an appropriate limit to an area computed through a Ryu-Takayanagi formula in dS_2 space with entangling surfaces at future and past infinity; providing a first principles example of holographic entanglement entropy for dS_2 space. This formula reproduces the Gibbons-Hawking entropy for specific entangling regions points, while it decreases for others. This construction does not display some of the puzzling features in dS holography. The entanglement entropy remains real-valued (since the boundary theory is unitary), and it depends on Krylov state complexity in this limit.

12:35-13:05
Sergey Vernov (SINP, Moscow)
Primordial black holes formation in new inflationary F(R) gravity models
The F(R) gravity models of inflation have been revisited in light of recent observations of cosmic microwave background radiation from the Atacama Cosmology Telescope and the DESI collaboration. A detailed study of the evolution equations in the Jordan frame has been with a new slow-roll approximation for F(R)-gravity inflationary models has been proposed. It is found that all those models of inflation are significantly constrained by demanding a higher (than the Planck Telescope value) cosmological tilt n_s of scalar perturbations and a positive running index α_s favored by ACT. Using the proposed slow-roll approximation in the Jordan frame, we provide a new F(R) gravity modification of the Starobinsky inflationary model, which satisfies all ACT constraints. An F(R)-gravity model that unifies inflation and production of primordial black holes is also proposed. The talk in based on the paper by S.V. Ketov, E.O. Pozdeeva, and S.Yu. Vernov, arXiv:2508.08927.

13:30-14:00
Alexander Zakharov (Moscow, ITEP)
Quantum black holes and their shadows
Black hole shadows were first considered in Bardeen's thought experiment in 1973. Zakharov et al. (2005) showed that the black hole shadow for the Galactic Center (GC) black hole can be reconstructed using observations in the mm or submillimeter range. This has been solved and the Event Horizon Telescope (EHT) Collaboration reconstructed the black hole shadow in GC using EHT observations done in 2017 (shadow for M87* has been reconstructed in 2019). Theoretical attempts of shadow reconstructions for quantum black holes were done. However, for the shadows of quantum black holes to be reconstructed in the near future, their masses would need to be significantly increased or the values of their quantum parameters would need to be significantly increased.

14:00-14:30
Victor Vedenyapin (Keldysh Inst.Appl.Math.)
Vlasov Equations, Geometry, Gravity, Electrodynamics and Cosmology
Accelerated expanding of Universe is justified rigorously from classical least action principle. We get proper equations from relativistic Einstein action without any Lambda, dark energy or additional fantastical fields and also we get that curvature of Universe in the framework of FRLW-model is negative.

14:35-14:55
Ekaterina Pozdeeva (SINP, Moscow)
Primordial black hole formation in chiral cosmological models
We consider the chiral cosmological models with two scalar fields inspired by modified gravity. For some values of model parameters, we reproduce appropriate values for inflationary parameters. During inflation we get ultra-slow-roll regime corresponding to the reflection point of the potential and increasing of energy density perturbations which lead to primordial black hole formation in the radiation dominant stage.

14:55-15:15
Wu Jingxu (MSU, Moscow)
Coherent Structures and Energy Exchange near Rotating Black Holes
A theoretical model is presented describing the nonlinear dynamics of fields and the formation of spatial structures near the event horizon of Kerr black holes. Within the framework of the covariant Ginzburg–Landau equation for a complex field A interacting with a slowly varying background variable X reflecting curvature or density feedback, metastable states and rotating spiral structures are identified. Their evolution is determined by the effects of inertial frame dragging and superradiant amplification in Kerr geometry. The resulting self-organized configurations exhibit a quasi-periodic exchange of energy and angular momentum between A and X, generating partially coherent oscillations analogous to combined gravitational and electromagnetic wave signals. The model forms a unified representation linking near-horizon morphology, nonlinear wave coherence, and spin-dependent spectral features of the radiation from rotating black holes.

15:15-15:35
Sergei Barakin (MIPT, ITMP)
Brane bound states, deformations and OM.
We're exploring an effect of the String Theory dynamical objects creation by the proper generalised Yang-Baxter deformation. Such a non-perturbative creation is observed in terms of the bound-states of the F1-D1-D3 and M2-M2-M5, produced from pure D3 and M5 solutions in the Type IIB and 11D SUGRAs. In such a setting, parametric anisotropic systems related to (1+3) and (1+5) zero-temperature holography naturally arise as the results of the U-duality action.

17:10-17:30
Igor Mol (Federal University of Juiz de Fora)
Comments on Celestial CFT and AdS_{3} String Theory

In a recent work, Ogawa et al. (2024) proposed a model for celestial conformal field theory (CFT) based on the H+3-Wess-Zumino-Novikov-Witten (WZNW) model. In this paper, we extend the model advanced by Ogawa et al. (2024), demonstrating how it can holographically generate tree-level MHV scattering amplitudes for both gluons and gravitons when analytically continued to the ultra-hyperbolic Klein space R22, thereby offering an alternative to celestial Liouville theory. We construct a holographic dictionary in which vertex operators and conformal primaries in celestial CFT are derived from their worldsheet counterparts in Euclidean AdS3 (bosonic) string theory. Within this dictionary, we derive the celestial stress-energy tensor, compute the two- and three-point functions, and determine the celestial operator product expansion (OPE). Additionally, we derive a system of partial differential equations that characterises the celestial amplitudes of our model, utilising the Knizhnik--Zamolodchikov (KZ) equations and worldsheet Ward identities. In the Appendix, we provide a concise introduction to the H+3-WZNW model, with emphasis on its connection to Euclidean AdS3 string theory.

17:30-17:50
Vladimir Khiteev (Lebedev Physical Institute of RAS, Moscow)
Gravitational Wilson networks and Witten diagrams
The main topic of my talk is the correspondence between the gravitational Wilson line networks and Witten diagrams for massive scalar fields in AdS. I will show that Witten diagram can be expanded into a sum of the gravitational Wilson line networks, where each term in the sum has distinct boundary behaviour. This expansion is similar to the conformal block expansion of conformal correlators and clearly shows the holographic correspondence between Witten diagrams in the bulk and conformal blocks at the boundary of AdS.

17:50-18:10
Nguyen Hoang Vu (BLTP JINR)
Color superconductivity in general dimension via holography
We generalize the concept of holography for the color superconductivity (CSC) phase by considering a d-dimensional Anti de Sitter (AdS) space instead of the traditional 6 dimensions. The corresponding dual field theory is an arbitrary confining gauge theory with $SU(N_c)$ symmetry, like quantum chromodynamics (QCD) CSC. We then use a holographic model based on Einstein-Maxwell gravity in d-dimensional AdS spacetime to study this phenomenon in both confinement and deconfinement phase, and we focus to study the confinement-deconfinement phase transition and the condition for the $N_c=2$ CSC phase with the special case $d=4$.

Friday 21.11.2025

11:30-12:30
Pavel Slepov (MIRAS)
Energy loss in holographic QCD
The different types of Wilson loops (temporal, light-like, and spatial) were considered as probes of the phase transition structure in holographic QCD models. Temporal Wilson loops describe the confinement/deconfinement phase transition, light-like Wilson loops can probe a first-order phase transition, and spatial Wilson loops can probe a second-order phase transition for the spatial string tension that is related to drag forces. Using light-like Wilson loops, we estimate the jet quenching parameter and study its behavior near a first-order phase transition; using spatial Wilson loops, we estimate drag forces and study the phase transition for spatial string tension in hot dense quark-gluon plasma with two types of anisotropy.

12:35-13:05
Antonino Marciano (Fudan U., China)
The stochastic gradient flow approach to QCD confinement and mass gap generation
We propose a scenario according to which the ultraviolet completion of General Relativity is realized through a stochastic gradient flow towards a topological BF theory. Specifically, we consider the stochastic gradient flow of a pre-geometric theory proposed by Wilczek. Its infrared limit exists, and corresponds to a fixed point where stochastic fluctuations vanish. Diffeomorphism symmetries are restored in this limit, where the theory is classical and expressed by the Einstein-Hilbert action. The infrared phase then corresponds to the classical theory of General Relativity, the quantization of which becomes meaningless. Away from the infrared limit, in the pre-geometric phase of the stochastic gradient flow, the relevant fields of the Wilczek theory undergo stochastic fluctuations. The theory can be quantized perturbatively, generating corrections to the classical Einstein-Hilbert action. The stochastic gradient flow also possesses an ultraviolet fixed point. The theory flows to a topological BF action, to which general non-perturbative quantization methods can be applied. Two phase transitions occur along the thermal time dynamics, being marked by: i) the breakdown of the topological BF symmetries in the ultraviolet regime, which originates the pre-geometric phase described by the Wilczek theory; ii) the breakdown of the parental symmetries characterizing the Wilczek theory, from which General Relativity emerges. The problem of quantizing the Einstein-Hilbert action of gravity finally becomes redundant.

13:30-14:00
Shahin Mamedov (Institute for Physical Problems at Baku State University)
Holographic study of inner structure of deuteron

We study gravitational deuteron form factors (GFF) and generalized parton distributions (GPDs) within the soft-wall AdS/QCD model, where deuteron is described by the bulk vector field with twist 6. For finite-temperature studies, we apply the soft-wall model, which is thermalized by introducing a thermal dilaton field. The GPDs and charge density are considered in impact parameter (IP) space and at zero and finite temperatures. We plotted the temperature dependence of these quantities in the IP space and observe a decrease in their peaks as the temperature increases. The gravitational root mean square radius obtained here is close to the range given by experimental data for the mass radius and has low sensitivity to the temperature.

14:00-14:20

Anton Anufriev (St. Petersburg State University)

Application of the holographic equation of state in numerical simulation of relativistic heavy ion collisions

At the beginning of the 21st century, a new phase state of strongly interacting matter was established, known as the quark-gluon plasma (QGP) [1]. To study the formation of the QGP in collisions of heavy nuclei, the solution of a system of equations of relativistic hydrodynamics with a specific equation of state (EoS) is typically employed. In light of difficulties for non-zero baryonic potentials within Lattice QCD, various holographic models based on the well-known AdS/CFT duality have been proposed to obtain EoS for the QGP using the thermodynamic properties of the corresponding black brane in AdS5. In the present work, a calibration method is proposed for the holographic EoS developed by I. Ya. Aref'eva's theoretical group [2] to study QGP properties within the framework of relativistic hydrodynamics. Machine learning methods were applied to address the regression and optimization issues during the calibration of the relevant parameters using the LQCD results for quark masses that approximate the physical values [3]. The effect of matching the equation of state with the hadron gas equation [4] at low temperatures is shown. To account for the hadron strangeness in the holographic model, we use phenomenological hypotheses of the chemical potential on density relation derived from the hadron gas model [5] and the Fermi quark gas [6]. For practical applications in studying heavy-ion collisions, the corresponding holographic EoS was incorporated into the relativistic hydrodynamics packages MUSIC [7] and vHLLE [8]. To obtain the final hadron spectra, numerical simulations were conducted using the iEBE-MUSIC and SMASH-vHLLE frameworks, which additionally include a set of packages for initial conditions, freeze-out and hadronic afterburner. Consequently, the transverse mass distributions of produced hadrons were calculated at the energies of NA49 experiment. The authors acknowledge Saint-Petersburg State University for a research project 103821868.

14:20-14:40

Alice Tsymbal (St. Petersburg State University)

The Regge Spectrum in Phenomenology and AdS/QCD Models

The first part of the talk is devoted to the analysis of the spectrum of light non-strange mesons. According to current data, these mesons are grouped into clusters with similar masses, which can be interpreted as a manifestation of dynamical O(4) symmetry, analogous to the symmetry of the Coulomb potential in the hydrogen atom. The spectrum depends with high accuracy only on the sum of the orbital L and radial n quantum numbers and is well described by the Regge relation $M^2 = a(L + n) + b$ with two parameters, a and b. The second part of the talk will demonstrate how a similar spectral structure is reproduced in holographic soft-wall models.

14:45-15:15

Vaid Deepak (NITK, Karnataka)

Bosonic String Theory and Minimum Area

In the first part I will talk about how to write down an action for the bosonic string which incorporates a minimum area. This is motivated by the fact that loop quantum gravity has an area operator which has a positive minimum quantum of area as its lowest eigenvalue. I will demonstrate how the resulting theory can be understood in terms of a ""bimetric"" action for string theory - with this being the first time anybody has presented such an actual bimetric string theory action (and not simply bimetric gravity in the context of string theory as has been discussed by other authors). I will further show that when we try to write down a string action with local gauge symmetry - as opposed to simply introducing bulk gauge fields as external fields - we are naturally led to a holographic picture at the level of the classical gauged string action (based on: https://arxiv.org/abs/2407.13807v2)

15:15-15:35

Mrityunjay Nath (Indian Inst. Tech., Indore)

Wormholes as Finite N corrected geometries in AdS

We show that a class of wormholes viz. Damur Solodukhin wormholes furnish a representantion of finite N corrected geometries. We show this explicitly in 2 dimensions via HKLL construction and using SFF calculations in 3 dimensions.