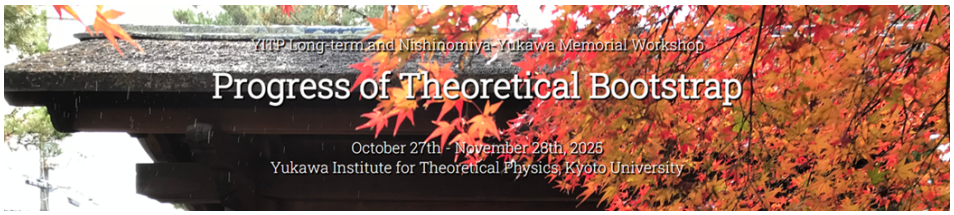
Progress of Theoretical Bootstrap

Monday, October 27, 2025 - Friday, November 28, 2025

YITP



Book of Abstracts

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Slava Rychkov ”The renaissance of axiomatic methods in quantum field theory”

The textbook approach to quantum field theory is to start from the Lagrangian and then either do perturbation theory or, if the theory is strongly coupled, resort to lattice Monte Carlo simulations. Recently there has been renewed interest in developing and applying “bootstrap methods”, which have different spirit. They use nonperturbatively valid “axioms”to obtain concrete numerical results about experimentally relevant strongly coupled QFTs. After a pedagogical background introduction, I will describe these bootstrap methods and some of their applications in the study of critical phenomena and scattering processes.

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Andreas Stergiou ”Redundancy Channels in the Conformal Bootstrap”

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Sridip Pal "Universality of spectrum at large spin in non-rational 2D CFT"

Abstract: In a unitary 2D modular invariant CFT, the high-energy density of states is universal and follows the famous Cardy formula, the precise version of which requires an averaging over an order-one window. In non-rational 2D CFTs, an extended version of the Cardy formula exists for the density of states with finite twist and large spin. In this talk, we will answer in which sense this extended formula gives a coarse-grained approximation of finite twist, large spin density of states. In particular, using elementary complex analysis methods, we prove that 1) the averaging over spin is NOT required and 2) if appropriately smeared over a window of twist, the extended Cardy formula is valid up to O(J^{-N}) for any N>0. This is much stronger/universal than the usual Cardy formula at large energy. Furthermore, by making the size of twist-window shrinking to 0 as J \to\ infty, we prove that the spectrum is dense in the large spin limit i.e, the spacing of operators with large spin and twist lying in a bound subinterval of ((c-1)/12,\infty) goes to 0 at least as fast as J^{-1/4} as J\to\infty. This is based on work with Jiaxin Qiao, Balt C van Rees, arXiv: 2505.02897

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Dalimil Mazac " L-functions and the conformal bootstrap"

Recently, a close parallel emerged between conformal field theory in general dimension and the theory of automorphic forms. I will review this connection and explain how it can be leveraged to make rigorous progress on central open problems of number theory, using methods borrowed from the conformal bootstrap. In particular, I will use the crossing equation to prove new subconvex bounds on L-functions. Based on work with Adve, Bonifacio, Kravchuk, Pal, Radcliffe, and Rogelberg: https://arxiv.org/abs/2508.20576.

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Shiraz Minwalla "Semi-universality of CFT$_d$ entropy at large J"

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Yuto Moriwaki ”2d Conformal bootstrap equation and axiomatic QFT”

Axiomatic quantum field theory is a mathematically rigorous formulation of quantum field theory proposed in the 1950s.

Notable frameworks include the Wightman axioms for quantum fields on Minkowski spacetime and the Osterwalder-Schrader axioms, formulated via Schwinger functions on Euclidean spacetime.

In this talk, based on joint work with M. S. Adamo and Y. Tanimoto, we will discuss how, in two dimensions, one can construct an axiomatic QFT from the bootstrap equations under the assumption that the theory enjoys a sufficiently large chiral symmetry.

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Vasileios Niarchos ”Deep Finite Temperature Bootstrap”

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Parijat Dey ”Towards bootstrapping de Sitter correlators”

Towards bootstrapping de Sitter correlators

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Nathan Benjamin ”Scalar partition functions in 2d CFTs”

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Denis Karateev ”Bounds on Conserved Currents in 4d CFTs”

I will discuss recent progress in constraining four-dimensional conformal field theories with Abelian conserved currents using the conformal bootstrap. After setting up the bootstrap problem for the four-point function of U(1) currents, I will present numerical bounds on operator dimensions and on physical quantities such as the ratio between the ’t Hooft anomaly and the current central charge. Finally, I will describe recent developments in the automatic construction of spinning conformal blocks in 4d, which enable systematic bootstrap analyses involving non-Abelian conserved currents and stress tensors.

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Valentina Prilepina ”Illuminating CFTs with the Higher-Point Bootstrap: A Powerful Approach”

In this talk, I will present a practical realization of the higher-point conformal bootstrap, focusing on the five-point comb channel implementation thereof. I will consider 5-point scalar correlators in d-dimensional conformal field theories (CFTs). I will begin by laying out a robust algorithm for the efficient numerical evaluation of conformal blocks for exchanged primary operators of arbitrary spin. I will then describe an explicit implementation of the 5-point bootstrap.
With this, I will proceed to study 5-point correlators in the 3d critical Ising model. I will examine correlators involving \sigma, and \epsilon, truncating the oper-ator product expansion (OPE) to include contributions due to operators with
conformal dimension below a certain cutoff. In each case, I will approximate the remaining contributions by their counterparts in a suitable disconnected five-point correlator. Finally, I will discuss the results obtained through the five-point
bootstrap for a number of OPE coefficients involving two or more spinning operators. While these coefficients are nontrivial to access by means of the four-point bootstrap, they are within ready reach of the higher-point bootstrap, where we are able to compute a number of OPE coefficients with greater accuracy than previous methods. I will compare some newly-determined OPE coefficients to corresponding results from the four-point bootstrap and the fuzzy sphere regularization technique. At the end, I will give a preview of the six-point snowflake channel implementation of this method. This analysis will ultimately establish the higher-point bootstrap as a powerful tool for studying CFTs.

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Fabiana De Cesare ”Disturbing news about the 2+epsilon expansion”

The O(N) Non-Linear Sigma Model (NLSM) in d=2+epsilon has long been conjectured to describe the same conformal field theory as the Wilson-Fisher O(N) fixed point obtained from the (phi^2)^2 model in
d=4-epsilon. In this talk, we put this conjecture into question, building on the recent observation [Jones,2024] that the NLSM CFT possesses a protected operator with dimension N-1, which is instead absent in the WF O(N) CFT. We propose several scenarios that may explain this discrepancy.

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Zechuan Zheng ” The Analytic Functional in the Numerical Conformal Bootstrap”

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Wenliang Li ”Accurate boundary bootstrap for the 3d O(N) normal universality class”

Accurate boundary bootstrap for the 3d O(N) normal universality class

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Shai Chester ”Bootstrapping critical 3d gauge theories”

We consider the simplest class of 3d gauge theories, which is N complex scalar fields coupled to an Abelian gauge field. For large N this theory is known to flow to a CFT with SU(N)xU(1) symmetry, but for finite N there is controversy in the literature. The N=2 case is particularly famous, as its believed to describe the Neel-VBS phase transition, which might be experimentally realizable. Previous lattice studies suggested the SU(2)xU(1) symmetry is enhanced to SO(5), but the assumption of no relevant SO(5) singlet was ruled out by the bootstrap. We perform a bootstrap study assuming SO(5) symmetry, and find a point on the boundary of the allowed region that matches large N predictions, and was recently confirmed by a newer lattice study. We also perform a bootstrap study of the N=3 theory, and find a point on the boundary of the allowed region that matches large N, large charge, and lattice predictions.

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Poster Session

Stanislav Filatov “Geometry of Two-Qubit Entanglement on Two Bloch Spheres”
Yuma Furuta “On the quadratic equations for detecting duality symmetries of compact boson CFTs”
Samuel Laliberte “Quantum mechanics bootstrap and supersymmetry”
Yuefeng Liu “Bootstrap about new crosscap states and non-invertible symmetry”
Souparna Nath “Complexity Growth, Krylov-Wigner function and Gravity”
Toshiki Onagi “Do Conformal Bootstraps Dream of Duality?”
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Ahmed Abdalla “Foundational Inconsistencies in the No-Boundary Proposal”
Ross Dempsey “Integral constraints for the superconformal bootstrap”
Indranil Dey “A universal inequality on the unitary 2D CFT partition function”
Mohammad Reza Khansari “Bubbles in AdS”
Kamran Salehi Vaziri “Non-perturbative cosmological bootstrap: A construction of de Sitter late-time boundary”
kangning liu “Supersymmetric complex Liouville string”

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Opening

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Alessandro Piazza "Bootstrap bounds on Yang-Mills in AdS"

Yang-Mills theory in AdS_4 with Dirichlet boundary conditions is expected to undergo a deconfinement-confinement transition as the AdS radius varies, as the global symmetry of the boundary CFT cannot hold in flat space. We apply the conformal bootstrap to four-point functions of non-abelian conserved currents in 3d to place bounds on proposed mechanisms for the transition. We rule out the scenario in which the boundary current decouples by bounding the current central charge. We also obtain bounds on the dimension of the lightest scalar operators, which disfavour a bulk-Higgs mechanism and instead support a transition triggered by a scalar singlet becoming marginal.

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Marten Reehorst " Bootstrapping the Simplest Deconfined Quantum Critical Point"

We study the $N = 3$ case of the $NCCP^{N-1}$ model, which is a field theory of N complex scalars in 3d coupled to an Abelian gauge field with $SU(N) \times U(1)$ global symmetry. Recent evidence suggests the $N = 2$ theory is not critical, which makes the $N = 3$ theory the simplest possibility of deconfined quantum criticality. We apply the conformal bootstrap to correlators of charge $q = 0, 1, 2$ scalar operators under the $U(1)$ symmetry, which gives us access also to $q = 3, 4$ operators. After imposing that only the lowest $q = 0, 1, 2$ scalar operators are relevant, we find that the bootstrap bounds are saturated by the large N prediction for $q = 1, 2, 3, 4$ scalar monopole operator scaling dimensions, which were shown earlier to be accurate even for small N, as well as a lattice prediction for the $q = 0$ non-monopole scalar operator. We also predict the scaling dimensions of the lowest spinning monopole operators, which we match to the large charge prediction for spinning operators. This suggests that the critical $NCCP^2$ model is described by this bootstrap bound.

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Yuan Xin "Yang-Lee Criticality in Various Dimension" (online)

Yang-Lee criticality is the simplest non-Hermitian conformal field theory. The model was first reported as a phase transition of Ising model in imaginary longitudinal magnetic field more than half a centry ago. Since then, many qualitative and quantitative properties of YL criticality have been studied, remarkably, including the fact that the model can be described in Landau-Ginzburg scheme with a scalar $i\phi^3$ theory in $D < 6$ and the fact that the 2D version is an exactly solvable minimal model. In higher dimensions, the model lacks the same level of understanding as the Ising criticality due to its non-Hermitian nature. We report a new study of 3D YL criticality as a phase transition

of Fuzzy Sphere model, which facilitates a direct survey of many quantities such as the spectrum and OPE coefficient to high precision. These quantitative results show a beautiful agreement with conformal symmetry and previous estimates from $(6-\epsilon)$ expansion, high temperature expansion and conformal bootstrap. We also discuss possible approaches in dimensions higher than 3.

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Francesco Bertucci "Bootstrapping Euclidean lattices"

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Jiaxin Qiao "QFT as a set of ordinary differential equations"

I will discuss quantum field theories (QFTs) on hyperbolic surface (i.e. Euclidean AdS2) with a conformal boundary condition. Correlation functions of local operators in such QFTs can be fully characterized by the QFT data: (1) scaling dimensions of boundary operators, (2) boundary operator product expansion (OPE) coefficients, and (3) boundary operator expansion (BOE) coefficients for bulk operators.

We derive a universal set of first-order ordinary differential equations (ODEs) that encode the variation of the QFT data under an infinitesimal change of a bulk relevant coupling. In principle, these ODEs can be used to follow a renormalization group (RG) flow starting from a solvable QFT into a strongly coupled phase and toward the flat-space limit. If time permits, I will also discuss the mechanism of level repulsion, which arises as a natural consequence of the ODEs.

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Free discussion

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Sinya Aoki "Derivation of the GKP-Witten relation by symmetry without Lagrangian"

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Guilherme L. Pimentel ”Overview of Cosmological Correlators”

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Yu-tin Huang ”When gravity meets narrow resonances”

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Xi Tong ”Unitary renormalisation and the quantum breaking of cosmological reality”

Abstract: Cosmological correlators and the associated wavefunction coefficients serve as a smoking gun towards the physics of inflation at high energy scales. In minimal setups of single-field inflation, wavefunction coefficients are purely real at tree-level due to unitarity, locality and scale invariance, leading to the so-called no-go theorems on parity violation. Such parity-violating correlators are therefore null tests of fundamental principles. Yet interestingly, there exists a twist of plot when quantum loops are involved. We show that such cosmological reality must be spontaneously broken by the renormalisation of UV divergences in de Sitter loops. More specifically, unitarity and analyticity dictate a universal imaginary part from the logarithmic running of the real part of the wavefunction coefficients. We then discuss the implications related to this universality.

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Alexander Zhiboedov ”Scattering on the Coulomb Branch of N=4 SYM”

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Charlotte Sleight ”Holograms in the Sky from EAdS”

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Vladimir Rosenhaus ”Renormalization Group in far-from-equilibrium states”

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Martin Kruczenski ”The Gauge Theory Bootstrap: Predicting pion dynamics from QCD”

Abstract: The Gauge Theory Bootstrap computes the strongly coupled pion dynamics by considering the most general scattering matrix, form factors and spectral densities and matching them with perturbative QCD at high energy and with weakly coupled pions at low energy. In this talk (based on https://arxiv.org/abs/2505.19332 with Yifei He, ENS, Paris), we show that further constraints on the spectral densities significantly reduce the possible solutions to a small set of qualitatively similar ones. Quantitatively, the precise solution is controlled by the asymptotic value of the form factors and SVZ sum rules. We also introduce an iterative procedure that, starting from a generic feasible point, converges to a unique solution parameterized by the UV input. For the converged solution we compute masses and widths of resonances that appear, scattering lengths and effective ranges of partial waves, low energy coefficients in the effective action. Additionally, we use these results to discuss the thermodynamics of a pion gas including pair correlations of pions with same and opposite charge.

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Lorenzo Di Pietro ”QCD in AdS”

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Arnab Priya Saha ”Bootstrapping string amplitudes”

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Felipe Figueroa Vilar ”Progress on Regge theory for Dual Model amplitudes”

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Andrea Cristofoli ”The Common On-Shell Language of Black Hole Mergers and Radiation”

Abstract: The two-body problem in general relativity can be described —in the post-Minkowskian expansion —purely in terms of on-shell amplitudes and their classical limit, without ever invoking a Lagrangian or equations of motion. However, beyond this perturbative regime, it is not known whether more complex aspects of binary dynamics —such as the merger phase or the influence of

event horizons —can be captured on-shell. In this talk, I will argue that both the merger and the presence of an event horizon can indeed be described on-shell within a common framework based on mass-changing three-point amplitudes. The merger can be viewed as a fusion process once such amplitudes are introduced. Conversely, the presence of an event horizon can be described either as a decay process (Hawking radiation) or as a fusion process (classical wave absorption), following the same logic. This leads to a unified on-shell viewpoint in which black-hole mergers, gravitational-wave absorption, and Hawking radiation —seemingly distinct nonperturbative phenomena —reveal a surprising simplicity and common structure when formulated through on-shell methods. As an application, I will show how to derive conservation laws and compute memory waveforms associated with black-hole mergers, as well as how to describe the effects of Hawking radiation on the two-body problem using only gauge-invariant data and on-shell mass-changing amplitudes.

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Facundo Rost ,”The Cosmological Grassmannian”
Guangzhuo Peng, “Running EFT-hedron with null constraints at loop level”
Kamran Salehi Vaziri. “Non-perturbative cosmological bootstrap: A construction of de Sitter late-time boundary”
Mang Hei Gordon Lee, “Positivity for scalar propagators in dS”
Mehmet Asim Gumus, “A geometric view on Crossing Symmetric Dispersion Relations”
Nathan Meurrens, “Constraints on Long-Range Forces in De Sitter Space”
Simon Metayer, “Recent advances on primal S-matrix bootstrap”

Stanislav Filatov, “Geometry of Two-Qubit Entanglement on Two Bloch Spheres.”
Sumer Jaitly “Exact superposition positivity bounds”
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Yongjun Xu “Scalar weak gravity bound from full unitarity”
Yu Wenqi “On the IR dependence, conformal anomaly and renormalization of de Sitter correlators”

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Carlos Duaso Pueyo ”Boostless cosmological collider bootstrap of tensor bispectra”

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Yu Wenqi ”On the IR dependence, conformal anomaly and renormalization of de Sitter correlators”

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