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Abstract

We study the thermodynamics of a self-gravitating system of charged fermions at finite temperature and analyze its backreaction in an asymptotically AdS space. We consider a perfect fluid satisfying hydrodynamic and thermodynamic equilibrium in curved space-time, and solve the Tolman-Oppenheimer-Volkov equations. We obtain the density profiles in the AdS bulk and find that the electron star has a phase transition into a Reisnner-Norström black hole at the origin and a charged cloud of fermions surrounding the black hole. This electron star can be used to obtain new insight in holographics superconductors and its transition into strange metals, similarly as recently reported for neutron holographic stars.

P02

Root $T\bar{T}$-like Deformation and ModMax Theories in 2D and 4D

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We present our poster on the non-linear extensions of classical electrodynamics, such as the ModMax theory and its generalization to the Born-Infeld theory[1].
We will analyze the relationship between this theory and the deformations of quantum field theories. A first result of this study was our proposal of "Root-$T\bar{T}$" deformations of 4-dimensional and 2-dimensional QFTs [2, 3]. This is a marginal family of deformations that has a universal form when expressed in terms of the energy-stress tensor of a theory (like the well-known "$T\bar{T}$" deformation). We aim to better understand the relationship between Root-$T\bar{T}$, ModMax and symmetries, especially integrability, and to explore it within the broader framework of string theory and holography.

[1] I. Bandos, K. Lechner, D. Sorokin and P. K. Townsend, "A non-linear duality-invariant conformal extension of Maxwell's equations," Phys. Rev. D **102**, 121703 (2020), [arXiv:2007.09092 [hep-th]].
[2] H. Babaei-Aghbolagh, K. B. Velni, D. M. Yekta and H. Mohammadzadeh, "Emergence of non-linear electrodynamic theories from $T\bar{T}$-like deformations," Phys. Lett. B **829**, 137079 (2022), [arXiv:2202.11156 [hep-th]].
[3] H. Babaei-Aghbolagh, K. Babaei Velni, D. M. Yekta and H. Mohammadzadeh, "Marginal $T\bar{T}$-Like Deformation and ModMax Theories in Two Dimensions," Phys. Rev. D 106 (2022), no. 8, 086022, [arXiv:2206.12677 [hep-th]].

P03

BCFT One-point Functions of Coulomb Branch Operators

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Abstract

We show that supersymmetry can be used to compute the BCFT one-point function coefficients for chiral primary operators, in 4d $\mathcal{N} = 2$ SCFTs with $\frac{1}{2}$-BPS boundary conditions. The main ingredient is the hemisphere partition function, with the boundary condition on the equatorial S^3. A supersymmetric Ward identity relates derivatives with respect to the chiral coupling constants to the insertion of the primaries at the pole of the hemisphere. Exact results for the one-point functions can be then obtained in terms of the localization matrix model. We discuss in detail the example of the super Maxwell theory in the bulk, interacting with 3d $\mathcal{N} = 2$ SCFTs on the boundary. In particular we derive the action of the SL(2,$\mathbb{Z}$) duality on the one-point functions.

arXiv: arXiv:2311.17888 [hep-th]

P04

Towards Celestial Holography in (2+1) dimensions

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Celestial holography is the idea that the holographic dual theory for an asymptotically flat spacetime is codimension 2 CFT living in the celestial sphere at null infinity. Originally proposed in 4 dimensions, this idea is non-trivial to extend in lower dimensional gravitational theories due to absence of propagating gravitons. In this poster, based on [1, 2], we will show the construction of a one-dimensional dual theory that effectively describes the phase space of (2+1) dimensional gravity near a cosmological saddle. This Schwarzian type dual theory, living on the celestial circle, describes the dynamics of (pseudo)-Goldstone modes associated with the asymptotic symmetries of flat space. We also compute the Bekenstein-Hawking entropy of Flat Space Cosmological solutions and find agreement with gravitational calculations. This establishes the notion of Celestial Holography for pure gravity in (2+1) dimensions.

[1] A. Bhattacharjee and M. Saha, JHEP **01** (2023), 138 doi:10.1007/JHEP01(2023)138 [arXiv:2211.13415 [hep-th]].
[2] A. Bhattacharjee and M. Saha, [arXiv:2310.02682 [hep-th]].

P05

Interpolating Wilson loops in ABJM and boundary conditions on AdS_2

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Motivated by the existing supersymmetric ABJM Wilson loops one-parameter family that interpolates between the 1/2-BPS fermionic and the 1/6-BPS bosonic ones, we look at the string excitations around an $AdS_2 \subset AdS_4 \times \mathbb{CP}^3$ worldsheet. In this way, we obtain correlators of operators inserted along a 1D defect. Considering two kinds of boundary conditions for massless scalars on AdS_2 that interpolate between the Dirichlet and Neumann cases while preserving scale invariance, these 2- and 4-point correlators are computed holographically.

[1] A. Canazas, D. Correa, A. Faraggi, G. Silva, JHEP **02**, 146 (2023).

P06

On constructibility of AdS supergluon amplitudes

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We prove that all tree-level n-point supergluon (scalar) amplitudes in AdS_5 can be recursively constructed, using factorization and flat-space limit. Our method is greatly facilitated by a natural R-symmetry basis for planar color-ordered amplitudes, which reduces the latter to "partial amplitudes" with simpler pole structures and factorization properties. Given the n-point scalar amplitude, we first extract spinning amplitudes with $n-2$ scalars and one gluon by imposing "gauge invariance", and then use a special "no-gluon kinematics" to determine the $(n+1)$-point scalar amplitude completely (which in turn contains the n-point single-gluon amplitude).

P07

Mixed boundary conditions in AdS_2/CFT_1 from the coupling with a Kalb-Ramond field

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The dynamics of fields propagating within Anti-de Sitter (AdS) space is known to encode the set of correlation functions of certain conformal field theories (CFTs). The presence of a boundary in AdS implies that different boundary conditions for fields give rise to diverse behaviors and properties in the corresponding dual CFT.

For massless scalar fields in AdS_2, a different type of boundary conditions that mix longitudinal and transverse derivatives was considered in [1]. Since the mixing parameter is dimensionless in that case, one might expect these boundary conditions to be associated with a marginal deformation rather than with a flow of the renormalization group. However, determining whether these boundary conditions correspond to a conformal theory on the line or not, is not straightforward, as this will depend on the actual details of the AdS_2/CFT_1 realization.

Massless scalar fields in AdS_2 typically arise when studying the fluctuations on an open string world-sheet dual to line operators in various d-dimensional CFTs.

An interesting case is that of the Wilson loops in the ABJ(M) model, a prototypical example of the AdS/CFT correspondence where the $\mathcal{N} = 6$ super Chern-Simons theory with gauge group $U(N)_k \times U(N)_{-k}$ is conjectured to be equivalent to type IIA string theory in $AdS_4 \times \mathbb{CP}^3$.

This model admits a simple and interesting generalization, in which the gauge group in the Chern-Simons theory is taken to be $U(N + \ell)_k \times U(N)_{-k}$. In this case, the dual string theory description includes an additional flat Kalb-Ramond field, having a non-trivial holonomy on the non-contractible $\mathbb{CP}^1 \subset \mathbb{CP}^3$. Being the Kalb-Ramond field flat, its coupling to the open string only leads to a boundary term. The boundary term from the coupling with the Kalb-Ramond field is responsible for the materialization of the aforementioned kind of mixed boundary conditions when we study the open string dual to the 1/6 BPS *bosonic* Wilson line.

A Witten diagram computation with fluctuations on an AdS_2 world-sheet enables the holographic realization of the correlation functions of operators inserted on the Wilson line.

This effective theory on a line can preserve conformal symmetry at the quantum level or not, which should be reflected in the functional dependence of the correlation functions of excitations.

The main result of our work [2] is a perturbatively test of conformal covariance of the theory on the line dual to the open string with mixed boundary conditions. To achieve this, we find the functional dependence of holographic 4-point correlators as a cross-ratio function.

[1] D. H. Correa, V. I. Giraldo-Rivera and G. A. Silva, JHEP **03** 010,(2020).[arXiv:1910.04225 [hep-th]].
[2] D. H. Correa, **M. G. Ferro**,V. I. Giraldo-Rivera, [arXiv:2312.13258 [hep-th]].

P08

Duality defects in D_n-type Niemeier lattice CFTs

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Two dimensional conformal field theories(CFTs) have seen renewed interests in recent times. These developments have happened in the classification problem through the modular bootstrap program as well as through the correspondence with 4D superconformal field theories. Another interesting development is triggered by the study of topological defects in 2D CFTs. The defects are extended states in the CFT generated by line or surface operators. They dig out new symmetries in these theories. The lines in the 2D CFTs are objects of the fusion category. The fusion category of a 2D CFT generally contains non-invertible lines.

We discuss the construction of topological duality defects in $c = 24$ meromorphic CFTs that correspond to Niemeier lattices. The $c = 24$ meromorphic CFTs are interesting because they are purely chiral CFTs and possess holomorphic factorization. Although the modular tensor category of these CFTs is trivial, we find non-invertible duality defects in the Tambara-Yamagami fusion category. We will illustrate our constructions for the D_n-type lattices [1]. We will identify non-anomalous $\mathbb{Z}_2$ symmetries of these theories, and we show that on orbifolding with respect to these symmetries, these theories map to each other. We investigate this map, and in the case of self-dual orbifolds, we provide the duality defect partition functions. In particular, we find that the duality defects are non-invertible. We show that exchange automorphisms in some CFTs give rise to a new class of defect partition functions.

[1] S. Grover, S. Hegde and D. P. Jatkar, [arXiv:2312.17165 [hep-th]].

P09

Lining up a Positive Semi-Definite Six-Point Bootstrap

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In our recent work [1], we initiate a positive semi-definite numerical bootstrap program for multi-point correlators. Considering six-point functions of operators on a line, we reformulate the crossing symmetry equation for a pair of comb-channel expansions as a semi-definite programming problem. Through a combination of analytical and numerical techniques, we obtain rigorous bounds on CFT data in the triple-twist channel for several examples.

The focus of this contribution to the ICTP sping school 2024 poster session is on answering the following three central questions:

- Why should we bootstrap multi-point correlators?
- What did we learn in [1] about how to bootstrap six-point functions?
- How can and should the six-point bootstrap develop in the short term future?

[1] S. P. Harris, A. Antunes, A. Kaviraj, V. Schomerus, arXiv:2312.11660,(2023)

P10

Conformal Blocks in Two- and Four Dimensions from the Oscillator Formalism

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By introducing coherent states associated to the Euclidean conformal group, we are able to compute higher-point global conformal blocks in two dimensions on the plane and the torus. We subsequently generalize the approach to scalar conformal blocks in four dimensions and motivate the spinning case. The method is inherently constructive and as such promises to be useful for conformal blocks that are still difficult to compute with the usual approaches.

P11

3d N=2 SQCD and the quantum K-theory of the Grassmannian

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We review some new results we recently obtained [1, 2, 3] about the infrared physics of 3d $\mathcal{N} = 2$ SQCD with a unitary gauge group, in particular in the presence of a non-zero Fayet-Iliopoulos parameter and with generic values of the Chern-Simons levels. We review the 3d GLSM (also known as 3d A-model) approach to the computation of the 3d $\mathcal{N} = 2$ twisted chiral ring of half-BPS lines. For particular values of the Chern-Simons levels, this twisted chiral ring has a neat interpretation in terms of the quantum K-theory (QK) of the Grassmannian manifold. We propose a new set of line defects of the 3d gauge theory, dubbed Grothendieck lines, which represent equivariant Schubert classes in the QK ring. In particular, we show that double Grothendieck polynomials, which represent the equivariant Chern characters of the Schubert classes, arise physically as Witten indices of certain quiver supersymmetric quantum mechanics. We also explain two distinct ways how to compute K-theoretic enumerative invariants using the 3d GLSM approach.

[1] C. Closset, O. Khlaif, JHEP 05 (2023) 148.
[2] C. Closset, O. Khlaif, SciPost Phys. 15, 085 (2023).
[3] C. Closset, O. Khlaif, JHEP 12 (2023) 082.

P12

A String Theory for Two Dimensional Yang-Mills Theory I

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Abstract

Two dimensional gauge theories with charged matter fields are useful toy models for studying gauge theory dynamics, and in particular for studying the duality of large N gauge theories to perturbative string theories. A useful starting point for such studies is the pure Yang-Mills theory, which is exactly solvable. Its $1/N$ expansion was interpreted as a string theory by Gross and Taylor 30 years ago, but they did not provide a worldsheet action for this string theory, and such an action is useful for coupling it to matter fields. The chiral sector of the Yang-Mills theory can be written as a sum over holomorphic maps and has useful worldsheet descriptions, but the full theory includes more general extremal-area maps; a formal worldsheet action including all these maps in a "topological rigid string theory" was written by Hořava many years ago, but various subtleties arise when trying to use it for computations. In this paper we suggest a Polyakov-like generalization of Hořava's worldsheet action which is well-defined, and we show how it reproduces the free limit of the Yang-Mills theory, both by formal arguments and by explicitly computing its partition function in several cases. In the future we plan to generalize this string theory to the finite-coupling gauge theory, and to analyze it with boundaries, corresponding either to Wilson loops or to dynamical matter fields in the fundamental representation.

P13

Solving S-matrix Bootstrap Equations using Machine Learning

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The S-matrix bootstrap aims to study fully nonperturbative scattering amplitudes. This is achieved by assuming extended analyticity of the S-matrix, which, together with unitarity and crossing symmetry, imposes constraints on the amplitude.

S-matrix bootstrap can establish bounds on the nonperturbative couplings by maximizing these couplings under the mensioned constraints (see, [1, 2, 3, 4]). The outcome of such precedure is a boundary within which all theories that fullfill the bootstrap axioms must reside.

The bootstrap equations can also be used to define a closed system of equations for the amplitude that remains to be solved. This task was undertaken using an iteration algorithm to find the fixed point in $d \leq 4$ [5, 6]. In this setup the number of bound state, the value of the amplitude at the crossing-symmetric point, the S-wave inelasticity, etc. serve as input.

I employed machine learning techniques to explore a broader range of parameters where the iterative algorithm was not converging. This approach yielded promising results in two dimensions and in four diemsions in the low spin dominance limit. Imposing fully elastic unitarity I was able to reproduce a part of the boundary derived in [4] where the spin-0 partial wave dominates. Additionally, I explored the interior of the boundary using a different input for the threshold behaviour of the spin-0 partial wave. There the amplitude exhibits a resonance characterised by a zero of the partial wave in the complex plane.

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P14

Symmetry group at future null infinity

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We reduce the massless scalar/vector/gravitational field theories in Minkowski spacetime to future null infinity. The Poincaré flux densities are computed whose Fourier transformations generate the supertranslations and superrotations. After taking normal order, these generators are lifted to quantumm flux operators which form a representation of Carrollian diffeomorphism for scalar theory. For the spinning theories, we need to introduce a helicity flux operator to close the algebra, which shows the intertwinement between Carrollian diffeomorphism and duality transformation. Moreover, we have a non-trivial central charge for the commutator of supertranslation flux operators, and this makes the commutator becomes a Virasoro algebra.

[1] W.-B. Liu, J. Long, Phys. Rev. D 107, 126002 (2023).
[2] W.-B. Liu, J. Long, JHEP 07, 152 (2023).
[3] W.-B. Liu, J. Long, JHEP 10, 117 (2023).

P15

Complementary Strings on AdS3

P16

Exact results in QFTs: dualities, Higgsing and tensor deconfinement

P17

Abstract preparation for Poster
Asymptotic symmetries in p-form gauge theories and their duals

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In 1962 Bondi, van der Burg and Metzner and Sachs [1],[2] investigated the symmetry structure of asymptotically flat space-times at null infinity, finding an infinite dimensional enhancement of the Poincaré group dubbed BMS group. This is the first example of asymptotic symmetry that is a symmetry emerging at any physical finite or infinite distance boundary of the space-time [3–5]. In the same years, i.e. in 1965 [6], Weinberg significantly developed and generalized to gravity soft theorems; they originally emerged in quantum electrodynamics and characterize universal properties of Feynman diagrams and scattering amplitudes when a massless external particle becomes soft [7]. Recently Strominger et al. understood that soft theorems and asymptotic symmetries are different facets of a triangular equivalence called infrared triangle along with memory effects [3].
We studied asymptotic symmetries of p-forms gauge theories in arbitrary dimensions. Our interest in such theories is also motivated by the duality linking forms of different degree [8–10]. We consider p-form gauge theories in Lorentz gauge and we derive the gauge parameters which give the asymptotic symmetries. In order to have finite non-vanishing asymptotic charges we need to consider a polyhomogenous expansion which also takes into account logarithmic terms. In the perspective of the duality, we find a bijection between asymptotic charges of the dual descriptions; moreover in dimensions $D = p + 2$ a p-form is dual to a scalar and we propose as a scalar asymptotic charge the one emerging in the p-form gauge theory context also for the odd dimensional case.
The duality can be taken into account in more general gauge theories where the gauge connections are mixed symmetry tensors as in the case of hook fields.

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P18

Holographic Entanglement Entropy for a local quench in higher dimensions

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This research investigates holographic entanglement entropy (HEE) [1] for a local excitation insertion in a CFT. Specifically, we compute HEE for a local quench [2], a unitary evolution of a pure state triggered by a sudden change of parameters in a localized region, in higher-dimensional $\mathrm{AdS}_{d+1}/\mathrm{CFT}_d$ setups, with $d > 2$. Holographically this insertion is described by a free-falling massive particle in an AdS spacetime, which can asymptotically be considered as a black hole.

We explore the injection of this radiation into a CFT via local modifications to the vacuum state using a local operator. Our investigation extends to higher dimensions, employing CFT as a laboratory for studying quantum gravity processes. We find that the time evolution of the HEE is given by a Page-like curve in which the curve goes to zero at early and late times. We also find an agreement with the perturbative description for a small black hole given in a previous work [2].

In the second part of our work, we introduce a boundary in the CFT (BCFT) [3], extending the two-dimensional setup of [4] to higher dimensions. We therefore establish a double-holographic system, where the CFT degrees of freedom are replaced by their gravity dual, consisting of a higher-dimensional asymptotically AdS space ending on an end-of-the-world (EoW) brane with fluctuating metrics. Also in this setup, we compute the HEE in higher dimensions, both numerically and perturbatively. These holographic configurations are also interesting because they find applications in the black hole information paradox.

The research workflow unfolds as follows: introduction of the conformal setup with an excited state, numerical treatment for the configuration with the local excitation, depiction of the time evolution of holographic entanglement entropy, comparison with previous perturbative results, and finally, computation of HEE for holographic local quenches in $\mathrm{AdS}_{d+1}/\mathrm{BCFT}_d$, $d > 2$, both numerically and perturbatively.

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P19

Advances in finite Thermal CFTs

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I will present recent developments in Conformal Field Theories (CFTs) at finite temperature based on [1, 2, 3]. This setup is extremely important in experiments as well as in holography, for the study of black holes and black branes in AdS. Thermal effects in CFTs can be computed by considering the theory on $S^1 \times R^{d-1}$, with suitable periodicity/anti-periodicity conditions for bosons/fermions. I will present an overview of [1, 2, 3] with some details on a subset of the results contained in the references.

First I will discuss the symmetries of the thermal theory, by showing broken Ward identities for broken symmetries. Those identities represent non-trivial constraints for the theory and systematically reproduce the structure of the Operator Product Expansion (OPE) applied to a thermal two-point function of scalars.

The dynamics of the theory can be constrained from the Kubo-Martin-Schwinger (KMS) condition, which is the periodicity of the two-point functions (of scalars) on S^1. We derived explicit sum rules from KMS combined with OPE from which one-point functions of light operators can be computed. I will also discuss heavy operators by proving a version of the Tauberian theorems by using KMS, OPE and the thermal inversion formula. From the Tauberian theorem we read the leading behaviour of the heavy operators' one-point functions.

The setup can be enriched even more by considering a defect: their importance both for black holes' physics and confinement pushed us in the study of Polyakov loops, namely defects wrapping the thermal circle, in an ongoing project with J. Barrat (DESY) and B. Fiol (Barcelona Univeristy) [3]. I will also mentioned some results about thermal correlation functions in presence of this type of defects.

[1] E. Marchetto, A. Miscioscia, E.Pomoni, JHEP 12 (2023) 186.
[2] E. Marchetto, A. Miscioscia, E.Pomoni, arxiv:2312.13030.
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P20

Positivity of the q-deformed Veneziano Amplitude in $D = 4$

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In the context of the modern S-matrix bootstrap program, there has been a renewed interest in studying the Coon amplitude [1, 2, 3, 4, 5]. This amplitude is a q-deformed generalization of the Veneziano amplitude, featuring logarithmic Regge trajectories that exhibit a semi-infinite sequence of poles converging on an accumulation point. The Veneziano amplitude describes the tree-level scattering of four open strings. The Coon amplitude, less widely known, is a one-parameter deformation of the Veneziano amplitude, with a real-valued deformation parameter, $q \geq 0$. When $q = 0$, the Coon amplitude reduces to the field theory amplitude, and at $q = 1$, it is equivalent to the Veneziano amplitude. The Coon amplitude, as a function of q, showcases a nuanced interplay between unitarity and meromorphicity in the Mandelstam variables. For $0 < q < 1$, the Coon amplitude is unitary and non-meromorphic, featuring an accumulation point spectrum. Conversely, for $q > 1$, the Coon amplitude becomes non-unitary and meromorphic, with no accumulation point. At $q = 1$, only the Veneziano amplitude is both unitary and meromorphic, without an accumulation point.

One of the important properties that S-matrix of a sensible theory satisfies is the unitarity condition which translates to the fact that a S-matrix must satisfy the condition $S^\dagger S = 1$. Our primary objective in this work [6] was to gain insights into the unitarity of the Coon amplitude. One of the important implications of unitarity is the positivity of the coefficients of the partial wave expansion of the amplitude. In other words, in a unitary theory, the residue of each pole of the four-point amplitude must have an expansion on the Gegenbauer polynomials with positive partial wave coefficients. We have explicitly computed, in this work, the partial wave coefficients on the leading Regge trajectory in $D = 4$, and we have found that these coefficients always remain positive, even though their magnitude decreases with spin. The coefficients on the subleading trajectories are observed to be larger than those on the leading ones which implies that our core result for the positivity of the partial wave coefficients on the leading Regge trajectories indicates the positivity of the full Coon amplitude in $D = 4$.

While there is yet no definitive field theory or string worldsheet realization of the Coon amplitude, accumulation point spectra like those exhibited by the Coon amplitude with $q < 1$ have recently been found in a stringy set-up involving open strings ending on a D-brane [7]. Moreover, accumulation point spectra have appeared in various contexts in the modern S-matrix bootstrap program, so it is important to understand physical origins of Coon amplitude. The analysis of Maldacena and Remmen [7] suggested that there are certain qualitative behaviours which are common between the Coon amplitude and the string amplitude for a string propagating in the AdS background. However, it's important to note that there isn't an exact correspondence. It is plausible, though, that the Coon amplitude could be related to string amplitude of ordinary strings moving in some other suitable background.

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[2] N. Geiser, L. W. Lindwasser, JHEP 12 (2022) 112.
[3] C. Cheung, G. N. Remmen, JHEP 01 (2023) 122.
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P21

Loop Amplitudes in the Coulomb Branch of $\mathcal{N} = 4$ Super-Yang-Mills Theory

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In [1], we study four point planar loop amplitudes at an arbitrary point in the Coulomb branch of $\mathcal{N} = 4$ super-Yang-Mills (sYM) theory. We study two particle unitary cuts up to four loop order. We explicitly verify that bubble and triangle graphs do not contribute at one loop level and show that the results hold at higher loop level as well. We also write down an all loop recursion relation for two particle reducible graphs for four point amplitudes.
In [2], we study on-shell functions in the kinematic space for the Coulomb branch of $\mathcal{N} = 4$ sYM. We construct BCFW bridges that help us build bigger on-shell functions. As a consequence, we provide on-shell diagram formulations for BCFW shifts that correspond to various mass configurations in the Coulomb branch. We will use this to calculate the quadruple cut for the one-loop amplitude on the Coulomb branch and maximal cuts for higher-loops.

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P22

Entanglement in String Theory

P23

B3W on the Spindle

P24

Abstract for ICTP Spring School

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In this poster, I will discuss the collective field theory description of Unitary matrix quantum mechanics. The I will introduce a new set of boundary conditions for higher spin gravity in AdS_3 where the boundary dynamics of spin two and other higher spin fields are governed by the interacting collective field theory Hamiltonian of Avan and Jevicki.Then, I will show that the time evolution of spin two and higher spin fields can be captured by the classical dynamics of folded fermi surfaces. I will also discuss the construction of infinite sequences of conserved charges showing the integrable structure of higher spin gravity (for spin 3) under the boundary conditions we considered.

P25

Abstract template for Sping School on Superstring Theory and Related Topics

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We consider high energies processes for elastic scattering of bosons and fermions in ten dimensions at fixed angle and Regge limit using superstring scattering amplitudes getting the respective four dimensional behavior through Polchinski-Strassler ansatz [1].

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P26

Title: 3 Dimensional Bose-Fermi dualities in the non relativistic limit

Authors: Indranil Halder, Lavneet Janagal, Shiraz Minwalla, Chintan Patel, Naveen Prabhakar, Djordje Radicevic

Abstract: We find a non-relativistic description of matter Chern Simons theories on a sphere. We argue that the n particle Hamiltonian is the Laplacian for n particles moving on a sphere in the background of a 'Knizhnik–Zamolodchikov gauge field'. We argue that the inner product on the n particle Hilbert space is given in terms of the inner product on the space of conformal blocks. Using the pairing of conformal blocks under level-rank duality, we find a dual description of the n particle wavefuntion which is that of n particles coupled to the level-rank dual Chern Simons gauge boson. When all the particles are in fundamental or antifundamental representation, we demonstrate that the parity of the wavefunction changes under duality, which clearly is a demonstration of the Bose-Fermi duality.

P27

Half-BPS Wilson line in $\mathcal{N} = 4$ Chern-Simons matter theories

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In gauge theories Wilson loops represent a class of fundamental non-local observables that offer profound insights across both weak and strong coupling regimes. They find a clear interpretation in terms of Lagrangian fields at weak coupling, while their characterization at strong coupling is encoded in the degrees of freedom of semiclassical open strings. Moreover, supersymmetric BPS Wilson lines are particularly interesting as they can support supersymmetric defect field theories [1], offering rich analytical opportunities for further developments. In four-dimensional theories Wilson loops have been extensively studied in the years leading to numerous interesting results and applications. The landscape changes however in 3d theories, where the realization of 1/2-BPS Wilson operators has proved to be more intricate, necessitating careful consideration of fermionic contributions [2]. In this framework, recent investigations have revealed additional properties of Wilson lines, especially in the context of the ABJM theory, offering promising avenues for exploring correlators along the CFT_1 line defect also by employing methodologies such as the analytic bootstrap [3].
This ongoing research aims to expand the above discussion by investigating the role of Wilson lines in 3d theories with less supersymmetry, focusing on defect operator insertions along the 1/2-BPS Wilson line [4] within a $\mathcal{N} = 4$ Chern-Simons matter theory [5]. Beginning with an exposition on defect CFT, we delve into the breaking pattern of the spacetime symmetry induced by the presence of the Wilson line. By employing both the weak coupling Lagrangian description and the framework of representation theory of the preserved superconformal group along the line, we identify the displacement supermultiplet. We study then the Operator Product Expansion and the selection rules for the superprimary, which will allow us to systematically explore the defect operator insertions in a class of four-point functions. Leveraging on the superspace description and the symmetries on the line, we investigate how the correlators are constrained to depend on a single function of the cross-ratio in one dimension. This function, subject to stringent constraints stemming from crossing symmetry and internal consistency, serves as the starting point for an analytical bootstrap strategy, offering a pathway to study the initial subdominant contribution at strong coupling.

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[3] L. Bianchi, G. Bliard, V. Forini, L. Griguolo and D. Seminara, "Analytic bootstrap and Witten diagrams for the ABJM Wilson line as defect CFT_1," JHEP **08**, 143 (2020)
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[5] K. Hosomichi, K. M. Lee, S. Lee, S. Lee and J. Park, "$\mathcal{N} = 4$ Superconformal Chern-Simons Theories with Hyper and Twisted Hyper Multiplets," JHEP **07**, 091 (2008)

P28

Supersymmetric deformation of the $\mathbb{CP}^1$ model and its conformal limits

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Abstract

We prove that the supersymmetric deformed $\mathbb{CP}^1$ sigma model (the generalization of the Fateev-Onofri-Zamolodchikov model) admits an equivalent description as a generalized Gross-Neveu model. This formalism is useful for the study of renormalization properties and particularly for calculation of the one- and two-loop β-function. We show that in the UV the superdeformed model flows to the super-Thirring CFT, for which we also develop a superspace approach. It is then demonstrated that the super-Thirring model is equivalent to a sigma model with the cylinder $\mathbb{R} \times S^1$ target space by an explicit computation of the correlation functions on both sides. Apart from that, we observe that the original model has another interesting conformal limit, given by the supercigar model, which as well could be described in the Gross-Neveu approach.

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P29

Double-copy supertranslations (Poster)

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The double copy (DC) correspondence provides a surprising connection between gravity and gauge theories, whereas the former can be understood in terms of a suitable square of the latter. While well established at the amplitude level, a clear-cut understanding of the double copy at level of the symmetries underlying both the gauge and gravitational sides is under investigation. In this spirit, we aim to discuss the role of the DC correspondence as a tool to a deeper understanding of the asymptotic symmetries for the N=0 supergravity multiplet, known to rule important infrared observables including soft theorems and memory effects. We illustrate the main issues connected with the extension of the DC to fields at null infinity and we identify "double-copy supertranslations", i.e. BMS supertranslations and two-form asymptotic symmetries, in terms of gauge components. Furthermore, we present a DC derivation of the asymptotic surface charges, which highlights the existence of infinitely many conserved charges involving the DC scalar.

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P30

Axial anomaly in nonlinear conformal electrodynamics

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We study the axial anomaly of Dirac spinors on gravitational instanton backgrounds in the context of nonlinear electrodynamics. In order to do so, we consider Einstein gravity minimally coupled to a recently proposed conformal electrodynamics that enjoys duality transformation invariance. These symmetries allow us to generalize the Eguchi-Hanson configuration while preserving its geometry. We then compute the Dirac index of the nonlinearly charged Eguchi-Hanson and Taub-NUT configurations. We find that there is an excess of positive chiral Dirac fermions over the negative ones which triggers the anomaly. [1]

Colipí-Marchant, Francisco and Corral, Cristóbal and Flores-Alfonso, Daniel and Sanhueza, Leonardo, Phys. Rev. D 107, (2023) 104042

P31

Soft-wall holographic model for the early universe phase transition in the composite Higgs boson scenario

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Abstract for the *Spring School on Superstring Theory and Related Topics (smr 3932)* to be held in person from *22 Apr 2024* to *26 Apr 2024*.
AdS/CFT correspondence provides a non-perturbative method to investigate strongly coupled gauge theories within weakly coupled gravitational models. Studying of the black objects in bulk of the dual theory allows one to scrutinise thermodynamic aspects of the original theory at nonzero temperature [1]. In particular, we consider the dual soft-wall holographic Composite Higgs model and found in it first order phase transition, that is required for resolving the baryon asymmetry problem according to Sakharov's conditions[2, 4, 3]. Besides, the gravitational wave spectrum produced during the nucleation phase was also estimated. We find it to be detectable with the planned gravitational wave detectors[5].

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P32

Title: Killing Spinors for Finite Temperature Euclidean Solutions at the BPS Bound

Abstract: In a recent paper [arXiv:2308.00038], Anupam, Chowdhury, and Sen conjectured that the finite temperature Euclidean five-dimensional Cvetic-Youm solution saturating the BPS bound is supersymmetric. In this paper, we explicitly construct Killing spinors for this solution in five-dimensional minimal supergravity. We also expand on the previous discussions of Killing spinors for the finite temperature Euclidean Kerr-Newman solution saturating the BPS bound. For both these cases, we show that the total charge gets divided into two harmonic sources on three-dimensional flat base space.

P33

Spinning Mellin amplitudes and AdS gluon scattering

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In the study of scattering amplitudes in AdS spacetime, much focus has been on scalar external particles. Despite many nice results [1, 2, 3, 4], a detailed study of amplitudes with high multiplicity necessarily involves the study of lower-point amplitudes with spinning external particles. Here, we report on recent progress [5] made in this regard. We define the Mellin amplitude of multiple spinning particles and study its factorization properties. We apply the formalism to bootstrap lower-point spinning and higher-point scalar amplitudes in a special super-Yang-Mills theory [1]. We also discuss the relation of various spinning components with flat-space amplitudes.

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Black Hole Singularity from OPE