iTHEMS-YITP Workshop: Bootstrap, Localization and Holography

Report of Contributions

https://indico.yukawa.kyoto-u.ac.jp/e/blh2024

Contribution ID: **1** Type: **not specified**

Review talk on ”Supersymmetric Localization”

Wednesday, May 22, 2024 9:00 AM (1h 30m)

Presenter: MINAHAN, Joseph (Uppsala University)

Contribution ID: **2** Type: **not specified**

Double copy and soft limits in (A)dS

Tuesday, May 21, 2024 10:45 AM (1 hour)

The study of the double copy relating gluon to graviton amplitudes and their soft limits has been a major driving force in the study of scattering amplitudes in flat space. I will describe recent progress in generalising these ideas to (A)dS, which may have interesting implications for holography and cosmology.

Presenter: LIPSTEIN, Arthur (Durham University)

Contribution ID: **3** Type: **not specified**

Integrated correlators beyond localisation

Wednesday, May 22, 2024 1:30 PM (1 hour)

I will review 4-pnt half BPS correlators in planar N=4 super Yang-Mills theory (SYM), dual to graviton scattering in AdSxS via AdS/CFT. In particular I will review the generating functions describing them for all charges at both weak and strong coupling. Integrating certain four-point correlators over their space-time dependence yields quantities that can be computed exactly by supersymmetric localisation, whereas correlators with more general charges are not accessible from this method. Nevertheless we propose an exact expression of such integrated correlators, valid for arbitrary 't Hooft coupling. The expression matches with the known exact localisation-based results for specific charges, as well as with all existing perturbative and strong-coupling results in the literature for more general charges. As an application, our result is used to determine certain 7-loop Feynman integral periods and fix previously unknown coefficients in the correlators at strong coupling.

Presenter: HESLOP, Paul (Durham University)

Contribution ID: **15** Type: **not specified**

Review talk on ”Analytic Bootstrap for Holographic Correlators”

Monday, May 20, 2024 9:30 AM (1h 30m)

Presenter: ZHOU, Xinan (Kavli Institute for Theoretical Sciences)

Contribution ID: **16** Type: **not specified**

Remarks about integrated correlators in N=4 and N=2 SYM superconformal theories in d=4

Wednesday, May 22, 2024 10:45 AM (1 hour)

Localization allows to compute via a matrix model integrated forms of correlators, such as a 4-point function or a two-point function in presence of a defect, whose coordinate dependence is not fixed by conformal symmetry. These correlators are interesting as they holographically dual to scattering processes in AdS5 and the integrated results extend the data for a bootstrap reconstruction. In this talk I will focus on two topics. The first one regards the integrated two-point functions in presence of a Wilson line defect in the N=4 theory. Following 2308.16575 (M.B, Frau, Galvagno, Lerda) I will discuss how the Defect CFT constraints and the Ward identities of the preserved supersymmetries determine the measure of integration and I will rephrase their localization computation (already given in 2305.08297) in the so-called "full Lie algebra" approach. This technique is well suited for extending the discussion to $N = 2$ superconformal theories and my second topic will be the matrix model computation of integrated 4-pt correlators in a specific N=2 superconformal YM theory called E-theory; this part is based on 2311.17178 with Frau, Lerda, Pini.

Presenter: BILLO, Marco (Turin University)

Contribution ID: **17** Type: **not specified**

Modularity and Resurgence for N=4 Integrated Correlators

Wednesday, May 22, 2024 4:15 PM (1 hour)

I will describe a surprisingly simple representation of a class of integrated correlation functions of four superconformal primaries in the stress tensor multiplet of N=4 supersymmetric Yang-Mills theory with arbitrary simple gauge group, G. I then present exact formulae for these integrated correlators which are manifestly invariant under GNO electro-magnetic duality. For classical gauge groups, G=SU(N), SO(N), USp(2N), In the large-N limit these correlators are interpreted via holography in terms of the low-energy expansion of type IIB superstring amplitudes in AdS_5XS^5 or an orientifold thereof.
From the asymptotic perturbative large-N expansion of these integrated correlators we can reconstruct non-perturbative, but modular invariant exponentially suppressed terms via resurgence analysis.

Presenter: DORIGONI, Daniele (Durham University)

Contribution ID: **18** Type: **not specified**

Scattering from long strings in AdS5 x S5

Wednesday, May 22, 2024 3:00 PM (1 hour)

Motivated by understanding the scattering of gravitons from extended (or long) strings in type IIB string theory at finite coupling via AdS/CFT, we study an integrated two-point function of stress tensor multiplet operators in the presence of a half-BPS line defect in N=4 SU(N) super-Yang-Mills theory.

We determine this integrated correlator at the five lowest non-trivial orders in 1/\sqrt{N} at fixed Yang-Mills coupling and θ-angle. Our calculations are performed explicitly when the line defect is a Wilson line, in which case we find a finite number of perturbative contributions at each order in 1/\sqrt{N}, as well as instanton contributions.

Using SL(2,Z) transformations, our results can also be applied to Wilson-'t Hooft line defects dual to extended (p, q)-strings in the bulk.

We analyze features of these integrated correlators in the weak coupling expansion by comparing with open-closed amplitudes of type IIB string theory on AdS5 x S5, as well as in its flat space limit.

We predict new higher-derivative interaction vertices on the D1-brane and, more generally, on (p, q)-strings.

Presenter: RODRIGUEZ, Victor (Princeton University)

Contribution ID: **19** Type: **not specified**

New recursion relation for M2-brane matrix model

Tuesday, May 21, 2024 1:30 PM (1 hour)

In this talk we study a theory of M2-branes with mass deformations. The Fermi gas formalism allows us to calculate all order 1/N corrections to the partition function when mass parameters are small, for which this model is getting attention in various different
contexts such as matrix model and integrable systems, precision holography and conformal bootstrap. Recently, motivated by the connection between the Fermi gas system and topological string (TS/ST correspondence) it was found that the partition function satisfies non-linear difference equations such as q-deformed Painleve/Toda equations. By combining this with the three-dimensional dualities we find a new recursion relation, which is a powerful tool to calculate exact values of the partition function for large but finite N. As an application, we reveal the large N asymptotics of the partition function when the mass parameters are large, where the aforementioned 1/N expansion is invalid due to the instability of 1/N non-perturbative effects interpreted as
M2-instantons in the gravity side.

Presenter: NOSAKA, Tomoki (Kavli Institute for Theoretical Science)

Contribution ID: **20** Type: **not specified**

Review talk on ”Numerical Bootstrap”

Thursday, May 23, 2024 9:00 AM (1h 30m)

Presenter: CHESTER, Shai (Imperial College)

Contribution ID: **21** Type: **not specified**

Doubled Hilbert space in double-scaled SYK

Tuesday, May 21, 2024 9:30 AM (1 hour)

We consider matter correlators in the double-scaled SYK (DSSYK) model. It turns out that matter correlators have a simple expression in terms of the doubled Hilbert space
$\mathcal{H} \otimes \mathcal{H}$, where $\mathcal{H}$ is the Fock space of q-deformed oscillator (also known as the chord Hilbert space).
In this formalism, we find that the operator which counts the intersection of chords should be conjugated by certain entangler" anddisentangler". We explicitly demonstrate this structure for the two- and four-point functions of matter operators in DSSYK.

Presenter: OKUYAMA, Kazumi (Shinshu University)

Contribution ID: **22** Type: **not specified**

Bootstrapping SCFTs with Integral Constraints

Thursday, May 23, 2024 10:45 AM (1 hour)

The numerical conformal bootstrap has put impressive bounds on the data of CFTs, including superconformal field theories, by using the equations for crossing symmetry of correlators expanded in derivatives of cross-ratios. Supersymmetric localization provides complementary constraints on SCFTs in terms of integrals of correlators over the cross-ratios. In this talk, I will describe how to include these constraints from localization into the bootstrap. I will focus on two examples: 4D N = 4 super-Yang-Mills theory, and 3D ABJM theory. In both cases, the use of integral constraints dramatically improves bootstrap bounds, and enhances the sensitivity of the bounds to higher-derivative corrections coming from the holographic dual models.

Presenter: DEMPSEY, Ross (Princeton University)

Contribution ID: **23** Type: **not specified**

Tachyon-Dilaton Eschatology and Diffeomorphism in String Field Theory

Thursday, May 23, 2024 1:30 PM (1 hour)

I will discuss a formulation of conformal perturbation theory through closed string field theory and nontrivial string background deformations described by string fields.

Presenter: YIN, Xi (Harvard University)

Contribution ID: **24** Type: **not specified**

Bootstrapping 3d CFTs with O(N) symmetry

Thursday, May 23, 2024 3:00 PM (1 hour)

In this talk, I summarize various numerical bootstrap studies on CFTs with O(N) symmetry. These bootstrap problems are translated to very challenging computational tasks, and several advanced numerical techniques have been developed to address the challenges in recent years. I will review these techniques and discuss the O(2), O(3), O(5) studies and the implications for relevant physics questions.

Presenter: SU, Ning (Caltech)

Contribution ID: **25** Type: **not specified**

Spectrum and bootstrap –happy together?

Thursday, May 23, 2024 4:15 PM (1 hour)

I will review the status of the integrability for the spectrum in N=4 SYM and on how we plan to get beyond the spectrum with the help of the conformal bootstrap.

Presenter: GROMOV, Nikolay (King's College London)

Contribution ID: **26** Type: **not specified**

Global Symmetry and Integral Constraint on Superconformal Impurities

Friday, May 24, 2024 9:00 AM (1 hour)

We study properties of point-like impurities preserving flavor symmetry and supersymmetry in four-dimensional N=2 field theories. At large distances, such impurities are described by half-BPS superconformal line defects. By working in the AdS2*S2 conformal frame, we develop a novel, simpler, way of deriving the superconformal Ward identities relating the various two-point functions of flavor current multiplet operators in the presence of the defect. We use these relations to simplify a certain integrated two-point function of flavor current multiplet operators, which is accessible by exact methods such as supersymmetric localization and provides useful input for further bootstrap studies.

Presenter: WANG, Yifan (New York University)

Contribution ID: **27** Type: **not specified**

1-point blocks for Thermal CFTs

Friday, May 24, 2024 10:15 AM (1 hour)

We study conformal blocks for thermal one-point functions on the sphere in the presence of angular potential in conformal field theories. Much like ordinary four-point conformal blocks, the thermal blocks satisfy Dolan-Osborn-like Casimir differential equations. We will obtain a general solution using recursion relations and weight-shifting operators. As an application, we consider the block decomposition for a few examples. We also discuss an asymptotic formula for the three-point coefficients of primary operators in the limit where two of the operators are heavy.

Presenter: VICHI, Alessandro (Pisa University)

Contribution ID: **28** Type: **not specified**

Bootstrapping the AdS Veneziano amplitude

Monday, May 20, 2024 11:15 AM (1 hour)

I will present the derivation of the AdS Veneziano amplitude for the scattering of gluons in type IIB string theory on AdS5×S5/Z2in the presence of D7 branes, in a small curvature expansion. This is achieved by combining a dispersion relation in the dual 4d N=2 SCFT with an ansatz for the amplitude as an open string worldsheet integral over single-valued polylogarithmic functions evaluated on the real line. Single-valued functions arise because curvature corrections can be thought of as extra insertions of soft gravitons. In this way we fix the first two curvature corrections, which satisfy consistency checks in the high energy limit, the low energy expansion as previously fixed using supersymmetric localisation, and for the classical energy of the exchanged massive string operators. Our result predicts new Wilson coefficients and quantum corrections to the energies of massive strings that could be checked with future localisation, semi-classical or integrability computations.

Presenter: HANSEN, Tobias (Durham University)

Contribution ID: **29** Type: **not specified**

High energy scattering of strings in AdS

Monday, May 20, 2024 1:45 PM (1 hour)

When studying string scattering in flat space, we rely on a world-sheet description, yet extending this to curved backgrounds poses nontrivial challenges. In this talk, we discuss how to compute string amplitudes on AdS as a curvature expansion around flat space and emphasize the pivotal role of single valuedness, akin to its significance in flat space. Specifically, we focus on the AdS Virasoro-Shapiro amplitude and start from its recent representation as a world-sheet integral. We take the next step towards a world-sheet theory in AdS by investigating the high-energy regime. As in flat space, this is accessed by saddle point techniques. Moreover, the path integral representation for the amplitude is dominated by a classical solution. Our algorithm computes AdS classical solutions to arbitrary order in a 1/R expansion, where R is the radius of AdS, in terms of single-valued multiple polylogarithms whose letters are the locations of the punctures. Finally, we show that AdS curvature corrections exponentiate in this limit!

Presenter: NOCCHI, Maria (University of Oxford)

Contribution ID: **30** Type: **not specified**

A Differential Representation for Holographic Correlators

Monday, May 20, 2024 3:15 PM (1 hour)

I will discuss a differential representation for holographic four-point correlators. In this representation, the correlators are given by acting differential operators on certain seed functions. The number of these functions is much smaller than what is normally seen in known examples of holographic correlators, and all of them have simple Mellin amplitudes. This representation establishes a direct connection between correlators in position space and their Mellin space counterparts. The existence of this representation also imposes non-trivial constraints on the structure of holographic correlators. We illustrate these ideas by correlators in AdS5xS5 and AdS5xS3.

Presenter: YUAN, Ellis (Zhejiang University)

Contribution ID: **31** Type: **not specified**

Bootstrapping F-theory

Monday, May 20, 2024 4:30 PM (1 hour)

We consider a set of 4d N=2 SCFTs defined by N D3 branes probing F-theory singularities with constant value of the axio-dilaton. In these theories we focus on the four-point function of the moment map operator at large N, which is holographically dual to a gluon amplitude in AdS_5 x S^3. We use the relation between a certain integral of the correlator to the mass-deformed sphere free energy of the theory to put constraints on this observable at the first few orders in the 1/N expansion. In the only case admitting a gauge theory description, we can use standard techniques of supersymmetric localization and fix the coefficients of certain higher-derivative terms in the F-theory effective action as functions of the axio-dilaton. On the other hand, the other theories do not have a Lagrangian but we are still able to use their Seiberg-Witten description to fix a logarithmic threshold term in the gluon amplitude, which is regulated by string theory. Our result agrees with the prediction from the flat space limit. This is the first step towards fixing the coefficients of higher-derivative terms in the F-theory effective action using supersymmetric localization, even for strongly coupled fixed points.

Presenter: FERRERO, Pietro (Stony Brook University)

Contribution ID: **35** Type: **not specified**

M2-branes, Painleve equations and affine Weyl groups

Friday, May 24, 2024 11:30 AM (1 hour)

It was known that multiple M2-branes are described by supersymmetric Chern-Simons theories and the grand canonical partition functions of these theories sometimes satisfy q-deformed Painleve equations. Since Painleve equations are constructed from affine Weyl groups of exceptional algebras, this implies that these grand partition functions enjoy hidden symmetries of affine Weyl groups. After clarifying how symmetries of discrete translations are realized on the grand partition function, we find that the domain of the grand partition function is extended to the whole parameter space of relative ranks, where the q-Painleve equation continues to hold. This work is based on collaborations with Tomoki Nosaka.

Presenter: MORIYAMA, Sanefumi (Osaka Metropolitan University)

Contribution ID: **36** Type: **not specified**

Bosons and/ or fermions at large charge

Friday, May 24, 2024 2:00 PM (1 hour)

In this talk I will review the general semiclassical method of computation of strongly coupled CFT data for operators of large charge Q,
and its application to strongly-coupled bosonic and supersymmetric theories. I will particularly emphasize the use of
double-scaling limits to interpolate continuously between field-theoretic weak-coupling perturbation theory and large-charge EFT,
when a theory-dependent weak-coupling parameter is available. I will then discuss more recent results applying the same
methods to fermionic CFT, including an analysis of a special case (the O(2N) x O(2N)-symmetric Gross-Neveu model) whose large-charge regime is controlled by
Landau Fermi-liquid theory. I will then extend the picture by showing (based on work in progress with Bersini, Orlando and Reffert)
that this theory has a third regime at ultra-large charge described by a novel nonabelian
superfluid phase. I will explain the transition to this phase via the BCS mechanism which is controlled quantitatively by
a second double-scaling limit of Q taken to infinity with Q \exp{-N} held fixed.

Presenter: HELLERMAN, Simeon (Tokyo University)