YITP Workshop "Strings and Fields" July 22-26, 2014
Abstract

— YITP Panasonic hall—

Tuesday, July 22

Morning session 1 (10:30-11:40)

Masato Taki (RIKEN)

5d SCFTs, Enhanced Symmetry and Nekrasov Partition Functions

5d supersymmetric gauge theories are perturbatively non-renormalizable, but some of them are believed to be, nevertheless, consistent quantum theories since they have UV fixed points.This fact was pointed out by Seiberg in 1996. However, the corresponding SCFTs are strongly-coupled and it has been so far very hard to study them directly. Recent developments in localization and stringy arguments start shedding new light on these theories. In this talk I will give an overview of these new results on 5d SCFTs.Localization of 5d partition functions enable us to evaluate the superconformal index of such a SCFT by using only the IR Lagrangian description. The resulting index enjoys the enhanced E_n global symmetry expected from the Type I' construction. We can also reproduce this enhancement from Type IIB 5-brane webs and refined topological strings. These methods leads to new conjectural relations between 5d partition functions. These new results imply hidden E_n symmetry controls 5d Nekrasov partition functions and topological string theory.

Morning session 2 (12:00-12:50)

Akinori Tanaka (Osaka University)

Superconformal index on $\mathbb{RP}^2 \times S^1$ and mirror symmetry

We define supersymmetric gauge theories on squashed $S^2 \times S^1$ and squashed $RP^2 \times S^1$ by turning on a certain background U(1) gauge field.Intuitively, known squashing procedures on S^2 and RP^2 do not break the 3rd component of the angular momentum j_3.Therefore, we can define so-called superconformal index which have fugacity with respect to the j_3, and calculate the superconformal index via the localization technique.We show that the index does not depend on the squashing parameter. As an more interesting application, we check the 3d mirror symmetry.

Heng-Yu Chen (National Taiwan University)

Defects and Duality in Superconformal Indices

We provide a systematic prescription for inserting surface defects into four dimensional N=2 and N=1 superconformal indices by explicitly evaluating the residues at suitable singularities. To verify such prescription, we also compute the elliptic genera for the proposed two dimensional N=(2,2) and N=(0,2) world volume theories of the defects. Finally we study how four dimensional gauge theory dualities can descend to the two world volume of the surface defects, giving rise to new two dimensional dualities.

Afternoon session 1 (14:00-15:40)

Yutaka Yoshida (KIAS)

Higgs branch localization of 3d N=2 theories

We study N=2 supersymmetric gauge theories on squashed 3-sphere and $S^1 \times S^2$. Recent studies have shown that the partition functions in a class of N=2 theories have factorized forms in terms of vortex and anti-vortex partition functions by explicitly evaluating matrix integrals obtained by Coulomb branch localization. We directly derive this structure by performing Higgs branch localization. It turns out that more general N=2 theories have this factorization property. We also discuss the factorization of supersymmetric Wilson loop. (arXiv:1312.3627)

Tatsuhiro Misumi (Keio University)

Exact Results in Supersymmetric Lattice Gauge Theories

It is known that some of physical quantities are exactly calculable in certain low-dimensional gauge theories, whose integrability is proved by the "localization" technique with the theories embedded in supersymmetric gauge theories. We apply the localization technique to certain lattice gauge theories in two dimensions (the deformed Kazakov-Migdal model), and elucidate their integrability structure. This process is equivalent to exact calculation of partition functions in the two-dimensional N=(2,2) supersymmetric lattice gauge theory (Sugino model). Our results imply potential simplification of numerical analysis of the SUSY lattice models and could be applied to matrix models and superstring theories.

Shamik Banerjee (Kavli IPMU)

Trace Anomaly Matching and Exact Results For Entanglement Entropy

Following the ideas developed by Komargodski and Schwimmer in [**?**, **?**], we argue that the IR dilaton effective action on the cone computes the entanglement entropy of an even dimensional non-conformal field theory interpolating between a UV and an IR fixed point. We restrict our attention to theories which flow to trivial IR fixed point. We get exact non-perturbative results for the coefficients of the logarithmically divergent term of the entanglement entropy in these field theories in arbitrary even dimensions. The results match precisely with the weak coupling results available in the literature and also with the strong coupling results obtained via holography. We also write the universal terms for field theories which interpolate between two fixed points which are scale invariant but not conformally invariant.

Shin Sasaki (Kitasato University)

World-volume Effective Actions of Exotic Five-branes

We construct world-volume effective actions of exotic 5^2_2-branes in type IIA and IIB string theories. The effective actions are given in fully space-time covariant forms with two Killing vectors associated with background isometries. The effective theories are governed by the six-dimensional $\mathcal{N} = (2, 0)$ tensor multiplet and $\mathcal{N} = (1, 1)$ vector multiplet, respectively. Performing the S-duality transformation to the 5^2_2-brane effective action in type IIB string theory, we also work out the world-volume action of the 5^2_3-brane. We discuss some additional issues relevant to the exotic five-branes in type I and heterotic string theories. (1404.5442)

Afternoon session 2 (16:25-18:05)

Yuki Yokokura (Yukawa Institute for Theoretical Physics)

An Approach to the Information Problem in a Self-consistent Model of the Black Hole Evaporation

We constructed a self-consistent model which describes a black hole from formation to evaporation including the back reaction from the Hawking radiation, under some conditions. In the model we investigate the information and entropy problems.

Reiji Yoshioka (Osaka City University)

q-Virasoro/W algebra at root of unity limit and parafermion

2d-5d connection states that there exists a correspondence between CFT based on q-deformed Virasoro/W algebra and 5-dim supersymmetric gauge theory. In this talk, a root of unity limit in q is considered and we will show that the $\mathbf{Z}_r$-parafermions appear in the 2-d side. From the consideration of the 2d-5d connection in this limit, we will also examine the correspondence between the parafermonic CFT and the gauge theory on $\mathbf{R}^4/\mathbf{Z}_r$.

Pei-Wen Kao (National Taiwan University)

Doubled D-branes in generalized geometry.

In our previous paper arXiv:1107.0876, we considered a T-dual pair of D-branes which we called a double D-brane as a canonical object in doubled geometry. In this talk I will reinterpret double D-branes in terms of some particular structures in generalized geometry.

Tetsuji Kimura (Tokyo Institute of Technology)

Duality Transformations of Gauged Linear Sigma Model with F-term

We develop the duality transformation rules in two-dimensional theories in the superfield formalism. Even if the chiral superfield which we dualize is involved in F-term, we can convert the F-term to D-terms by virtue of the property of chiral superfields. We apply the duality transformation rule of the neutral chiral superfield to the $\mathcal{N} = (4, 4)$ gauged linear sigma model for five-branes. We also investigate the duality transformation rule of the charged chiral superfield in the $\mathcal{N} = (4, 4)$ gauged linear sigma model for the A_1-type ALE space. In both cases we obtain the dual Lagrangians in the superfield formalism. In the low energy limit we find that their duality transformations are interpreted as the T-duality transformations consistent with the Buscher rule.This presentation is based on my various works in collaboration with Shin Sasaki (Kitasato Univ.) and Masaya Yata (KEK). (arXIv:1406.0087)

Wednesday, July 23

Morning session 1 (9:00-10:10)

Gary Shiu (Hong Kong IAS / Wisconsin-Madison)

Progress in String Cosmology

TBA

Morning session 2 (10:40-11:55)

Daniel Junghans (Hong Kong IAS)

Brane Curvature Corrections to the N=1 Type II/F-theory Effective Action

We initiate a study of corrections to the Kähler potential of N=1 type II/F-theory compactifications that arise from curvature terms in the action of D-branes and orientifold planes. We first show that a recently proposed correction, which was argued to appear at order α' 2gs and be proportional to the intersection volume of D7-branes and O7-planes, is an artifact of an inconvenient field basis in the dual M-theory frame and can be removed by a field redefinition. We then analyze to what extent curvature

terms in the DBI and WZ action may still lead to corrections of a similar kind and identify two general mechanisms that can potentially modify the volume dependence of the Kähler potential in the presence of D-branes and O-planes. The first mechanism is related to an induced Einstein-Hilbert term on warped brane worldvolumes, which leads to a shift in the classical volume of the compactification manifold. The resulting corrections are generic and can appear at one-loop order on branes and O-planes of various dimensions and for configurations with or without intersections. We discuss in detail the example of intersecting D7-branes/O7-planes, where a correction can appear already at order $\alpha'^2 g_s^2$ in the Kähler potential. Due to an extended no-scale structure, however, it is then still subleading in the scalar potential. We also discuss a second mechanism, which is due to an induced D3-brane charge in the WZ action of D7-branes. Contrary to the first type of corrections, it appears at open string tree-level and shifts the definition of the Kähler coordinates in terms of the classical volume but leaves the volume itself uncorrected. Our work has implications for moduli stabilization and model building and suggests interesting generalizations to F-theory.

Pablo Soler (Hong Kong IAS)

U(1) portals into hidden sectors

Extra U(1) gauge groups and axion-like particles are among the most popular extensions of the Standard Model. They are very well motivated from string theory and have interesting phenomenological applications. I will describe how these ingredients can be used to probe hidden sectors in which, e.g. Dark Matter and/or SUSY breaking could reside. I will focus in particular on models with millicharged Dark Matter and Z' mediation, and construct explicit D-brane setups where these elements arise. (arXiv:1302.5471, arXiv:1401.5880, arXiv:1401.5890)

Taizan Watari (Kavli IPMU)

Distribution of Number of Generations

Flux compactification of Type IIB string/ F-theory generates a landscape of vacua. It is interesting to derive statistical distribution of observables in realistic set-ups of particle physics. Using the continuous approximation approach by Ashoke, Denef and Douglas a decade ago, and its F-theory adaptation in arXiv:1401.5908, we study how the number of vacua vary for different number of generations, among other things. For this purpose, we also study when the 4-cycles of a Calabi-Yau 4-fold can be decomposed into a sum of horizontal and vertical cycles, and when they cannot be.This presentation is based on a joint work in progress with A. Braun.

Morning session 3 (12:10-13:00)

Yukihiro Fujimoto (Osaka University)

Operator analysis of magnetized $T^2/\mathbb{Z}_N$ orbifolds

In the context of higher dimensional field theories with a homogeneous magnetic background, the fermion flavor structure with three generations can appear. Furthermore, we can obtain rich flavor structure if we introduce $\mathbb{Z}_N$ orbifold to the system. However, the analysis, i.e. the calculation of the number of generations, totally depends on the numerical calculation because of the appearance of the overlap integrals of the theta function. In this talk, we derive the exact analytic results for the system from a equivalent quantum mechanical system analysis. All of the results are consistent with the former numerical calculations and are applicable to phenomenological models. Moreover, There is a room to derive a new mathematical formula of the theta function.

Toshifumi Noumi (RIKEN)

Effective field theory for spacetime symmetry breaking

Symmetry and its spontaneous breaking play an important role in various areas of physics. In particular, the effective field theory based on the underlying symmetry structures provides a powerful framework for low-energy dynamics in the symmetry broken phase. For internal symmetry breaking, we have the well-established coset construction of the low-energy effective action. On the other hand, the understanding of spacetime symmetry breaking seems to be limited so far compared to the internal case: For example, it is known that a naive counting of broken global spacetime symmetries leads to a wrong counting of Nambu-Goldstone (NG) modes. Correspondingly, the coset construction has to be implemented with the so-called inverse Higgs constraints to remove such redundant NG modes. Although the coset construction has been applied to various condensed matter systems and captures a certain aspects of spacetime symmetry breaking, its understanding seems to be still incomplete. Indeed, there is no proof that it provides the most general effective action. In this presentation, we would like to revisit the effective action construction for spacetime symmetry breaking from the viewpoint of local symmetry breaking and develop an alternative approach complementary to the standard coset construction (this presentation is based on a collaboration with Yoshimasa Hidaka and Gary Shiu).

Afternoon session 1 (14:15-15:05)

Yutaka Ookouchi (Kyushu University)

Discrete Gauge Symmetry and Aharonov-Bohm Radiation in String Theory

We investigate cosmological constraints on phenomenological models with discrete gauge symmetries by discussing the radiation of standard model particles from Aharonov-Bohm strings. Using intersecting D-brane models in Type IIA string theory, we demonstrate that Aharonov-Bohm radiation, when combined with cosmological observations, imposes constraints on the compactification scales. (arXiv:1310.4026)

Shun'ya Mizoguchi (KEK)

F-theory Family Unification: A new geometric mechanism for unparallel three families and large lepton-flavor mixings

We propose a new geometric mechanism for naturally realizing unparallel three families of flavors in string theory, using the framework of F-theory. We consider a set of coalesced local 7-branes of a particular Kodaira singularity type and allow some of the branes to bend and separate from the rest, so that they meet only at an intersection point. Such a local configuration can preserve supersymmetry. Its matter spectrum is investigated by studying string junctions near the intersection, and shown to coincide, after an orbifold projection, with that of a supersymmetric coset sigma model whose target space is a homogeneous Kahler manifold associated with a corresponding painted Dynkin diagram. In particular, if one starts from the E_7 singularity, one obtains the $E_7/(SU(5)\times U(1)^3)$ model yielding precisely three generations with an unparallel family structure. Moreover, surprisingly enough, if we start from the E_8 singularity, we then obtain three sets of nonchiral singlet pairs with precisely the correct $U(1)$ charges needed for explaining the Yukawa hierarchies and large lepton-flavor mixings in a well-known seesaw model. The "E-twist" (mixing of $\bar{\mathbf{5}}$'s in **10** and **16** of $SO(10)$)is understood as the exchange symmetry of two **C** branes constituting the E-series singularities. (arXiv:1403.7066 [hep-th])

Afternoon session 2 (Poster Session) (15:25-17:55)

Poster session 1

List of the presenters (Alphabetical order)

Yuki Amari (Tokyo University of Science)

Collective coordinate quantization of the $\mathbb{CP}^2$ extended Skyrme-Faddeev soliton

The Skyrme-Faddeev model is extensively studied for discussing various low energy phenomena of QCD. It is well known that the extended version of the Skyrme-Faddeev model on the target space CP^N possesses an exact vortex solutions. We examine the mass spectrum of the vortex solutions in the CP^2 extended Skyrme-Faddeev model by employing the collective coordinate quantization. In this meeting, we will report on the physical interpretation of the mass spectrum and the quantum stability of the vortex solutions.

Florian Beye (Nagoya University)

A Classification of Bosonic Supercurrents

The heterotic covariant lattice (bosonic supercurrent) formalism is revisited and a classification of right-mover c=9 lattice SCFTs that potentially lead to chiral four-dimensional models is performed. All these SCFTs are related to certain (asymmetric) orbifold constructions, and 19 SCFTs lead to spacetime N=1 supersymmetry. Modular invariance implies that the corresponding left-mover lattice CFTs can be studied using the theory of lattice genera. Then, using the Minkowski-Siegel mass formula, lower bounds on the number of left-mover CFTs are calculated.

Shoichi Ichinose (University of Shizuoka)

Dissipative Models and Non-equilibrium Statistical Approach

Spring-Block model, Burridge-Knopoff model などの散逸モデル使い（これらは地震のモデルである)、その幾何構造（計量）を決める。統計ゆらぎをファイマンの経路積分で導入する。余次元座標が場の空間変数の共役な運動量になる。通常の（連続な）時間変数は使用せず、菊池 ('91) らの"Discrete Morse Flow Theory" を使ったステップ数 n を用いる。いくつかの simulation 結果を見せる。Hawking radiation, Unrhu effect にも言及する。 (arXiv:1404.6627, その他)

Takenori Ishii (Ritsumeikan University)

Thermodynamic limit of the Nekrasov-type formula for E-string theory

We talk about a Nekrasov-type partition function in a (1,0) supersymmetric theory in six dimensions, called E-string theory. An effective low energy theory of E-string theory obtained by the torus compactification has been studied by using the Seiberg-Witten description. In 2012, the Nekrasov-type formula for E-string theory was discovered by one of the authors. However it requires a proof and we gave it in our work. The proof is showing that the Seiberg-Witten description can be reproduced in a semi-classical limit of the Nekrasov-type partition function, following a method by N.Nekrasov and A.Okounkov. However the method cannot be directly applied to the Nekrasov-type partition function for E-string since parameters it includes has different physical interpretations than ones in Nekrasov partition functions for ordinary gauge theories. This issue can be resolved by defining an appropriate meromorphic function and a resolvent as its derivative. A Seiberg-Witten curve with genera we do not expect appears but it is mapped to the correct Seiberg-Witten curve by a simple mapping. This research is in collaboration with Kazuhiro Sakai and based on JHEP02(2014)087, arXiv:1312.1050[hep-th].

Hiroshi Isono (National Tsing Hua University)

Note on the self-duality of gauge fields in topologically nontrivial spacetime

We show the derivation of the self-duality relation of higher form abelian gauge field strength in the topologically nontrivial spacetime background. The Pasti-Sorokin-Tonin action for the self-dual abelian gauge field assumes that the spacetime topology is trivial to derive the self-duality relation using a gauge transformation of the action. In this paper we find a new gauge transformation of the same theory and show that this new gauge transformation enables us to derive the self-duality relation even in the topologically nontrivial spacetime background. [based on 1406.6023]

Satoru Itaya (Tokyo University of Science)

Superconducting strings in the classical U(1) ✕ U(1) model

The classical $U(1) \times U(1)$ model is a model of vortex whose doubly scalar fields are coupled with each other by non-trivial way. The scalar fields constitute band structure corresponding to a superconductor. We have found several solutions of the model in terms of the numerical or the simulational techniques. We will report on some of the following topics: (a) the solutions with rotational symmetry, (b) the multi-winding number solutions, (c) the solutions of the gauged model, (d) the solutions with non-rotational symmetry, (e) existence of the multi-band solutions.

Yuta Ito (SOKENDAI)

Numerical studies on the early universe by large-scale numerical computations in the Lorentzian IIB matrix model

In recent numerical studies on the Lorentzian IIB matrix model, a conjectured nonperturbative formulation of superstring theory, it was found that only 3d space starts to expand exponentially from (9+1)d spacetime.Moreover, by simulating a simplified model in the (5+1)d case, we discussed a possibility that the exponential expansion changes into a power-law expansion at late times.In this work we study the simplified model in the (9+1)d case on a large-scale parallel computer. We confirm that only 3d space expands exponentially and that the expansion changes into a power-law at late times. We also analyze the fluctuation of spacetime and study whether the classical equation of motion becomes valid at later times as speculated earlier.

Yusuke Kanayama (Tokyo Institute of Technology)

Central charges in Omega-deformed N=4 super Yang-Mills theory

Though translational symmetries and the parts of supersymmetries are broken in the Omega-deformation of SUSY gauge theories, it is known that taking the Nekrasov-Shatashvili limit enhances them partially. We examine the supersymmetry of four-dimensional N=4 SUSY Yang-Mills Theory in this limit based on the known three kinds of topological twists, and obtain the central charges. Then, we derive the equations of the BPS solitons corresponding the central charges by examining the BPS bound of the Energy.

Taishi Katsuragawa (Nagoya University)

Anti-evaporation in massive/bi-gravity

It is well known that the horizon radius of the black hole usually decreases by the Hawking radiation. Bousso and Hawking, however, found a phenomenon where the black hole radius increases by the quantum correction for the specific Nariai black hole.This phenomenon is called anti-evaporation of black holes.We consider and discuss the phenomenon for black holes in massive gravity which describes a massive graviton and in bigravity which describes a massive graviton and a massless graviton.

Yoji Koyama (National Tsing-Hua University)

Slow-roll inflation model from higher-dimensional gravity with a U(1) gauge theory

The two scalar fields called "radion" and "gauge-scalar" (Wilson line phase) arise from the extra space components of the higher-dimensional metric and gauge field, respectively, after the dimensional reduction. Each of these scalars can be identified with the inflaton, but the property of the inflaton potential is completely different from each other. In this talk, we want to address an issue that the radion plus gauge-scalar model can be applied to slow-roll inflation scenario. Our model is 5 dimensional gravity plus a $U(1)$ gauge theory with some matters compactified on S^1. We are intersted in an interesting possibility to describe the hybrid inflation using our radion-gauge-scalar potential.This talk is based on an ongoing study with Yugo Abe, Yoshiharu Kawamura (Shinshu U) and Takeo Inami (NTU). (arXiv:1404.5125)

Shogo Kuwakino (Chung Yuan Christian University)

Discrete Flavor Symmetry in String Model

We show that a non-Abelian gauge symmetry can be an origin of a non-Abelian discrete symmetry in orbifold string models. This can be understood from orbifold models at around a symmetry enhance point in moduli space. We also show a realization of a non-Abelian discrete symmetry in a string model on non-geometric background. Phenomenological applications will also be discussed.

Christopher Locke (Tokyo Institute of Technology)

ODE/IM correspondence and modified affine Toda field equations

We study the two-dimensional affine Toda field equations for affine Lie algebra $\hat{\mathfrak{g}}$ modified by a conformal transformation and the associated linear equations.In the conformal limit, the associated linear problem reduces to a (pseudo-)differential equation.For classical affine Lie algebra $\hat{\mathfrak{g}}$, we obtain a (pseudo-)differential equation corresponding to the Bethe equations for the Langlands dual of the Lie algebra $\mathfrak{g}$, which were found by Dorey et al. in study of the ODE/IM correspondence. (arXiv:1312.6759)

Bekir Can Lutfuoglu (Akdeniz University)

Models inspired by Gursey model and their RG analysis.

We demonstrate some models, that are equivalent to the Gurseymodel classically. We gauged them with abelian and non abelian fields. We found out how to construct a nontrivial model by RG analysis.

Hiroki Matsuno (Tokyo Institute of Technology)

Supersymmetric backgrounds from 5d N=1 supergravity

We construct curved backgrounds with Euclidean signature admitting rigid supersymmetry by using a 5d N=1 off-shell Poincare supergravity. We solve the conditions for the background Weyl multiplet that preserves at least one supersymmetry parameterized by a symplectic Majorana spinor, and represent the solution in terms of several independent fields. We also show that the partition function does not depends on the local degrees of freedom of the background fields. Namely, as far as we focus on a single coordinate patch, we can freely change the independent fields by combining Q-exact deformations and gauge transformations. (arXiv:1404.0210)

Akitsugu Miwa (Nihon University)

Quantum corrections for a string world sheet in AdS/CFT correspondence.

In AdS/CFT correspondence, a Wilson loop operator in the CFT side corresponds to a string world sheet in the AdS side. Classical solutions for a string world sheet and their CFT duals have been well studied in this context. In this talk, we consider effects of some quantum corrections for a string world sheet and discuss their correspondence to CFT results.

Hironori Mori (Osaka University)

M5-branes and Wilson Surfaces in AdS_7/CFT_6 Correspondence

We study AdS_7/CFT_6 correspondence between M-theory on $AdS_7 \times S^4$ and the 6D $\mathcal{N} = (2,0)$ superconformal field theory. In particular we focus on Wilson surfaces. We use the conjecture that the (2,0) theory compactified on S^1 is equivalent to the 5D maximal super Yang-Mills (MSYM) and Wilson surfaces wrapping this S^1 correspond to Wilson loops in 5D MSYM. The Wilson loops in 5D MSYM obtained by the localization technique result in the Chern-Simons matrix model. We calculate the expectation values of Wilson surfaces in large rank symmetric representations and anti-symmetric representations by using this result. In the gravity side, the expectation values for probe M5-branes wrapping submanifolds of the background are computed. Consequently we find new, non-trivial evidence for the AdS_7/CFT_6 correspondence that the results in the gravity side perfectly agree with those in the CFT side. (arXiv:1404.0930)

Hisayoshi Muraki (Tohoku University)

D-brane on Poisson manifold and Generalized Geometry

The properties of the D-brane fluctuations are investigated using the two types of deformation of the Dirac structure, based on the B-transformation and the β-transformation, respectively. The former gives the standard gauge theory with 2-form field strength. The latter gives a non-standard gauge theory on the Poisson manifold with bivector field strength and the vector field as a gauge potential, where the gauge symmetry is a diffeomorphism generated by the Hamiltonian vector field. The map between the two gauge theories is also constructed with the help of Moser's Lemma and the Magnus expansion. We also investigate the relation to the gauge theory on the noncommutative D-branes. (arXiv:1402.0942)

Daichi Muranaka (Nagoya University)

The study of thermal Skyrmions in Yang-Mills theory

Recently some significant features of the calorons are revealed.Calorons are periodic instantons in Yang-Mills theory, which interpolate between instantons and monopoles in some limits.Since the period can be interpreted as temperature in physical context, the study of calorons gives us some knowledge of the field theory with finite temperature.In particular, it is known that the Skyrmions, which are model of nucleons, can be constructed from the instantons with Atiyah-Manton ansatz.If we apply calorons to the construction, then we can obtain new Skyrmions with finite temperature.In this poster session we explain some results of above topic.

Satoshi Nakamura (The University of Tokyo)

Instanton counting for classical groups

tba

Thursday, July 24

Afternoon session 1 (14:00-15:40)

Tsukasa Tada (RIKEN)

Sine-Square Deformation and its Relevance to String Theory

Sine-square deformation, a recently found modulation of the coupling strength in certain statistical models, is discussed in the context of two-dimensional conformal field theories, with particular attention to open/closed string duality. This deformation is shown to be non-trivial and leads to a divergence

in the worldsheet metric. The structure of the vacua of the deformed theory is also investigated. The approach advocated here may provide an understanding of string duality through the worldsheet dynamics. (arXiv:1404.6343)

Kenji Hotta (Hokkaido University)

Brane-Antibrane and Closed Superstrings at Finite Temperature in the Framework of Thermo Field Dynamics

Previously we have investigated the thermodynamical properties of D-brane–anti-D-brane pairs by calculating the one-loop free energy and the finite temperature effective action in the framework of Matsubara formalism. This calculation is based on boundary string field theory, and we have a problem of a choice of Weyl factors on the two boundaries of one-loop open string worldsheet. We have chosen one of them, and compute the one-loop free energy. In this talk, we compute the thermal vacuum state and the partition function for a single open string on a D-brane–anti-D-brane pair in the framework of thermo field dynamics. From this we can reproduce the free energy for multiple strings in the case of Matsubara method. This implies that our choice of Weyl factors in the previous work is quite natural. We also compute the thermal vacuum state and the partition function for a single closed string, and reproduce the free energy for multiple strings in the case of Matsubara method.

Masafumi Ishihara (AIMR)

Glueball instability and thermalization driven by dark radiation

We study glueballs in the holographic gauge theories embedded in the AdS_4 space-time.The corresponding 5D bulk is obtained from a solution of the type IIB superstring theory with twoparameters, 4D cosmological constant λ and the dark radiation C.The theory is in confining phase for $\lambda < 0$ and small C, then we observe stable glueball spectrum in thistheory. However, the stability of the glueball is lost when a the dark radiation increases andexceeds a critical point. Above this point, the dark radiation works as the heat bath of the Yang-Mills theory since the Hawking temperature is defined.Then the thermalization is realized and the theroy is in the high temperature deconfinement phase, namely in the QGP phase. We observe this process of the thermalization through the glueball spectra by changing the density of dark radiation.

Hiroyuki Kitamoto (Seoul National University)

Stochastic Dynamics of Infrared Effects in Accelerating Expanding Universe

We extend stochastic interpretation of the infrared effects in accelerating expanding universes. In these universes, quantum fluctuations of a massless and minimally coupled scalar field at the super-horizon scale render physical observables growing in time. On the de Sitter background, it was already found and proved that such infrared effects can be well-described by the Langevin equation and that the stochastic approach is equivalent to the resummation of leading powers of the growing time dependence. In this talk, we make the resummation derivation of the Langevin equation in a more general accelerating expanding universe. We find that the resulting stochastic equation matches perfectly with the semi-classical description of the scalar field, including all coefficients.

Afternoon session 2 (16:00-16:50)

Yuji Igarashi (Niigata University)

Functional Renormalization Group approach and realization of gauge symmetry in QED

We discuss within the framework of Functional Renormalization Group how gauge symmetry is realized in QED.The Ward-Takahashi (WT) identity constructed for the Wilson action with an infrared momentum

cutoff contains a non-trivial loop contribution from the Jacobian factor in functional measure. A couple of WT relations for low dimensional operators require the presence of a momentum dependent (non-local) mass-like term as well as higher dimensional interactions in the Wilson action. We can solve them exactly by introducing some form factors in the chiral invariant 4-fermi couplings. Taking account of momentum dependence in the WT relations, we obtain the one corresponding to the standard $Z_1 = Z_2$.

Shin-Ichiro Kumamoto (Kanazawa University)

Weak renormalization group approach to the dynamical chiral symmetry breaking

We analyze the spontaneous chiral symmetry breaking in the Nambu-Jona-Lasinio model by solving the non-perturbative renormalization group equation, which is a nonlinear partial differential equation (PDE). In case that the spontaneous chiral symmetry breaking occurs, the nonlinear PDE encounters some non-analytic singularities at the finite critical renormalization scale t_c even though the initial function is continuous and smooth, that is, there is no usual solution beyond t_c. Therefore we introduce the notion of a weak solution to get the global solution in the renormalization scale upto the infrared limit. In this presentation we numerically calculate the viscosity solution, which is one of the weak solutions of the PDE, and show its properties. The obtained viscosity solution perfectly describes the physically correct vacuum even in the case of the first order phase transition appearing in a finite-density medium, which is also demonstrated by the auto-convexification of the effective potential.

Afternoon session 3 (17:10-18:25)

Makoto Sakamoto (Kobe University)

Non-renormalization theorem and cyclic Leibniz rulein lattice supersymmetry

We first show that full SUSY algebras cannot be realized on lattice but only nilpotent SUSY algebras on lattice. We then propose a lattice model of a complex SUSY quantum mechanics which realizes nilpotent SUSYs but the non-renormalization theorem on lattice. In our lattice model, the Leibniz rule in the continuum, which cannot hold on lattice due to a no-go theorem, is replaced by the cyclic Leibniz rule (CLR) for difference operators. It is shown that the CLR allows two of four supercharges of the continuum theory to preserve while a naive lattice model can realize one supercharge at the most. A striking feature of our lattice model is that there are no quantum corrections to potential terms in any order of perturbation theory. This is one of characteristic properties of SUSY theory in the continuum. It turns out that the CLR plays a crucial role in the proof of the non-renormalization theorem. This result suggests that the CLR grasps an essence of supersymmetry on lattice.

Kengo Kikuchi (Yukawa Institute for Theoretical Physics)

Supersymmetric Extension of Gradient Flow Equation

The gradient flow in Yang-Mills theory is a useful method to construct renormalized physical observables without additional renormalization. We propose the extension of the gradient flow in super Yang-Mills theory based on superfield formalism. As a result, we construct a supersymmetric extension of the gradient flow equation, which includes only finite terms in the Wess-Zumino gauge. Our result also provide the gradient flow equation of the matter field very naturally.

Richard Eager (Kavli IPMU)

Superconformal field theories and cyclic homology

The spectrum of operators with protected scaling dimensions in superconformal field theories is encoded by cyclic homology. These operators are the operators that contribute to the superconformal index, or

alternatively the states of a holomorphic twist of the gauge theory. We give evidence that a holomorphic version of the AdS/CFT correspondence relates open strings states to closed string states via a map from cyclic homology to Poisson homology. As a concrete example, we show that for quiver gauge theories which are dual to type IIB string theory on the product of an arbitrary smooth Sasaki-Einstein manifold with five-dimensional AdS space, the superconformal index calculated both from the gauge theory and gravity viewpoints agree. Finally we show how to match the spectrum of protected operators on a supergravity compactification involving generalized complex geometry discovered by Pilch and Warner.

Friday, July 25

Morning session 1 (9:00-10:10)

Shlomo Razamat (IAS)

Connections between supersymmetric dualities in different dimensions (tentative)

TBA

Morning session 2 (10:40-11:30)

Yu Nakayama (Kavli IPMU)

Five dimensional O(N)-symmetric CFTs from conformal bootstrap

We investigate the conformal bootstrap approach to O(N) symmetric CFTs in five dimension with particular emphasis on the lower bound on the current central charge. The bound has a local minimum for all $N > 1$, and in the large N limit we propose that the minimum is saturated by the critical O(N) vector model at the UV fixed point, the existence of which has been recently argued by Fei, Giombi, and Klebanov. The location of the minimum is generically different from the minimum of the lower bound of the energy-momentum tensor central charge when it exists for smaller N. To better understand the situation, we examine the lower bounds of the current central charge of O(N) symmetric CFTs in three dimension to compare. We find the similar agreement in the large N limit but the discrepancy for smaller N with the other sectors of the conformal bootstrap.

Tatsuo Azeyanagi (Ecole Normale Superieure)

On Noether charge for theories with Chern-Simons terms and fluid/gravity correspondence

We revisit the covariant formulation of Noether charges in the presence of Chern-Simons terms and discuss the relations between previous proposals and ours. We then compute the entropy of the charged-rotating-AdS black holes in higher space-time dimensions constructed by the fluid/gravity derivative expansion. We show the agreement with the result of the 'replacement rule' in CFT side. (based on works with R. Loganayagam, G.S. Ng, and M.J. Rodriguez)

Morning session 3 (11:45-13:00)

Shinsuke M. Nishigaki (Shimane University)

Tracy-Widom distribution as instanton sum of 2D IIA superstrings

We present an analytic expression of the nonperturbative free energy of a double-well SUSY matrix model in its double scaling limit, which corresponds to 2D type IIA superstring theory on a nontrivial

RR background. To this end we draw upon the wisdom of random matrix theory developed by Tracy and Widom, that expresses the largest eigenvalue distribution of unitary ensembles in terms of a Painleve II transcendent. Regularity of the result at any value of the string coupling constant shows that the 3rd-order phase transition between a SUSY-preserving phase and broken phase, previously found at the planar level, becomes a smooth crossover in the double scaling limit. Accordingly, SUSY is always broken spontaneously as its order parameter stays nonzero for the whole region of the coupling constant. Coincidence of the result with the unitary one-matrix model suggests that 2D U(N) gauge theory corresponds to a sector of the type IIA superstring theory. Our formulation naturally allows for introduction of an instanton chemical potential, and reveals the presence of a novel phase transition, possibly interpreted as condensation of instantons. (arXiv:1405.1633)

Sanefumi Moriyama (Nagoya University)

Instanton Effects in Orbifold ABJM Theory

We generalize our previous study on the partition function of the ABJM theory to that of the orbifold ABJM theory, which is the N=4 circular quiver Chern-Simons-matter theory with alternating levels. We find that the grand potential of the orbifold ABJM theory is expressed in terms of that of the ABJM theory. As shown previously, the ABJM grand potential consists of the primary non-oscillatory term and the subsidiary infinitely-replicated oscillatory terms. We find that the subsidiary oscillatory terms in the ABJM theory actually give a non-oscillatory primary term in the orbifold ABJM theory. Also, the perturbative part in the ABJM theory results in a novel instanton contribution in the orbifold theory. I will explain these results in my talk. (arXiv:1404.0676)

Shoichi Kawamoto (National Center for Theoretical Sciences, Taiwan)

Exact vs. high-energy symmetries in string scattering amplitudes

I would like to discuss the high-energy limit of string scattering amplitudes. String scattering amplitudes are known to obey nontrivial linear relations at high energy, which is suspected to be a signal of stringy symmetry. Starting with exact relations among amplitudes based on the deformation of vertex operators, I investigate their asymptotic forms in the high-energy limit and how these relations constrain the asymptotic amplitudes. With a couple of examples, we discuss how the known linear relations are extracted. (arXiv:1309.3443)

Afternoon session 1 (14:15-15:05)

Noriaki Ikeda (Maskawa Institute for Science and Culture)

BV-BFV and AKSZ Formalisms of Current Algebras

We propose a supergeometic formulation of the current algebra theory a la the BV-BFV formalism and a kind of a holographic principle.Not only known current algebras and anomaly terms are refomulated and unified, but also we find a new current algebra.

Muneto Nitta (Keio University)

Non-relativistic Nambu-Goldstone modes localized around topological solitons

Two kinds of gapless Nambu-Goldstone (NG) modes appear when a continuous symmetry is spontaneously broken; type-I NG modes with linear dispersion relation and type-II NG modes with quadratic dispersion relation. The counting rule was derived for internal symmetry breaking by Watanabe and Murayama and Hidaka independently, but it is not yet for space-time symmetry. Here, I discuss NG modes for space-time symmetry breaking in the presence of quantized vortices in superfluids [1], a domain

wall in anisotropic ferromagnets [2], a skyrmion line in isotropic ferromagnets [3], and a domain wall in two-component Bose-Einstein condensates (BECs) [4]. They all have gapless modes associated with translational symmetry breaking; a Kelvin mode or Kelvon for a quantized vortex [1] and skyrmion line, a ripple mode or ripplon for domain walls in anisotropic ferromagnets [2] and two-component BECs [4]. In addition, some of them accompany additional gapless modes associated with internal symmetry and/or scale symmetry breaking. I also discuss quantum effects on NG modes, with an example of non-Abelian NG modes localized in a non-Abelian vortex core in multi-component BECs [5].[1] M.Kobayashi and M.Nitta, Prog.Theor.Exp.Phys.:021B01,2014 [arXiv:1307.6632 [hep-th]]. [2] M.Kobayashi and M.Nitta, arXiv:1402.6826 [hep-th]. [3] M.Kobayashi and M.Nitta, arXiv:1403.4031 [hep-th]. [4] D.A.Takahashi, M.Nitta, arXiv:1404.7696 [cond-mat.quant-gas] [5] M.Nitta, S.Uchino and W.Vinci, arXiv:1311.5408 [hep-th]

Afternoon session 2 (Poster Session) (15:25-17:55)

Poster session 2

List of the presenters (Alphabetical order)

Mitsuhiro Nishida (Osaka University)

Phase Diagram of a Holographic Superconductor Model with s-wave and d-wave

We consider a holographic model with a scalar field, a tensor field and a direct coupling between them as a superconductor with an s-wave and a d-wave. We find a rich phase structure in our model. Depending on the direct coupling, the model exhibits coexistence of the s-wave and the d-wave, and/or order competition, and has a triple point. (arXiv:1403.6070)

Takuya Nishimura (The University of Tokyo)

Three-point functions in AdS_5/CFT_4 at weak coupling from integrability

Three-point functions in $\mathcal{N} = 4$ super Yang-Mills theory are fundamental and important building blocks in the context of AdS_5/CFT_4 since they correspond to the interactions of three strings. The studies of spectrum, namely, two-point functions has been based on integrability tools such as spin chain or Bethe ansatz techniques. As with the case of three-point functions, it turns out that such techniques are quite useful. In particular, at weak coupling, it is known that the computations of the simplest class of three-point functions are reduced to the calculations of the scalar products of the so called Bethe states, which are the excited states of the XXX spin chain. We derive a new analytic expression for the scalar product and discuss that this expression is expected to give a simple and physical intuition for the semi-classical limit. We also discuss the constraints on the three-point functions that come from the underlying integrable structure. (This poster presentation is based on arXiv:1304.5011 and joint work in progress with Y. Kazama and S. Komatsu.)

Tomoki Nosaka (Yukawa Institute for Theoretical Physics)

The Partition Function of Super Chern-Simons theories from Fermi Gas Approach

We study the perturbative sum of the partition function of general three-dimensional N=4 Chern-Simons theories.It was known that the partition functions in a general class of N=3 U(N) necklace quiver Chern-Simons theory with levels k's are summed up to the Airy function $e^{A_k} C_k^{-1/3} \mathrm{Ai}[C_k^{-1/3}(N - B_k)]$ with coefficients C_k, B_k and A_k.We give an explicit general formula for B_k when the supersymmetry is

enhanced to N=4.We also proceed to the non-perturbative effect and find a cancellation between two types of instantons.

Tokiro Numasawa (Yukawa Institute for Theoretical Physics)

Entanglement Entropy of local operator excited states in 2d RCFTs

We study entanglement entropy of excited states in two dimensional conformal field theories (CFTs). Especially we consider excited states obtained by acting primary operators on a vacuum. We show that under its time evolution, entanglement entropy increases by a finite constant when the causality condition is satisfied. Moreover, in rational CFTs, we prove that this increased amount of (both Renyi and von-Neumann) entanglement entropy always coincides with the log of quantum dimension of the primary operator. (hep-th/1403.0702)

Yuichi Ohara (Nagoya University)

New model of massive spin-2 and its possible application

The consistent free theory of massive spin-2 particle was constructed by Fierz and Pauli in 1939. The mass term for the spin-2 field gives a ghost mode in general, but they resolved this problem by tuning the mass term. After that, lots of attempts to extend the Fierz-Pauli theory to a fully non-linear (background independent) theory had been made, but it turned out that such a non-linear extension generally leads to another ghost. In 2010, however, de Rham,Gabadadze, and Tolley have finally formulated the background independent massive spin-2 theory called dRGT massive gravity. In the dRGT model, the fully non-linear potential terms (dRGT potential) take special forms and the theory does not contain any ghost thanks to the special forms. In our study, we focus on the fact that the leading term of the dRGT potential does not generate any ghost when we add the leading term to the Fierz-Pauli theory. This means we can construct a new model of the massive spin-2. We consider possible application of this model.

Satoshi Okano (Nihon University)

A twistorial model for massive spinning particles

It is known that in twistor theory, massive particles can be described in terms of $N(\geq 2)$ twistor variables entailing a SU(N) internal symmetry. In the present work, we construct a massive spinning particle model with a SU(2) gauge symmetry, which corresponds to the case $N = 2$. Carrying out the canonical quantization, we show that this model describes massive particles with an arbitrary spin. We also examine properties of the SU(2) symmetry. Furthermore, we systematically derive equations of motion for higher spin fields within the model.

Ayuki Saito (Tokyo University of Science)

Brane solutions of Hopf soliton in seven dimensions

We consider a seven-dimensional brane world model. The brane is described by an localized solution to the extended Skyrme-Faddeev model embedding in the extra dimensions. The solutions are axially symmetric knotted solitons with non-zero Hopf charge $Q_H = 2(m = 1, n = 2)$ and numerically solve the coupled system of the Einstein and the matter field equations by Newton-Raphson method. We obtain the several solutions with both of signs of constant and also with / without of the effect of the inflation. We thoroughly discuss the localizing proparty of the gravity. In terms of the inherent chiral character of the solutions, we are able to discuss the property of the localized chiral fermions in our branes.

Yuho Sakatani (Seoul National University)

Defect branes as Alice strings

We construct a new seven-brane background with a T-duality monodromy, namely a T-fold, in type II string theory. One of the simplest known examples of T-folds in string theory is the 5^2_2-brane background, which can be obtained by taking a T-duality in the Kaluza-Klein monopole background. We show that while the monodromy of our seven-brane background is the same as that of the 5^2_2-brane background, it also has a non-locally distributed F1 charge. We discuss the meaning of such non-local charge by regarding the seven brane as an Alice string studied in the soliton literature [A. Schwarz, 1982]. This presentation is based on the collaboration with Takashi Okada.

Yoshiki Sato (Kyoto University)

Holographic Schwinger effect in confining theories

We study the Schwinger pair production in confining theories. The production rate in an external electric field is numerically evaluated by using the holographic description. There exist two kinds of critical values of the electric field.We argue the universal exponents associated with the critical behaviors. This presentation is based on PRD 89, 101901(R) [arXiv:1312.4341] and work in progress in collaboration with Daisuke Kawai and Kentaroh Yoshida.

Kiyoshi Shiraishi (Yamaguchi University)

Spontaneous Compactification of Six-dimensional Bimetric Theory

We study a model of bimetric gravity in six dimensions. The mixing of two metrics is provided by the term including two gauge field strengths in our model. In the model, a massive graviton is governed by the Fierz-Pauli Lagrangian in the weak field limit and one massless graviton is left in four dimensions. (arXiv:1405.0064v2)

Sotaro Sugishita (Kyoto University)

Holographic holes in higher dimensions

In the context of the AdS/CFT correspondence, it is conjectured that the entanglement entropy of a region in the boundary theory is evaluated by the extremal area of the bulk surface which is homologous to the boundary region. We show that the area of a more general codimension-two surface in the bulk can be evaluated in terms of a combination of the entanglement entropy in the boundary theory. This talk is based on the work (arXiv:1403.3416) with Robert C. Myers and Junjie Rao.

Koki Takesue (Tokyo University of Science)

Calorons and the monopole limit

The Nahm data of periodic instantons, often called calorons, with spatial C_3-symmetries are extensively discussed. It is found that the “scale parameters” of these calorons have upper bounds in their values, so that they do not have the large scale, or monopole,limits. In order to clarify details of the mechanism, we numerically examined behavior of the action density. We found that it gradually shrinks as the scale parameter increases and finally disappears.

Yuta Tamaki (Tokyo University of Science)

Integrable sectors of multi-vortices in the Skyrme-Faddeev type model

Integrable, molecular-type vortex solutions in the extended Skyrme-Faddeev (ESF) model are constructed.The solutions are a holomorphic type which satisfies the zero curvature condition and then they necessarilyhave an infinite number of conserved current. We propose a new potential which supports the existence ofthe solutions. Numerically it is checked employing the simulated annealing method.

Anderson Trimm (University of Texas, Austin)

Tinkertoy construction of gauge theories

(arXiv:1403.4604)

Jackson Wu (National Center for Theoretical Sciences, Taiwan)

Quantum quench in the holographic Kondo model

We study quantum quench in our recently constructed holographic model of the Kondo efffect.

Futoshi Yagi (KIAS)

Base-Fiber Duality and Global Symmetry Enhancement

We study the global symmetry enhancement for the five dimensional $\mathcal{N} = 1$ supersymmetric gauge theories compactified on S^1. We especially consider the $SU(2)$ gauge theory with n flavor, whose global symmetry is enhanced to E_{n+1} at the UV fixed point. By taking into account the "Base-Fiber duality", we see that the Nekrasov partition function can be rewritten in a way that the enhanced symmetry is manifest.

Masaya Yata (KEK)

Toric GLSM for ALE space

A GLSM (gauged linear sigma model) is known as the UV completion of NLSM(non linear sigma model) and the target space of the NLSM is T-dualized by the Rocek-Verlinde transformation in the GLSM level. It is considered that a toric GLSM realizes the target space which is specified with the toric data in the IR limit, however, there is no explicit calculation for the target space metric from the GLSM. In the poster, we reproduce A1-ALE space metric by introducing an F-term in the toric GLSM. We also explain the new duality transformation rule for GLSMs with charged chiral superfields in F-terms, and we will show that A1 toric GLSM is converted to the parallel NS5 GLSM by the new transformation. (arXiv :1402.5580, arXiv:1406.0087)

Takahiro Yonemoto (Kyushu University)

Radiation of Supersymmetric Particles from Aharonov-Bohm R-string

We study radiation of supersymmetric particles from an Aharonov-Bohm string associated with a discrete R-symmetry. Radiation of the lightest supersymmetric particle stabilzed by the R-symmetry, when combined with cosmological observations, imposes constraints on the tension of the string or freeze-out temperature of the particle. We also comment on an application of Aharonov-Bohm radiation to string theories.

Hiroaki Yoshii (Tokyo University of Science)

The Dirac equation in the five-dimensional AdS space-time

We study several localizing modes of the Dirac fermions in the five-dimensional spherical AdS space-time. As a first step, we constructed a plane-wave orthogonal basis in the flat space-time. For the AdS space-time, we introduce a Schrödinger-like equation for the larger component of the spinor and decompose it into the radial and the angular part. The angular part is expressed in terms of the standard Wigner rotation matrices. We show that the radial component can be written in terms of the hypergeometric functions. In order to check that our analysis is valid, we also present our numerical results of the localizing modes.

Saturday, July 26

Morning session 1 (9:00-10:10)

Sumit Das (University of Kentucky)

SCALING IN QUANTUM QUENCH : HOLOGRAPHY AND BEYOND

TBA

Morning session 2 (10:30-11:45)

Shotaro Shiba (Maskawa Institute for Science and Culture)

Analysis of black branes in field theory via p-soup model

We propose "p-soup model" as a new description of black brane systems in string and M-theory. In this model the scalar moduli in field theory on branes strongly interact with each other, and they make the liquid-like (soup) system. In this talk, I'd like to show this model can reproduce various aspects of black brane systems. For example, Gregory-Laflamme transition for compactification of spacetime, entropy of black branes, and so on. These results are perfectly consistent with supergravity results.

Charles Melby-Thompson (Kavli IPMU)

Defect Holography and the Fractional Quantum Hall Effect

We consider the holography of D7 probe branes in an AdS soliton background, whose dual is known to be a 3d gauge theory with confinement. When the probe branes are allowed to reach the AdS boundary they become dual to domain walls in the confining theory. At low energies the defect physics is dominated by the induced Chern-Simons term on the D7 brane, resulting in a chiral $U(k)$ current algebra living on each defect that interacts in an interesting manner with irrelevant operators in the system. We examine the holography of the system in detail, with particular attention paid to its relation with the fractional quantum Hall effect and 2d QCD.(Work in progress with M. Fujita, R. Meyer, and S. Sugimoto.)

Goro Ishiki (Yukawa Institute for Theoretical Physics)

Emergent bubbling geometries in gauge theories with $SU(2|4)$ symmetry

We study the gauge/gravity duality between bubbling geometries in type IIA supergravity and gauge theories with $SU(2|4)$ symmetry, which consist of $\mathcal{N} = 4$ super Yang-Mills on $R \times S^3/Z_k$, $\mathcal{N} = 8$ super Yang-Mills on $R \times S^2$ and the plane wave matrix model. We show that the geometries are realized as field configurations in the strong coupling region of the gauge theories. On the gravity side, the bubbling geometries can be mapped to electrostatic systems with conducting disks. We derive integral equations which determine the charge densities on the disks. On the gauge theory side, we obtain a matrix integral by applying the localization to a 1/4-BPS sector of the gauge theories. The eigenvalue densities of the matrix integral turn out to satisfy the same integral equations as the charge densities on the gravity side. Thus we find that these two objects are equivalent. (arXiv:1406.1337)

Morning session 3 (12:00-13:15)

Hidehiko Shimada (Okayama Institute for Quantum Physics)

Membranes from monopole operators in ABJM theory: Large angular momentum and M-theoretic AdS4/CFT3

In the talk, I will consider states with large angular momentum to facilitate the study of the M-theory regime of the AdS4/CFT3 correspondence (duality between M-theory on $AdS_4 \times S^7/Z_k$ and ABJM theory

with gauge group $U(N) \times U(N)$ and level k, where k is finite and N is large). In particular I will discuss near-BPS operators in ABJM theory which correspond to states of membranes with large angular momenta on AdS. The talk will be based on my work with Stefano Kovacs(DIAS) and Yuki Sato (Wits University). (arxiv:1310.0016)

Daisuke Yokoyama (Seoul National University)

Free energy from toric diagram in AdS4/CFT3

We discuss a way to extract free energy of 3d $\mathcal{N} = 2$ supersymmetric gauge theory in large N limit from a general toric diagram.The gauge theory is related to AdS4 with a certain 7-dimensional Sasaki-Einstein manifold.A benefit of this way is that we can show the equivalence between a free energy and a volume of the Sasaki-Einstein manifold,hence, the equivalence between F-maximization and volume-minimization.

Yasuaki Hikida (Rikkyo University)

Higher spin AdS_3 holography and superstring theory

Higher spin gauge theory can be thought as a toy model of string theory, and it attracts a lot of attention recently due to the application for AdS/CFT correspondence. A famous example is the duality between a 4d higher spin gauge theory and 3d O(N) vector model. 3d higher spin gauge theory is also supposed to be dual to a large N minimal model. We are interested in the latter case since lower dimensional theories are more tractable in general. Recently it was proposed that a 4d higher spin gauge theory with matrix valued fields is dual to Aharony-Bergman-Jafferis (ABJ) theory. Since ABJ theory is known to be dual to a superstring theory, this duality implies a non-trivial relation between higher spin gauge theory and superstring theory. Here we propose that a similar type of 3d higher spin theories are dual to 2d Grassmannian-like models, and we give supports for the conjecture. We also discuss possible relations to superstring theory. (arXiv:1306.0466)

Afternoon session 1 (14:25-15:40)

Shigenori Seki (Hanyang University)

EPR = ER and Scattering

Entanglement is an intriguing property in quantum mechanics. Maldacena and Susskind have recently conjectured that the entanglement of EPR pair is interpreted to an ER bridge or a wormhole. This conjecture is called "EPR = ER". Indeed, it is known that, from the holographic point of view, there is a wormhole on the world-sheet minimal surface corresponding to a (EPR) pair of accelerating quark and anti-quark. We study the causal structure on the world-sheet minimal surface of gluon scattering and find a wormhole parametrized by Mandelstam variables, thereby demonstrate the EPR = ER relation for gluon scattering. Furthermore we discuss the relation between the entanglement entropy and scattering amplitude. (arXiv:1404.0794)

Masahiro Nozaki (Yukawa Institute for Theoretical Physics)

Notes on Quantum Entanglement of Local Operators

This is an expanded version of the short report arXiv:1401.0539, where we stud- ied the (Renyi) entanglement entropies for the excited state defined by acting a given local operator on the ground state. We introduced the (Renyi) entanglement entropies of given local operators which measure the degrees of freedom of local operators and characterize them in conformal field theories from the viewpoint of quantum entanglement. In present paper, we explain how to compute them in free massless scalar field theories and we also investigate their time evolution. The results are interpreted in terms of relativistic propagation

of an entangled pair. The main new results which we acquire in the present paper are as follows. Firstly, we provide an explanation which shows that the (Renyi) entanglement entropies of a specific operator are given by (Renyi) entanglement entropies of binomial distribution by the replica method. That operator is constructed of only scalar field. Secondly, we found the sum rule which (Renyi) entanglement entropies of those local operators obey. Those local operators are located separately. Moreover we argue that (Renyi) entanglement entropies of specific operators in conformal field theories are given by (Renyi) entanglement entropies of binomial distribution. These specific operators are constructed of single-species operator. We also argue that general operators obey the sum rule which we mentioned above.

Pawel Caputa (Yukawa Institute for Theoretical Physics)

Entanglement of Local Operators in large N CFTs

I will talk about recent progress in Renyi entropies for excited states obtained by a local operator acting on the vacuum. In particular, I will focus on conformal field theories with large central charge c or large N and explain how excited Renyi entropies characterise the local operators from the perspective of the entanglement. Finally, I will interpret the results using AdS/CFT. (arXiv:1405.5946 [hep-th])

Afternoon session 2 (16:15-17:30)

Song He (Yukawa Institute for Theoretical Physics)

Holographic entanglement temperature for low thermal excited states

We will talk about the entanglement temperature of a small scale subsystem in low excited states by using holographic method. Especially, we study the entanglement entropy and entanglement temperature in two groups of gravity theories. The first theory is higher derivative gravity theory and the other is some new asymptotic AdS solutions in Einstein dilation theory. We find that the entanglement entropy are related to data of boundary theory. The relation between the variance of entanglement entropy and energy of a small scale subsystem has been also obtained. Furthermore, the relation is consistent with the first law-like relation that is proposed by Phys. Rev. Lett. 110, 091602 (hep-th/1308.0819,hep-th/1305.2682)

Noburo Shiba (Yukawa Institute for Theoretical Physics)

Entanglement between two interacting CFTs and generalized holographic entanglement entropy

We discuss behaviors of entanglement entropy between two interacting CFTs and its holographic interpretation using the AdS/CFT correspondence. We explicitly perform analytical calculations of entanglement entropy between two free scalar field theories which are interacting with each other in both static and time-dependent ways. We also conjecture a holographic calculation of entanglement entropy between two interacting N = 4 super Yang-Mills theories by introducing a minimal surface in the S^5 direction, instead of the AdS_5 direction. This offers a possible generalization of holographic entanglement entropy. (arXiv:1403.1393)

Noriaki Ogawa (RIKEN)

Entanglement Entropy of de Sitter Space α-Vacua

We generalize the analysis of arXiv:1210.7244 to de Sitter space α-vacua and compute the entanglement entropy of a free scalar for the half-sphere at late time. (Based on work with N. Iizuka and T. Noumi)
