YITP Workshop
"Developments in String Theory and Quantum Field Theory"

Panasonic Hall, Yukawa Institute for Theoretical Physics,
November 9 - 13, 2015

Abstract

November 9 (Monday)

K. Tsumura (Kyoto U.)
Prospects of LHC Run II

S. Mizoguchi (KEK)
Anomaly-free Multiple Singularity Enhancement in F-theory

We study global Calabi-Yau realizations of multiple singularity enhancement relevant for family-unification model building in F-theory. We examine the conditions under which the generation of extra chiral matter at multiple singularities on 7-branes in six-dimensional F-theory can be consistent with anomaly cancellation. It is shown that the generation of extra matter is consistent only if it is accompanied by simultaneous degenerations of loci of the leading polynomial of the discriminant so that the total number of chiral matter does not change. We also show that the number of singlets expected to arise matches the decrease of the complex structure moduli for the restricted geometry. In the $SU(5) \to E_8$ case, a curious coincidence is found between the numbers of degenerating loci and the powers of the canonical class of the corresponding sections in the weighted projective bundle (work in collaboration with T.Tani).

Y. Sumitomo (KEK)
De Sitter vacua from a D-term generated racetrack potential in hypersurface Calabi-Yau compactifications

In arXiv:1407.7580 a mechanism to fix the closed string moduli in a de Sitter minimum was proposed: a D-term potential generates a linear relation between the volumes of two rigid divisors which in turn produces at lower energies a race-track potential with de Sitter minima at exponentially large volume. In this paper, we systematically search for implementations of this mechanism among all toric Calabi-Yau hypersurfaces with $h_{1,1} \leq 4$ from the Kreuzer-Skarke list. For these, topological data can be computed explicitly allowing us to find the subset of three-folds which have two rigid toric divisors that do not intersect each other and that are orthogonal to $h_{1,1} - 2$ independent four-cycles. These manifolds allow to find D7-brane configurations compatible with the de Sitter uplift mechanism and we find an abundance of consistent choices of D7-brane fluxes inducing D-terms leading to a de Sitter minimum. Finally, we work out a couple of models in detail, checking the global consistency conditions and computing the value of the potential at the minimum.

S. Ichinose (U. Shizuoka)
CMB Power Spectrum in the Background Field Formalism
A new field theory formulation is presented for the analysis of the CMB power spectrum distribution in the cosmology. The background-field formalism is fully used. The gravitational (metric) field g_{mn} is not taken as the quantum-field variables, but as the background field. The quantum effect of the metric field is taken into account by the path (hyper-surface)-integral over the space-time. Using a simple scalar model on the curved (dS_4) space-time, some important points are examined: 1) Clear separate treatment of the classical effect, the statistical effect and the quantum effect. 2) The systematic formulation of the field quantization. For example, n-point Green function, S-matrix, Renormalization procedure. Casimir energy of the universe is obtained. 3) For the classical part, the systematic treatment of the perturbation around the homogenous and isotropic limit (the Friedman-Robertoson universe,) using the *propagator method*. 4) We introduce fluctuation around the homogeneous part as the statistically-distributed classsical fluctuation. We introduce a statistical averaging functional using the path-integral method. We make the functional by use of the *area* of a 3D hyper surface embedded in 3+1 space-time. We stress that the fluctuation comes not from the quantum gravity but from the unkown 'statistical' movement at the classical level. 5) IR parameter (l) is introduced for the time axis as the periodicity for the time axis. Time reversal(Z_2)-symmetry is introduced in order to treat the problem separately with respect to the Z_2 parity $P = \pm 1$. This procedure much helps both UV and IR regularization to work well. Related work: arXiv:1308.1163, JPS Conf.Proc. 1, 013103

S. Kawamoto (Chung Yuan U.)
Size scaling of self gravitating polymers and strings
We study a statistical ensemble of a single polymer with self gravitational interaction. This is a model of a gravitating string — the precursor of a black hole. We analyze averaged sizes by mean field approximations with an effective Hamiltonian a la Edwards with Newtonian potential as well as a contact repulsive interaction. We find that there exists a certain scaling region where the attractive and the repulsive forces balance out. The repulsive interaction pushes the critical gravitational coupling to a larger value, at which the size of a polymer becomes comparable to its Schwarzschild radius, and as a result the size of the corresponding black hole increases considerably. We show phase diagrams in various dimensions that clarify how the size changes as the strengths of repulsive and gravitational forces vary.

S. Sugishita (Kyoto U.)
Random volumes from matrices
We propose a new class of models generating three-dimensional random volumes. As the Feynman diagrams of matrix models can be interpreted as triangulations of two-dimensional surfaces, the diagrams of our models can be regarded as collection of triangles glued together along multiple hinges. These "triangle-hinge models" are characterized by semisimple associative algebras, and the set of possible diagrams can be reduced by an appropriate "large N limit" such that they represent only and all of the tetrahedral decompositions of three-dimensional manifolds. Thus, the models give discretized description of three-dimensional quantum gravity. [Ref. arXiv:1503.08812, arXiv:1504.03532]

T. Kuroki (Kagawa Coll. Tech.)
Large order behavior and instanton action in supersymmetric matrix model
By applying the results in the Gaussian matrix model and using the Nicolai mapping, we obtain correlation functions of arbitrary genus of non-SUSY protected operators in a supersymmetric matrix model in zero dimension, which is predicted to be a nonperturbative formulation of a superstring theory in two dimensions. Thus we get their large order behavior of this theory from which we convince ourselves that this is indeed a string theory and deduce nonperturbative ambiguity. We confirm that the ambiguity reproduces the instanton action.

A. Buchel (U. Western Ontario)
Gravitational instability in AdS and thermalization of dual gauge theories

K. Murata (Keio U.)
Electric field quench and turbulent meson condensation in AdS/CFT
An electric field quench, a suddenly applied electric field, can induce nontrivial dynamics in confining systems which may lead to a deconfinement transition. In order to analyze this non-equilibrium transitions, we use the AdS/CFT correspondence for N=2 supersymmetric QCD that has a confining meson sector. We find that the electric field quench causes the deconfinement transition even when the magnitude of the applied electric field is smaller than the critical value for the static case (which is the QCD Schwinger limit for quark-antiquark pair creation). The quark deconfinement is accompanied by a coherent condensation of higher meson resonances. There, we observe a "turbulent" energy flow to higher meson modes, which finally results in the quark deconfinement. Our observation is consistent with seeing deconfinement as a condensation of long QCD strings.

D. Kawai (Kyoto U.)
Chaotic strings in a near Penrose limit of $\mathbf{AdS}_5\times\ \mathbf{T}^{1,1}$
We study chaotic motions of a classical string in a near Penrose limit of $AdS_5?T^{1,1}$. It is known that chaotic solutions appear on $R?T^{1,1}$, depending on initial conditions. It may be interesting to ask whether the chaos persists even in Penrose limits or not. In this talk, we show that sub-leading corrections in a Penrose limit provide an unstable separatrix, so that chaotic motions are generated as a consequence of collapsed Kolmogorov-Arnold-Moser (KAM) tori. Our analysis is based on deriving a reduced system composed of two degrees of freedom by supposing a winding string ansatz. Then, we provide support for the existence of chaos by computing Poincare sections.

M. Ishihara (Tohoku U.)
A Holographic Realization of Ferromagnets
A holographic realization for ferromagnetic systems has been constructed. Owing to the holographic dictionary proposed on the basis of this realization, we obtained relevant thermodynamic quantities such as magnetization, magnetic susceptibility, and free energy. This holographic model reproduces the behavior of the mean field theory near the critical temperature. At low temperatures, the results automatically incorporate the contributions from spin wave excitations and conduction electrons.

M. Fujita (U. Kentucky)
Effective hopping in a holographic Bose-Hubbard model
We analyze the gravity dual to the SU(N) Bose-Hubbard model, where the SU(N) Bose-Hubbard model is an extended version of the Bose-Hubbard model including the hopping term. The vacuum expectation value (VEV) of the hopping term is analyzed in the gravity dual changing the bulk mass and the coupling constant. The VEV is then compared with the analysis in the SU(N) Bose-Hubbard model.

C. Hasegawa (Rikkyo U.)
Extremal Surfaces in Asymptotic AdS Black Hole and Holographic Entanglement Entropy
We study AdS/CFT correspondence by calculating holographic entanglement entropy. We calculated extremal (and/or minimal) surface in asymptotically AdS black hole solution in 2+1 dimensional space-time and 3+1 dimensional space-time especially. Then, we considered them from the point of view of both entanglement entropy and black hole entropy. As a result, we reconfirmed that each viewpoints satisfy qualitative consistency and quantitative consistency in 2+1 dimensional space-time. Moreover, we will check in 3+1 dimensional space-time similarly. This talk presentation is based on our work in progress, which is collaborating with T. Eguchi.

S. Ohya (Nihon U.)

Recurrence Relations for Finite-Temperature Correlators via AdS_2/CFT_1

We propose a new algebraic approach to momentum-space correlators in conformal field theory. As an illustration we present a new Lie-algebraic method to compute frequency-space two-point functions for charged scalar operators of CFT_1 dual to the AdS_2 black hole with constant background electric field. Our method is based on the real-time prescription of AdS/CFT correspondence and the ladder equations of one-dimensional conformal algebra $\int\wr(2,1)$. We derive novel recurrence relations for real-time CFT_1 two-point functions, which are exactly solvable and completely determine the frequency- and charge- dependences of two-point functions. Our results are consistent with the known results.

Y. Amari (Tokyo U. of Science)

Quantized states of vortex in a CP^2 Skyrme-Faddeev type model

The Skyrme-Faddeev model is extensively studied for various low energy phenomena of QCD. It is well known that an extension of the Skyrme-Faddeev model on the target space CP^N possesses vortex solutions. Within the regime of standard collective coordinate quantization scheme, we compute the quantized state of the planar soliton of the model. In this conference, we will report on the physical interpretation of quantum numbers and quantum statistics of the quantum soliton.

M. Fukuda (U. Tokyo)

SH^c Realization of Minimal Model CFT: Triality, Poset and Burge Condition

Recently an orthogonal basis of $\mathcal{W}_N$-algebra (AFLT basis) labeled by arrays of Young diagrams was found in the context of 4D/2D duality. Recursion relations among the basis are summarized in the form of an algebra SH^c which is universal for any N. It includes an infinite number of commuting operators which are diagonal on the basis. In this paper, we study the level-rank duality between the minimal models from SH^c. It is shown that the nonvanishing states in both systems are described by N or M Young diagrams with the rows of boxes appropriately shuffled. The analysis demonstrates that SH^c has triality symmetry for some specific choices of parameters. The reshuffling of rows implies there exists partial ordering of the set which labels them. For the simplest example, one can compute the partition functions for the partially ordered set (poset) explicitly, which reproduces the Rogers-Ramanujan identities. We also study the description of minimal models by SH^c. Simple analysis leads to some known properties of minimal models, the structure of the singular vectors and N-Burge condition in the Hilbert space.

M. Hamanaka (Nagoya U.)

Noncommutative Instantons and Reciprocity

We would like to discuss the ADHM construction of U(N) instantons in noncommutative spaces. We prove one-to-one correspondence (reciprocity) between the moduli space of instantons and the moduli space of ADHM data in both the star-product formalism and the operator formalism. We revisit the problem on origin of the instanton number by applying an idea of Atiyah and Hori to the noncommutative situation. This is based on collaboration with Toshio Nakatsu (Setsunan Univ).

A. Kasai (Kyushu U.)

Decay of False Vacuum via Fuzzy Monopole in String Theory

According to one of the recent topics of string theory, string landscape, there are about 10^{500} possibilities of flux compactification, metastable vacua in string theory. Then a vacuum decays into one with lower energy by quantum tunneling via forming bubbles. Thus rate of tunneling determines lifetime of model in string theory and the number of bubbles in multiverse. In fact we would discuss these are determined not only by potential of string theory but also impurities can accelerate tunnelings. We take monopole as impurity and study catalytic effect on decay of false vacuum in string theory.

M. Miyaji (Yukawa Inst.)

Boundary states as holographic duals of trivial spacetimes

We show that conformal boundary states in CFT have no short range entanglement. This means that conformal boundary states can be used as IR states of Multi-scale Entanglement Renormalization Anzatz. Moreover, with the identification of bulk spacetime as quantum entanglement, we conclude conformal boundary states are dual to trivial spacetimes.

H. Mori (Osaka U.)

Surface defects in class $\mathcal{S}_k$ and an elliptic algebra

We investigate the aspects of surface defects in a new class of 4d $\mathcal{N} = \infty$ superconformal quiver theories named class $\mathcal{S}_k$. A way to see the surface defects in IR is to higgs UV theories of class $\mathcal{S}_k$ by giving the vevs to some fields, and we can specify them as 2d $\mathcal{N} = (0, 2)$ vortex string theories by computing its elliptic genera encoded in the IR description of the superconformal indices of class $\mathcal{S}_k$. This picture is still consistent with type IIA brane construction of the vortex strings. Furthermore, the surface defects are considered as the difference operators which act on the superconformal indices and form the algebras labelled by the representations of SU(N) flavor symmetries. We approach the specific actions of those difference operators with its eigenvalues.

T. Nishimura (U. Tokyo)

Novel construction and monodromy relation for three-point functions at weak coupling

In the AdS_5/CFT_4, which is the duality between four dimensional $\mathcal{N} = 4$ super Yang-Mills theory and string theory on $AdS_5\times S^5$ background, various integrability based techniques have been applied to study various observables. In particular, much attention has been paid to the three-point functions recently. As a step toward uncovering the relation between the weak and the strong coupling regimes of the $\mathcal{N} = 4$ super Yang- Mills theory beyond the spectral level, we develop a novel group theoretic interpretation of the Wick contraction of the fields, which allows us to compute a much more general class of three-point functions in the SU(2) sector, as in the case of strong coupling. Furthermore, we derived a non-trivial identity for the three-point functions with monodromy operators inserted, being the discrete counterpart of the global monodromy condition which played a crucial role in the computation at strong coupling.

J. Sakamotoi (Kyoto U.)

Yang-Baxter deformations of Minkowski spacetime

In this talk, we introduce Yang-Baxter deformations of 4D Minkowski spacetime. The Yang-Baxter sigma model description was originally developed for principal chiral models based on a modified classical Yang-Baxter equation. It has been extended to coset curved spaces and models based on the usual classical Yang-Baxter equation. It would be very interesting to generalize deformations of this type to the case of flat space. However, for flat space, there is the obvious problem that the standard bilinear form degenerates if we employ the familiar coset Poincaré group/Lorentz group. Instead we consider a slice of AdS_5 by embedding the 4D Poincae group into the 4D conformal group SO(2, 4). With this procedure we obtain metrics and B-fields as Yang-Baxter deformations which correspond to well-known configurations such as T-duals of Melvin backgrounds,Spradlin-Takayanagi-Volovich backgrounds, pp-waves, and T-duals of dS_4 and AdS_4.This talk is based on arXiv:1505.04553.

Y. Sato (Kyoto U.)

Entanglement entropy in the dS/CFT correspondence

We consider the entanglement entropy in the dS/CFT correspondence. In Einstein gravity on de Sitter spacetime we propose the holographic entanglement entropy as the analytic continuation of the extremal surface in Euclidean anti-de Sitter spacetime. Even though dual conformal field theories for Einstein gravity on de Sitter spacetime have not been known yet, we analyzed the free $Sp(N)$ model dual to Vasiliev's higher spin gauge theory as a toy model. In this model we confirmed the behaviour similar to our holographic result from Einstein gravity.

T. Takezaki (U. Tokyo)

A_∞ structure from the Berkovits formulation of open superstring field theory

When we quantize open string field theory, the structure called A_∞ plays a crucial role. However, the Berkovits formulation of open superstring field theory, which is one of the most successful formulations of superstring field theory, is based on the large Hilbert space of the superconformal ghost sector, and we have not been able to see the A_∞ structure in this formulation. Recently, on the other hand, Erler, Konopka and Sachs succeeded in constructing an action with the A_∞ structure by formulating open superstring field theory based on the small Hilbert space. We show that the action with the A_∞ structure can be obtained from an action based on the large Hilbert space by partial gauge fixing, and the action based on the large Hilbert space is related to the action of the Berkovits formulation by field redefinition.

S. Terashima (Yukawa Inst.)

Exact Computations in Confining Phase using SUSY Localization

We show that the gaugino condensation of 4d $\mathcal{N} = 1$ supersymmetric gauge theories in the confining phase can be computed by the localization technique with an appropriate choice of a supersymmetry generator.

November 11 (Wednesday)

D. Gang (Kavli IPMU)
Supersymmetric defects in 3d-3d correspondence
3d/3d correspondence relates 3d superconformal field theories to 3-manifolds (or knots). The correspondence has a natural interpretation using 6d (2,0) theories on 3-manifolds. I will talk about two types of defects (co-dimension 2 and co-dimension 4) in the 6d (2,0) theories and their roles in 3d/3d correspondence.

A. Tanaka (RIKEN)
RP^2 index and its application
We consider a new 3d superconformal index defined as the path integral over $RP^2 \times S^1$, and get the generic formula for this index with arbitrary number of U(1) gauge symmetries via the localization technique. We find two consistent parity conditions for the vector multiplet, and name them P and CP. We investigate the simplest version of 3d mirror symmetry on $RP^2 \times S^1$ and observe coincidence between the SQED and the XYZ model. In this talk, we will comment on our new results on ongoing project.

Y. Sasai (Meiji Gakuin U.)
On the Coulomb branch localization for 1d gauged linear sigma model
We reconsider localization for 1d $\mathcal{N} = 4$ supersymmetric $U(N)$ gauge theory with fundamental chiral multiplets. This theory has two branches: Higgs branch and Coulomb branch. In the Coulomb branch, this theory describes N electrically charged BPS particles around a magnetically charged BPS particle in a 4d $\mathcal{N} = 2$ supergravity theory. We find that by taking some limit, the field configurations are localized in the Coulomb branch in the localization calculation and the refined index can be written as a sum over those fixed points.

Y. Yoshida (KIAS)
Gauged linear sigma models and Calabi-Yau 3-folds in Grassmanianns
We study gauged linear sigma models (GLSMs) which flow to complete intersection Calabi-Yau 3-folds with one Kahler moduli in Grassmanianns. We also apply supersymmetric localization techniques to GLSMs and compute geometric invariants. This talk is based on join works with Kazushi Ueda.

T. Suyama (Osaka City U.)
Instanton Effects in Orientifold ABJM Theory
We study quantum effects in $\mathcal{N} = 5$ superconformal Chern-Simons-matter theory which is an orientifold of ABJM theory. Using Fermi gas formalism, we determine the grand potential including worldsheet/D-brane instanton corrections. We find an interesting relation to ABJM theory in terms of the grand potential, which turns out to be powerful enough to determine the instanton corrections.

T. Nosaka (Yukawa Inst.)
Exact large N partition function of non-conformally deformed ABJM theory
We consider a non-conformal deformation of the ABJM theory on the three sphere. The ABJM theory is the three dimensional $U(N) \times U(N)$ $\mathcal{N} = 6$ superconformal Chern-Simons theory. From its Higgs branch moduli space and the $N^{3/2}$ scaling of the free energy, this theory is believed to have the supergravity dual $AdS_4 \times S^7/\mathbf{Z}_k$. On the other hand, though the deformation is known to keep the $N^{3/2}$ scaling behavior, eleven dimensional description of the deformed theory is still obscure. We compute the exact large N expansion of the partiton function of this deformed theory, including all order 1/N corrections. We find that the non-perturbative corrections in 1/N have the similar structure as the instanton effects in the ABJM case which have an eleven dimensional interpretation as membranes winding on $\mathbf{C}^4/\mathbf{Z}_k$. Starting with more general $\mathcal{N} = 4$ quiver superconformal Chern-Simons theories, we also discovered that the non-conformal deformation causes recombination of the instantons.

M. Honda (Weizmann Inst.)
The Interpolating Function
In theoretical physics, we sometimes have two perturbative expansions of physical quantity around different two points in parameter space, e.g. in theory with S-duality, lattice gauge theory with weak and strong coupling expansions, field theory with gravity dual, and statistical system with low and high temperature expansions, etc. In terms of the two perturbative expansions, we can construct smooth interpolating functions, which are consistent with the both expansions up to some orders. In my talk, I will report recent progress on such interpolating functions.

K. Hotta (Hokkaido U.)
Thermal Vacuum State for Multiple Closed Superstrings in the Framework of Thermo Field Dynamics
Although the finite temperature systems of strings have been mainly examined in the framework of Matsubara formalism, quite a few works have been done to investigate these systems in the framework of thermo field dynamics. Previously we have calculated the thermal vacuum state and the partition function for a single closed superstring in the framework of thermo field dynamics. From this we can reproduce the free energy for multiple strings in the case of Matsubara method. However it is unsatisfactory to derive free energy in such a way, since the free energy for multiple strings should be obtained by only calculating the expectation value of the corresponding operator in the thermal vacuum state. In this talk, we compute the thermal vacuum state for multiple closed superstrings based on free light-cone superstring field theory. From this we can reproduce the free energy for closed superstrings in the case of Matsubara method. We coment on the relation between this closed superstrings at finite temperature and the open superstrings on D9-brane–anti-D9-brane pairs.

S. Kanno (Tokyo Tech)
4D $\mathcal{N} = 1$ gauge theories from M5-branes on D-type singularity
We consider 4D $\mathcal{N} = 1$ supersymmetric gauge theories obtained by compactification of multiple M5-branes on D_k singularity. Especially, we discuss relation geometry of punctured Riemann surfaces and feature of gauge theories.

Tetsuji Kimura (Keio U.)
Improved GLSM for exotic five-brane
We improve 2D N=(4,4) GLSM for exotic five-brane proposed by Sasaki and myself in arXiv:1304.4061. In this previous work we applied the duality relation between chiral superfields and twisted chiral superfield even without shift symmety. Even this case we could find the correct sigma model, whilst the form was quite complicated. Now we introduce a complex linear superfield (a kind of reducible superfield) to analyze the duality transformation. This technique has been discussed by Grisaru, Massar, Sevrin and Troost in 1998. They insist that a chiral superfield is converted to a complex linear superfield under the duality relation without isometry. Applying this method to the GLSM for five-branes, we can obtain quite a simple form of the sigma model for the exotic five-brane.

T. Kojita (Kyoto Sangyo U.)
Defects in open string field theory
We show that world sheet topological defects (TD) generate new classical solutions of open string field theory (OSFT) from a given solution. To make this clear, we first derive the explicit formula of a TD action on boundary fields, including boundary condition changing operators (bcco), by generalization of the results of Graham and Watts. We study the composition of the so-defined open string defects and we find that the fusion algebra of the underlying CFT is realized only up to an automorphism of the OSFT star product. By studying the gauge invariant observables, we show that the boundary state of an OSFT solution acted by an open string defect coincides with the action of a closed string defect on the boundary state of the initial solution.

H. Kyono (Kyoto U.)

Lax pair on Yang-Baxter deformed backgrounds

We explicitly derive Lax pairs for string theories on various Yang-Baxter deformed backgrounds. Then we can find out a concise derivation of Lax pairs based on simple replacement rules. Furthermore, each of the above deformations can be reinterpreted as a twisted periodic boundary conditions with the undeformed background by using the rules. This talk is based on the work with T. Kameyama, J. Sakamoto, and K. Yoshida; arXiv/hep-th: 1509.xxxxx.

M. Nishida (Osaka U.)

Entanglement negativity of a free massless Dirac fermion on 2d torus

Entanglement negativity is one of entanglement measures such as mutual information. We study the entanglement negativity of a free massless Dirac fermion on 2d torus by bosonization. Our result from two-point function is consistent with the result on 2d flat spacetime.

K. Shimizu (Yukawa Inst.)

Large N behavior of M2-M5 branes system

We study the masssive-ABJM theory which represents M2-M5 system in the large N limit. The exact partition function on S^3 can be written by the matrix model using localization technique. The large N behaviors are determined by saddle solution of saddle point equation of the matrix model. We find new solution of the saddle-points equation. Then we compute the partition function and other quantities of the theory. This presentation is based on the collaboration with Seiji Terashima and Tomoki Nosaka.

H. Shu (Tokyo Tech)

Modified affine B2 Toda equations and AdS_4 minimal surface via ODE/IM correspondence

We consider modified affine B_2 Toda equations via ODE/IM correspondence. We rewrite these equations as the linear problem of the flat connection. From the asymptotic behavior of the solution of the linear problem, Q-functions is introduced. We obtain functional relations for the Q- function, which has the form of Bethe ansatz equation. From the Stokes multiplier of the solution, we introduce T-,Y-functions. Their functional relations are also derived.

K. Sugita (Nihon U.)

Singular Gauge Transformation and the Erler-Maccaferri Solution in Bosonic Open SFT

We study multiple-brane solutions in bosonic open SFT. There are two types of such solutions, the pure-gauge-form solutions and the Erler-Maccaferri solutions. In the former solutions, the multiplicity is changed by singular gauge transformations, while in the latter ones, it is changed by bcc operators. We study solutions which are obtained from the Erler-Maccaferri solutions by singular gauge transformations.

K. Takesue (Kitasato U.)

ADHM like construction in $\mathbf{R}^8$

It is well known that instanton on $\mathbf{R}^4$ can be produced generally through the ADHM construction. In this poster, we consider constructing the ADHM like construction on $\mathbf{R}^8$ what this construction produce a instanton in $\mathbf{R}^8$.The instantons in $\mathbf{R}^8$ are defined which these satisfy the self-dual equations on $\mathbf{R}^8$. By the example of the ADHM like construction on $\mathbf{R}^8$, we perform constructing the $\mathbf{R}^8$ charge 1 instanton which called a SO(8) instanton.

K. Watanabe (Yukawa Inst.)

Quantum Entanglement of Excited States by Heavy Local Operators in Large-c 2d CFT at Finite Temperature

We study the time evolutions of entanglement entropy and mutual information for locally excited states in Large-c 2d CFT at finite temperature and the holographic versions. We consider excited states obtained by acting heavy primary operators on thermal states constructed from thermofield double states and calculate the entanglement entropy on 1-side and 2-sides and the mutual information on 2-sides. The results in CFT side mathches those in gravity side. We also obtain so-called "scrambling time", which the entanglement of the state in the system we observe is disrupted and the state becomes a typical (thermal) state, from the mutual information and the 2-point function. This talk and poster is based on a work with Pawel Caputa, Joan Simon, Andrius Stikonas and Tadashi Takayanagi.

N. Watanabe (Kavli IPMU)

On skein relations in class $\mathcal{S}$ theories

Loop operators of a class S theory arise from networks on the corresponding Riemann surface, and their operator product expansions are given in terms of the skein relations, that we describe in detail in the case of class S theories of type A. As two applications, we explicitly determine networks corresponding to dyonic loops of N=4 SU(3) super Yang-Mills, and compute the superconformal index of a nontrivial network operator of the T3 theory.

November 12 (Thursday)

L. Rastelli (Stony Brook U.)
The (2, 0) Superconformal Bootstrap
The six-dimensional conformal field theories with (2, 0) supersymmetry play an increasingly central role in theoretical physics. These theories lack a conventional Lagrangian description and have proved stubbornly resistant to study by traditional quantum field theory methods. Their high degree of symmetry and conjecture uniqueness make them however ideal candidates for an abstract algebraic approach the conformal bootstrap. This talk will review the modern bootstrap program and its application to the (2, 0) theories.

K. Maruyoshi (Imperial London)
Chiral theories of class $\mathcal{S}_\Gamma$
In this talk, we consider a class of four-dimensional $\mathcal{N} = 1$ superconformal field theories obtained from compactification of the six-dimensional (1, 0) theory, on M5-branes proving $\mathbf{C}^2/\Gamma_G$ singularity, on a Riemann surface. This produces various quiver gauge theories whose matter contents are chiral. We classify the building blocks associated to pairs-of-pants, and study the gauging of them as the gluing of punctures. The Riemann surface picture makes the duality of the resulting quiver theories manifest: the theories associated to the same Riemann surface flow to the same nontrivial infrared fixed point. We discuss the 't Hooft anomalies of the global symmetries and central charges from the six-dimensional view point, and also a relation to a two-dimensional theory on the Riemann surface. This talk is based on collaboration with Amihay Hanany.

H. Shimizu (U. Tokyo)
6d $\mathcal{N} = (1, 0)$ theories on $\mathbf{T}^2$ and class $\mathcal{S}$ theories
We study the T^2 copmactification of various 6d $\mathcal{N}$=(1, 0) theories. For a class of 6d theories we call very Higgsable, we showed that the resulting 4d $\mathcal{N}$=2 theory is superconformal and its anomaly polynomial is given in terms of the anomaly polynomial of the parent 6d theory. For a class of 6d theories which is Higgsable to $\mathcal{N}$=(2, 0) theories, we showed that the resulting 4d $\mathcal{N}$=2 theory is generically given by two superconformal matter sectors coupled via an IR- free gauge multiplet and another conformal gauge multiplet. For many examples, we found that the 4d $\mathcal{N}$=2 superconformal theories which appear in the T^2 compactification are in fact class S theories.

T. Nishinaka (Yukawa Inst.)
On the Superconformal Index of Argyres-Douglas Theories
We conjecture a closed-form expression for the Schur limit of the superconformal index of two infinite series of Argyres-Douglas (AD) superconformal field theories (SCFTs): the (A_1, A_{2n-3}) and the (A_1, D_{2n}) theories. Since their superconformal R-symmetry is emergent, the supersymmetric localization is not available. Instead, we use a relation to two- dimensional q-deformed Yang-Mills theory and data from the class S construction. Our results are consistent with the two-dimensional chiral algebras associated with the (A_1, A_3) and (A_1, D_4) SCFTs, an S-duality of the (A_3, A_3) SCFT, the Higgs branch relations, a series of RG flows, and the Cardy-like behavior in the small S^1 limit.

M. Taki (RIKEN)
Tao Probing the End of the World 1
In this talk, I will introduce a new IIB 5-brane description for the 6d E-string theory which is the world-volume theory on M5-brane probing the end of the world M9-brane. The E-string in our new realization, which is named Tao web, is depicted as spiral 5-branes web equipped with the cyclic structure which is a key to uplifting to 6 dimensions. Utilizing the topological vertex to the 5-brane web configuration enables us to write down a combinatorial formula for the generating function of the E-string elliptic genera, namely the full partition function of topological strings on local K3 surface.

F. Yagi (KIAS)
Tao Probing the End of the World 2
Generalizing the idea of "Tao diagram", we investigate the class of five dimensional $\mathcal{N} = 1$ supersymmetric gauge theories whose ultraviolet fixed point is six dimensional $\mathcal{N} = (1, 0)$ theories. We propose that the existence of such diagram can be used as a criterion for 5d theories to have 6d UV fixed points.

H. Muraki (U. Tsukuba)
Gravity theory on Poisson manifold with R-flux
A novel gravity theory based on Poisson Generalized Geometry is investigated. A gravity theory on a Poisson manifold equipped with a Riemannian metric is constructed from a contravariant version of the Levi-Civita connection, which is based on the Lie algebroid of a Poisson manifold. Then, we show that in Poisson Generalized Geometry the R-fluxes are consistently coupled with such a gravity. An R-flux appears as a torsion of the corresponding connection in a similar way as an H-flux which appears as a torsion of the connection formulated in the standard Generalized Geometry. We give an analogue of the Einstein-Hilbert action coupled with an R-flux, and show that it is invariant under both β-diffeomorphisms and β-gauge transformations.

M. A. Heller (Tohoku U.)
R-flux string sigma model and algebroid duality on Lie 3-algebroids
We are interested in the geometry of T-duality and (non-)geometric fluxes in string theory. T-duality converts H- , F-, Q-, R-fluxes into each other. In the H-flux case the standard Courant algebroid appears quite naturally as mathematical structure. We construct a topological sigma model of the Courant algebroid on a Poisson manifold (Poisson Courant algebroid) with R-flux using supergeometric formulation. From there we obtain a string sigma model with R-flux. We find a duality map between the standard Courant algebroid with H-flux and the Poisson Courant algebroid with R-flux that transforms H- flux and R-flux. After that we unify both algebroids as substructures of a Lie 3-algebroid. Various types of Courant algebroids can be embedded as substructures within the Lie 3-algebroid. Therefore, we define an algebroid duality between these substructures that transforms H-, F-, Q-, R-fluxes. We propose this framework to analyze T-duality geometry. Finally, we derive the current algebra corresponding to the Lie 3- algebroid and obtain current algebras on the substructures by twisting.

S. Kinoshita (Chuo U.)
Conic D-branes
The shape of D-branes is of fundamental interest in string theory. We find that generically D-branes can form a conic shape under external uniform forces. Surprisingly, the apex angle is found to be unique, once the spatial dimensions of the cone is given. In particular it is universal irrespective of the external forces. The quantized angle is reminiscent of Taylor cones of hydrodynamic electrospray. We show three explicit examples of conical D-brane solutions as well as the mechanism of a force balance on the cone, for D-branes in RR, NSNS flux background and AdS spacetime background.

Taro Kimura (Keio U.)
Band spectrum as D-brane shape
We show that band spectrum of class A topological insulators in two and four dimensions can be identified as the shape of D-branes in string theory. This is based on a relation between the Berry connection associated with the band structure and the ADHM/Nahm construction of solitons whose geometric realization is available with D-branes.

T. Fujimori (Keio U.)

Instantons in Lifshitz field theories

Instantons are topologically non-trivial saddle points of the Euclidean action and give non-perturbative contributions to the path integral. They play an important role in 2d non-linear sigma models and 4d Yang-Mills theories. Although the standard higher dimensional versions of those models are perturbatively non-renormalizable, there are also renormalizable generalization, called the Lifshitz type field theories, characterized by the anisotropic scaling of the time and space coordinates: $t \to \lambda^z t$, $x \to \lambda x$. The Horava- Lifshitz gravity is a power-counting renormalizable gravity theory based on the idea of the anisotropic scaling. There are also renormalizable non-linear sigma models and Yang-Mills theories in higher dimensions. They are expected to be asymptotically-free and have rich non-perturbative properties. Although Lifshitz type theories do not have Poincare symmetry, they can have a supersymmetry characterized by the time translation: $\{Q, \bar{Q}\} = 2i\partial_t$. The BPS instantons preserve a half of the supersymmetry and described by the gradient flow equation of the functional W defining the so-called detail balance condition in the context of the Lifshitz type theories. In this talk, I will explain (1) Skyrmions in 3d sigma model (W is Wess-Zumino-Witten term) and (2) Yang-Mills instantons in 6d gauge theory (W is 5d Chern-Simons term).

Y. Okawa (U. Tokyo)

Complete action of open superstring field theory

We construct a complete action of open superstring field theory which includes the Neveu-Schwarz sector and the Ramond sector. For the Neveu-Schwarz sector, we use the string field in the large Hilbert space of the superconformal ghost sector, and the action in the Neveu-Schwarz sector is the same as the Wess-Zumino-Witten-like action of the Berkovits formulation. For the Ramond sector, we use the string field in the small Hilbert space which is further projected to a subspace so that the BRST cohomology on the subspace reproduces the correct spectrum. We show that the action is invariant under gauge transformations which are consistent with the projection for the string field in the Ramond sector.

R. Meyer (Stony Brook U.)

Double Field Theory and Non-Relativistic String Theory

Double Field Theory provides a geometric framework capable of describing string theory backgrounds that cannot be understood purely in terms of Riemannian geometry. In this talk, I present recent results that show that the non-relativistic closed string theory of Gomis and Ooguri arises precisely as such a non-Riemannian string background, and that the Gomis-Ooguri sigma model is equivalent to the Double Field Theory sigma model of on this background. I further show that the target-space formulation of Double Field Theory on this non-Riemannian background correctly reproduces the appropriate sector of the Gomis-Ooguri string spectrum.

Y. Sakatani (Seoul National U.)

$O(D, D)$ **Covariant Noether Currents and Global Charges in Double Field Theory**

Double field theory is an approach for massless modes of string theory, unifying and geometrizing all gauge invariances in a manifestly O(D,D)-covariant manner. In this approach, we derive off-shell conserved Noether currents associated with the unified gauge invariances. We check our O(D,D)-covariant formula reproduces the well-known ADM energy-momentum for conventional backgrounds. Further, we show that the formula for the momenta along the dual directions matches with the conventional formula for the string winding charges. This talk is based on a collaboration with Jeong-Hyuck Park, Soo-Jong Rey, and Woohyun Rim.

S. Komatsu (Perimeter Inst.)
Integrable Bootstrap for Structure Constants in N=4 SYM
I will discuss an integrability-based framework to compute the structure constants in N=4 SYM at finite coupling. After briefly reviewing the spectral problem, I will explain our proposal and how it reproduces the results at weak and strong coupling known in the literature. In particular, I will show that our prediction is in perfect agreement with the three-loop perturbative results, which are obtained quite recently by the OPE decomposition of four-point functions.

T. Kameyama (Kyoto U.)
Minimal surfaces in q-deformed $\mathbf{AdS}_5\times\ \mathbf{S}^5$
I will present a possible holographic setup for the q-deformed $\mathrm{AdS}_5\times\mathrm{S}^5$ superstring. An interesting issue is to consider a holographic relation in the q-deformed geometry. A proposal is that the singularity surface in the deformed metric may be regarded as the holographic screen. For this purpose, it is nice to introduce a coordinate system which describes only the spacetime enclosed by the singularity surface. In particular, I will talk about minimal surfaces whose boundary shape is a circle in the deformed AdS space. A solution corresponds to a 1/2 BPS circular Wilson loop in the $q \to 1$ limit. A remarkable point is that the classical Euclidean action is not divergent unlike the undeformed one. The finiteness indicates that the q-deformation may be regarded as a UV regularization.

Y. Kimura (Okayama Inst.)
Negative anomalous dimensions in $\mathcal{N} = 4$ SYM
We consider the one-loop anomalous dimension of so(6)-singlet multi-trace operators in $\mathcal{N} = 4$ $SU(N_c)$ SYM at finite N_c. We study how $1/N_c$ corrections lift the large N_c degeneracy of the spectrum, which we call the operator submixing problem. We observe that all large N_c zero modes acquire a non-positive anomalous dimension starting at order $1/N_c^2$, and they mix only among the operators with the same number of traces at the leading order. This talk is based on the collaboration with Ryo Suzuki.

T. Matsumoto (U. Tsukuba)
New construction method of matrix regularization using coherent states
We propose a new construction method of the matrix regularization for Riemann surfaces. We note that by using the coherent states the concept of locality can be introduced into noncommutative spaces and any noncommutative space should locally have the same structure as the noncommutative plane. Based on this idea, we find a general form of the coordinate operators on a general noncommutative surface. We apply our method to the 2-dimensional torus and sphere and demonstrate the validity of this method.

H. Shimada (Okayama Inst.)
On membrane interactions and a three-dimensional analog of Riemann surfaces
The talk will be based on a work done in collaboration with Stefano Kovacs (DIAS), Yuki Sato(Wits Univ.). Splitting(-joining) processes of membranes in the pp-wave matrix model will be discussed. I will discuss a continuum approximation under which the BPS instanton equation governing the processes can be mapped to the 3D Laplace equation. I will further show that the splitting processes are described by solutions of the Laplace equation defined on a "Riemann space" – a three-dimensional analog of a Riemann surface –, and discuss explicit analytic solutions and general features of the construction.

G. Ishiki (U. Tsukuba)
Spherical M5-branes from the plane wave matrix model
The plane wave matrix model (PWMM) is conjectured to give a formulation of M theory on the pp-wave background. In the M-theory, there exist spherical M5-branes with vanishing light cone energy. If the matrix model formulation of the M-theory is correct, these M5 branes should be somehow realized in PWMM. Using the localization, we show that such spherical branes are indeed realized in PWMM as the eigenvalue distribution of the SO(6) scalar fields. We also show that the radius of the distribution exactly agrees with the radius of the M5-branes.

End of Workshop