KEK Theory Workshop 2023

Report of Contributions

https://conference-indico.kek.jp/e/231

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

Opening Session

Presenter: Prof. NISHIMURA, Jun (KEK, SOKENDAI)

Session Classification: Opening Address

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

A new recursion relation for ABJ matrix models

Wednesday, November 29, 2023 3:00 PM (15 minutes)

We find new bilinear relations for the partition functions of $U(N)_k \times U(N+M)_{-k}$ ABJ theory with two parameter mass deformation (m1,m2), which generalize the q-Toda-like equation found previously for m1=m2. By combining the bilinear relations with the Seiberg-like dualities and the duality cascade relations, we can determine the closed form expressions of the partition functions recursively with respect to N. This method is more efficient than the exact calculation by the standard TBA-like approach in the Fermi gas formalism. As an application we study the large N asymptotics of the partition function with the mass parameters in the supercritial regime where the large N expansion obtained for small mass parameters is invalid.

Presenter: Dr NOSAKA, Tomoki (Kavli Institute for Theoretical Sciences, University of Chinese Academy of Sciences)

Session Classification: Parallel Session A

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

Photon sphere and quasinormal modes in AdS/CFT

Wednesday, November 29, 2023 2:00 PM (15 minutes)

Photon spheres are the characteristic of general black holes, thus are a suitable touchstone for the emergence of gravitational spacetime in the AdS/CFT correspondence. We provide a spectral analysis of an AdS Schwarzschild black hole near its photon sphere. We find that quasinormal modes near the photon sphere reflect the AdS boundary, resulting in a peculiar spectral pattern. Our large angular momentum analysis owes to an analogue to solvable Schrödinger equations such as an inverted harmonic oscillator and the Pöschl-Teller model, with a Dirichlet boundary condition. Through the AdS/CFT dictionary, it predicts the existence of a peculiar subsector in the large angular momentum spectrum of thermal holographic CFTs on a sphere. This talk is based on arXiv:2307.00237 with Koji Hashimoto, Katsuyuki Sugiyama, and Takuya Yoda.

Presenter: Mr SUGIURA, Kakeru (Kyoto University)

Session Classification: Parallel Session A

Contribution ID: **4** Type: **not specified**

A Semi-classical Spacetime Region with Maximum Entropy

Wednesday, November 29, 2023 5:00 PM (15 minutes)

We consider a 4D spherically-symmetric static spacetime region as a collection of quanta in the semi-classical Einstein equation and study the entropy including the self-gravity. For sufficiently excited states, we estimate the entropy in a WKB-like method considering the non-locality of entropy and local consistency with thermodynamics and find its upper bound. The saturation condition uniquely determines the entropy-maximized spacetime as a dense configuration with near-Planckian curvatures and a surface just outside the Schwarzschild radius, and the metric is a non-perturbative solution for Planck constant, leading to the species bound. The maximum entropy then saturates the Bousso bound and coincides with the Bekenstein-Hawking formula. Thus, the Bousso bound in this class of spacetime is verified by constructing the saturating configuration that has no horizon and stores information inside. [arXiv: 2309.00602 (ver2)]

Presenter: Dr YOKOKURA, Yuki (RIKEN iTHEMS)

Session Classification: Parallel Session A

Contribution ID: **5** Type: **not specified**

Krylov complexity and chaos in quantum mechanics

Wednesday, November 29, 2023 2:15 PM (15 minutes)

Recently, Krylov complexity was proposed as a measure of complexity and chaoticity of quantum systems. We consider the stadium billiard as a typical example of the quantum mechanical system obtained by quantizing a classically chaotic system, and numerically evaluate Krylov complexity for operators and states. Despite no exponential growth of the Krylov complexity, we find a clear correlation between variances of Lanczos coefficients and classical Lyapunov exponents, and also a correlation with the statistical distribution of adjacent spacings of the quantum energy levels. This shows that the variances of Lanczos coefficients can be a measure of quantum chaos. The universality of the result is supported by our similar analysis of Sinai billiards. Our work provides a firm bridge between Krylov complexity and classical/quantum chaos.

Presenter: Mr WATANABE, Ryota (Kyoto University)

Session Classification: Parallel Session A

Contribution ID: **6** Type: **not specified**

Operator dynamics in Lindbladian SYK

Wednesday, November 29, 2023 2:45 PM (15 minutes)

Under the Hamiltonian evolution, a simple operator turns into a complicated operator. The growth of such an operator is drastically different when the system is connected to a dissipative environment than in a typical closed system. We probe such growth via a recently explored measure of scrambling known as Krylov complexity and aim to propose an operator growth hypothesis in open quantum systems. By testing our hypothesis in a dissipative version of SYK model, which is a paradigmatic model of quantum chaos and a toy model of holography, we motivate the notion of "dissipative quantum chaos".

Presenter: Dr NANDY, Pratik (YITP, Kyoto University)

Session Classification: Parallel Session A

Contribution ID: **7** Type: **not specified**

Exact WKB Analysis and TBA Equations for the Stark Effect

Thursday, November 30, 2023 4:45 PM (15 minutes)

In this talk, I will discuss the application of the exact WKB analysis to a couple of one-dimensional Schrödinger-type equations reduced from the Stark effect of hydrogen. By introducing Langer' s modification, we prove the exactness of the Bohr-Sommerfeld quantization conditions for the Borel-resummed quantum WKB periods at the weak electric field intensities and also find these quantization conditions get modified with an additional suppressed contribution when the electric field becomes large. We also present TBA equations governing the quantum periods in the absence of Langer's modification. I will mention its possible application to supersymmetric gauge theory and quasi-normal modes around black holes in the end.

Presenter: Dr YANG, Jingjing (Tokyo Institute of Technology)

Session Classification: Parallel Session B

Contribution ID: **8** Type: **not specified**

Chiral theory as edge modes

Wednesday, November 29, 2023 10:00 AM (1 hour)

I give a review (, possibly biased,) on chiral theory as edge modes from a personal point of view. After reviewing the problem of chiral theory on the lattice, I comment on the standard method by symmetric mass generation of mirror fermion.I also review the recent work on chiral boson theory in 1+1 d by M. DeMarco, E. Lake, X.-G. Wen.

Presenter: Prof. ONOGI, Testuya (Osaka University)

Session Classification: Plenary Session

Contribution ID: **9** Type: **not specified**

Opening Address

Wednesday, November 29, 2023 9:50 AM (10 minutes)

Presenter: Prof. NISHIMURA, Jun (KEK, SOKENDAI)

Session Classification: Opening Address

Contribution ID: **10** Type: **not specified**

Research on QFT beyond the high-symmetry regime -resurgence, lattice and graph-

Wednesday, November 29, 2023 11:30 AM (1 hour)

Since the establishment of the Standard Model of elementary particles, the research in quantum field theory has investigated non-perturbative analysis based on theories with high symmetry, such as supersymmetry. However, the Standard Model, including QCD, has relatively low symmetry, and it is getting important to analyze theories based on features appearing only in QFT with low symmetry. In this talk, I will introduce resurgence theory and graph-based lattice field theory as directions for non-perturbative understanding of QFT that does not rely on symmetry, and will provide a guideline for future research on QFT.

Presenter: Prof. MISUMI, Tatsuhiro (Kindai University)

Session Classification: Plenary Session

Contribution ID: **11** Type: **not specified**

Hartle-Hawking v.s. Vilenkin saddle points in quantum cosmology by the generalized Lefschetz thimble method

Wednesday, November 29, 2023 2:00 PM (15 minutes)

Quantum cosmology investigates the origins of our Universe, including the concept of "tunneling from nothing" proposed by Vilenkin and Hartle-Hawking. Recent advancements have renewed interest in this field, employing the Picard-Lefschetz theory in Lorentzian quantum gravity. In this study, we address crucial challenges using the generalized Lefschetz thimble method, overcoming the sign problem in Monte Carlo techniques. By the mini-superspace model, we perform first-principle calculations to shed light on fundamental issues. We tackle concerns regarding the integration domain of the lapse function and explore the Robin boundary condition at the initial time, incorporating aspects of Dirichlet and Neumann boundary conditions. Our findings reveal the Stokes phenomenon, where the dominant saddle point transitions from Vilenkin to Hartle-Hawking, aligning with expectations from the Picard-Lefschetz theory. Notably, we focus on the intricate simulation of the Hartle-Hawking proposal for a minute final size of the universe, which is highly nontrivial.

Presenter: Mr CHIEN-YU, CHOU (SOKENDAI)

Session Classification: Parallel Session B

Contribution ID: **12** Type: **not specified**

The effect of fermions on the emergence of (3 +1)-dimensional expanding space-time in the Lorentzian type IIB matrix model

Wednesday, November 29, 2023 2:15 PM (15 minutes)

The Lorentzian type IIB matrix model is a promising candidate for a non-perturbative formulation of superstring theory. Recently, we have performed complex Langevin simulations adding a Lorentz invariant mass term as an IR regulator. In this talk, we will show that the (3+1)-dimensional expanding space-time emerges due to the effect of fermions.

Presenter: Dr HATAKEYAMA, Kohta (Hirosaki University)

Session Classification: Parallel Session B

Contribution ID: **13** Type: **not specified**

Color confinement due to topological defects —restoration of residual gauge symmetries—

Wednesday, November 29, 2023 2:30 PM (15 minutes)

The local gauge symmetry remaining even after imposing a gauge fixing condition is called the residual local gauge symmetry, which is spontaneously broken in the perturbative vacuum, and is expected to be restored in the true confining vacuum. Indeed, the criterion for restoring a special choice of the residual gauge symmetry was shown to be equivalent to the Kugo-Ojima color confinement criterion in the Lorenz gauge. In the previous paper, we demonstrated that such restoration can occur even in the Maximal Abelian gauge due to topological defects. However, it was later found that the topological defects introduced in the previous paper give an infinite Euclidean action and hence do not contribute to the path integral. In this talk, therefore, we reexamine modified topological defects giving a finite Euclidean action to contribute to the path integral. We show the restoration of the residual local gauge symmetry in the Maximal Abelian gauge due to such a class of topological defects.

Presenter: Mr FUKUSHIMA, Naoki (Chiba University)

Session Classification: Parallel Session B

Contribution ID: **14** Type: **not specified**

Semiclassical analysis of the bifundamental QCD with anom aly-preserving T^2 compactification

Wednesday, November 29, 2023 2:45 PM (15 minutes)

Bifundamental QCD, an $SU(N) \times SU(N)$ gauge theory with a bifundamental fermion, has received substantial attention due to its rich phase structure and its notable relevance to the large-N orbifold equivalence. To investigate the vacuum structure and phase diagrams of this model, we employ a semiclassical center-vortex description of the confining vacuum, enabled through anomaly-preserving T^2 compactification under the assumption of adiabatic continuity. In this presentation, we will show how our semiclassical framework explains one of the conjectured phase diagrams previously proposed in literature. Specifically, our results provide positive support for the nonperturbative validity of the large-N orbifold equivalence between bifundamental QCD and $\mathcal{N} = 1$ $SU(2N)$ supersymmetric Yang-Mills theory.

Presenter: Dr HAYASHI, Yui (YITP, Kyoto University)

Session Classification: Parallel Session B

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

A new perspective on thermal transition in QCD

Wednesday, November 29, 2023 3:00 PM (15 minutes)

Motivated by the picture of partial deconfinement developed in recent years for large-N gauge theories, we propose a new way of analyzing and understanding thermal phase transition in QCD. We find nontrivial support for our proposal by analyzing the lattice configuration for 4d SU(3) QCD with dynamical quarks, produced by WHOT-QCD collaboration. In the discussion, the Polyakov line plays a crucial role in characterizing the phases at large N and finite N, without relying on center symmetry. Confinement at low temperatures is characterized by the Haar-random distribution of the Polyakov line phases. Haar-randomness, which is stronger than unbroken center symmetry, indicates that Polyakov loops in any nontrivial representations have vanishing expectation values and deviation from the Haar-random distribution at higher temperatures is quantified with the loops. We discuss that the transitions separating the partially-deconfined phase are characterized by the behaviors of Polyakov loops in various representations. As a nontrivial test for our proposal, we also investigate the relation between partial deconfinement and instanton condensation and confirm the consistency with the lattice data. This work is based on our recent works arXiv:2310.01940 and arXiv:2310.07533.

Presenter: Dr WATANABE, Hiromasa (YITP, Kyoto University)

Session Classification: Parallel Session B

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

Three ways of calculating comp osite-particle spectra of gauge theories in the Hamiltonian formalism

Wednesday, November 29, 2023 3:15 PM (15 minutes)

We propose three distinct methods to compute the mass of composite particles (hadrons) of gauge theories in the Hamiltonian formalism. Determination of the mass spectrum of hadrons is one of the key issues in QCD, which has been precisely calculated by the Monte Carlo simulation based on the Lagrangian formalism. We newly show how to compute the mass spectra in the Hamiltonian formalism, which is suitable for quantum computation and tensor network methods. The three methods, by examining the correlation function, the one-point function, and the dispersion relation, are demonstrated using the density-matrix renormalization group (DMRG) in the 2-flavor Schwinger model, which shares important properties with QCD. We show that their results are consistent with each other, and discuss their potential applications. (preprint: https://arxiv.org/abs/2307.16655)

Presenter: Mr MATSUMOTO, Akira (YITP, Kyoto University)

Session Classification: Parallel Session B

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

Giant graviton expansions for N=2 superconformal field theories

Wednesday, November 29, 2023 4:30 PM (15 minutes)

The giant graviton expansion of the superconformal index gives the finite rank corrections to the calculation of the index of the superconformal field theory via AdS/CFT correspondence. We study the giant graviton expansions focusing on the 4-dimensional N=2 superconformal field theories realized on D3-branes in 7-brane backgrounds with constant axiodilaton. For some theories including them, the expansion can be reduced to a simple sum over the wrapping numbers of the giant gravitons. This talk is based on arXiv:2310.03332 in collaboration with S. Fujiwara, Y. Imamura, T. Mori, and D. Yokoyama.

Presenter: Dr MURAYAMA, Shuichi (Tokyo Institute of Technology)

Session Classification: Parallel Session A

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

Eclectic Flavor Symmetry in Type IIB String Landscape

Wednesday, November 29, 2023 4:45 PM (15 minutes)

We examine symmetries of chiral four-dimensional vacua of Type IIB flux compactifications with vanishing superpotential W=0. We find that the N=1 supersymmetric MSSM-like and Pati-Salam vacua possess enhanced discrete symmetries in the effective action below the mass scale of stabilized complex structure moduli and dilaton. Furthermore, a generation number of quarks/leptons is small on these vacua where the flavor, CP and metaplectic modular symmetries are described in the framework of eclectic flavor symmetry.

Presenter: Mr KAI, Takafumi (Kyushu University)

Session Classification: Parallel Session A

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

Relation between covariant and light-cone superstring field theory

Wednesday, November 29, 2023 4:00 PM (15 minutes)

In perturbative string theory, there have mainly been two ways to quantize the string. Either one quantizes in lightcone gauge, or one quantizes covariantly. The difference between them is only gauge condition, and the equivalence of on-shell amplitudes had been already shown. String field theory is a candidate for a non-perturbative formulation of string theory. There have mainly been two formulations, they are covariant string field theory (covariant SFT) and light-cone string field theory (light-cone bosonic SFT) In bosonic string field theory, it is shown that the light-cone bosonic SFT is an effective SFT which is obtained by integrating out some degrees of freedom from a covariant bosonic SFT by Erler-Matsunaga. We show that the light-cone super SFT is an effective SFT for a covariant super SFT. This talk is based on the collaboration with R.Fujii, H.Kunitomo and J.Yoshinaka.

Presenter: Mr ANDO, Yuji (University of Tsukuba)

Session Classification: Parallel Session A

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

Derivation of 11 dimensional spacetime without assuming supersymmetry

Wednesday, November 29, 2023 5:15 PM (15 minutes)

In this talk, I demonstrate that scale invariance and electromagnetic duality are strong enough to restrict the spacetime dimension. 10 and 11 dimensional spacetimes are obtained as solutions of these constraints. In this derivation, supersymmetry and general relativity are not assumed.

Presenter: Dr MORITA, Takeshi (Shizuoka University)

Session Classification: Parallel Session A

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

Page curves for 2d black holes with multiple injections

Wednesday, November 29, 2023 3:15 PM (15 minutes)

We talk about Page curves for 2d black holes with multiple injections. The feature is that a decreasing entanglement entropy related to time is replaced with a increasing one when a energy is injected. After each energy injection, we find a sudden increase in the entropy, and also subsequent increasing period. Then, after a "Page time", there comes a decreasing period untill the next energy flow is injected.

Presenter: Mr SAITO, Yuuta (CST, Nihon University)

Session Classification: Parallel Session A

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

Automatic hermiticity for mixed states

Thursday, November 30, 2023 5:15 PM (15 minutes)

We previously proposed a mechanism to effectively obtain, after a long time development, a Hamiltonian being Hermitian with regard to a modified inner product I_Q that makes a given non-normal Hamiltonian normal by using an appropriately chosen Hermitian operator Q. We studied it for pure states. In this talk we show that a similar mechanism also works for mixed states by introducing density matrices to describe them and investigating their properties explicitly. In particular, in the future-included theories, where not only a past state at the initial time T_A but also a future state at the final time T_B is given, we introduce a "skew density matrix"composed of both ensembles of the future and past states such that the trace of the product of it and an operator O matches a normalized matrix element of O. We argue that the skew density matrix defined with I_Q at the present time t for large T_B-t and large $t-T_A$ approximately corresponds to another density matrix composed of only an ensemble of past states and defined with another inner product I_{Q_J} for large $t-T_A$. This talk is based on the collaboration with Holger Bech Nielsen [Prog. Theor. Exp. Phys. 2023 (3) 031B01] (arXiv:arXiv:2209.11619 [hep-th]).

Presenter: Prof. NAGAO, Keiichi (Ibaraki University)

Session Classification: Parallel Session A

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

The phase diagram of the bosonic Lorentzian IKKT matrix model with the mass term

Wednesday, November 29, 2023 4:00 PM (15 minutes)

The IKKT matrix model was proposed in 1996 as a non-perturbative description of superstring theory. One of its appealing features is the fact that spacetime emerges naturally from first principles as the eigenvalue distribution of the bosonic matrix degrees of freedom. For the past few decades, there has been extensive number of numerical attempts to study the model. In this work, we investigate the bosonic Lorentzian IKKT model with the addition of the mass term to regularize the path integral. We first exhaust all the classical solutions at N=2 and find that there are non-trivial solutions representing lower-dimensional spacetimes. By performing the perturbative expansions and computing the partition functions associated with the solutions, we can obtain a phase diagram of the theory. We also discuss the possibility of the emergence of the real spacetime.

Presenter: Mr PIENSUK, Worapat (SOKENDAI)

Session Classification: Parallel Session B

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

The analysis of the Lorentzian IKKT matrix model at large D

Wednesday, November 29, 2023 4:15 PM (15 minutes)

The IKKT matrix model is the most promising candidate of a non-perturbative formulation of superstring theory. Recently it has been proposed to introduce the Lorentz invariant mass term as a regularization. This model has SO(9,1) Lorentz symmetry, and a partition function diverges due to the non-compactness of the volume of the Lorentz group. In this study, we have done the analytical calculation at large D. In the case with N=2, there are three classical solutions in total. We clarified the physical meaning of the solutions and a phase diagram of the theory by doing a 1/D expansion around each solution.

Presenter: Mr YAMAMORI, Naoyuki (SOKENDAI)

Session Classification: Parallel Session B

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

Lefschetz-thimbl e analysis of the Lorentzian IKKT matrix model around saddle point configurations

Wednesday, November 29, 2023 4:30 PM (15 minutes)

The type IIB matrix model is a promising candidate for a nonperturbative definition of superstring theory. The Lorentzian version, however, is not well defined as it is, and it was recently proposed to introduce a Lorentz invariant mass term in the action as an IR regulator. Depending on the sign of this term, we either have a model that is truly Lorentzian or one that is comparable to the Euclidean model. In this work we numerically investigate the purely Lorentzian case using Lefschetz thimble method. Our investigation of the simplest N = 2 bosonic case confirms certain surprising properties of the model predicted from the analytical calculations like divergence of the partition function, phase transition etc. We claim that these features are truly Lorentzian in nature. We also discuss the impact of this statement in the possible emergence of (3+1)D expanding space-time.

Presenter: Mr TRIPATHI, Ashutosh (KEK)

Session Classification: Parallel Session B

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

Perturbative superstring theory and the IKKT matrix model

Wednesday, November 29, 2023 4:45 PM (15 minutes)

In this talk, we revisit the "derivation" of the IKKT matrix model from perturbative string theory and discuss how we should define the path integral of the matrix model. In course of the "derivation," we will see that kappa symmetry is formally enhanced and that there is a subalgebra of the gauge symmetry closed off-shell, in sharp contrast to the fact that the kappa symmetry in the Nambu-Goto/Polyakov-type Green-Schwarz formalism is closed only on-shell. This allows us to utilise the BRST quantisation for the perturbative superstring and provides a construction of vertex operators in the matrix model.

Presenter: Mr ASANO, Yuhma (University of Tsukuba)

Session Classification: Parallel Session B

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

Ground state degeneracy and module category

Wednesday, November 29, 2023 5:00 PM (15 minutes)

One of the goals in quantum field theory is to identify long distance behaviors of a theory defined at a short distance. One criterion to distinguish long distance behaviors is the precense of gap. When it is gapped, in two-dimensional space(time), the phases stand in bijection with module categories. In particular, ground state degeneracies (GSDs) of gapped phases are given by ranks of module categories. In this talk, we present a method to classify module categories. The results constrain (or fix) GSDs in gapped phases. Sometimes, it also implies symmetries in the problem should be spontaneously broken.

Presenter: Dr KIKUCHI, Ken (National Taiwan University)

Session Classification: Parallel Session B

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

Correlation functions from homotopy algebras and the applications

Wednesday, November 29, 2023 5:15 PM (15 minutes)

Homotopy algebras algebras have been contributed to describe string field theory effectively. Recently, it has been recognized that these algebras can also be used to express quantum field theory, and its formulas are believed to be universal. In the recent research, it is presented that correlation functions of scalar field theories can be written in terms of homotopy algebras. In this talk, we present that the same formula can be used to describe correlation functions for both scalar fields and Dirac fields based on the work arXiv:2305.11634 with Yuji Okawa and arXiv:2305.13103. We also present some applications of our formulas.

Presenter: Mr KONOSU, Keisuke (The University of Tokyo)

Session Classification: Parallel Session B

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

On Holography in de Sitter Space

Thursday, November 30, 2023 9:00 AM (1 hour)

In this talk, we will discuss possible holographic dual of de Sitter Space from two different ideas. One is the original dS/CFT correspondence, and we will present an explicit CFT dual for three dimensional de Sitter space and examine its properties. The other is to study a holographic dual of a half de Sitter space, which has a time- like boundary. After we explain the results based on these approaches, we will discuss their implications.

Presenter: Prof. TAKAYANAGI, Tadashi (YITP, Kyoto University)

Session Classification: Plenary Session

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

The Petz (lite) recovery map for scrambling channel

Thursday, November 30, 2023 10:15 AM (1 hour)

We study the properties of the Petz recovery map in chaotic systems, such as the Hayden-Preskill setup for evaporating black holes and the SYK model. Since these systems exhibit the phenomenon called scrambling, we expect that the expression of the recovery channel $\mathcal{R}$ gets simplified, given by just the adjoint $\mathcal{N}^\dagger$ of the original channel $\mathcal{N}$ which defines the time evolution of the states in the code subspace embedded into the physical Hilbert space. We check this phenomenon in two examples. The first one is the Hayden-Preskill setup described by Haar random unitaries. We compute the relative entropy $S(\mathcal{R}\left[\mathcal{N}[\rho]\right]||\rho)$ and show that it vanishes when the decoupling is archived. We further show that the simplified recovery map is equivalent to the protocol proposed by Yoshida and Kitaev. The second example is the SYK model where the two dimensional code subspace is defined by an insertion of a fermionic operator, and the system is evolved by the SYK Hamiltonian. We check the recovery phenomenon by relating some matrix elements of an output density matrix $\langle T|\mathcal{R}[\mathcal{N}[\rho]]|T'\rangle$ to R\'enyi-two modular flowed correlators, and show that they coincide with the elements for the input density matrix with small error after twice the scrambling time.

Presenter: Prof. UGAJIN, Tomonori (Rikkyo University)

Session Classification: Plenary Session

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

Gradient flow exact renormalization group: Illustration in the gauged NJL model

Friday, December 1, 2023 9:00 AM (1 hour)

Wilson's exact renormalization group (ERG) is a fundamental idea for defining quantum field theory at a non-perturbative level. The conventional ERG based on the momentum cutoff, however, cannot preserve the manifest gauge invariance and this fact hinders non-perturbative analyses of gauge theories using ERG. In this talk, I explain the gradient flow exact renormalization group (GFERG), which we have recently proposed and developed as an ERG that preserves the manifest gauge invariance. Here, in particular, we apply the GFERG to the U(1) gauged Nambu–Jona-Lasinio model and illustrate the advantage the GFERG offers compared to the conventional ERG.

Presenter: Prof. SUZUKI, Hiroshi (Kyushu University)

Session Classification: Plenary Session

Contribution ID: **32** Type: **not specified**

Problems and Prospects of Quantum Gravity and String Theory

Friday, December 1, 2023 10:30 AM (1 hour)

Current problems in quantum gravity and string theory will be summarized and how they may be overcome in the future will be discussed.

Presenter: Prof. KAWAI, Hikaru (National Taiwan University)

Session Classification: Plenary Session

Contribution ID: **33** Type: **not specified**

Exploring the Landscape of 6d supergravity

Thursday, November 30, 2023 11:30 AM (1 hour)

Exploring the Landscape of 6d supergravity

Presenter: Mr HAMADA, Yuta (KEK)

Session Classification: Plenary Session

Contribution ID: **34** Type: **not specified**

Fractional topological charge in lattice non-Abelian gauge theory

Thursday, November 30, 2023 2:00 PM (15 minutes)

We extend the definition of Lüscher's lattice topological charge to the case of 4d SU(N) gauge fields coupled with Z_N 2-form gauge fields. This result is achieved while maintaining the locality, the SU(N) gauge invariance, and Z_N 1-form gauge invariance, and we find that the manifest 1-form gauge invariance plays the central role in our construction. This result gives the lattice regularized derivation of the mixed 't Hooft anomaly in pure SU(N) Yang-Mills theory between its Z_N 1-form symmetry and the θ periodicity.

Presenter: Dr ABE, Motokazu (Kyushu University)

Session Classification: Parallel Session A

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

Lattice study of RG fixed point based on gradient flow in 3D O(N) sigma model

Thursday, November 30, 2023 2:15 PM (15 minutes)

We present the lattice simulation of the renormalization group flow in the 3-dimensional O(N) linear sigma model. This model possesses a nontrivial infrared fixed point, called Wilson-Fisher fixed point. Arguing that the parameter space of running coupling constants can be spanned by expectation values of operators evolved by the gradient flow, we exemplify a scaling behavior analysis based on the gradient flow in the large N approximation at criticality. Then, we work out the numerical simulation of the theory with finite N. Depicting the renormalization group flow along the gradient flow, we confirm the existence of the Wilson-Fisher fixed point non-perturbatively.

Presenter: Dr MORIKAWA, Okuto (Osaka University)

Session Classification: Parallel Session A

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

Magnetic operators in 2D compact scalar field theories on the lattice

Thursday, November 30, 2023 2:30 PM (15 minutes)

The admissibility conditions are essential for obtaining a well-defined topological charge in lattice gauge theory. However, these conditions may naively seem to prohibit the existence of magnetic operators, as they automatically enforce the Bianchi identity. In this presentation, we will explain how this issue is addressed in the context of 2-dimensional compact scalar theories on a lattice. Additionally, we will explain how applications of this construction, such as ‘t Hooft anomalies and the Witten effect associated with electric and magnetic.

Presenter: Mr ONODA, Soma (Kyushu University)

Session Classification: Parallel Session A

Contribution ID: **37** Type: **not specified**

Curved domain-wall fermion and its applications

Thursday, November 30, 2023 2:45 PM (15 minutes)

The Witten effect predicts that a magnetic monopole acquires a fractional electric charge inside topological insulators. In this work, we give a microscopic description of this phenomenon as well as an analogous two-dimensional system with a vortex. We solve the Dirac equation of electron field both analytically in a continuum and numerically on a lattice by adding the Wilson term and smearing the gauge field within a finite range to regularize the short-distance behavior of the system. Our results reveal that the Wilson term induces a strong positive mass shift, creating a domain-wall around the monopole or vortex. This small yet finite-sized domain wall localizes the chiral zero modes and ensures their stability through the Atiyah-Singer index theorem, whose cobordism invariance is crucial in explaining why the electric charge is fractional.

Presenter: Dr KAN, Naoto (Osaka University)

Session Classification: Parallel Session A

Contribution ID: **38** Type: **not specified**

Phases in the fundamental Kazakov-Migdal model on the graph

Thursday, November 30, 2023 3:00 PM (15 minutes)

We discuss the phase structure of the fundamental Kazakov-Migdal (FKM) model, which is defined on graphs and a generalization of the Kazakov-Migdal model by replacing the scalar fields in the adjoint representation with the fundamental representation. We first show that the partition function of the FKM model can be represented by the unitary matrix valued graph zeta functions, which systematically counts possible Wilson loops on the graph. The effective action of the FKM model reduces to the Wilson action and is expected to induced Yang-Mills theory thanks to lack of the extra local symmetry. We evaluate the partition function of the FKM model exactly in the large N limit. In the different regions of the coupling constant corresponding to the confinement/deconfinement phase, the partition function is evaluated by using the factorizing property and saddle point method. In some cases depending on the graph structure, the derivative of the specific heat is jumped at the critical coupling constant. So we can expect that there is third order phase transition in the FKM model as well as the Gross-Witten-Wadia phase transition. We also perform the numerical analysis by using the HMC and check the above phase structure of the FKM model on various graphs.

Presenter: Prof. OHTA, Kazutoshi (Meiji Gakuin University)

Session Classification: Parallel Session A

Contribution ID: **39** Type: **not specified**

Non-invertible duality defect and non-commut ative fusion algebra

Thursday, November 30, 2023 2:00 PM (15 minutes)

We study non-invertible duality symmetries by gauging a diagonal subgroup of a non-anomalous U(1) × U(1) global symmetry. In particular, we employ the half-space gauging to c=2 bosonic torus conformal field theory (CFT) in two dimensions and pure U(1) × U(1) gauge theory in four dimensions. In c=2 bosonic torus CFT, we show that the non-invertible symmetry obtained from the diagonal gauging becomes emergent on an irrational CFT point. We also calculate the fusion rules concerning the duality defect. We find out that the fusion algebra is non-commutative. We also obtain a similar result in pure U(1) × U(1) gauge theory in four dimensions. This presentation is based on the joint work with Yuta Nagoya [arXiv: 2309.05294, hep-th] .

Presenter: Mr SHIMAMORI, Soichiro (Osaka University)

Session Classification: Parallel Session B

Contribution ID: **40** Type: **not specified**

Non-invertible symmetries in Maxwell theory on non-spin manifold

Thursday, November 30, 2023 2:15 PM (15 minutes)

We consider non-invertible symmetries in Maxwell theories on a non-spin manifolds. Since line operators can be either bosonic or fermionic on such manifolds, three slightly different Maxwell theories without an anomaly can be formulated. We investigate the behaviors of these theories under gauging one-form symmetries, and construct non-invertible symmetries on these theories from half gauging.

Presenter: Mr WADA, Hiroki (Osaka University)

Session Classification: Parallel Session B

Contribution ID: **41** Type: **not specified**

Generalized chiral instabilities, linking numbers, and non-invertible symmetries

Thursday, November 30, 2023 2:30 PM (15 minutes)

We demonstrate a universal mechanism of a class of instabilities in infrared regions for massless Abelian p-form gauge theories with topological interactions, which we call generalized chiral instabilities. Such instabilities occur in the presence of initial electric fields for the p-form gauge fields. We show that the dynamically generated magnetic fields tend to decrease the initial electric fields and result in configurations with linking numbers, which can be characterized by non-invertible global symmetries. The so-called chiral plasma instability and instabilities of the axion electrodynamics and (4+1)-dimensional Maxwell-Chern-Simons theory in electric fields can be described by the generalized chiral instabilities in a unified manner. We also illustrate this mechanism in the (2+1)-dimensional Goldstone-Maxwell model in electric field.

Presenter: Dr YOKOKURA, Ryo (Keio University)

Session Classification: Parallel Session B

Contribution ID: **42** Type: **not specified**

Sequestered String Models imply Split Supersymmetry

Thursday, November 30, 2023 5:00 PM (15 minutes)

Sequestering is a promising mechanism in 4D string models to reconcile high scale inflation with low-energy supersymmetry. In this scenario the MSSM lives on branes at singularities and it is sequestered from the sources of supersymmetry breaking in the bulk. The soft-terms are suppressed with respect to the gravitino mass so that all moduli are heavy enough to avoid any cosmological moduli problem. In this talk, we focus on stability bounds and flavour constraints on sequestered string models, finding that they can be satisfied if the soft-terms give rise to a mass spectrum typical of split supersymmetry with TeV-scale gauginos and sfermions around 10^7 GeV. When instead scalar and gaugino masses are of the same order of magnitude, large flavour changing neutral currents can be avoided only by pushing the soft-terms above 10^6 GeV. However this scenario is in tension with stability bounds due to the presence of charge and colour breaking vacua which could be populated in the early universe, and the possible emergence of directions along which the potential is unbounded from below. Reference: 2309.05752 [hep-th]

Presenter: Dr OTSUKA, Hajime (Kyushu University)

Session Classification: Parallel Session A

Contribution ID: **43** Type: **not specified**

The effective potential for string backgrounds from string geometry theory

Thursday, November 30, 2023 3:00 PM (15 minutes)

String geometry theory is one of the candidates of the non-perturbative formulation of string theory. In this theory, strings constitute not only particles but also the space-time. In this talk, in string geometry theory, we identify perturbative vacua in string theory, which include general string backgrounds. From fluctuations around these vacua, we derive the path-integrals of perturbative strings on the string backgrounds up to any order. Furthermore, the identification of the perturbative vacua enables us to obtain differential equations that determine an effective potential for string backgrounds. We solve the differential equations and obtain an effective potential explicitly up to the second order. In a generic region, we show that the minimum of the second order potential gives a non-trivial background. This fact supports that the full effective potential can determine the true vacuum in string theory. The urgent problem is to find the global minimum and we introduce both analytical and numerical methods.

Presenter: Prof. SATO, Matsuo (Hirosaki University)

Session Classification: Parallel Session B

Contribution ID: **44** Type: **not specified**

On the classification of 6d supergravities

Thursday, November 30, 2023 4:00 PM (15 minutes)

Requiring the absence of gauge and gravitational anomalies places very strong constraints on six-dimensional chiral theories. For 6d supergravity with minimal supersymmetry there is a natural way to identify consistent theories with cliques in a certain multigraph which encodes the pair-wise compatibility of simple, irreducible theories. Leveraging ideas from graph theory, I will discuss the classification of these theories for any number of tensor multiplets and largely unconstrained semi-simple gauge group and hypermultiplet representations.

Presenter: Mr LOGES, Gregory (KEK)

Session Classification: Parallel Session A

Contribution ID: **45** Type: **not specified**

Black hole/string transition in the black hole evaporation

Thursday, November 30, 2023 4:15 PM (15 minutes)

In this talk, we discuss the black hole/string transition in the black hole evaporation. Susskind proposed that a black hole turns into a highly excited string as one adiabatically decreases the string coupling. Horowitz and Polchinski constructed a model of string bound state which describes the string phase of the black hole/string transition. In the previous work, we extended the Horowitz-Polchinski model by taking the non-linear effect of gravity and found that the black hole phase can also be desribed by the bound state of strings. At low temperatures, the string bound state approximately behaves as a black hole, but the geometry has no event horizon. In this study, we take the effect of the Hawking radiation and introduce the time evolution of the black hole. Our model describes the evaporation of black holes including the transition to strings in the final stages.

Presenter: Dr MATSUO, Yoshinori (Kindai University)

Session Classification: Parallel Session A

Contribution ID: **46** Type: **not specified**

UV Dispersive Effects on Hawking Radiation

Thursday, November 30, 2023 4:30 PM (15 minutes)

We revisit the connection between Hawking radiation and high-frequency dispersions for a Schwarzschild black hole following the work of Brout et al.. After confirming the robustness of Hawking radiation for monotonic dispersion relations, we consider non-monotonic dispersion relations that deviate from the standard relation only in the trans-Planckian domain. Contrary to the common belief that Hawking radiation is insensitive to UV physics, it turns out that Hawking radiation is subject to significant modifications after the scrambling time. Depending on the UV physics at the singularity, the amplitude of Hawking radiation could diminish after the scrambling time, while the Hawking temperature remains the same. Our finding is thus not contradictory to earlier works regarding the robustness of Hawking temperature.

Presenter: Mr WANG, Cheng-Tsung (National Taiwan University)

Session Classification: Parallel Session A

Contribution ID: **47** Type: **not specified**

Volume complexity of dS bubbles

Thursday, November 30, 2023 4:45 PM (15 minutes)

Holographic complexity is conjectured to probe the evolution of spacetime. For black holes in anti-de Sitter (AdS) spacetime the growth rate of complexity approaches a constant value at late times, while in de Sitter (dS) spacetime it diverges at a finite critical time. In this talk, we consider geometries interpolating between AdS and dS. In particular, we discuss the evolution of volume complexity in a class of three-dimensional asymptotically anti-de Sitter geometries including dynamical bubbles of de Sitter in their interior. According to the dynamics of the bubble, complexity qualitatively behaves either as in the AdS black hole or as in the dS case. We conclude with some remarks about the possible dual interpretation.

Presenter: Dr ZENONI, Nicolo (Osaka University)

Session Classification: Parallel Session A

Contribution ID: **48** Type: **not specified**

Renormalization group and quantum error correction

Thursday, November 30, 2023 3:15 PM (15 minutes)

It has been suggested that quantum error correction plays a significant role in the AdS/CFT correspondence. It has also been pointed out that a tensor network given by MERA can be viewed as bulk space emerging from a boundary theory through the structure of the renormalization group. Motivated by these insights, we demonstrate that the renormalization group serves as an approximate quantum error correction mechanism in scalar field theory, by considering scale dependence of vacuum wave functional and using coherent states.

Presenter: Mr NASU, Ryota (Shizuoka University)

Session Classification: Parallel Session B

Contribution ID: **49** Type: **not specified**

Analysis of entanglement entropy based on tensor renormalization group

Thursday, November 30, 2023 4:30 PM (15 minutes)

The tensor renormalization group (TRG) method was originally proposed in condensed matter physics and has recently been drawing attention in particle physics. We investigated the shape dependence of entanglement entropy in the two-dimensional Ising model using the TRG method and obtained the central charge of the theory from the scaling property of entanglement entropy. We also developed a brand new method to analyze the shape dependence of entanglement entropy within the TRG framework.

Presenter: Dr TANAKA, Gota (Doshisha University)

Session Classification: Parallel Session B

Contribution ID: **50** Type: **not specified**

Grassmann tensor network study of multi-flavor gauge theory

Thursday, November 30, 2023 4:15 PM (15 minutes)

Dealing with multiple flavors of Wilson fermions with Grassmann TRG is known to be difficult due to the exponential growth of the tensor size. Here, we propose a way to overcome this problem by separating the initial tensor into layers, each corresponding to different flavor. A compression scheme for the initial tensor is also proposed to further reduce the size. We test our method by studying the chiral phase transition. We also demonstrate the Silver Blaze phenomenon in Abelian gauge theory with up to 4 flavors, which is impossible with the Monte Carlo method due to the severe sign problem.

Presenter: Mr YOSPRAKOB, Atis (Niigata University)

Session Classification: Parallel Session B

Contribution ID: **51** Type: **not specified**

A recipe for a bulk construction from a scalar CFT by a conformal flow

Thursday, November 30, 2023 2:45 PM (15 minutes)

We summarize our recent attempt to construct a bulk spacetime from a scalar CFT such as an O(N) vector model by a conformal flow, which generates bulk fields from boundary scalar fields by smearing them. In this approach, bulk correlation functions are completely determined by the boundary theory, while bulk geometry is unspecified. We propose a method to determine the bulk geometry depending on a bulk state we consider, by employing the Bures information metric adopted for a specific state. We finally comment on necessities of both holography and large N limit for a geometric description of CFT.

Presenter: Prof. AOKI, Sinya (YITP, Kyoto University)

Session Classification: Parallel Session B

Contribution ID: **52** Type: **not specified**

Gradient Flow Exact Renormalisation Group for Scalar Quantum Electrodynamics

Wednesday, November 29, 2023 2:30 PM (15 minutes)

We apply the gradient flow exact renormalisation group (GFERG) for scalar quantum electrodynamics. The flow equations for the Wilsonian effective action is derived by means of perturbative expansion in the gauge coupling. In this work, we deal with quantum corrections to the correlation functions up to second order of the gauge coupling. We demonstrate especially that the GFERG formalism actually respects the gauge invariance in sense that the anomalous dimension of the gauge field agrees with the standard perturbative computation and the mass of the photon keeps vanishing in general spacetime dimensions. The latter is a noteworthy fact which contrasts with the conventional exact renormalisation group formalism in which an artificial photon mass proportional to a cutoff scale is induced. These results may therefore imply the ability of the GFERG formalism as a gauge-invariant renormalisation group flow.

Presenter: Dr HARUNA, Junichi (Osaka University)

Session Classification: Parallel Session A

Contribution ID: **53** Type: **not specified**

A mathematical formulation of index theorem on a lattice

Thursday, November 30, 2023 4:00 PM (15 minutes)

We propose a mathematical formulation of the Atiyah-Singer index on a lattice. Employing a one-parameter family of the massive Wilson Dirac operator, our lattice definition of the index does not rely on chiral symmetry or Ginsparg-Wilson relation. We give a mathematical proof that at fine but finite lattice spacing, our definition converges to the index in the continuum theory. This talk is based on a work in collaboration with S. Aoki, M. Furuta, S. Matsuo, T. Onogi, S. Yamaguchi and M. Yamashita.

Presenter: Dr FUKAYA, Hidenori (Osaka University)

Session Classification: Parallel Session B

Contribution ID: **54** Type: **not specified**

Complex Langevin Applied to Lattice QCD at High Density

The complex Langevin method is applied to the lattice QCD at high density. We propose a new method where a source term coupled with a diquark is introduced to investigate the color-superconductivity in the gauge invariant manner.

Presenter: Dr MIURA, Kohtaroh (KEK IPNS)

Session Classification: Parallel Session B

Contribution ID: **55** Type: **not specified**

Closing Session

Friday, December 1, 2023 11:30 AM (15 minutes)

Presenter: Prof. ISO, Satoshi (KEK)

Session Classification: Closing Address

Contribution ID: **56** Type: **not specified**

TBA

Wednesday, November 29, 2023 4:15 PM (15 minutes)

TBA

Presenter: Dr AKHOND, Mohammad (Kyoto University)

Session Classification: Parallel Session A

Contribution ID: **57** Type: **not specified**

TBA

Thursday, November 30, 2023 3:15 PM (15 minutes)

TBA

Presenter: Mrs TAKEUCHI, Maki (Kobe University)

Session Classification: Parallel Session A

Contribution ID: **58** Type: **not specified**

TBA

Thursday, November 30, 2023 5:00 PM (15 minutes)

TBA

Presenter: Mr ZHU, Mingshuo (Tokyo Institute of Technology)

Session Classification: Parallel Session B