KEK Theory workshop 2020

Report of Contributions

https://conference-indico.kek.jp/e/116

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

Non-abelian DBI Action on Magnetized Extra Dimensions

Wednesday, 16 December 2020 15:20 (20 minutes)

We study the D-branes on the magnetized extra dimensions and corrections of the flux to the effective theories. Specifically we focus on toroidal compactifications of non-abelian DBI action, and compute the flux corrections to the gauge couplings, the Kaehler metrics of charged matters and the scalar four-point couplings. In this talk, we would like to show the results of the dimensional reduction and discuss the D-term potential and whether the Kaehler metric can be read consistently with the D-tem potential. This talk is based on the work in progress with Tetsutaro Higaki, Tatsuo Kobayashi and Shintaro Takada.

Presenter: Mr ABE, Yoshihiko (Kyoto U.)

Session Classification: Short talks

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

Restoration of chiral symmetry in cold and dense Nambu — Jona-Lasinio model with tensor renormalization group

Wednesday, 16 December 2020 16:00 (20 minutes)

We analyze the chiral phase transition of the Nambu — Jona-Lasinio model in the cold and dense region on the lattice developing the Grassmann version of the anisotropic tensor renormalization group algorithm. The model is formulated with the Kogut — Susskind fermion action. We use the chiral condensate as an order parameter to investigate the restoration of the chiral symmetry. The first-order chiral phase transition is clearly observed in the dense region at vanishing temperature with $\mu/T \sim O(10^3)$ on a large volume of $V = 1024^4$. We also present the results for the equation of state.

Presenter: Mr AKIYAMA, Shinichiro (U. of Tsukuba)

Session Classification: Short talks

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

Thermodynamics of TT-bar deformed O(N) vector model

Wednesday, 16 December 2020 16:00 (20 minutes)

We investigate an irrelevant deformation of 2D quantum field theories, called “TT-bar deformation”. Although this is known as an integrable deformation, its quantum aspects have not been completely understood yet. For example, TT-bar deformation of the free massless O(N) vector model is said to be Nambu-Goto action in the static gauge. In this talk, we compute the thermal free energies in both theories, and discuss the equivalence between TT-bar deformed O(N) vector model and Nambu-Goto action at quantum level.

Presenter: Mr HARUNA, Junichi (Kyoto U.)

Session Classification: Short talks

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

The effects of fermions in the complex Langevin simulation of the Lorentzian type IIB matrix model

Thursday, 17 December 2020 15:40 (20 minutes)

The type IIB matrix model was proposed as a nonperturbative formulation of superstring theory. In particular, interesting results such as the emergence of (3+1)D exponentially expanding space-time have been obtained from the Lorentzian version of the model. Recently the complex Langevin simulation of the bosonic model has been performed to avoid the previously used approximation in overcoming the sign problem. In this talk, we include the effects of fermions in this simulation to discuss their impact on the (3+1)D space-time structure.

Presenter: Dr HATAKEYAMA, Kohta (KEK)

Session Classification: Short talks

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

Complex poles of QCD propagators and their interpretation

Wednesday, 16 December 2020 16:20 (20 minutes)

We consider the analytic structures of the gluon, quark, and ghost propagators in the Landau-gauge QCD and their implications. We first investigate the analytic structure of the QCD propagators using the massive Yang-Mills model, an effective model of the Landau-gauge Yang-Mills theory. It turns out that the gluon and quark propagators in this model have complex poles that invalidate the usual spectral representation. We then discuss formal aspects of complex singularities of propagators, especially on the reflection positivity and locality, and consider their implications on a possible quantum mechanical interpretation and confinement mechanism.

Presenter: Ms HAYASHI, Yui (Chiba U.)

Session Classification: Short talks

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

Implications of the weak gravity conjecture in anomalous quiver gauge theories

Thursday, 17 December 2020 15:20 (20 minutes)

We argue a smallness of gauge couplings in abelian quiver gauge theories, taking the anomaly cancellation condition into account. In theories of our interest there exist chiral fermions leading to chiral gauge anomalies, and an anomaly-free gauge coupling tends to be small, and hence can give a non trivial condition of the weak gravity conjecture. As concrete examples, we consider U(1)^{k} gauge theories with a discrete symmetry associated with cyclic permutations between the gauge groups, and identify anomaly-free U(1) gauge symmetries and the corresponding gauge couplings. Owing to this discrete symmetry, we can systematically study the models and we find that the models would be examples of the weak coupling conjecture. It is conjectured that a certain class of chiral gauge theories with too many U(1) symmetries may be in the swampland. We also numerically study constraints on the couplings from the scalar weak gravity conjecture in a concrete model. These constraints may have a phenomenological implication to model building of a chiral hidden sector as well as the visible sector.

Presenter: Dr HIGAKI, Tetsutaro (Keio U.)

Session Classification: Short talks

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

Space-time structure in the Lorentzian type IIB matrix model in the large-N limit

Wednesday, 16 December 2020 17:40 (20 minutes)

The Lorentzian type IIB matrix model is a promising candidate for a non-perturbative formulation of superstring theory. In the previous work, Monte Carlo calculations provided interesting results indicating the spontaneous breaking of SO(9) to SO(3) and the emergence of (3+1)-dimensional space-time. There, an approximation was used to avoid the sign problem, however. In this talk, we report our results obtained by using the complex Langevin method to overcome the sign problem instead of using the approximation. In particular, we discuss the space-time structure in the large-N limit based on our results obtained for the bosonic model at large matrix size.

Presenter: Mr HIRASAWA, Mitsuaki (SOKENDAI)

Session Classification: Short talks

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

Classical Statistical simulation of Quantum Field Theory

Thursday, 17 December 2020 17:00 (20 minutes)

We study a classical theory which contains a Gaussian noise as a source. This source is responsible for the creation and annihilation of particle from the vacuum and the energy of the resultant configuration is same as the zero point energy of quantum field theory. We show that after taking the average over the samples, the perturbative expansion of the expectation value, n-point function, can be expressed by the tree and loop Feynman graphs which are exactly same as those in the corresponding quantum field theory. We comment on the similarity and difference to the stochastic quantization.

Presenter: Prof. HIRAYAMA, Takayuki (Chubu U.)

Session Classification: Short talks

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

Momentum-space entanglement in scalar field theory on the fuzzy sphere

Wednesday, 16 December 2020 14:20 (20 minutes)

In this talk, I will study the quantum entanglement in the momentum space for scalar field theory on a fuzzy sphere. In an interacting quantum field theory, the degrees of freedom in momentum space show entanglement; it quantifies the correlation between the high/low momentum modes. On a fuzzy sphere, an example of noncommutative space, it is known that the UV and IR degrees of freedom show a characteristic correlation known as UV/IR mixing. I thus study the entanglement entropy in the momentum space for quantum field theory defined on the fuzzy sphere and examine the difference from the theory on the ordinary sphere.

Presenter: Dr KAWAMOTO, Shoichi (NTHU)

Session Classification: Short talks

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

Can QCD Axion explain the CMB anisotropy?

Thursday, 17 December 2020 16:00 (20 minutes)

In this talk, I discuss a possibility that the CMB anisotropy is dominantly generated by the primordial fluctuations of QCD axion under a circumstance that usual fluctuations by inflaton is too small to explain the anisotropy. The following conditions must be satisfied in this scenario: (i) sufficient amplitudes of the CMB anisotropy (ii) isocurvature constraint and (iii) non Gaussianity constraint. By carefully studying those conditions, I show that a large energy fraction Ω_A of the axion is necessary at the QCD phase transition, but simultaneously, it must become tiny at the present era due to the isocurvature constraint.

Presenter: Dr KAWANA, Kiyoharu (SNU)

Session Classification: Short talks

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

JT gravity and the asymptotic Weil-Petersson volume

Thursday, 17 December 2020 14:00 (20 minutes)

A path integral in Jackiw-Teitelboim gravity is given by integrating over the volume of the moduli of Riemann surfaces with boundaries, known as the "Weil-Petersson volume," together with integrals over wiggles along the boundaries. The exact computation of the Weil-Petersson volume is difficult when the genus g of Riemann surface becomes large. Utilizing two partial differential equations known to hold on the Weil-Petersson volumes, we estimate asymptotic behaviors of the volumes with two and three boundaries when the genus g is large. We also present a conjecture on the asymptotic expression for the general volume with any number of boundaries when the genus g is large.

Presenter: Dr KIMURA, Yusuke (KEK)

Session Classification: Short talks

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

Curvature perturbation and Anomaly explains dark energy

Thursday, 17 December 2020 16:20 (20 minutes)

We investigate the history of dark energy to explain the present magnitude. We assume the dark energy is the residual cosmological constant. The most important channel in the reheating process is the gluon pair productions by QCD trace anomaly. We argue dark energy decays rapidly by gluon pair emissions during the reheating and after the big bang. The reheating temperature is determined by the decay width of dark energy Γ. It is low as $\sqrt{M_P\Gamma} \sim 10^6$ GeV. It is the consequence of Friedmann's equation and an equilibrium condition $\Gamma \sim H$. As the Universe cools below the hadronic scale, dark energy density is almost frozen. The density of dark energy further decreases by emitting two photons. We have pinned down the current magnitude of dark energy from Friedmann equation and the QED trace anomaly in an excellent agreement with the observations.

Presenter: Prof. KITAZAWA, Yoshihisa (KEK)

Session Classification: Short talks

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

Catalytic Creation of Bubble Universe Induced by Quintessence in Five Dimensions

Wednesday, 16 December 2020 15:40 (20 minutes)

We investigate the bubble nucleation in five dimensional spacetime catalyzed by quintessence. We especially focus on decay of a metastable Minkowski vacuum to an anti-de Sitter vacuum and study dynamics of the bubble on which four dimensional expanding universe is realized. We also discuss the trans-Planckian censorship conjecture and impose a constraint on the parameter space of the catalysis. As an application of this model, we propose an inflation mechanism and an origin of the dark energy in the context of quintessence in five dimensions.

Presenter: Mr KOGA, Issei (Kyushu U.)

Session Classification: Short talks

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

Non-perturbative Tests of Duality Cascades in Three Dimensional Supersymmetric Gauge Theories

Wednesday, 16 December 2020 17:20 (20 minutes)

It has been conjectured that duality cascade occurs in the N = 3 supersymmetric Yang-Mills Chern-Simons theory with the gauge group U(N)*U(N +M) coupled to two bi-fundamental hypermultiplets. The brane picture suggests that this duality cascade can be generalized to a class of 3d N = 3 supersymmetric quiver gauge theories coming from so-called Hanany-Witten type brane configurations. In this paper we perform non-perturbative tests of the duality cascades using supersymmetry localization. We focus on S^3 partition functions and prove predictions from the duality cascades.

Presenter: Mr KUBO, Naotaka (YITP)

Session Classification: Short talks

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

Wavefunctions in dS/CFT revisited: principal series and double-trace deformations

Wednesday, 16 December 2020 16:20 (20 minutes)

We study wavefunctions of heavy scalars on de Sitter spacetime and their implications to dS/CFT correspondence. In contrast to light fields in the complementary series, heavy fields in the principal series oscillate outside the cosmological horizon. As a consequence, the quadratic term in the wavefunction does not follow a simple scaling and so it is hard to identify it with a conformal two-point function. In this paper, we demonstrate that it should be interpreted as a two-point function on a cyclic RG flow which is obtained by double-trace deformations of the dual CFT. This is analogous to the situation in nonrelativistic AdS/CFT with a bulk scalar whose mass squared is below the Breitenlohner-Freedman (BF) bound. We also provide a new dS/CFT dictionary relating de Sitter two-point functions and conformal two-point functions in the would-be dual CFT.

Presenter: Ms LIU, Hoiki (U. of Tokyo)

Session Classification: Short talks

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

A physicist-friendly reformulation of the mod-two Atiyah-Patodi-Singer index

Tuesday, 15 December 2020 16:25 (20 minutes)

Gauge anomaly in 4-dimensions can be viewed as a current inflow into an extra-dimension, where the total phase of the fermion partition function is given in a gauge invariant way by the Atiyah-Patodi-Singer(APS) eta-invariant of a 5-dimensional Dirac operator. However, this formalism requires a non-local boundary condition, which makes the physical roles of edge/bulk modes unclear and the causality of the total theory doubtful. In this talk, we consider a special case where the Dirac operator is in a real representation and its eta invariant becomes the mod-two type APS index. We propose a physicist-friendly reformulation of the mod-two index using domain-wall fermion formalism, which naturally describes how the global anomaly is canceled between edge and bulk.

Presenter: Mr MATSUKI, Yoshiyuki (Osaka U.)

Session Classification: Short talks

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

Islands in Schwarzschild black holes

Friday, 18 December 2020 17:00 (20 minutes)

We study the Page curve for asymptotically flat eternal Schwarzschild black holes in four (or higher) spacetime dimensions. Before the Page time, the entanglement entropy grows linearly in time. After the Page time, the entanglement entropy of a given region outside the black hole is largely modified by the emergence of an island, which extends to the outer vicinity of the event horizon. As a result, it remains a constant value which reproduces the Bekenstein-Hawking entropy, consistent with the finiteness of the von Neumann entropy for an eternal black hole.

Presenter: Dr MATSUO, Yoshinori (Osaka U.)

Session Classification: Short talks

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

Current Driven Tricritical Point in Large- Nc Gauge Theory

Thursday, 17 December 2020 14:40 (20 minutes)

We discover a new tricritical point realized only in nonequilibrium steady states, using the AdS/CFT correspondence. Our system is a (3+1)-dimensional strongly coupled large-Nc gauge theory. The tricritical point is associated with a chiral symmetry breaking under the presence of an electric current and a magnetic field. The critical exponents agree with those of the Landau theory of equilibrium phase transitions. This suggests that the presence of a Landau-like phenomenological theory behind our nonequilibrium phase transitions.

Presenter: Prof. NAKAMURA, Shin (Chuo U.)

Session Classification: Short talks

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

Pole-skipping of scalar and vector fields in hyperbolic space

Thursday, 17 December 2020 14:20 (20 minutes)

Motivated by the recent connection between pole-skipping phenomena of two point functions and four point out-of-time-order correlators (OTOCs), we study the pole structure of thermal two-point functions in d-dimensional conformal field theories (CFTs) in hyperbolic space. We derive the pole-skipping points of two-point functions of scalar and vector fields by three methods (one field theoretic and two holographic methods) and confirm that they agree. We show that the leading pole-skipping point of two point functions is related with the late time behavior of conformal blocks and shadow conformal blocks in four-point OTOCs.

Presenter: Dr NISHIDA, Mitsuhiro (Gwangju Inst. of Sci. and Tech.)

Session Classification: Short talks

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

Topological term, QCD anomaly, and the η' chiral soliton lattice in rotating baryonic matter

Tuesday, 15 December 2020 16:05 (20 minutes)

We study the ground states of low-density hadronic matter and high-density color-flavor locked color superconducting phase in three-flavor QCD at finite baryon chemical potential under rotation. We find that, in both cases under sufficiently fast rotation, the combination of the rotation-induced topological term for the η' meson and the QCD anomaly leads to an inhomogeneous condensate of the η' meson, known as the chiral soliton lattice (CSL). We find that, when baryon chemical potential is much larger than isospin chemical potential, the critical angular velocity for the realization of the η' CSL is much smaller than that for the π_0 CSL found previously. We also argue that the η' CSL states in flavor-symmetric QCD at low density and high density should be continuously connected, extending the quark-hadron continuity conjecture in the presence of the rotation.

Presenter: Mr NISHIMURA, Kentaro (Keio U.)

Session Classification: Short talks

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

Wilson-'t Hooft lines as transfer matrices

Wednesday, 16 December 2020 17:00 (20 minutes)

We establish a correspondence between a class of Wilson-'t Hooft lines in four-dimensional N=2 supersymmetric gauge theories described by circular quivers and transfer matrices constructed from dynamical L-operators for trigonometric quantum integrable systems. We compute the vacuum expectation values of the Wilson-'t Hooft lines in a twisted product space S^1xR^3 by supersymmetric localization and show that they are equal to the Wigner transforms of the transfer matrices. A variant of the AGT correspondence implies an identification of the transfer matrices with Verlinde operators in Toda theory, which we also verify. We explain how these field theory setups are related to four-dimensional Chern–Simons theory via embedding into string theory and dualities.

Presenter: Mr OTA, Toshihiro (Osaka U.)

Session Classification: Short talks

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

Entanglement entropy in interacting field theories

Wednesday, 16 December 2020 14:00 (20 minutes)

Entanglement entropy (EE) is a useful quantity to measure quantum correlation between separated systems. There has been accumulating progress in the analysis on it, especially in the case of free theories and CFTs. On the other hand, we have relatively little understanding on EE in general interacting field theories. In this work, we propose a general method for calculating such EE by combining 2PI formalism and orbifold method, the latter of which is some variation of replica method. We show that we can write down the EE in terms of exact propagator, which suggest the method is applicable to theories with large radiative correction in the 2-point function.

Presenter: Dr SAKAI, Katsuta (KEK)

Session Classification: Short talks

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

Relativistic fluid dynamics for spin polarization.

Thursday, 17 December 2020 17:20 (20 minutes)

Measurements made recently by the STAR collaboration show that the Lambda hyperons produced in relativistic heavy-ion collisions are subject to global spin polarization with respect to an axis coincident with the axis of rotation of the produced matter. Recently formulated formalism of relativistic hydrodynamics with spin, which is a generalization of the standard hydrodynamics, is a natural tool for describing the evolution of such systems. This approach is based on the conservation laws and the form of the energy-momentum tensor and spin tensor postulated by de Groot, van Leeuwen, and van Weert (GLW). Using Bjorken symmetry we show how this formalism may be used to determine observables describing the polarization of particles measured in the experiment.

Presenter: Mr SINGH, Rajeev (Inst. of Nucl. Phys. Polish Academy of Sciences)

Session Classification: Short talks

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

Topological color-superconductivity in QCD with one flavor

Tuesday, 15 December 2020 15:45 (20 minutes)

Superconductive gaps have topologically protected nodes if the fermions form the inter-chiral Cooper pair [1]. We generalize this Li and Haldane's argument to the color superconductivity in QCD with one flavor. Among several order parameters with different spins and colors, we find that the nodes in the phases with a simple color-spin structure have the vortices characterized by the Berry monopole. On the other hand, the paring function has no nodes if the color and spin degrees of freedom are entangled, such as in the so-called color-spin locking phase. Even in this case, we find a non-trivial Berry curvature defined by the gap eigenvectors in the color-spin space. We argue that the topological phase transition should occur between the trivial low-density hadronic matter and the non-trivial high-density quark matter with well-defined chirality. Our preliminary results suggest the breakdown of the quark-hadron continuity scenario in QCD with one flavor studied earlier by T. Schäfer [2]. [1] Yi Li and F. D. M. Haldane, "Topological nodal Cooper pairing in doped Weyl metals," Phys. Rev. Lett. 120, 067003 (2018). [2] T. Schäfer, "Quark hadron continuity in QCD with one flavor," Phys. Rev. D 62, 094007 (2000).

Presenter: Dr SOGABE, Noriyuki (KEK and Institute of Modern Physics)

Session Classification: Short talks

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

Topological Vertex/anti-Vertex and Supergroup Gauge Theory

Wednesday, 16 December 2020 14:40 (20 minutes)

We propose a new vertex formalism, called anti-refined topological vertex (anti-vertex for short), to compute the generalized topological string amplitude, which gives rise to the supergroup gauge theory partition function. We show the one-to-many correspondence between the gauge theory and the Calabi–Yau geometry, which is peculiar to the supergroup theory, and the relation between the ordinary vertex formalism and the vertex/anti-vertex formalism through the analytic continuation.

Presenter: Dr SUGIMOTO, Yuji (U. of Sci. and Tech. of China)

Session Classification: Short talks

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

KdV-charged black holes

Friday, 18 December 2020 17:40 (20 minutes)

We construct black hole geometries in 3d AdS with non-trivial values of KdV charges. The black holes are saddle points of the free energy that is holographically dual to that of the generalized Gibbs ensemble containing the chemical potentials of quantum KdV charges in 2d CFT. The introduction of the chemical potentials means the deformation of the boundary Hamiltonian which results in the changes of the boundary conditions in the gravity side. We show that new geometries, not the conventional BTZ ones, can be the leading saddles for a certain value of chemical potentials.

Presenter: Dr SUGISHITA, Sotaro (KEK)

Session Classification: Short talks

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

Instatons and Berry's connections on quantum graph

Wednesday, 16 December 2020 15:20 (20 minutes)

We discuss topological properties of boundary conditions on a quantum graph from the viewpoint of the Berry's connections. The quantum graph is known as a quantum mechanical system on a one dimensional graph which consists of edges and vertices connected with each other, and boundary conditions are imposed on each vertex. This graph is applied to the various research areas, e.g., scattering theory, nanotechnology, and also an extra dimensional model which can qualitatively explain the fermion generations, mass hierarchy, CP phase in the standard model, and the boundary conditions play important roles in each case. In this talk, we will reveal the structure of the boundary conditions and show that configuration of the instantons appear as the Berry's connections on a parameter space of them.

Presenter: Mr UEBA, Inori (Kobe U.)

Session Classification: Short talks

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

Partial Deconfinement at Strong Coupling on the Lattice

Wednesday, 16 December 2020 17:20 (20 minutes)

Partial deconfinement is proposed in the context of the deconfinement transition for the large N gauge theories, as the coexisting phenomenon of the confined and deconfined sectors in the space of color degrees of freedom. It is well-established analytically for weakly-coupled theories, while it remains unclear whether the above picture is valid at strong coupling. We provide some evidence for the above situation using lattice Monte Carlo simulations of two bosonic matrix models.

Presenter: Mr WATANABE, Hiromasa (U. of Tsukuba)

Session Classification: Short talks

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

Holographic Moving Mirror and Page Curve

Friday, 18 December 2020 17:20 (20 minutes)

In this talk, we discuss moving mirror setups in CFT and their gravity duals. We derive the page curve from gravity duals. An intriguing relation between moving mirror in CFT and Hawking radiation from a black hole will be discussed using double holography explored in our previous work 2007.06800. This work is based on the collaborations with Ibrahim Akal, Yuya Kusuki, Noburo Shiba and Tadashi Takayanagi. This talk is based on arXiv:2007.06800 and a work in preparation.

Presenter: Mr WEI, Zixia (YITP)

Session Classification: Short talks

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

Complex Langevin analysis of four-dimensional SU(2) gauge theory with a theta term

Wednesday, 16 December 2020 17:00 (20 minutes)

Gauge theory with a theta term has recently been of great interest, especially at $\theta = \pi$, where nontrivial phase structure is expected from the ‘t Hooft anomaly matching condition. However, it is difficult to study the theory numerically due to the severe sign problem. We try to overcome this by using the complex Langevin method. In our previous work, we apply the technique to the 2d U(1) gauge theory. We were able to reproduce the exact result by introducing a puncture on the torus. We also show that the effect of the puncture disappears in the infinite volume limit in the region $|\theta| < \pi$. In this study, we attempt to apply the method in the 4d SU(2) gauge theory and present some preliminary results.

Presenter: Mr YOSPRAKOB, Atis (SOKENDAI)

Session Classification: Short talks

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

Equivalence Principle, Decoupling Principle, and Information Loss Paradox

Friday, 18 December 2020 09:00 (1 hour)

We review the origin and basics of the black-hole information loss paradox, and comment on some of its potential resolutions.

Presenter: Prof. HO, Pei-Ming (NTU)

Session Classification: Invited talks

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

Black hole as a quantum field configuration

Friday, 18 December 2020 10:30 (1 hour)

In quantum theory, black holes evaporate. We adopt this property as the 0th approximation and provide a field-theoretic description of black holes. To do that, we analyze time evolution of a spherical collapsing matter together with the back reaction of (pre)Hawking radiation by solving the semi-classical Einstein eq coupled with N massless scalar quantum fields. We find a 4D self-consistent non-perturbative solution w.r.t. $\hbar$. It describes the most part of the black hole in the semi-classical level while it connects the semi-classical region to the quantum gravity region smoothly. [arxiv:2002.10331]

Presenter: Dr YOKOKURA, Yuki (iTHEMS, RIKEN)

Session Classification: Invited talks

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

Entanglement between two disjoint universes

Friday, 18 December 2020 14:00 (1 hour)

We use the replica method to compute the entanglement entropy of a universe without gravity entangled in a thermofield-double-like state with a disjoint gravitating universe. Including wormholes between replicas of the latter gives an entropy functional which includes an "island" on the gravitating universe. We solve the back-reaction equations when the cosmological constant is negative to show that this island coincides with a causal shadow region that is created by the entanglement in the gravitating geometry. At high entanglement temperatures, the island contribution to the entropy functional leads to a bound on entanglement entropy, analogous to the Page behavior of evaporating black holes. We also apply the formalism to black holes in de Sitter space, and find similar islands.

Presenter: Dr UGAJIN, Tomonori (YITP)

Session Classification: Invited talks

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

Universes as Bigdata: from Geometry, to Physics, to Machine-Learning

Thursday, 17 December 2020 09:00 (1 hour)

We briefly overview how historically string theory led theoretical physics first to algebraic/differential geometry, and then to computational geometry, and now to data science.
Using the Calabi-Yau landscape - accumulated by the collaboration of physicists, mathematicians and computer scientists over the last 4 decades - as a starting-point and concrete playground, we then launch to review our recent programme in machine-learning mathematical structures and address the tantalizing question of how AI helps doing mathematics, ranging from geometry, to representation theory, to combinatorics, to number theory.

Presenter: Prof. HE, Yang-Hui (Merton Coll., U. of Oxford)

Session Classification: Invited talks

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

The Topology of Data: from String Theory to Cosmology to Phases of Matter

Thursday, 17 December 2020 10:15 (1 hour)

We are faced with an explosion of data in many areas of physics, but very so often, it is not the size but the complexity of the data that makes extracting physics from big datasets challenging. As I will discuss in this talk, data has shape and the shape of data encodes the underlying physics. Persistent homology is a tool in computational topology developed for quantifying the shape of data. I will discuss three applications of topological data analysis: 1) identifying structure of the string landscape, 2) constraining primordial non-Gaussianity from CMB measurements and large scale structures data, and 3) detecting and classifying phases of matter. Persistent homology condenses these datasets into their most relevant (and interpretable) features, so that simple statistical pipelines are sufficient in these contexts. This suggests that TDA can be used in conjunction with machine learning algorithms and improves their architecture.
Based on https://arxiv.org/abs/2009.14231, https://arxiv.org/abs/2009.04819, https://arxiv.org/abs/1907.10072, https://arxiv.org/abs/1812.06960, https://arxiv.org/abs/1712.08159.

Presenter: Prof. SHIU, Gary (U. of Wisconsin-Madison)

Session Classification: Invited talks

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

Hidden structures in the landscape of heterotic line bundle models

Thursday, 17 December 2020 11:30 (45 minutes)

We show that neural networks can detect hidden structures in the string landscape, in particular, heterotic string theory on Calabi-Yau threefolds with line bundles. It turns out that three-generation models cluster in particular islands specified by deep autoencoder networks and k-means++ clustering.
Especially, we explore mutual relations between model parameters and the cluster with densest three-generation models (called "3-generation island"). We find that the 3-generation island has a strong correlation with the topological data of Calabi-Yau threefolds, namely, second Chern class of the tangent bundle of the Calabi-Yau threefolds.
Reference: arXiv:2003.11880 [hep-th]

Presenter: Dr OTSUKA, Hajime (KEK)

Session Classification: Invited talks

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

Dense QCD matter tackled by experiments, observations, and theory

Wednesday, 16 December 2020 09:00 (1 hour)

Dense QCD matter appears in compact astrophysical phenomena and heavy-ion collisions. Phenomenological EOS (equation of state) needs extrapolation or interpolation and has large uncertainty. Thus we need first-principles or model-independent theoretical studies, or experiments where dense QCD matter is directly probed. In this talk, I first review physics of finite density QCD from the viewpoints of experiments, astronomical observations, and phenomenology. Next I will discuss several theoretical developments in approaches toward solving the sign problem, topological order arguments, and transport model approaches, which may reduce the EOS uncertainty and elucidate the neutron star interior.

Presenter: Prof. OHNISHI, Akira (YITP)

Session Classification: Invited talks

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

Exploring the QCD phase diagram with holographic models

Wednesday, 16 December 2020 10:20 (40 minutes)

In this talk, I will explain the recent progress of understanding the QCD phase diagram based on the holographic models. Particularly, this talk concentrates on the treatment of the color superconductivity and the application of the imaginary chemical potential in the bottom-up approach. In addition, I will explain what interesting phenomena will be discussed via the bottom-up holographic models.

Presenter: Prof. KASHIWA, Kouji (Fukuoka Inst. of Tech.)

Session Classification: Invited talks

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

Color superconductivity in lattice QCD

Wednesday, 16 December 2020 11:20 (40 minutes)

Exploring the QCD phase diagram is known to be extremely difficult at finite density due to the sign problem, which occurs in lattice QCD calculations. We show that this problem can be overcome by the complex Langevin method in a certain parameter region at low temperature and high density. This, in particular, gives us a hope to investigate color superconductivity in lattice QCD by first principle calculations. I will discuss the existence of a new phase with a quark-quark condensate based on the gap equation in the perturbative regime, and show some results of the complex Langevin method, which turn out to be consistent with this prediction.

Presenter: Prof. NISHIMURA, Jun (KEK)

Session Classification: Invited talks

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

Introduction to higher form symmetries

Tuesday, 15 December 2020 09:05 (1h 30m)

I will review a basic notion of higher form symmetries, which are symmetries for extended objects such as vortices, and domain walls. As an application, we discuss spontaneous symmetry breaking of higher form symmetries, topological order, and symmetry-protected topological phases of matter.

Presenter: Prof. HIDAKA, Yoshimasa (KEK)

Session Classification: Invited talks

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

Symmetry protected topological phases and generalized (co)homology theory

Tuesday, 15 December 2020 10:50 (1h 30m)

It is discussed that the symmetry protected topological phase (SPT phase) is well described by generalized cohomology theory. Identifying the classification of SPT phases on a real-space manifold X as a homology group on X offers a unified understanding of SPT phenomena through the axioms and general properties of the generalized (co)homology. In this talk, I will give a brief review of how the mathematical structure of generalized (co)homology theory can help us to consider SPT phases and quantum anomalies.

Presenter: Prof. SHIOZAKI, Ken (YITP)

Session Classification: Invited talks

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

Higher-form symmetries and 3-group in axion electrodynamics

Tuesday, 15 December 2020 14:30 (1 hour)

We study higher-form symmetries in a low-energy effective theory of a massless axion coupled with a photon in $(3+1)$ dimensions. It is shown that the higher-form symmetries of this system are accompanied by a semistrict 3-group (2-crossed module) structure, which can be found by the correlation functions of symmetry generators of the higher-form symmetries. We argue that the Witten effect and anomalous Hall effect in the axion electrodynamics can be described in terms of 3-group transformations.

Presenter: Dr YOKOKURA, Ryo (KEK)

Session Classification: Invited talks

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

Higher groups and topological phases of matter

Tuesday, 15 December 2020 17:00 (30 minutes)

I will describe how symmetry structures appearing in quantum many-body systems can be understood within the framework of fusion categories. Quantum systems with "higher symmetry" structures naturally appear by generalising or weakening certain axioms of these fusion categories. I will touch upon various topological aspects of higher group symmetries such as symmetry protected topological phases, anomalies and topological gauge theories.

Presenter: Dr TIWARI, Apoorv (U. of Zurich)

Session Classification: Invited talks

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

Superconformal index of the 6d (2,0) theory via the AdS/CFT correspondence

Wednesday, 16 December 2020 17:40 (20 minutes)

We study the superconformal index of the 6d (2,0) theory by using the AdS/CFT correspondence. It is well known that on the gravity side at the large N limit, the index can be calculated from the contribution of the Kaluza Klein modes. For the AdS_5/CFT_4 cases, recent works show that in addition to Kaluza Klein modes, D3-branes wrapped on the compact space contribute to the index at the finite N region. In this talk we apply this method to M-theory on AdS_7×S^4 and propose the superconformal index of the 6d (2,0) theory. Namely, we calculate the index of the 6d (2,0) theory from dual gravity side at finite N by considering the M2-branes wrapped on compact space S^4. We also discuss the validity of the results obtained from our proposing formula.

Presenter: Mr FUJIWARA, Shota (Tokyo Inst. of Tech.)

Session Classification: Short talks

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

Applications of the twisted boson theory and linear response theory to XXZ chain

Thursday, 17 December 2020 17:40 (20 minutes)

In this talk, I introduce two different approaches to treat the XXZ Heisenberg chain with twisted boundary conditions. One is the linear response theory, which treats the twists as a perturbation. The other is the twisted boson theory, which treats irrelevant terms as a perturbation after considering the effects of the twists. Surprisingly, these two formalisms cannot make the same results. We reveal the reason for this mismatch and demonstrate related problems which are significant when considering fundamental aspects of equilibrium and nonequilibrium physics.

Presenter: Dr FUKUSUMI, Yoshiki (Zagreb U.)

Session Classification: Short talks

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

Non-simply laced Lie groups and half-hypermultiplets in F-theory

Wednesday, 16 December 2020 15:40 (20 minutes)

In six-dimensional F-theory/Heterotic string theory, half-hypermultiplets arise only when they correspond to particular quaternionic Kähler symmetric spaces, which are mostly associated with the Freudenthal-Tits magic square. Motivated by the intriguing singularity structure previously found in such F-theory models with a gauge group SU(6), SO(12) or E_7, we investigate, as the final magical example, an F-theory on an elliptic fibration over a Hirzebruch surface of the non-split I_6 type, in which the unbroken gauge symmetry is supposed to be Sp(3). Rather unexpectedly, we find significant qualitative differences between the previous F-theory models associated with the magic square and the present case.

Presenter: Mr KURAMOCHI, Rinto (SOKENDAI)

Session Classification: Short talks

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

Opening address

Tuesday, 15 December 2020 09:00 (5 minutes)

Presenter: Prof. NISHIMURA, Jun (KEK)

Session Classification: Opening address

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

Closing address

Friday, 18 December 2020 18:00 (5 minutes)

Presenter: Dr SUYAMA, Takao (KEK)

Session Classification: Closing address

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

What microstate geometries tell us

Friday, 18 December 2020 15:30 (1 hour)

Microstate geometries are smooth horizonless geometries that have the same mass and charge as a black hole. In this talk, I will review the current status of the research in microstate geometries, such as their construction, counting and lifting, and discuss their physical implications, such as evolution toward more typical microstates.

Presenter: Prof. SHIGEMORI, Masaki (Nagoya U. & YITP)

Session Classification: Invited talks