KEK Theory Workshop 2021

Report of Contributions

https://conference-indico.kek.jp/e/144

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

Perturbative S-matrix unitarity $(S^\dagger S = 1)$ in R^2 gravity

Tuesday, 7 December 2021 16:20 (20 minutes)

We investigate the relation perturbative unitarity and renormalizablility in quantum gravity. In particle theories point of view, Llewellyn Smith conjectured that renormalizablility and tree-unitarity at high energy give the same conditions for theories. If we apply this conjecture to gravity theory, it is shown that Einstein gravity is not renormalizable and does not hold perturbative unitarity at high energy. One candidate of quantum gravity, the quadratic gravity ($R^2_{\mu\nu}$ gravity or higher derivative gravity), is a renormalizable theory, but it contains negative norm states and hence does not satisfy tree-unitarity. This gives that the quadratic gravity is one of a counterexample of Llewellyn Smith's conjecture. In this talk, I introduce that Llewellyn Smith's conjecture and our contribution. Especially, we show that in a higher derivative theory, the unitarity bound at tree level (tree unitarity) is violated but S-matrix unitarity ($S^\dagger S = 1$ or often called pseudo-unitarity) is satisfied. The point is our new conjecture that renormalizablility and S-matrix unitarity at high energy give the same conditions for theories.

Presenter: Dr ABE, Yugo (Miyakonojo KOSEN)

Session Classification: Short talk

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

Chiral fermion on curved domain-wall

Thursday, 9 December 2021 14:20 (20 minutes)

We consider a massive fermion system having a curved domain-wall embedded in a square lattice. As already reported in condensed matter physics, the massless chiral edge modes appearing at the domain-wall feel “gravity”through the induced spin connections. In this work, we embed S^1 and S^2 domain-wall into a Euclidean space and show how the gravity is detected from the spectrum of the Dirac operator.

Presenter: Mr AOKI, Shoto (Osaka University)

Session Classification: Short talk

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

What is chiral susceptibility probing?

Thursday, 9 December 2021 14:00 (20 minutes)

In the early days of QCD, the axial U(1) anomaly was considered to trigger the breaking of the SU(2)_L ×SU(2)_R symmetry through topological excitations of gluon fields. However, it has been a challenge for lattice QCD to quantify the effect. In this work, we simulate QCD at high temperatures with the overlap Dirac operator. The exact chiral symmetry enables us to separate the contribution from the axial U(1) breaking from others among the susceptibilities in the scalar and pseudoscalar channels. Our result in two-flavor QCD indicates that the chiral susceptibility, which is conventionally used as a probe for SU(2)_L×SU(2)_R breaking, is actually dominated by the axial U(1) anomaly at temperatures T ≥ 165 MeV.

Presenter: Prof. FUKAYA, Hidenori (Osaka University)

Session Classification: Short talk

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

Color confinement due to restoration of the residual local gauge symmetry

Thursday, 9 December 2021 16:00 (20 minutes)

All colored particles including dynamical quarks and gluons are confined if the color confinement criterion proposed by Kugo and Ojima is satisfied. The criterion was obtained under the gauge fixing of the Lorenz type. However, it was pointed out that the Kugo-Ojima criterion breaks down for the Maximal Abelian gauge, which is quite strange in view of the fact that quark confinement has been verified according to the dual superconductivity caused by magnetic monopole condensations. In order to make a bridge between color confinement due to Kugo and Ojima and the dual superconductor picture for quark confinement, we reconsider the color confinement criterion to obtain the unified picture for confinement. We show that the restoration of the residual local gauge symmetry which was shown by Hata to be equivalent to the Kugo-Ojima criterion in the Lorenz gauge occurs also in the Maximal Abelian gauge for the SU(N) Yang-Mills theory in two-, three- and four-dimensional Euclidean spacetime once the singular topological configurations of gauge fields are taken into account. This result indicates that the color confinement phase is a disordered phase caused by non-trivial topological configurations irrespective of the gauge choice. As a byproduct, we show that the compact U(1) gauge theory can have the disordered confinement phase, while the non-compact U(1) gauge theory has the deconfined Coulomb phase.

Presenter: Mr FUKUSHIMA, Naoki (Chiba University)

Session Classification: Short talk

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

Fixed Point Structure of Gradient Flow Exact Renormalization Group

Wednesday, 8 December 2021 16:20 (20 minutes)

Gradient Flow Exact Renormalization Group (GFERG) is a framework of Exact Renormalization Group and defines the Wilson action via Gradient Flow equation. We study the fixed point structure of the GFERG equation associated with the general Gradient Flow equation for scalar fields and show that it is almost the same as that of the Wilson-Polchinski (WP) equation. Furthermore, we discuss that the GFERG equation has a similar RG flow structure around a fixed point to the WP equation. We illustrate these results with O(N) non-linear sigma model in 4-epsilon dimensions and the Wilson-Fisher fixed point.

Presenter: Mr HARUNA, Junichi (Kyoto University)

Session Classification: Short talk

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

Signature change of the space-time in the type IIB matrix model

Thursday, 9 December 2021 16:40 (20 minutes)

We perform numerical studies of the type IIB matrix model, which was proposed as a nonperturbative formulation of superstring theory in 1996. In our study, we apply the complex Langevin method in order to overcome the sign problem, which occurs in Monte Carlo simulations. In particular, we investigate a scenario on how the signature of space-time could be determined dynamically in this model and discuss the possibility of the emergence of the (3+1)D expanding universe.

Presenter: Dr HATAKEYAMA, Kohta (KEK)

Session Classification: Short talk

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

New 4D EFT from 10D non-Abelian DBI action in magnetic compactifications

Tuesday, 7 December 2021 14:20 (20 minutes)

We study a systematic derivation of four dimensional N = 1 supersymmetric effective theory (EFT) from ten dimensional non-Abelian Dirac-Born-Infeld (DBI) action compactified on a six dimensional torus with magnetic fluxes on the D9-branes. We find a new type of matter Kahler metric while gauge kinetic function and superpotential are consistent with previous studies. For the ten dimensional action, we use a symmetrized trace prescription and focus on the bosonic part up to O(F^4). In the presence of the supersymmetry, four dimensional chiral fermions can be obtained via index theorem. The new matter Kahler metric is independent of flavor but depends on the fluxes, 4D dilaton, Kahler moduli and complex structure moduli, and will be always positive definite if an induced RR charge of the D-branes on which matters are living are positive. We read the superpotential from an F-term scalar quartic interaction derived from the ten dimensional action and the contribution of the new matter Kahler metric to the scalar potential which we derive turns out to be consistent with the supergravity formulation.

Presenter: Prof. HIGAKI, Tetsutaro (Keio University)

Session Classification: Short talk

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

Nonvanishing finite scalar mass in flux compactification

Tuesday, 7 December 2021 14:40 (20 minutes)

We study possibilities to realize a nonvanishing finite Wilson line (WL) scalar mass in flux compactification. Generalizing loop integrals in the quantum correction to WL mass at one-loop, we derive the conditions for the loop integrals and mode sums in one-loop corrections to WL scalar mass to be finite. We further guess and classify the four-point and three-point interaction terms satisfying these conditions. As an illustration, the nonvanishing finite WL scalar mass is explicitly shown in a six dimensional scalar QED by diagrammatic computation and effective potential analysis. This is the first example of finite WL scalar mass in flux compactification.

Presenter: Mr HIROSE, Takuya (Osaka City University)

Session Classification: Short talk

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

Momentum-space entanglement in scalar field theory on noncommutative spaces

Wednesday, 8 December 2021 14:20 (20 minutes)

In this talk, I consider the quantum entanglement in the momentum space for scalar field theory on noncommutative spaces. 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. In noncommutative spaces, 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 noncommutative spaces, in particular on the fuzzy sphere, and examine the difference from the theory on the commutative counterpart.

Presenter: Dr KAWAMOTO, Shoichi (National Tsing Hua Universiry)

Session Classification: Short talk

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

Symmetry enhancement in RCFT

Wednesday, 8 December 2021 15:00 (20 minutes)

We propose when and why symmetry enhancements happen in massless renormalization group (RG) flows to two-dimensional rational conformal field theories (RCFTs). We test our proposal against known RG flows from unitary minimal models. We also suggest which sign of the relevant coupling triggers the massless RG flow. The other sign triggers massive RG flows to topological quantum field theories (TQFTs). We comment on their ground state degeneracies.

Presenter: Dr KIKUCHI, Ken (Yau Mathematical Sciences Center)

Session Classification: Short talk

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

4D N=1 SCFTs on S-folds with T-branes

Thursday, 9 December 2021 16:20 (20 minutes)

We discuss four-dimensional (4d) N=1 superconformal field theories (SCFTs) obtained as deformations of 4d N=2 SCFTs on S-folds by tilting 7-branes. Geometric compatibility with the structures of S-folds constrains the forms of T-branes.

Presenter: Dr KIMURA, Yusuke (KEK)

Session Classification: Short talk

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

Semiclassical analysis of axion-assisted and axion-driven pair production

Tuesday, 7 December 2021 16:00 (20 minutes)

We study the pair production of fermions in a time dependent axion background with and without an electric background. We construct the adiabatic mode functions which incorporate the gauge field and the axion velocity dependence of the dispersion relation. The semiclassical approach using this adiabatic basis shows two types of pair production. One is axion-assisted pair production: the presence of the axion velocity gives enhancement and interference effects on the pair production driven by the electric field. The other is axion-driven pair production: the time variation of the axion velocity causes the pair production even though the electric field is absent.

Presenter: Dr KITAMOTO, Hiroyuki (Yukawa Institute for Theoretical Physics)

Session Classification: Short talk

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

Non-split singularities and conifold transitions in F-theory

Wednesday, 8 December 2021 11:20 (20 minutes)

In F-theory, if a fiber type of an elliptic fibration involves a condition that requires an exceptional curve to split into two irreducible components, it is called “split”or “non-split”type depending on whether it is globally possible or not. In the latter case, the gauge symmetry is reduced to a non-simply-laced Lie algebra due to monodromy. We show that the transition from a split to a non-split model is, except in certain exceptional cases, a conifold transition from the resolved to the deformed side, associated with the conifold singularities emerging at the codimension-two loci where the codimension-one singularity is enhanced to $D_{2k+2}(k¥geq1)$ or E_7. This clarifies the origin of non-local matter in the non-split case, which has been a mystery for many years. Reference: arXiv:2108.10136 [hep-th]

Presenter: Mr KURAMOCHI, Rinto (SOKENDAI)

Session Classification: Short talk

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

Complex Langevin simulation of 4D SU(2) gauge theory with a theta term

Thursday, 9 December 2021 14:40 (20 minutes)

The Monte Carlo simulation of the gauge theory with a theta term is extremely difficult due to the sign problem. The complex Langevin method (CLM) is one of the approaches which allow us to avoid the problem. Recently the analytic study of 't Hooft anomaly matching condition predicted some nontrivial phase structures around $\theta=\pi$. We use CLM to study 4D SU(2) gauge theory with a theta term. Since the topological charge on the lattice is contaminated by short-range fluctuations, we apply the stout smearing to recover the topological property. In this method, the effect of the smearing can be included dynamically. We discuss the relation between the validity of CLM and the behavior of the topological charge.

Presenter: Mr MATSUMOTO, Akira (SOKENDAI)

Session Classification: Short talk

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

Holographic index calculation for Argyres-Douglas and Minahan-Nemeschansky theories

Wednesday, 8 December 2021 11:40 (20 minutes)

We calculate the superconformal indices of the ¥$mathcal N = 2$ superconformal field theories realized on N coincident D3-branes in 7-brane backgrounds with constant axiodilaton via the AdS/CFT correspondence. We include the finite-N corrections as the contribution of D3-branes wrapped around 3-cycles in the internal space. We take only single-wrapping contributions into account for simplicity. We also determine the orders of the next-to-leading corrections which we do not calculate. The orders are relatively high, and we obtain many trustable terms. We give the results for $N = 1, 2, 3$ explicitly, and find nice agreement with known results.

Presenter: Mr MURAYAMA, Shuichi (Tokyo Institute of technology)

Session Classification: Short talk

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

Small flux superpotential in F-theory compactifications

Wednesday, 8 December 2021 11:00 (20 minutes)

We investigate whether a class of models describing F-theory compactifications admits a specific type of flux vacua with an exponentially small vacuum expectation value of the superpotential, by generalizing a method recently developed in Type IIB flux compactifications. First we clarify that a restricted choice of G4-flux components reduces a general flux superpotential into a simple form, which promotes the existence of supersymmetric vacua with one flat direction at the perturbative level. Then we utilize the techniques of mirror symmetry to determine one-instanton corrections to the potential and investigate in detail the vacuum solutions of a particular model.

Presenter: Dr OTSUKA, Hajime (Institute for Basic Science)

Session Classification: Short talk

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

Entanglement entropy and two-point functions of operators

Wednesday, 8 December 2021 14:00 (20 minutes)

Entanglement entropy (EE) is one of the basic measure of the quantum entanglement between the subsystem we see and the other. In order to establish the relation between such an entanglement and realistic observable, it is inevitable to study EE in general interacting field theory. In this talk, I will present our analysis in the case where the subsystem is a half-space, and give a formula for would-be-dominant contribution to EE in terms of renormalized two-point functions of various operators. Then, in attempt to generalize the result and to grasp the underlying structure, I will reconsider EE for a general subsystem in the free theory case, which is expressed with two-point function of the fundamental fields.

Presenter: Dr SAKAI, Katsuta (KEK)

Session Classification: Short talk

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

Perturbative Strings on Various Curved Backgrounds from String Geometry Theory

Thursday, 9 December 2021 17:00 (20 minutes)

One perturbative string theory is defined on one fixed background. On the other hand, it is necessary that a non-perturbative formulation of string theory includes all the perturbatively stable vacuum and perturbative string theories on various curved backgrounds are derived from the single theory. In this talk, we derive perturbative string theories on various curved backgrounds from the fluctuations around fixed backgrounds in a single string geometry theory, which is one of the candidates of the non-perturbative formulation of string theory.

Presenter: Prof. SATO, Matsuo (Hirosaki University)

Session Classification: Short talk

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

Rotating strings and particles in AdS: Holography at weak gauge coupling and without conformal symmetry

Wednesday, 8 December 2021 14:40 (20 minutes)

We consider gauge/gravity correspondence between maximally supersymmetric Yang-Mills theory in (p+1) dimensions and superstring theory on the near-horizon limit of the Dp-brane solution. The string-frame metric is AdS_{p+1}\times S^{8-p} times a Weyl factor, and there is no conformal symmetry except for p=3. We consider states which have angular momenta in the AdS directions. We first show that Gubser, Klebanov and Polyakov's solution, in which a folded string is rotating near the center of AdS, can be recast into a form which connects two points on the boundary. Transition amplitudes of such strings can be interpreted as gauge theory correlators, whether or not there is conformal symmetry. Then, we consider the case of zero gauge coupling, assuming the string worldsheet consists of discrete bits. We reproduce the free-field correlators from string theory, extending the previous result obtained for a special operator. (Based on 2109.12091 [hep-th])

Presenter: Prof. SEKINO, Yasuhiro (Takushoku University)

Session Classification: Short talk

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

UV divergent structure of supersymmetric gradient flow in N=1 SQCD

Wednesday, 8 December 2021 16:00 (20 minutes)

I will discuss perturbation theory of supersymmetric gradient flow in four-dimensional N = 1 SQCD and show one-loop calculations to the flowed fields. In flow theory, the perturbation theory consists of a perturbative expansion of the 4D gauge theory and an iterative expansion of the flow equations. We apply the same technique to SQCD in the Wess-Zumino gauge. Once the boundary theory is renormalized in the standard way, flowed two-point functions for the gauge multiplet are UV finite. The matter multiplets require extra renormalization, and its renormalization factor is the same for all component fields.

Presenter: Mr SUZUKI, Mitsuyo (Osaka City University)

Session Classification: Short talk

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

Higher derivative extension of the functional renormalization group

Wednesday, 8 December 2021 16:40 (20 minutes)

We study higher derivative extension of the functional renormalization group (FRG).We consider the general form of the FRG equations for a scalar field that include higher functional derivatives with respect to the field. We show that the epsilon expansion around the Wilson-Fisher fixed point is indeed reproduced by the local potential approximation of the general FRG equations.

Presenter: Mr TANAKA, Gota (Shizuoka University)

Session Classification: Short talk

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

Constrained Superfields in Dynamical Background

Tuesday, 7 December 2021 16:40 (20 minutes)

We study nonlinear realization of supersymmetry in a dynamical/cosmological background in which derivative terms like kinetic terms are finite. Starting from a linearly realized theory, we integrate out heavy modes without neglecting derivative terms to obtain constraints on superfields. Thanks to the supersymmetry breaking contribution by the kinetic energy, the validity of constrained superfields can be extended to cosmological regimes and phenomena such as reheating after inflation, kinetic-energy domination, and (kinetic) misalignment of axion. (based on a paper with S. Aoki, to appear on arXiv: 2111.XXXXX [hep-th].)

Presenter: Dr TERADA, Takahiro (Institute for Basic Science)

Session Classification: Short talk

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

Anomaly structure of finite discrete symmetries

Tuesday, 7 December 2021 14:00 (20 minutes)

Finite discrete symmetries are attractive especially for flavor symmetry of quarks and leptons. However, some classical symmetries can be broken by quantum anomaly effects. I will discuss anomaly free and anomalous structure of a finite discrete group G generally.

Presenter: Mr UCHIDA, Hikaru (Hokkaido University)

Session Classification: Short talk

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

Topological axion electrodynamics and 4-group symmetry

Tuesday, 7 December 2021 15:00 (20 minutes)

We study higher-form symmetries and a higher group in the low energy limit of a $(3+1)$-dimensional axion electrodynamics with a massive axion and a massive photon. A topological field theory describing topological excitations with the axion-photon coupling, which we call a topological axion electrodynamics, is obtained in the low energy limit. Higher-form symmetries of the topological axion electrodynamics are specified by equations of motion and Bianchi identities. We find that there are induced anyons on the intersections of symmetry generators. By a link of worldlines of the anyons, we show that the worldvolume of an axionic domain wall is topologically ordered. We further specify the underlying mathematical structure elegantly describing all salient features of the theory to be a 4-group.

Presenter: Dr YOKOKURA, Ryo (KEK)

Session Classification: Short talk

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

Tensor renormalization group and the volume independence in 2D U(N) and SU(N) gauge theories

Thursday, 9 December 2021 15:00 (20 minutes)

The tensor renormalization group method is a promising approach to lattice field theories, which is free from the sign problem unlike standard Monte Carlo methods. In this work, we apply the method to two dimensional U(N) and SU(N) gauge theories, where we propose a practical strategy to restrict the number of representations in the character expansion when constructing the fundamental tensor. Using this, we investigate the behaviour of singular values in the large-N limit and propose a novel interpretation of the Eguchi-Kawai reduction in the context of TRG. Additionally, with the presence of a theta term, we find a new type of volume independence in the strong-coupling phase, which goes beyond the Eguchi-Kawai reduction.

Presenter: Mr YOSPRAKOB, Atis (SOKENDAI)

Session Classification: Short talk

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

Progress in heterotic string compactification and phenomenology

Thursday, 9 December 2021 11:00 (50 minutes)

TBA

Presenter: Prof. ANDERSON, Lara (Virginia Polytechnic Institute and State University)

Session Classification: Invited talk

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

Challenges for an accelerating universe in string theory

Tuesday, 7 December 2021 18:00 (50 minutes)

Presenter: Prof. ANTONIADIS, Ignatios (Laboratoire de Physique Théorique et Hautes Energies)

Session Classification: Invited talk

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

Under the spell of Dynkin

Wednesday, 8 December 2021 10:00 (50 minutes)

I will explain how the Dynkin index of an embedding gives a unique perspective on the type of representations that appear in generic constructions in F-theory and how it provides a new point of view on the relationship between representation theory and crepant resolutions of singularities of elliptic fibrations.

Presenter: Prof. ESOLE, Jonathan Mboyo (Northeastern University)

Session Classification: Invited talk

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

Enhanced gauge symmetry and suppressed cosmological constant in non-supersymmetric heterotic string

Tuesday, 7 December 2021 10:10 (50 minutes)

Presenter: Prof. ITOYAMA, Hiroshi (Osaka City University)

Session Classification: Invited talk

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

Modular flavor symmetries from string compactification

Tuesday, 7 December 2021 11:10 (50 minutes)

Presenter: Prof. KOBAYASHI, Tatsuo (Hokkaido University)

Session Classification: Invited talk

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

The Remarkable Properties of Non-Supersymmetric String Theories

Wednesday, 8 December 2021 18:00 (50 minutes)

TBA

Presenter: Prof. PARAMESWARAN , Susha (University of Liverpool)

Session Classification: Invited talk

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

”Heterotic/F theory dual SU(5) model”

Thursday, 9 December 2021 10:00 (50 minutes)

Presenter: Prof. RABY, Stuart (Ohio State University)

Session Classification: Invited talk

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

Hybrid inflation and waterfall field in string theory from D7-branes

Tuesday, 7 December 2021 17:40 (20 minutes)

We present an explicit string realisation of the hybrid inflation scenario within the framework of type IIB flux compactifications in the presence of three magnetised D7-brane stacks. The inflaton is identified with the total internal volume modulus and inflation takes place around a metastable de Sitter vacuum, obtained at the very shallow local minimum of the volume modulus scalar potential. Inflation ends due to the presence of "waterfall" fields, realized by open string states, that drive the evolution of the Universe from a nearby saddle point towards a global minimum. The vacuum energy can be tuned so as to describe the present state of our Universe.

Presenter: Dr LACOMBE, Osmin (Yukawa Institute for Theoretical Physics)

Session Classification: Short talk