

Poster Session Oct. 30 (Thu.)

16:00-18:30 [37 Posters]

Poster Session Venue : Y206 [18 posters]

1. **Akashdeep Roy** (Tata Institute of Fundamental Research)

Title : JT Gravity in de Sitter Space and Its Extensions

Abstract : We discuss and extend some aspects pertaining to the canonical quantisation of JT gravity in de Sitter space, including the problem of time and the construction of a Hilbert space. We then extend this discussion to other two dimensional models obtained by changing the dilaton potential and show that the canonical quantisation procedure can be carried out for a large class of such models. Some discussion leading towards a path integral understanding for states, other than the Hartle Hawking state, is also included here, along with comments pertaining to Holography and the entropy of de Sitter space.

2. **Akihiro Miyata** (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : Multipartite Markov Gaps and Entanglement Wedge Multiway Cuts

Abstract : The Markov gap, defined as the difference between reflected entropy and mutual information, serves as a diagnostic for quantum recoverability and multipartite entanglement. In holographic settings, it admits a geometric interpretation as the deviation between entanglement wedge cross-sections and RT surfaces. Motivated by this holographic perspective, we propose a generalization of the Markov gap to multipartite systems by using a reflected multi-entropy. The resulting Multipartite Markov gap can capture geometric obstructions to bulk reconstruction. We investigate the properties of this quantity from both information-theoretic and holographic viewpoints, and examine its potential operational significance through candidate recovery maps. We further introduce the genuine reflected multi-entropy, which is designed to vanish for states containing only lower-partite entanglement. Together, these quantities offer complementary probes of recoverability and multipartite structure in holographic quantum systems.

3. **Andrea Di Biagio** (IQOQI Vienna)

Title : Permutation invariance and the quantum geometry exclusion principle

Abstract : Quantum polyhedra are geometrical objects that appear naturally in the state space of loop quantum gravity and represent the quanta of space. But they also appear in condensed matter systems, as their physical Hilbert space is the rotationally-invariant subspace of a tensor product of several spin Hilbert spaces.

Seeing the names as the discrete version of coordinates, we argue that states of quantum geometry should also be invariant under permutations of the spins, a discrete analog of diffeomorphism invariance. Imposing this additional symmetry leads to some geometries being excluded. We study in detail the case of the equiarea tetrahedron and some of the volume eigenstates are excluded because their eigenspaces carry the wrong representation of the permutation group. We conclude with some considerations about imposing permutation invariance to loop quantum gravity.

4. **Anne-Catherine de la Hamette** (ETH Zurich)

Title : Quantum reference frames and the localisation of events in superpositions of spacetimes

Abstract : The study of quantum reference frames (QRFs) is motivated by the idea of taking into account the quantum properties of the reference frames that we use, explicitly or implicitly, in our description of physical systems. Like a classical reference frame, a QRF can be used to define physical quantities such as time, position, momentum, and spin relationally. Unlike its classical analogue, it relativises the notions of superposition and entanglement of quantum systems.

In this talk, I will introduce the key principles of QRFs and illustrate their relevance at the interface of quantum theory and gravity. A crucial step in this context is to consider quantum superpositions of semiclassical spacetimes, as might be sourced by a gravitating object in superposition. But what does it mean for a gravitational source to be in a superposition of different locations? Due to the diffeomorphism invariance of general relativity, there is no natural notion of “same” or “different” points across branches. We address this by constructing a comparison map using coincidences of four scalar fields, allowing us to determine whether events occur at the same or different points across the spacetimes. Different choices of scalar fields can be understood as different instantiations of QRFs. As an explicit application, we explore how the localisation of events is relative to the choice of QRF and formulate a quantum generalisation of Einstein’s famous hole argument, calling into question the metaphysical significance of spacetime points and their identification.

5. Merna Youssef (University of Texas)

Title : Dissipation in Open Holography

Abstract : We exploit the holographic realization of a conformal theory coupled to an external bath realized via a double trace deformation and its gravity dual in terms of transparent boundary conditions in order to map out some basic dissipative properties of this simple open holographic system. In particular, we determine the energy transmission coefficient across the boundary, discover a novel duality relating weak and strong coupling to the external bath, and quantify the dissipation in the system by working out the quasi normal modes.

6. Ashes Modak (IIT (ISM) Dhanbad)

Title : Logarithmic Corrections to Near-Extremal Kerr-Newman Black Holes in N=2 Supergravity

Abstract : We investigate one-loop quantum corrections to the entropy of near-extremal Kerr-Newman black holes in four-dimensional N=2 supergravity. Using the Euclidean path integral formalism in the near-horizon geometry, we identify and compute the contribution from a class of zero modes associated with boundary time reparametrizations. These zero modes give rise to infrared divergences in the extremal limit.

By carefully analyzing the near-extremal scaling limit, we regulate these divergences and extract the leading temperature-dependent corrections to the partition function. We employ a modified heat kernel method that treats the near-extremal geometry as a perturbation of the extremal background. This approach effectively incorporates both extremal and near-extremal contributions.

Our results yield explicit logarithmic corrections to the Bekenstein-Hawking entropy and represent a new benchmark for charged, rotating black holes in supersymmetric theories. This work highlights the role of reparametrization zero modes in black hole thermodynamics and offers insights into universal features of near-horizon quantum gravity.

7. **Daisuke Yoshida** (Nagoya University)

Title : The first law and weak cosmic censorship for de Sitter black holes

Abstract : We apply Iyer–Wald’s covariant phase space formalism to asymptotically de Sitter spacetimes and establish the thermodynamic first law, expressed in terms of the Abbott–Deser mass. Similar to Iyer–Wald’s first law for asymptotically flat black holes, our first law applies to general asymptotically de Sitter perturbations around a Reissner–Nordström–de Sitter black hole, without imposing any symmetry for the perturbations. We explicitly derive the first law up to the second order in perturbation. Additionally, we apply this first law to a thought experiment involving the overcharging of a Reissner–Nordström–de Sitter black hole by injecting energy and charge sources. We find that asymptotically de Sitter black holes cannot be overcharged, provided that the null energy condition holds, thereby reinforcing the weak cosmic censorship conjecture.

8. **Giacomo Marmorini** (Nihon University)

Title : Compressed sensing quantum state tomography for qudits: A comparison of Gell-Mann and Heisenberg-Weyl observable bases

Abstract : Quantum state tomography (QST) is an essential technique for reconstructing the density matrix of an unknown quantum state from measurement data, crucial for quantum information processing. However, conventional QST requires an exponentially growing number of measurements as the system dimension increases, posing a significant challenge for high-dimensional systems. To mitigate this issue, compressed sensing quantum state tomography (CS-QST) has been proposed, significantly reducing the required number of measurements. In this study, we investigate the impact of basis selection in CS-QST for qudit systems, which are fundamental to high-dimensional quantum information processing. Specifically, we compare the efficiency of the generalized Gell-Mann (GGM) and Heisenberg-Weyl observable (HWO) bases by numerically reconstructing density matrices and evaluating reconstruction accuracy using fidelity and trace distance metrics. Our results demonstrate that, while both bases allow for successful density matrix reconstruction, the HWO basis becomes more efficient as the qudit dimension increases. Furthermore, we find the best fitting curves that estimate the number of measurement operators required to achieve a fidelity of at least 95%. These findings highlight the significance of basis selection in CS-QST and provide valuable insights for optimizing measurement strategies in high-dimensional quantum state tomography.

9. Goncalo Araujo Regado (Okinawa Institute of Science and Technology)

Title : Relational entanglement entropies and quantum reference frames in gauge theories

Abstract : It has been shown that defining gravitational entanglement entropies relative to quantum reference frames (QRFs) intrinsically regularizes them. Here, we demonstrate that such relational definitions also have an advantage in lattice gauge theories, where no ultraviolet divergences occur. To this end, we introduce QRFs for the gauge group via Wilson lines on a lattice with global boundary, realizing edge modes on the bulk entangling surface. Overcoming challenges of previous nonrelational approaches, we show that defining gauge-invariant subsystems associated with subregions relative to such QRFs naturally leads to a factorization across the surface, yielding distillable relational entanglement entropies. Distinguishing between extrinsic and intrinsic QRFs, according to whether they are built from the region or its complement, leads to extrinsic and intrinsic relational algebras ascribed to the region. The "electric center algebra" of previous approaches is recovered as the algebra that all extrinsic QRFs agree on, or by incoherently twirling any extrinsic algebra over the electric corner symmetry group. Similarly, a generalization of previous proposals for a "magnetic center algebra" is obtained as the algebra that all intrinsic QRFs agree on, or, in the Abelian case, by incoherently twirling any intrinsic algebra over a dual magnetic corner group. Altogether, this leads to a compelling regional algebra and relative entropy hierarchy. Invoking the corner twirls, we also find that the extrinsic/intrinsic relational entanglement entropies are upper bounded by the non-distillable electric/magnetic center entropies. Finally, using extrinsic QRFs, we discuss the influence of "asymptotic" symmetries on regional entropies. Our work thus unifies and extends previous approaches and reveals the interplay between entropies and regional symmetry structures.

10. Hideo Furugori (Kyoto University)

Title : Apparent Horizons Associated with Dynamical Black Hole Entropy

Abstract : We define entropic marginally outer trapped surfaces (E-MOTSs) as a generalization of apparent horizons. We then show that, under first-order perturbations around a stationary black hole, the dynamical black hole entropy proposed by Hollands, Wald, and Zhang, defined on the background Killing horizon, can be expressed as the Wall entropy evaluated on an E-MOTS associated with it. Our result ensures that the Hollands--Wald--Zhang entropy reduces to the standard Wald entropy in each stationary regime of a dynamical black hole, thereby reinforcing the robustness of the dynamical entropy formulation.

11. **HIROKI MATSUI** (Nihon University)

Title : No-boundary Proposal and Hořava-Lifshitz Gravity

Abstract : In this talk, I will discuss the Hartle-Hawking no-boundary proposal within the framework of Hořava-Lifshitz Gravity. Although applying the no-boundary proposal to Hořava-Lifshitz Gravity is not straightforward, we demonstrate that the proposal can be formulated within Hořava-Lifshitz Gravity using the Lorentzian path integral formulation of quantum gravity. I will discuss how the no-boundary wave function is formulated under Dirichlet and Robin boundary conditions. For the Dirichlet boundary condition, we point out that its on-shell action diverges due to higher-dimensional operators, but this problem can, in principle, be ameliorated by considering the renormalization group flow. On the other hand, for the Robin boundary condition with a particular imaginary Hubble expansion rate at the initial hypersurface, the no-boundary wave function can be achieved in this gravity.

12. **Josh Kirklin** (Perimeter Institute)

Title : Generalised second law beyond the semiclassical regime

Abstract : We prove that the generalised second law (GSL), with an appropriate modification, holds in perturbative gravity to all orders beyond the semiclassical limit and without a UV cutoff imposed on the fields. Our proof uses algebraic techniques and builds on the recent work of Faulkner and Speranza, which combined Wall's proof of the GSL with the identification of generalised entropy as the von Neumann entropy of a boost-invariant crossed product algebra. The key additional step in our approach is to further impose invariance under null translations. Doing so requires one to describe horizon exterior regions in a relational manner, so we introduce 'dynamical cuts': quantum reference frames which give the location of a cut of the horizon. We use idealised dynamical cuts, but expect that our methods can be generalised to more realistic models. The modified GSL that we prove says that the difference in generalised entropies of the regions outside two dynamical cuts is bounded below by the free energy of the degrees of freedom giving the location of the later cut. If one takes a semiclassical limit, imposes a UV cutoff, and requires the cuts to obey certain energy conditions, then our result reduces to the standard GSL.

13. **Julian De Vuyst** (Okinawa Institute of Science and Technology)

Title : Crossed products from quantum reference frames and linearisation instabilities

Abstract : It has recently become a widely known fact that operator algebras of QFTs associated to subregions in spacetime are type III von Neumann algebras and therefore have no well-defined density matrices nor entropies. By now it was well-appreciated that the crossed product construction through the introduction of observer degrees of freedom is a way of intrinsically regularizing this algebra to one of type II on which one can define a trace and entropies in a well-defined manner. These observer degrees of freedom constitute what the foundational community would call a quantum reference frame (QRF). Hence, there should be a link between the two approaches and one should be able to use the theory of QRFs in the context of crossed products to allow for more general observer degrees of freedom.

In a series of papers: [2405.00114](#), [2411.19931](#), [2412.15502](#) we established this connection, leading to additional interesting results such as the observer dependence of gravitational entropy. Moreover, we explained that the imposition of the total Hamiltonian as a constraint, leading to the crossed product, can be motivated from the linearisation instability framework.

14. **Kaho Yoshimura** (The University of Tokyo)

Title : Causality Constraints on Black Hole Thermodynamics in Nonlinear Electrodynamics

Abstract : Black hole thermodynamics offers a valuable testbed for exploring quantum aspects of gravity. In particular, thought experiments involving charged black holes have played a central role in motivating various Swampland criteria, including the Weak Gravity Conjecture.

In this work, we study causality constraints on black hole thermodynamics in nonlinear electrodynamics, where the Lagrangian is taken to be an arbitrary function of the electromagnetic field strength. By requiring the absence of superluminal propagation, we show that the mass-to-charge ratio of extremal black holes exhibits a certain monotonicity behavior previously studied in the context of the Weak Gravity Conjecture.

Furthermore, under the same condition, we demonstrate that the entropy-to-mass-squared ratio—interpreted as an entropy density—decreases monotonically with increasing mass at fixed mass-to-charge ratio. This new monotonicity property generalizes previous results on the positivity of four-derivative corrections to black hole entropy in the microcanonical ensemble, extending them to all orders in nonlinear electrodynamics.

15. Kazuya Yamashita (The University of Osaka)

Title : Developing Hamiltonian engineering and high-resolution imaging system toward OTOC measurements in an optical lattice systems

Abstract : A quantum simulator using cold atoms is a promising platform for experimental studies of quantum many-body systems based on quantum information. We have been constructing a system to observe measurement-induced quantum phase transitions and to measure out-of-time-ordered correlators (OTOC) in cold quantum gases. We have achieved quantum degeneracy of Li atoms and loaded them into a two-dimensional optical lattice. Currently, as a preparation of the Hamiltonian engineering for OTOC measurements, we are constructing a fast switching coil system and the Floquet optical lattice, and also a high-resolution imaging system for the measurement of entanglement entropy.

In the poster, we will present the details of our experiments and the current status of the project.

16. Luca Marchetti (OIST and Kavli IPMU)

Title : Scalar cosmological perturbations from quantum-gravitational entanglement

Abstract : A major challenge at the interface between quantum gravity and cosmology is to understand how cosmological structures can emerge from physics at the Planck scale. In this talk, I will provide a concrete example of such an emergence process by extracting the physics of scalar and isotropic cosmological perturbations from full quantum gravity, as described by a group field theory model. From the perspective of the underlying quantum gravity theory, cosmological perturbations will be associated with (relational) nearest-neighbor two-body entanglement, providing crucial insights into the potentially purely quantum-gravitational nature of cosmological perturbations. I will also show that at low energies the emergent relational dynamics of these perturbations are perfectly consistent with those of general relativity, while at trans-Planckian scales quantum effects become important. Finally, I will comment on the implications of these quantum effects for the physics of the early universe and outline future research directions.

17. Masahiro Hotta (Tohoku University)

Title : Exceeding the maximum classical energy density in fully charged quantum batteries

Abstract : Quantum batteries are anticipated to achieve significant advancements in energy storage capacity. In classical batteries, the energy density at each subsystem reaches its maximum value, denoted as EC , which is determined by dividing the maximum energy by the number of subsystems. We demonstrate that this limit can be surpassed in quantum batteries by protocols of Quantum Energy Teleportation (QET), allowing for the energy density at a subsystem to exceed the value of EC . Our protocol offers enhanced efficiency, reduces experimental complexity on quantum computers, and enables instantaneous energy charging through Local Operations and Classical Communication (LOCC). Leveraging quantum entanglement, this protocol significantly improves quantum energy storage systems, promising advances in quantum computing and new technological applications. This work represents a crucial step towards revolutionizing quantum energy storage and transfer.

18. Masato Nozawa (Osaka Institute of Technology)

Title : The Kerr-Schild formalism and the Benenti-Francaviglia metric

Abstract : The Benenti-Francaviglia metric involving 10 arbitrary functions describes the most general metric that admits a Killing tensor.

We show that the special subclass of the Benenti-Francaviglia metric, characterized by 8 arbitrary functions, allows a shear-free null geodesic congruence. In this case, it turns out that the metric can be cast into the Kerr-Schild form, for which the background metric is another class of the Benenti-Francaviglia metric. Using this prescription, we explore the construction of black holes in $N=2$ gauged supergravity.

Poster Session Venue : Y306 [18 posters]

19. **Canceled ()**

20. **Mizuki Hamada** (Keio University)

Title : Topological entanglement swapping in spin-ladder systems

Abstract : We study how quantum measurements can transform quantum phases in spin ladder systems through an entanglement swapping protocol. Consecutive Bell measurements are performed between the legs of two independent ladders, followed by uniform post-selection of the measurement outcomes. We analyze the resulting phase realized in the unmeasured outer legs. Our analysis is based on topological indices protected by the $D_2=Z_2 \times Z_2$ spin rotational symmetry as well as the lattice translation symmetry. We find that these indices remain unchanged through the measurement process, leading to a nontrivial inheritance rule. Namely, the output state is topological if only one of the ladders is initially topological, while it becomes trivial if both are.

To illustrate this, we explicitly construct post-measurement states using matrix product states (MPS), in which the rung singlet (trivial) and Haldane (SPT) phases are represented by a product of singlets and a valence bond solid state, respectively. The MPS results are consistent with the index characterization and further reveal that the correlation length increases after measurement, indicating enhanced fluctuations. Finally, we perform a field-theoretical analysis using bosonization. By identifying the locking positions of bosonic fields associated with string order parameters, we determine the resulting phase and confirm consistency with both the index argument and MPS analysis. Interestingly, the post-measurement correlation length is approximately equal to the sum of those before measurement.

21. Patrick Orman (Caltech)

Title : Quantum chaos in the sparse SYK model, with analysis of recent experimental simulation of holography

Abstract : The Sachdev-Ye-Kitaev (SYK) model is a simple toy model of holography that has seen widespread study in the area of quantum gravity. It is particularly notable for its feasibility of simulation on near-term quantum devices. Recently, Swingle et al. introduced a sparsified version of the SYK model and analyzed its holographic properties, which are remarkably robust to deletion of Majorana interaction terms. Here we analyze its spectral and quantum chaotic properties as they pertain to holography as well as how they scale with sparsity and system size through large scale numerics. We identify at least two transition points at which features of chaos and holography are lost as the model is sparsified, and above which all important features are preserved, which may serve as guidelines for future experiments to simulate quantum gravity. Additionally, we apply these analyses to the SYK model that was recently experimentally simulated on the Google Sycamore quantum processor, which itself was a highly sparsified SYK model obtained through a machine learning algorithm incorporating mutual information signatures of a traversable wormhole.

22. Canceled ()

23. Riku Yoshimoto (Nagoya University)

Title : Condition for entanglement harvesting and partner formula

Abstract : Entanglement harvesting is a protocol which extract the non-local correlation from quantum fields through the interaction between the Unruh-DeWitt detectors and the quantum field. We discuss the criterion for successful entanglement harvesting from the perspective of the partner formula and see that entanglement harvesting is prohibited under certain specific condition.

24. **Ryota Maeda** (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : Dynamical formation of charged wormholes

Abstract : We construct static, spherically symmetric, charged traversable wormhole solutions to the Einstein--Maxwell equations, supported by bidirectional (ingoing and outgoing) null dust with negative energy, and discuss a scenario for their dynamical formation from a black hole.

Our solution contains a traversable throat, where the areal radius takes a minimum, although the spacetime is not asymptotically flat.

In our formation scenario, the spacetime evolves sequentially from a black hole to Vaidya regions and finally to a wormhole, with each transition mediated by an impulsive null shell.

We find that the radius of the wormhole throat is determined by the mass and charge of the initial black hole as well as those of the injected shell.

25. **Ryota Matsuda** (The University of Tokyo)

Title : Entanglement negativity in free fermions: twisted characteristic polynomial, universal bounds and area laws

Abstract : Entanglement negativity is an indispensable tool for studying entanglement in mixed states, providing a computable measure that successfully captures quantum correlations beyond the scope of entanglement entropy for bipartite pure states [1]. However, extending the notion of negativity to fermionic systems turns out to be highly nontrivial, as the entanglement structure differs fundamentally from that of bosons due to the anticommuting nature of fermionic operators and the intrinsic superselection rules [2]. Though the proposal of fermionic negativity in Ref. [2] was a breakthrough, both analytical and practical computations were highly involved, even for free fermions.

In our study, we demonstrate that the negativity in free fermions is simply determined by the zeros of the "twisted" characteristic polynomial of the covariance matrix. Utilizing our formula and the monotonicity of negativity under LOCC, we establish upper and lower bounds on both the negativity and its rate of change in dissipative dynamics. Combining these results with locality, we prove thermal and dynamical entanglement area laws. For the thermal area law, we prove the optimal condition for the area law of Gibbs states under the assumption of the clustering property, answering the open problem in Ref. [3] concerning long-range systems. For the local dissipative dynamics, we establish an area-law bound on entanglement generation in open systems, analogous to previously known results for entanglement entropy in unitary dynamics [4].

References: [1] G. Vidal and R. F. Werner, Phys. Rev. A 65, 032314 (2002). [2] H. Shapourian, K. Shiozaki, and S. Ryu, Phys. Rev. B 95, 165101 (2017). [3] D. Kim, T. Kuwahara, and K. Saito, Phys. Rev. Lett. 134, 020402 (2025). [4] Z.-X. Gong, M. Foss-Feig, F. G. S. L. Brandão, and A. V. Gorshkov, Phys. Rev. Lett. 119, 050501 (2017).

26. Ryui Kaneko (Sophia University)

Title : Efficient entanglement entropy computation of non-Gaussian-state dynamics in free Boson systems

Abstract : We propose a random sampling approach to the time evolution of the Renyi entanglement entropy following a quantum quench from an insulating state in free boson systems. Because of the non-Gaussian nature of the initial state, evaluating the Renyi entropy involves the exponential cost of calculating a matrix permanent. Our numerical results show that a straightforward random sampling technique can significantly reduce this cost. For an $N_s \times N_s$ matrix representing a system of N_s sites at half filling, our sampling cost scales as $O(2^{\alpha N_s})$ with a small constant $\alpha \ll 1$, which is more promising than the conventional method requiring $O(2^{N_s})$ summations. While the cost remains exponential, this improvement enables us to explore entanglement entropy dynamics in free boson systems with over 100 sites. We illustrate our method with several examples in low-dimensional systems.

27. SAIKAT GHOSH (ICTS-TIFR)

Title : Normalization of ZZ instanton amplitudes in type 0A minimal superstring theory

Abstract : We study ZZ instanton corrections in the $(2, 4k)$ $NN = 1$ minimal superstring theory with the type 0A GSO projection, which becomes the type 0A $NN = 1$ super-JT gravity in the $k \rightarrow \infty$ limit. Each member of the $(2, 4k)$ family of theories has two phases distinguished by the sign of the Liouville bulk cosmological constant. The worldsheet method for computing the one-loop normalization constant multiplying the instanton corrections gives an ill-defined answer in both phases. We fix these divergences using insights from string field theory and find finite, unambiguous results. Each member of the $(2, 4k)$ family of theories is dual to a double-scaled one-matrix integral, where the double-scaling limit can be obtained starting either from a complex matrix integral with a leading one-cut saddle point corresponding to a ungapped phase, or from a leading two-cut saddle point corresponding to a gapped phase. The matrix integral does exhibit a gap-closing transition, which is the same as the double-scaled Gross-Witten-Wadia transition when $k = 1$. We also compute instanton corrections in the double-scaled matrix integral for all k and in both phases, and find perfect agreement with the regulated string theory results.

28. Takahiro Orito (Nihon University)

Title : Strong and weak symmetries and their spontaneous symmetry breaking in mixed states emerging from the quantum Ising model under multiple decoherence

Abstract : In realistic settings, quantum systems often evolve from pure states to mixed states due to unintended interactions with the environment, a process known as quantum decoherence. Recently, phase transitions in mixed states induced by decoherence have attracted significant interest across various fields. In this work, we investigate such transitions in the transverse-field Ising model using tensor network methods. Specifically, we evaluate spontaneous symmetry breaking of strong and weak symmetries, which are characteristic of mixed states.

29. Canceled ()

30. Toshiaki Onogi (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : Do Conformal Bootstraps Dream of Duality?

Abstract : In theoretical physics, particularly at the fixed points of the renormalization group, there sometimes exists a peculiar phenomenon called duality. Prominent examples include T-duality of compact bosons and Kramers-Wannier duality of the Ising model in two dimensions, particle-vortex duality in three dimensions, and electromagnetic duality in four dimensions. However, the understanding of these dualities is based on the solvability of the theories, and it remains a mystery under what conditions duality can exist.

Therefore, we have considered investigating the necessary conditions for a theory to possess duality, using the conformal bootstrap method within conformal field theory, which are theories at the fixed points of the renormalization group. In this talk, we will particularly focus on a duality in 3D conformal field theories that exchanges high and low temperatures. We will show that when duality is imposed within the framework of the conformal bootstrap, the 3D Ising CFT is excluded, and instead, there exists another region where duality can be realized.

31. Yoshinori Matsuo (Department of Physics, Nagoya University)

Title : Self-gravitating strings and quantum effects in two-dimensional gravity

Abstract : It is expected that when the string coupling is taken to be sufficiently small, a black hole turns into a bound state of self-gravitating fundamental strings. This state would be described by the Horowitz-Polchinski solution. In this presentation, we discuss the Horowitz-Polchinski solution in two dimensions, which describes the geometry near the surface of the bound state of self-gravitating strings in the large-dimension limit, in a similar fashion to the two-dimensional black hole, which describes the near horizon geometry of the Schwarzschild black hole in the large-dimension limit. As quantum effects are taken into calculations in the RST model, and the Horowitz-Polchinski solution in the RST model contains background radiation in a similar fashion to the Hartle-Hawking vacuum around a black hole.

32. Yu Komiya (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : Inflation, relic formation, and early universe dynamics

Abstract : The impressive variety of models describing early universe dynamics present engaging areas of study due to the exotic objects and mechanisms that may arise, such as topological defects and primordial black hole formation. Meanwhile, the ‘utility’ in such topics can be found in their role as high-energy environments in which to investigate fundamental physics. We consider a picture containing inflation, phase transitions, testable predictions, and corrections to typical scenarios with the aim of probing cosmic history using modern tools of both a theoretical and an observational nature.

33. Yu Miyauchi (Keio University)

Title : Non-Extremal Quantum Dynamics in D-Dimensional Einstein-Maxwell Theory from Two-Dimensional Dilaton Gravity

Abstract : We study the quantum dynamics of non-extremal charged black holes via dimensional reduction to two-dimensional dilaton gravity. In particular, we focus on the Hawking–Page transition and derive the corresponding phase diagrams. Starting from the D-dimensional Einstein–Maxwell theory, we perform a Kaluza–Klein reduction on a compact internal manifold, yielding a two-dimensional dilaton gravity theory coupled to an electromagnetic field and graviphotons. We then integrate out the gauge fields and massive Kaluza–Klein modes to obtain an effective dilaton gravity theory with a non-trivial dilaton potential. Using this potential, we compute thermodynamic quantities through semi-classical methods and construct the phase diagrams. We also investigate one-loop quantum corrections to gravity and their effects on the thermodynamic properties.

34. **Yu-ki Suzuki** (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : New holographic entanglement entropy in de Sitter space

Abstract : We propose a new holographic entanglement entropy in the de Sitter space. We discuss when the entropy becomes consistent.

35. **Yuheng Sui** (Keio University)

Title : System-environment entanglement phase transitions for open boundary conditions

Abstract : A quantum channel described by a CPTP map generally turns a pure quantum state into a mixed state, which can be viewed as development of system-environment entanglement. We study a phase transition in the system-environment Renyi entanglement entropy (EE) when the XXZ chain with open boundary conditions is subject to continuous density measurements. We show that the EE exhibits a volume law followed by a subleading logarithmic term; the coefficient of the latter changes from 0 to $1/4$ as a function of the measurement strength. We also study the expectation value of a certain twist operator in the doubled Hilbert space formalism, that is expected to detect the phase transition. We compare our results with previous results for the periodic boundary condition as well as the boundary renormalization group analysis. All the work are done by the numerical calculation.

36. **Masataka Ishikawa** (The University of Tokyo)

Title : Perturbative unitarity bounds on field-space curvature in de Sitter spacetime: purity vs amplitudes (part 1)

Abstract : We study perturbative unitarity bounds on the field-space curvature in de Sitter spacetime, using the momentum-space entanglement approach recently proposed by Pueyo, Goodhew, McCulloch, and Pajer. As an illustration, we perform a perturbative computation of the purity in two-scalar models and compare the resulting unitarity bounds with those obtained via a flat space approximation. In particular, we find that perturbative unitarity imposes an upper bound on the field-space curvature of the Hubble scale order, in addition to a bound analogous to the flat space result. This reflects the thermal nature of de Sitter spacetime. We also discuss generalizations to higher-dimensional field spaces.

37. **Qianhang Cai** (The University of Tokyo)

Title : Perturbative unitarity bounds on field-space curvature in de Sitter spacetime: purity vs amplitudes (part 2)

Abstract : We study perturbative unitarity bounds on the field-space curvature in de Sitter spacetime, using the momentum-space entanglement approach recently proposed by Pueyo, Goodhew, McCulloch, and Pajer. As an illustration, we perform a perturbative computation of the purity in two-scalar models and compare the resulting unitarity bounds with those obtained via a flat space approximation. In particular, we find that perturbative unitarity imposes an upper bound on the field-space curvature of the Hubble scale order, in addition to a bound analogous to the flat space result. This reflects the thermal nature of de Sitter spacetime. We also discuss generalizations to higher-dimensional field spaces.
