Poster Session Oct. 28 (Tue.) 16:00-18:30 [36 Posters]

Poster Session Venue : Y206 [18 posters]

1. **Atis Yosprakob** (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : Reducing complexity in fermionic tensor network via Clifford circuits

Abstract : Fermionic systems often exhibit complex entanglement structures that challenge the efficiency of tensor network methods such as the Density Matrix Renormalization Group (DMRG). In this work, we explore a strategy to reduce entanglement complexity in fermionic matrix product states (MPS) by applying Clifford circuits as basis transformations during the DMRG optimization. Clifford unitaries, being efficiently simulable and preserving Pauli structure, offer a computationally tractable means to adaptively rotate the fermionic basis that mimimize the entanglement entropy. Initial results are presented.

2. **Benjamin Concepcion** (UC Berkeley)

Title : CFT Data from Black Hole Songs

Abstract : The AdS/CFT correspondence predicts that the bulk 2 point function should match the boundary 2 point function. Using work from the Thermal Product Formula (Dodelson et al. 2023) we can build the bulk 2 point function out of knowledge of a black hole's quasi-normal modes (QNMs). Likewise, we can build the boundary 2 point function out of CFT data in the conformal block expansion. Work in progress with Sean Colin-Ellerin to develop a direct map between black hole QNMs and CFT data.

3. **Bethany Suter** (University of California, Berkeley)

Title : Exact Results in Chiral Gauge Theories with Flavor

Abstract : We present exact results in softly-broken supersymmetric $SU(N_C)$ chiral gauge theories with charged fermions in one antisymmetric, N_F fundamental, and $N_C + N_F - 4$ anti-fundamental representations. We achieve this by considering the supersymmetric version of these theories and utilizing anomaly mediated supersymmetry breaking at a scale $m \ll \Lambda$ to generate a vacuum. The connection to non-supersymmetric theories is then conjectured in the limit $m \to \infty$. For odd N_C, we determine the massless fermions and unbroken global symmetries in the infrared. For even N_C, we find global symmetries are non-anomalous and no massless fermions. In all cases, the symmetry breaking patterns differ from what the tumbling hypothesis would suggest.

4. **Chris Waddell** (Perimeter Institute)

Title : Quantum cryptography, tensor networks, and the python's lunch

Abstract : In the AdS/CFT correspondence, a subregion of the CFT allows for the recovery of a corresponding subregion of the bulk known as its entanglement wedge. In some cases, an entanglement wedge contains a locally but not globally minimal surface homologous to the CFT subregion, in which case it is said to contain a python's lunch. It has been proposed that python's lunch geometries should be modelled by tensor networks that feature projective operations where the wedge narrows. This model leads to the python's lunch (PL) conjecture, which asserts that reconstructing information from past the locally minimal surface is computationally difficult. In this work, we use cryptographic tools related to a primitive known as the Conditional Disclosure of Secrets (CDS) to develop consequences of the projective tensor network model that can be checked directly in AdS/CFT. We argue from the tensor network picture that the mutual information between appropriate CFT subregions is lower bounded linearly by an area difference associated with the geometry of the lunch. Recalling that the mutual information is also computed by bulk extremal surfaces, this gives a checkable geometrical consequence of the tensor network model. We prove weakened versions of this geometrical statement in asymptotically AdS3 spacetimes satisfying the null energy condition, and confirm it in some example geometries, supporting the tensor network model and by proxy the PL conjecture.

5. **Elisa Tabor** (UC Berkeley)

Title : The algebraic structure of gravitational scrambling

Abstract : We introduce a new algebraic framework to describe gravitational scrambling, including the semiclassical limit of any out-of-time-order correlation function that consists of s-wave operator insertions separated by approximately the scrambling time. This algebra, which we call a modular-twisted product, is defined starting from two half-sided modular inclusions of von Neumann algebras, interpreted physically as the large N limit of products of early- and late-time single-trace operators. In limits where the separation between insertions is taken to be either much less or much greater than the scrambling time, the modular-twisted product reduces, respectively, to tensor- and free-product algebras previously studied in Chandrasekaran-Penington-Witten. In a sense, the modular-twisted product interpolates between these two products. Including the Hamiltonian in the scrambling algebra leads to a Type II$_\infty$ von Neumann algebra with finite renormalized entropies that interpolate between single-QES and multi-QES phases. We end by describing how to extend this algebra to include localized excitations.

6. **Gioele Zambotti** (SISSA)

Title : Negativity contour for bosonic Gaussian states

Abstract : Entanglement is a well known and studied subject in physics nowadays, with applications ranging from quantum
many-body systems to black hole physics. There exist many measures of the entanglement between spatial partitions of a state, such as the entanglement entropy and the logarithmic negativity. In general, however, it is not clear if it is possible, and how, to quantify the entanglement contribution of each spatial degree of freedom of the
system under consideration. The concept of entanglement contour was introduced precisely to try to characterize the spatial structure of entanglement. This is appealing for many reasons, for example, it would allow to check that the area law in quantum many-body systems emerges from the entanglement carried by the degrees of freedom at the boundary of the two partitions. It turns out that constructing a physically meaningful measure of localized entanglement is very hard and only few proposals for these quantities are available in the literature, mainly in the context of Gaussian states. I will discuss a proposal of a contour function for the logarithmic negativity in the setting of bosonic Gaussian states and present the results of the numerical analysis of this quantity in the context of harmonic lattices.

7. **Hajime Kobayashi** (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : Toward Modeling Quantum Aspects of Black Holes through Worldline Effective Field Theory Approach

Abstract : Understanding quantum aspects of black holes remains one of the most profound challenges in theoretical physics. In this work, we explore a novel application of the worldline effective field theory (EFT) framework to model quantum corrections to black hole dynamics. Originally developed to describe the gravitational interactions of compact objects in the post-Newtonian regime, the worldline EFT has recently been extended to incorporate finite-size and dissipative effects, offering a promising route to capture subtle quantum phenomena. We focus on tidal interactions and horizon dissipation, which encode information about the underlying microphysics of black holes, and examine how quantum signatures can manifest as corrections to worldline couplings. Our approach enables a controlled and systematic expansion around the classical background, potentially bridging semiclassical gravity and quantum black hole physics.

8. **Hayate Kimura** (The Graduate University for Advanced Studies (SOKENDAI))

Title : Quantum branes from the swampland conjecture

Abstract : The swampland cobordism conjecture predicts the existence of various defects in theories coupled to gravity.
We numerically constructed such defects as black brane solutions, supported by quantum effects (Casimir energy), in both the Standard Model and heterotic string theory.

9. **Hiroki Ohta** (Department of Physics, Chuo University)

Title : Measurement-Based Quantum Computation with the Anisotropic Spin-1 XXZ Chain in the Haldane Phase

Abstract : The Affleck-Kennedy-Lieb-Tasaki (AKLT) state is a prototypical state in the Haldane phase and is also known to serve as a resource for measurement-based quantum computation (MBQC). Motivated by the recent studies suggesting that a broader class of states within the Haldane phase may possess similar computational power, we study computational power of the spin-1 XXZ chain within the Haldane phase and evaluate its computational power via gate fidelity. We find that fidelity depends on antiferromagnetic spin correlations after measurement, and show numerically that introducing anisotropy enables high-fidelity single-qubit unitaries.

10. **Hiromasa Tajima** (Nagoya University)

Title : Information during inflation with stochastic approach

Abstract : Based on our work PRD.111.106009, we will show the specific model of inflation and stochastic formalism to show the equivalence between the e-folding bound and entropy bound. The e-folding bound is bound for the e-folding number by the Gibbons-Hawking entropy, and entropy bound is the bound for entanglement entropy (approximately equal to Shannon entropy in our setup) by the Gibbons-Hawking entropy. These bounds show the eternal inflation is prohibited. However, the e-folding number is a locally defined quantity but the eternal inflation is the scenario for the global spacetime. The Shannon entropy is also not enough globally defined because the global expansion effect is not under consideration. Then we used the volume-weighted probability distribution to consider the state including global statistics. Moreover, we obtain the result that eternal inflation is not prohibited from the aspect of entropy bound for the volume-weighted probability distribution. We will discuss the behavior of Shannon entropy and the outlook from the result.

11. **Isai Dávila** (SISSA)

Title : Symmetry-resolved Entanglement Entropies in the free Schrödinger field theory on the line

Abstract : In recent years, quantum information theory has assumed a relevant role to explore various aspects of quantum field theory, particularly in relativistic settings. However, non-relativistic models remain less explored, although they are very important to understand the continuum limit of quantum many-body systems.

In this talk, I present a study of the symmetry-resolved entanglement entropy of an interval on the infinite line for a free fermionic spinless Schrödinger field theory at finite density—a non-relativistic model characterized by a Lifshitz exponent z=2 and endowed with a U(1) symmetry. This quantity is explored through two approaches: one based on the prolate spheroidal wave functions and another one where the tau function characterizing this problem is employed. These methods allow us to study quantitatively the symmetry-resolved entanglement entropy in all the regimes of interest.

12. **Jan Boruch** (UC Berkeley)

Title : Multicentered black hole saddles for supersymmetric indices

Abstract : The supersymmetric index in string theory can sometimes have a discontinuous integer-valued jump, as the string coupling or other moduli are varied. This phenomenon is known as wall-crossing. When the index counts black hole microstates, crossing such walls of marginal stability amounts to the appearance or disappearance of a large number of such states. While wall-crossing has been understood in string theory and through the disappearance of extremal Lorentzian supergravity solutions as the moduli are varied, there has been no understanding about how the discontinuous changes in the index occur at the level of the gravitational path integral when using the Gibbons-Hawking prescription. In this paper, we find the finite-temperature saddles in 4d flatspace supergravity in which fermionic fields are periodic when going around the thermal circle that corresponds to the multi-center black hole contributions to the index. By analyzing these saddles, we can explain how wall-crossing occurs: as the scalar moduli in supergravity are varied at the asymptotic boundary, for a given split of the charges, the saddle point equations can no longer be solved and, consequently, the corresponding multi-center saddle no longer contributes to the index. While the values of the scalars and the jump in the index when a wall is crossed agree with the prediction from previously found Lorentzian supergravity solutions, the saddles in the index exhibit a much richer moduli space, which we analyze in detail.

13. **Kazunari Shima** (Saitama Institute of Technology)

Title : Implication of Nonlinear-supersymmetric General Relativity

Abstract : On (unstable) Riemann space-time whose tangent space possesses NLSUSY structure, i.e., specified by Majorana spinor（fermionic coordinates） ψαi (i=1...N) for SL(2,C) besides the ordinary Minkowski coordinates xa for SO(1,3) we find the unified vierbein waμ and performing the ordinary geometric argument of the general relativity we obtain straightforwardly new Einstein-Hilbert(EH)-type action (Nonlinear-supersymmetric general relativity(NLSGR)) LNLSGR (waμ) with the cosmological term and the global NLSUSY invariance. Due to NLSUSY structure of space-time LNLSGR (waμ) would collapse(Big collapse) producing the ordinary EH action for graviton eaμ, NLSUSY action for Goldstone(G) fermion ψαi (fundamental matter, superon) and their gravitational interaction described by superon-graviton action LSGM. (eaμ ψαi), which is the vacuum configuration of NLSGR.

Simultaneously the universal attractive force graviton would dictate the evolution(vaccum) of LSGM (eaμ, ψαi) by producing all possible gravitational composites of superons corresponding to the LSUSY (massless) supermultiplet fields of supergravity(SUGRA), which may be regarded as the ignition of the Big Bang of the universe.

As shown in the simple toy model, NLSGR paradigm bridges naturally the cosmology and the low energy particle physics, which provides new insights into unsolved problems of cosmology, SM and mysterious relations between them, e.g. the space-time dimension four, the origin of SUSY breaking, the dark energy and the dark matter, the dark energy density≃(neutrino mass)4 , the three-generations structure of quarks and leptons, the rapid expansion of space-time and the fate of black hole etc.

All results were published separately. For some references,

[Ref.]

[1] K. Shima, Invited talk at the symposium,
100 Years Werner Heisenberg-Works and Impact-, September 26-30, Bamberg, Germany.
Proceeding: Fortschr. Phys. 50 (2002) 5-7, 717, eds. D. Leust and W. Schleich.

[2] K. Shima, Invited talk at Conference on Cosmology, Gravitational Waves and Particles ,2017, NTU, Singapore (Uploaded at YouTube by IAS). Proceedings of CCGWP, ed. Harald Fritzsch, (World Scientific, Singapore, 2017), 301.

[3 K. Shima, Temporal preliminary report: arXiv:2012.01646[hep-th]

14. **Kosei Fujiki** (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : Einstein Equation and the First Law of Entanglement Entropy in dS/CFT

Abstract : In the framework of the AdS/CFT correspondence, it has been shown that the Einstein equation is equivalent to the first law of entanglement entropy. In this talk, we discuss this relation within the context of the dS/CFT correspondence. Specifically, we consider linear perturbations of the metric in de Sitter spacetime and solve the linearized Einstein equations. We also propose a prescription for determining the extremal surface in dS/CFT that satisfies the first law of entanglement entropy. This talk is based on the work with Michitaka Kohara, Kotaro Shimyo, Yu-ki Suzuki and Tadashi Takayanagi.

15. **Canceled** ()

16. **Masashi Kawahira** (Kobe University)

Title : Generalized symmetry from Type IIB string theory

Abstract : Recently, generalized symmetries have enabled the systematic analysis of various quantum systems. In this talk, we focus on global generalized symmetries that appear in the low-energy effective theory of type IIB superstring theory (i.e., type IIB supergravity) .

Specifically, we highlight the SL(2,$\mathbb{Z}$) gauge symmetry (self-duality) in type IIB supergravity. We see that a global $\mathbb{Z}_{12}$ eight-form symmetry arises as the quantum symmetry of the SL(2,$\mathbb{Z}$) gauge symmetry. And we discuss its relation to 7-branes.

This talk is based on ongoig work with Hiroki Wada (Tohoku University) and Naoto Kan (Osaka University).

17. **Michelle Xu** (Stanford University)

Title : Randomness boosters: from constant-time chaos to ∞-designs and beyond

Abstract : Many universal characteristics of chaotic quantum many-body systems can be understood through randomness. Here we provide strong evidence for an emergent random matrix universality using quantum state designs in the context of deep thermalization. Starting with a Hamiltonian modeled by the GUE, we identify times when even if the evolution itself is only an O(1) design, the projected ensemble is an exact (∞) design in the thermodynamic limit. We argue that without such chaotic characteristics, the generic design quality only deteriorates after the projected ensemble procedure. We discuss how our results can be appropriately applied to non-GUE Hamiltonians that nevertheless show chaotic signatures in their eigenbases. We show this is a form of randomness boosting via chaos, which is a novel mechanism in the context of designs.

18. **Nanami Nakamura** (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : Through the Wormhole: Non-Hermitian Entanglement as a Probe of Traversability

Abstract : Recent studies based on the holographic principle have explored the connection between traversable wormholes and the non-unitarity of density matrices. In this work, we investigate the traversability of the so-called Imaginary Janus wormhole, which remains traversable despite the absence of direct interactions. By analyzing this phenomenon from a quantum information perspective, we aim to gain insights into the fundamental nature of wormhole connectivity. Specifically, we compute the entanglement imagitivity—a recently proposed measure of non-Hermiticity—for both Janus and Double Trace AdS wormholes. A comparison of the results reveals characteristic differences in how non-Hermiticity manifests in these geometries.

Poster Session Venue : Y306 [18 posters]

19. **Nitesh Kumar Dubey** (Indian Institute of Astrophysics, Bengaluru, India)

Title : Vacuum entanglement & the event horizon

Abstract : We explore entanglement harvesting using two Unruh-DeWitt (UDW) detectors linearly coupled to the scalar density of a massless spin-1/2 field in 1+1 Schwarzschild spacetime. We consider different vacua, including the Boulware, HartleHawking-Israel (HHI), and Unruh vacua, and investigate various configurations depending on the choice of 2-bein in the interaction Hamiltonian. We find that the transition rate of the static UDW detector exhibits the expected Planckian behavior in the HHI state, while the Unruh state leads to the Helmholtz free energy density of a bosonic or fermionic thermal bath corresponding to the static or conformal 2-bein respectively. Further, we observe that the anti-Hawking effect enhances the entanglement between the two detectors while the gravitational redshift and Hawking radiation decreases it. In particular, due to the presence of the anti-Hawking effect, the mutual information and concurrence near the event horizon can be non-zero even for static detectors with static 2-bein, which is in contrast with the case of scalar field. We also show that the near-horizon entanglement properties for static detectors in the HHI state have similar behaviour with those in Minkowski vacua for uniformly accelerated detectors in Rindler spacetime.

20. **Peng-Xiang Hao** (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : Flat Space Holography via AdS/BCFT

Abstract : We study a new class of AdS/BCFT setups, where the world-volumes of end-of-the-world branes (EOW branes) are given by flat spaces, to explore flat space holography from an AdS bulk. We show that they provide gravity duals of CFTs in the presence of null boundaries. Our holographic calculations lead to many new predictions on entanglement entropy, correlation functions and partition functions for CFTs with null boundaries. By considering a bulk region between two EOW branes, we present an AdS/BCFT explanation that the flat space gravity is dual to a Carrollian CFT (CCFT), including the swing surface calculation of entanglement entropy.

21. **Pompey Leung** (University of British Columbia)

Title : Holographic renormalization group flows and sinusoidal scalar wormholes

Abstract : Recent developments in understanding cosmology through the lens of holography has revealed that big-bang/big-crunch cosmologies with an accelerating phase can be typically constructed by analytic continuation from two-sided Euclidean AdS wormholes. In the presence of a negative cosmological constant, such homogeneous and isotropic wormholes can be supported by the spatial gradients of inhomogeneous matter field distributions, without relying on exotic matter such as axions. One explicit construction of interest are wormholes sourced by a configuration of scalar fields with sinusoidal spatial profiles.

While this connected saddle of the two-boundary gravitational path integral has been previously studied in the context of holographic cosmology, the existence and meaning of the disconnected, one-boundary counterpart is less clear. In this work, we find perturbative and fully backreacted solutions of the disconnected bulk geometry, and examine the corresponding holographic RG flow. The result is a flow exhibiting non-monotonic, cyclic behaviour—a "boomerang RG flow". Comparing actions between the connected and disconnected saddles, we find that contrary to expectations, there is at least one case with no Hawking-Page transition—the wormhole saddle always dominates when it exists.

22. **Qi-Feng Wu** (Gent University)

Title : BTZ Black Hole as entangled Anyons

Abstract : The basic motivation starts from a prior observation by McGough and Verlinde in https://arxiv.org/abs/1308.2342, who noted that the Bekenstein-Hawking entropy of the BTZ black hole can be interpreted as a topological entanglement entropy. A natural question that arises is how to identify the entangled anyons.

In gauge theories, discussions of entanglement typically require the introduction of edge modes on the entangling surface, since the state space does not factorize. In the context of topological field theory, it was previously believed that this would necessitate placing two entangled CFTs on the entangling boundary. However, the descendants in these CFTs introduce divergences in the entanglement entropy, which conflict with the finiteness of the black hole entropy.

We observed that such descendants are not essential in topological field theories. For instance, the phase space of Chern-Simons theory depends only on the homotopy type of the bulk. This naturally suggests that one can deform the background topology—without changing the homotopy type—in order to eliminate those descendants.

The resulting edge modes form the Drinfel'd double of $SL_q(2, \mathbb{R}) \times SL_q(2, \mathbb{R})$. In this sense, we can say that the BTZ black hole horizon corresponds to a pair of entangled particles living on a quantum group.

23. **Ricardo Espindola Romero** (IAS Tsinghua University)

Title : The two-sided Crofton formula and the topology of kinematic spaces

Abstract : A central challenge in holography is understanding how spacetime emerges from the boundary conformal field theory (CFT). Entanglement provides a geometric perspective through kinematic space—the space of CFT point pairs or bulk minimal cuts—where spacetime geometry is encoded in an integral formula with quantum information meaning: the Crofton formula, a cornerstone of integral geometry. In this talk, I will present recent advances revealing a novel two-sided Crofton formula, which reconstructs wormhole geometries by resolving quantum puzzles. This reveals a deeper organizational principle leading to the discovery of new topological kinematic spaces with rich structure that precedes spacetime emergence.

24. **Jose Carlos Pelayo** (Kindai University)

Title : Suppressed correlation spreading in Hilbert space fragmented system

Abstract : Hilbert space fragmentation is a phenomenon in which the Hilbert space splits into exponentially large number of disconnected sectors due to the presence of dynamical constraints, thereby preventing thermalization. A specific example of this occurs in the dynamics of a doubly occupied charge density wave evolving under the one-dimensional Bose-Hubbard model. In this work, we investigate the signatures of non-ergodic behavior in the same model and initial state by analyzing both the single-particle and the density-density correlation functions. We find that in the former case, the nearest-neighbor correlations are much stronger than those at longer distances while in the latter case it is only moderately stronger. In both cases, the time scale at which the correlation spreads is proportional to interaction strength. This suggests that the correlations remain localized and that correlation spreading becomes highly suppressed in the limit of strong interactions. Moreover, we show that the suppression in correlation spreading is further enhanced in the presence of a trapping potential even with weak trap strengths. We also show that these features are observed in the case of an effective transverse field Ising model which becomes valid in the limit of strong interactions.

25. **Sergio Ernesto Aguilar Gutierrez** (Okinawa Institute of Science and Technology)

Title : Symmetry Sectors and Relational Holography in the DSSYK

Abstract : Can there be multiple bulk theories for the same boundary theory? We answer this affirmatively in the double-scaled SYK (DSSYK) model using the tools of constrained systems. We find different symmetry sectors generated by specific constraints within the Hilbert space of the DSSYK with matter. Each sector corresponds to a different bulk description. These include parity symmetry in the DSSYK, corresponding to End-Of-The-World branes and Euclidean wormholes in sine dilaton gravity; and relative time-translations in a doubled DSSYK model used in de Sitter holography. We study their holographic dictionary, and the Dirac quantization of the bulk theories. Moreover, these examples highlight what relational quantum dynamics in the boundary theory corresponds to in the bulk. We generate an observer in a closed universe as bulk matter fields traversing the Euclidean wormhole. This corresponds to adding matter operators in the cylinder amplitudes of the DSSYK. Furthermore, in the doubled DSSYK, there is a natural notion of clock observer and its system, which we use to derive the gauge invariant operator algebra of each DSSYK dressed with respect to its pair, and discuss its holographic interpretation.

26. **Shiki Yoshikawa** (Kyoto University)

Title : Probing Black Hole in the Dual CFT via Wave Packets

Abstract : We investigate how gravitational effects of a black hole manifest as thermal behavior in the dual finite-temperature conformal field theory (CFT). In the holographic framework of AdS/CFT, we analyze a wave packet propagating into a black hole geometry in the bulk by computing three-point functions of a primary operator in the boundary CFT. Our setup captures thermal signatures such as exponential damping of the expectation value, which are absent at zero temperature. This provides a concrete and analytically tractable example of how black hole physics can be probed from the CFT side.

27. **Shinichiro Akiyama** (University of Tsukuba)

Title : SU(2) principal chiral model with tensor renormalization group on a cubic lattice

Abstract : We study the continuous phase transition and thermodynamic observables in the three-dimensional Euclidean SU(2) principal chiral field model with the triad tensor renormalization group (tTRG) and the anisotropic tensor renormalization group (ATRG) methods. Using these methods, we find results that are consistent with previous Monte Carlo estimates and the predicted renormalization group scaling of the magnetization close to criticality. These results bring us one step closer to studying finite-density QCD in four dimensions using tensor network methods.

28. **Shono Shibuya** (Nagoya University)

Title : Non-perturbative overlaps in JT gravity and universal time evolution of holographic complexity

Abstract : The interplay between black hole interior dynamics and quantum chaos provides a crucial framework for probing quantum effects in quantum gravity. We investigated non-perturbative overlaps in Jackiw-Teitelboim (JT) gravity to uncover universal signatures of quantum chaos and quantum complexity. From the overlaps, we derived a generating function $\langle e^{-\alpha l}\rangle$, which serves as a probe for quantum chaos, exhibiting time evolution similar to that of the spectral form factor (SFF). Importantly, as α decreases, we observe a transition in behavior - from that of the SFF to that of the complexity - highlighting the utility of the generating function as a probe of quantum chaos.
We further generalize our result and demonstrate that universal time evolution of the complexity is governed by the pole structure of observables. Finally, we discuss extensions to codimension-zero observables.

29. **Souparna Nath** (Tata Institute of Fundamental Research)

Title : Complexity Growth, Krylov-Wigner function and Gravity

Abstract : Given a strongly coupled quantum system, what is the general strategy to identify when it admits a dual, semi-classical description, particularly one involving gravity?

A way of quantifying the notion of semi-classicality is by introducing the Wigner function, which is a 'quasi-probability' description of a quantum mechanical state in phase space. In general, given an everywhere-positive Wigner function, evolution with an arbitrary unitary operator will force it to develop negative regions. On the contrary, evolution by specific operators (called Clifford operations) will maintain its 'positivity'. Such operations are also the ones that can be described using polynomial run time algorithms. We have introduced a feature of these negative Wigner regions (called 'negativity') as a measure of non-polynomial run time evolution of a state (and hence present it as some notion of computational complexity).

Another interesting feature of the Wigner function is that even for the same set of operations, the rate of growth of the negative Wigner regions varies depending upon the basis in which one computes the Wigner function (clearly, the slower it grows, the more efficient the time evolution of a state is). We study the Wigner function in the Krylov basis and show that the growth is minimum in this basis. There is a connection of Krylov basis and gravity which lets us make the following claim: 'gravitational variables correspond to a basis that makes the time evolution as efficient as possible'.

30. **Stanislav Filatov** (Univesity of Latvia)

Title : Geometry of Two-Qubit Entanglement on Two Bloch Spheres.

Abstract : We have found a way to represent any pure two-qubit state within two Bloch Spheres. The main achievement is the representation of maximally entangled states. In such representation coordinate axes (x,y,z) of the spheres play a key role. Their relative orientation encodes particular maximally entangled state. A characteristic symmetry unites all maximally entangled state representations. It is a requirement that the coordinate systems of the spheres have opposite handedness: one right-handed, the other left-handed.
We would like to discuss with participants of the Bootstrap relation of this geometric peculiarity on two-partite level to geometry of entanglement on cosmological level (ER=EPR) and geometry of space(time) in general.
https://arxiv.org/abs/2406.05174
https://doi.org/10.3390/e26040280

31. **Taishi Kawamoto** (Yukawa Institute for Theoretical Physics, Kyoto University)

Title : Non-local TTbar deformation and wormholes in AdS/CFT

Abstract : Wormholes are universal objects in gravitational theories.
Recently importance of wormholes are getting important since they are accounts of structure of entanglement or chaos in holographic quantum many body systems. Even though the wormholes are important objects in AdS/CFT correspondence the concrete discussion for them are still limited in low dimensional examples basically in Nearly AdS2 /nearly CFT1 correspondence or JT/SYK correspondence.

In this talk I will introduce recent developments of the robust construction of wormholes in AdS3/CFT2 via back reacting deformations. Especially I discuss the non-local TT bar deformation and its holographic duals. We find that the deformed theory is duals to some non-local gravity theories which can be regarded as an effective field theory of microscopic wormhole in some local quantum gravity.

The talks are based on the papers arXiv:2502.03531.

32. **Takato Mori** (Rikkyo University)

Title : Quantum correlation beyond entanglement: Holographic discord and multipartite generalizations

Abstract : While entanglement is a cornerstone of quantum theory and holography, quantum correlations arising from superposition, such as quantum discord, offer a broader perspective that has remained largely unexplored in holography. We construct gravity duals of quantum discord and classical correlation. In both holographic systems and Haar random states, discord exceeds entanglement, revealing an additional quantum correlation linked to the Markov gap and non-distillable entanglement, suggesting holographic states are intrinsically non-bipartite. In black hole setups, discord can increase despite decoherence and persists beyond the sudden death of distillable entanglement. Motivated by the holographic formula, we define reflected discord — an optimization-free boundary quantity based on reflected entropy — which remains effective even outside the holographic regime. We also propose several multipartite generalizations of discord, including a holography-inspired one based on multi-entropy. These results provide new tools for quantifying quantum correlations beyond entanglement in strongly coupled many-body systems and offer a novel approach to multipartite correlation measures.

33. **Wayne Wei-en Weng** (Cornell University)

Title : Replica manifolds, pole skipping, and the butterfly effect

Abstract : In holographic theories, the butterfly velocity can be defined two different ways, using out-of-time-order correlators (OTOCs) or entanglement wedge reconstruction. There are many explicit calculations showing that the two velocities are equal, including in theories with higher curvature corrections, but there was no general explanation for this apparent coincidence. We show that it follows from a deeper relationship between replica manifolds, shockwaves, and the so-called pole skipping mode in the thermal two-point function.

Based on [2504.08139] with Wan Zhen Chua and Thomas Hartman.

34. **Wei-Hsiang Shao** (RIKEN iTHEMS)

Title : Stringy Nonlocality and Short-Lived Hawking Radiation

Abstract : Non-perturbative quantum gravity effects are expected to resolve the black hole information puzzle—but could such effects also significantly alter the Hawking process itself? This poster conveys two main points:

1. For large black holes formed by dynamical collapse, the effective field theory description of Hawking radiation breaks down after the scrambling time, signaling the need for a UV theory to describe the origin of late-time radiation.
2. In UV models of the radiation field incorporating string-inspired nonlocality with UV/IR mixing, Hawking radiation becomes strongly suppressed after the scrambling time, suggesting a major deviation from the conventional semiclassical picture of black-hole evaporation.

35. **Xin-Xiang Ju** (University of Chinese Academy of Sciences)

Title : Multi-invariants of stabilizer states

Abstract : Stabilizer states—central to quantum error correction—exhibit a flat Rényi-entropy spectrum for every bipartition. Going beyond bipartitions, we analyze a suite of multipartite invariants, focusing on multi-Rényi entropies, across large families of stabilizer states via combinatorial methods. We obtain explicit formulas showing that, unlike the bipartite case, the multi-Rényi spectra are nontrivial and organize into distinct polynomials in $1/n$ (with n the Rényi index). These results reveal fine-grained multipartite entanglement structure in stabilizer states and suggest how different multi-invariants capture distinct facets of these correlations.

36. **Canceled ()**