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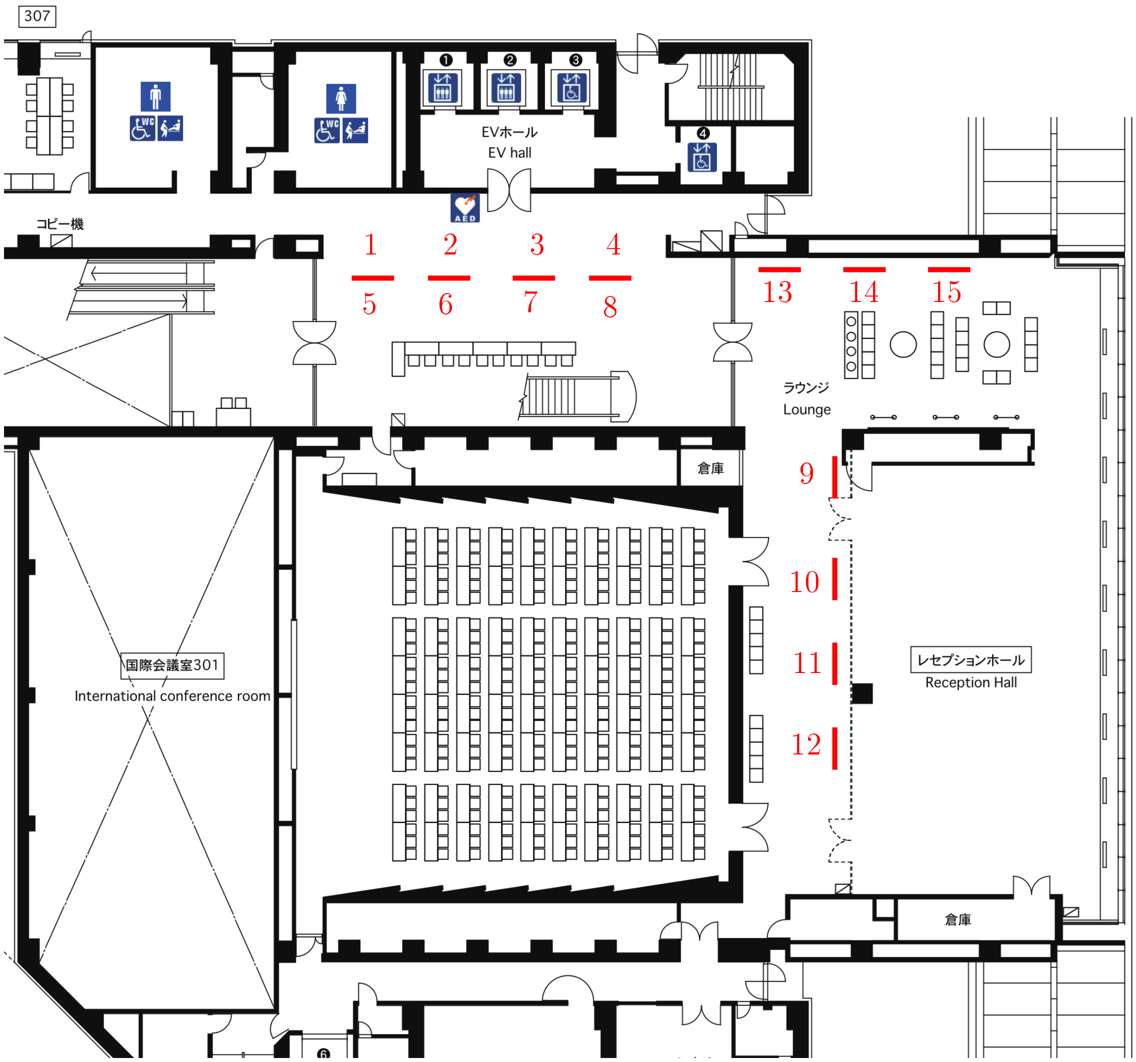
Poster Presentations

The locations of the posters are indicated by red segments.



List of poster presentations

Shu Hamanaka
Kyoto university

Analysis of the one-dimensional correlated non-Hermitian systems

Dec. 26 (Gong show+Poster Session 17:20-19:00)
Note that the presentation will be given online via Zoom.
The poster will also be shown on Poster Board:#1(Left Panel) during the meeting.

Non-Hermitian physics attracts a lot of attentions in condensed matter physics [1]. Because of non-Hermiticity, eigenvalues of the Hamiltonian may become complex. This mathematical property enriches the topological aspect in non-Hermitian systems. While most previous theoretical studies focused on the topology of non-interacting systems, some experiments realize the strongly correlated effect to non-Hermitian systems [2],[3]. Here we numerically clarify interaction effects on non-Hermitian systems for a one-dimensional correlated model [4],[5]. In particular, we discuss how the correlations affect the unique phenomenon of non-Hermitian physics such as skin effects and exceptional points [6][7].

[1] Y. Ashida et al., Adv. Phys. 69, 249-435 (2020).
[2] T. Tomita et al., Science Advances 3 e1701513 (2017).
[3] J. M. Koh et al., npj Quantum Inf 8, 16 (2022).
[4] L. M. Falicov and J. C. Kimball, Phys. Rev. Lett. 22, 997-999 (1969).
[5] J. Hubbard, Proc. R. Soc. Lond. A276238-257 (1963).
[6] S. Yao and Z. Wang, Phys. Rev. Lett. 121, 086803 (2018).
[7] T. Yoshida et al., Phys. Rev. B 99, 121101 (2019).

Jonathan Harper
Yukawa Institute for Theoretical Physics, Kyoto University

Perfect tensor hyperthreads

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#2(Left Panel)

Bit threads, a dual description of the Ryu-Takyanagi formula for holographic entanglement entropy (EE), can be interpreted as a distillation of the quantum information to a collection of Bell pairs between different boundary regions. In this presentation we discuss a generalization to hyperthreads which can connect more than two boundary regions leading to a rich and diverse class of convex programs. By modeling the contributions of different species of hyperthreads to the EEs of perfect tensors we argue that this framework may be useful for helping us to begin to probe the multipartite entanglement of holographic systems. Furthermore, we demonstrate how this technology can potentially be used to understand holographic entropy cone inequalities and may provide an avenue to address issues of locking.

Taishi Kawamoto
Yukawa Institute for Theoretical Physics, Kyoto University

AdS/CFT without boundary

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#3(Left Panel)

We consider field theory on AdS spacetime which couple to another AdS spacetime at the conformal boundaries. The two AdS spacetimes are expected to communicate with each other by energy flow passing through the conformal boundaries. We elaborate to solve the Israel junction for the pure gravities and the Vaidya metrics. We consider the holographic dual on the junction surface This set up is also related to the recent braneworld holography set up and one kind of dS/CFT correspondence.

This talk is based on a work on progress with Tadashi Takayanagi and Shan-Ming Ruan.

Yoshinori Matsuo
Kindai University

Fluid model of black hole/string transition

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#4(Left Panel)

We propose a fluid model of self-gravitating strings. It is expected that black holes turn into strings around the end of black hole evaporation. The transition will occur near the Hagedorn temperature. After the transition, strings would form a bound state by the self-gravitation. Horowitz and Polchinski formulated a model of self-gravitating strings by using winding strings wrapping on the Euclidean time circle. We first show that winding strings in the Horowitz-Polchinski model approximately behave as a perfect fluid. Then, we solve the Einstein equation for the fluid of winding strings. Our solution reproduces behaviors of the self-gravitating string solution in the Horowitz-Polchinski model near the Hagedorn temperature, while it approaches the Schwarzschild black hole in low temperature. Thus, our fluid model of self-gravitating strings gives a description of the transition between black holes and strings.

Ali Mollabashi
Yukawa Institute for Theoretical Physics, Kyoto University

Entanglement Evolution in Integrable Scale-invariant Theories

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#5(Left Panel)

In two dimensional isotropic scale-invariant theories, the time scaling of the entanglement entropy of a segment is fixed via the conformal symmetry. We show that the story is different in integrable Lifshitz theories where most of the entanglement is carried by the low-energy modes. At early times entanglement grows linearly due to the contribution of the high-energy modes, before smoothly entering a slow mode regime where it grows forever with $t^{1/1-z}$. We check our analytical results against numerical simulations in corresponding fermionic and bosonic lattice models finding extremely good agreement. We show that in these non-relativistic theories that the slow modes are dominant, local quantum information is universally scrambled in a stronger way compared to their relativistic counterparts.

Pratik Nandy
Yukawa Institute for Theoretical Physics, Kyoto University

Operator growth in open quantum systems

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#6(Left Panel)

Under the Hamiltonian evolution, a simple operator turns into a complicated operator. The growth of such an operator is drastically different when the system is connected with a dissipative environment than a typical closed system. We probe such growth with a recently explored measure of scrambling known as Krylov complexity. I will present some numerical results on open spin systems and some analytical results for the open SYK model.

Juan Pablo Bayona Pena
Condensed matter group, Kyoto University

Influence of random interactions in a many body dissipative system

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#7(Left Panel)

Our research is concerned with the introduction of random interactions for a mesoscopic quantum dot system undergoing dissipative dynamics. Random interactions are modeled as two-body interactions within the mesoscopic system through an SYK-2 Hamiltonian. The dynamics of the system is considered by deriving the equation of motion of the mesoscopic system imposing a Markovian evolution. Numerical analysis shows that randomness affects physical quantities such as purity and von-Neumann entropy behavior, inducing non-monotonic evolution, and the state at the long time limit differs from the maximally entangled state. Moreover, the correlation function of the dot particle was found to undergo slowly decaying dynamics which resembles classical spin glasses.

Shan-Ming Ruan
Yukawa Institute for Theoretical Physics, Kyoto University

Complexity Equals Anything

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#8(Left Panel)

In the previous work [arXiv:2111.02429], we present a new infinite class of gravitational observables in asymptotically Anti-de Sitter space living on codimension-one slices of the bulk geometry and argue that any member of this class of observables is an equally viable candidate as the extremal volume for a gravitational dual of complexity. Recently, we expanded on our results to a broad new class of gravitational observables living on codimension-zero regions of bulk spacetime. The most known observables in this class are the action and the spacetime volume of the Wheeler-DeWitt patch. We show that these infinite codimension-zero/one observables display two key universal features for the thermofield-double state: they grow linearly in time at late times and reproduce the switchback effect. Further, we show that variations of both the codimension-zero and codimension-one observables are encoded in the gravitational symplectic form on the semi-classical phase space, which can then be pushed to the boundary CFT.

Sunil Kumar Sake
Osaka University

Jackiw-Teitelboim Gravity in the Second Order Formalism

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#9(Left Panel)

We formulate the path integral for Jackiw-Teitelboim gravity in the second order formalism working directly with the metric and the dilaton in both Anti-de Sitter(AdS) and de Sitter space(dS). In the dS case with disk topology, the path integral evaluates the wavefunction of the universe which arises in the no-boundary proposal. We will also analyze the behavior in the presence of conformal matter. In the connected geometry with two boundaries, for both AdS and dS, we find that bosonic matter gives rise to a diverging contribution in the moduli space integral rendering the path integral ill-defined and shall discuss how this can be avoided. For the pure dS JT theory without matter, the path integral gives rise in general to the Hartle-Hawking wave function which describes an arbitrary number of disconnected universes produced by tunnelling "from nothing", or to transition amplitudes which describe the tunnelling of an initial state consisting of several contracting universes to a final state of several expanding universes. These processes can be described by a hologram consisting of Random Matrix Theory (RMT) or, after some modification on the gravity side, by a hologram with the RMT being replaced by SYK theory.

Soichiro Shimamori
Osaka University

The epsilon expansion of O(N) model with a line defect from conformal field theory

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#10(Left Panel)

Defect conformal field theories play an important role in describing critical phenomena and their universality classes in the presence of defects. In general, epsilon expansion around the free theory gives rise to new interacting conformal field theories. These theories are well known for Wilson-Fisher fixed points, where fields acquire anomalous dimensions due to quantum corrections. Rychkov and Tan show that these anomalous dimensions can be derived by using three reasonable axioms without resorting to Feynman diagram calculations. In my talk, I consider O(N) model with a line defect where a magnetic field is localized. I show that via Rychkov-Tan method, the bulk criticality and defect conformal symmetries completely and axiomatically determine the critical defect coupling up to leading order of ϵ. Furthermore, we give the outline for determining the anomalous dimensions of other operators which are vector or tensor representations of O(N).

Yusuke Taki
Yukawa Institute for Theoretical Physics, Kyoto University

CFT duals of three-dimensional de Sitter gravity

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#11(Left Panel)

dS/CFT correspondence, a holographic duality for de Sitter gravity, has not been well understood compared to AdS/CFT. We propose a class of dS/CFT correspondence between three-dimensional de Sitter spaces and two-dimensional CFTs. We argue that such a CFT includes an SU(2) WZW model in the critical level limit k->-2, which corresponds to the classical limit of the gravity side. This dS/CFT can be generalized to the higher-spin gravity on de Sitter space, which is dual to SU(N) WZW model with the limit k->-N. We confirm that under this proposed duality the classical partition functions in the gravity side can be reproduced from CFT calculations. Moreover, we analyze two-point functions and entanglement entropy in our dS/CFT correspondence.

Zixia Wei
Yukawa Institute for Theoretical Physics, Kyoto University

Counting atypical black hole microstates from entanglement wedges

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#12(Left Panel)

Typicality, the feature that almost any microstate living in the microcanonical subspace cannot be locally distinguished from a thermal ensemble, lies at the fundamental part of statistical physics. However, one may wonder if there exists a sufficient amount of orthogonal atypical states to account for the whole entropy.

In this talk, we show that, in some physical systems, there exists a sufficient amount of certain orthogonal atypical states to account for the leading order of the entropy in the following two scenarios, by finding proper upper bounds of the entanglement of formation (EoF) for each case and applying other techniques from quantum information theory.

In the first scenario, the physical system under consideration is AdS black holes at the semiclassical limit $G_N \to 0$. In this case, microcanonical subspace is the subspace formed by the black hole microstates, and typical states are usually considered to have a smooth horizon as well as the black hole interior. We consider a class of atypical states called disentangled states which have large entanglement deficits compared to typical states such that they cannot have smooth horizons. In this scenario, we use a geometric quantity called entanglement wedge cross section to give upper bounds to EoF.

In the second scenario, we consider generic quantum many-body systems with short-ranged interactions at the standard thermodynamic limit $V \to \infty$. In this case, it is known that typical microstates have volume law entanglement. We consider area-law entangled microstates as atypical states. We use reflected entropy to give upper bounds to EoF.

We will also discuss the relations of our results with the additivity conjectures and atypical black hole microstate counting.

This talk is based on 2211.11787, coauthored with Yasushi Yoneta.

Kazuya Yamashita
Graduate School of Science, Kyoto University

Production of ultracold atomic gases of lithium towards experiments on quantum information dynamics of quantum many-body systems

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#13(Left Panel)

In recent years, approaches to quantum many-body physics and quantum non-equilibrium phenomena from a quantum-informational viewpoint have been attracting much attention. In order to access this topic experimentally, we are constructing a new apparatus for producing quantum degenerate gases of lithium, which is designed to observe measurement-induced transition and to measure Out-of-Time-Ordered Correlator (OTOC) in ultracold atoms in an optical lattice. In this poster presentation, we will give the details of the experimental setup and future prospects.

Atis Yosprakob
Condensed matter theory group, Niigata University

Quantum tunneling in the real-time path integral by the Lefschetz thimble method

Dec. 26 (Gong show+Poster Session 17:20-19:00); Poster Board:#14(Left Panel)

Quantum tunneling has been playing an important role in high-energy physics and cosmology. The best method we use to understand the process so far is based on imaginary-time formalism. However, to study its dynamics, it is unavoidable to consider real-time formalism, whose path integral is highly oscillatory. Fortunately, Picard-Lefschetz theory can be used to make the integral converge, enabling us to perform the computer simulation. In this work, we apply the Monte Carlo simulation based on thimbles to study real-time tunneling and discuss the dominant trajectories that appear dynamically in the path integral. In particular, we discover that complex trajectories are playing an important role in the thimble calculation.

Shunsuke Furuya
Department of Basic Science, University of Tokyo

Preparation of many-body ground states via spatially varying feedback control

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#1(Right Panel)

Feedback control is an important concept to protect quantum states against unnecessary decoherence caused by their environments. In fact, many efforts have been made for Markovian feedback controls of quantum states to, for example, preserve the coherence of qubits or cool down cold atomic systems. In this presentation, we discuss the construction of the feedback Hamiltonian of a one-dimensional quantum many-body system based on the sine-square deformation.

Dongsheng Ge
Osaka University

Evolution of Entanglement Entropy in Virasoro Coherent States

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#2(Right Panel)

In this work we study families of generalised coherent states constructed from SL(2,R) subalgebras of the Virasoro algebra in two-dimensional conformal field theories. We derive the distribution of the energy density and entanglement entropy in these states and discuss their equivalence with analogous quantities computed in excited states. Finally, we discuss their holographic interpretation in AdS3, match our CFT results with Ryu-Takayanagi formula and discuss some of their applications in holography.

Atsushi Iwaki
University of Tokyo

Computational Complexity of MPS-based Samplings at Finite Temperature

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#3(Right Panel)

Random sampling methods are the standard numerical route to generate a thermal equilibrium quantum state at finite temperatures. Recently, Goto et al. defined the efficiency of samplings and demonstrated that internal entanglement of initial random states improves this sample efficiency [1]. Through careful examination of sample efficiency, we discovered an important physical quantity, normalized fluctuation of partition function (NFPF), and showed that fluctuation of physical quantities in random samplings is bounded by NFPF [2]. In this work, we investigate analytically and numerically NPFP which is proportional to the required number of samples, and we find that the system size dependence of NFPF varies with temperature.

[1] S. Goto, R. Kaneko, and I. Danshita, PRB 104, 045133 (2021).
[2] A. Iwaki and C. Hotta, PRB 106, 094409 (2022).

Yunhyeon Jeong
Quantum Dynamics Group, Tohoku University

Imaging of expanding edges in quantum Hall systems

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#4(Right Panel)

We present spectroscopy measurements with scanning confocal microscope resolving real-time and space domain and, imaging of expanding edges of quantum Hall systems. While expanding edges of quantum Hall systems might provide us new platform of experiments on cosmology, our experiments can answer the question: how do the edges expand?

Kohki Kawabata
University of Tokyo

Narain CFTs from quantum error-correcting codes

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#5(Right Panel)

Recently, a class of Narain CFTs was constructed from quantum error-correcting codes (QECCs). We generalize this construction to a larger class of QECCs called qudit codes. In particular, we focus on qudit CSS codes, which are closely related to classical linear codes. We also discuss partition functions averaged over qudit CSS codes and their properties.

Shunichiro Kinoshita
Nihon University

On geometrical origin of Kodama vector and its appliations

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#6(Right Panel)

It is known that warped product spacetimes such as spherically symmetric ones admit Kodama vectors, which provide a conserved current. We discuss geometrical origin of this vector and try generalizing the notion of the Kodama vector.

Hidetaka Manabe
Graduate School of Informatics, Kyoto University

Variational optimization of two-dimensional MERA with GPGPU

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#7(Right Panel)

Multi-scale entanglement renormalization ansatz (MERA) describes a ground state of quantum matter, especially at a quantum critical point. Most numerical calculations refer to one-dimensional models because working with two-dimensional lattices is difficult due to the large space and time complexity of MERA. In this study, we use heuristic contraction tree optimization and slicing technique to distribute computation over many GPGPUs, resulting in a tremendous increase in the computation speed of evaluating two-dimensional MERA.

Giacomo Marmorini
Nihon University

Quantum state tomography via compressed spiral sensing

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#8(Right Panel)

One of the fascinating aspects of the second quantum revolution is the inclusion of the density matrix among the observables that can be accessed experimentally, a process known as quantum state tomography. Remarkable success has been achieved in this direction in experiments with very few qubits, mostly in the context of photonic systems. Clearly, the exponential growth of the Hilbert space with the system size hinders the application of full tomography, but the introduction of quantum compressed sensing [1,2] via random Pauli measurements has paved the way for efficient tomography of physically interesting (low-rank) states of N-qubit systems, with N up to about 10. Here we develop a quantum tomography protocol that can be efficiently implemented in cold-atom systems in optical lattices, in particular two-component fermions/bosons simulating interacting spin-1/2 systems. The quantum gas microscopic technique [3] allows the measurement of one component of the (pseudo-)spin on individual sites and correlations thereof; however, performing generic Pauli measurements, if in principle possible, can be exceedingly expensive, due to the huge number of sensitive local optical operations needed. We propose a protocol inspired by the theory of antiferromagnetism that employs only "global" operations, namely spin rotations on all lattice sites described by a pitch vector. While the rigorous bounds of the original compressed sensing do not apply to the structured set of measurements obtained in this way, we show that a convincing degree of tomographic efficiency and accuracy can be obtained, especially for the ground state of common Hamiltonians.

[1] D. Gross et al., Phys. Rev. Lett. 105, 150401.
[2] C. Riofrío et al., Nat Commun 8, 15305 (2017).
[3] W. Bakr et al., Nature 462, 74-77 (2009).

Akira Matsumoto
iTHEMS, RIKEN

Mass spectrum of the 2-flavor Schwinger model with a theta term by tensor network method

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#9(Right Panel)

The Monte Carlo simulation plays an important role in studying nonperturbative aspects of QFT. However, it is not applicable to systems with a complex action, which is known as the sign problem. This problem prevent us from simulating various interesting systems such as finite density QCD, topological theta term and real-time dynamics. We focus on the Hamiltonian formalism of QFT, which is one of the methods to avoid the sign problem. Thanks to recent development of quantum computation and tensor network method, calculation of the ground state is becoming more efficient. In this work, we obtain the mass spectrum of the 2-flavor Schwinger model with a theta term by tensor network method (DMRG). We discuss the nontrivial phase structure at nonzero theta as well as the U(1) problem from the theta dependence of meson mass.

Koutaro Nakajima
Graduate School of Science and Technology, Niitgata University

Generalization of the angular-time evolution to the AKLT chain

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#10(Right Panel)

Quantum entanglement plays a key role for understanding physics of quantum many-body systems. However, since the quantum entanglement is not an observable, it is usually difficult to directly detect it. We propose a theory of an entanglement detection protocol for the AKLT chain, using the idea of the angular time evolution originating from a lattice version of the Unruh effect.

Arthur Parzygnat
Graduate School of Informatics, Nagoya University

Axioms for Quantum Retrodiction

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#11(Right Panel)

Quantum mechanics is typically formulated as a theory of prediction, where an initial state and dynamics (possibly stochastic/irreversible) are used to predict the probabilities of measurement outcomes. Retrodiction, on the other hand, is a method of inferring past states based on a final state together with dynamics (again, possibly stochastic). Retrodiction, its definition and applicability, has been a subject of great debate for over 65 years. I will provide axioms for quantum retrodiction that instantiate Bayesian inference in the classical setting. I will provide evidence that the Petz recovery map, and none of its rotated variants, satisfy these axioms. This is joint work with Francesco Buscemi.

Diego Soligon
Nagoya University

Maximum size of black holes in the accelerating universe

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#12(Right Panel)

Taking into account angular momentum, gravitational waves and matter content we can derive a cosmological upper bound for the area of stable marginally outer trapped surfaces in a spacetime with positive cosmological constant. The model under consideration is consistent with the observed accelerating universe. This result gives a concrete limit to the size of black holes, which is relevant especially in the study of the early universe.

Shiro Tamiya
Department of Applied Physics, Graduate School of Engineering, The University of Tokyo

Decoupling with logarithmic-depth random Clifford circuits

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#13(Right Panel)

Decoupling is a central concept for understanding interesting phenomena that appeared both in quantum information theory and physics, e.g., quantum coding, thermalization, and black hole physics. However, our understanding of the dynamics required to reach decoupling is limited. One of the results is that two-local random Clifford circuits with all-to-all connectivity achieve decoupling at depth $O(\log^3 N)$ where N is the system size [W. Brown and O. Fawzi, arXiv:1307.0632]. In this study, we establish a numerical method to evaluate a decoupling extent under the quantum coding setup and reveal that decoupling is reached at only $O(\log(N))$ depth with two-local random Clifford gates with nearest-neighbor connectivity. This result deepens our understanding of complex quantum dynamics and further paves the way for the realization of decoupling processes with near-term quantum devices.

Daisuke Yoshida
Department of Mathematics, Nagoya University

Implications of the singularity theorem for the size of a non-singular universe

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#14(Right Panel)

A general property of universes without initial singularity is investigated based on the singularity theorem, assuming the null convergence condition and the global hyperbolicity. As a direct consequence of the singularity theorem, the universal covering of a Cauchy surface of a non-singular universe with a past trapped surface must have the topology of S^3. In addition, we find that the affine size of a non-singular universe, defined through the affine length of null geodesics, is bounded above. In the case where a part of the non-singular spacetime is described by Friedmann-Lemaître-Robertson-Walker (FLRW) spacetime, we find that this upper bound can be understood as the affine size of the corresponding closed de Sitter universe. We also evaluate the upper bound of the affine size of our universe based on the trapped surface confirmed by recent observations of baryon acoustic oscillations, assuming that our universe has no initial singularity.

Hirotaka Yoshino
Osaka Metropolitan University

Evaporation of a regularized charged black hole and the information loss problem

Dec. 27 (Gong show+Poster Session 17:20-19:00); Poster Board:#15(Right Panel)

One of the attractive solutions to the information loss problem is that the event horizon does not appear in the process of gravitational collapse and subsequent evaporation once the spacetime singularity is regularized by some mechanism, as pointed out by Hayward and Frolov. In this presentation, we examine whether this Hayward-Frolov scenario holds for the collapse of a charged star. Modeling the process of collapse and evaporation with the charged Vaidya spacetime, we analyze the spacetime structure of the evaporating black hole. An appropriately regularized evaporating Reissner-Nordstrom "black hole" turns out to have no event and Cauchy horizons, indicating the possibility that the Hayward-Frolov scenario may have sufficient generality as the solution to the information loss problem.
