Talk Date	Surname	Given name	Affiliation	Title	Abstract
Sep.26	Tamaoka	Kotaro	Nihon University	**Aspects of pseudo entropy**	Pseudo entropy is a holography-inspired generalization of entanglement entropy. We discuss some basic properties and applications of pseudo entropy, including amplification phenomena and the spectrum form factor.
Sep.26	Harper	Jonathan Edward	YITP, Kyoto University	**Perfect tensor hyperthreads**	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 article 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.
Sep.26	Numasawa	Tokiro	ISSP, The University of Tokyo	**SYK Lindbladian**	We study the Lindbladian dynamics of the Sachdev-Ye-Kitaev (SYK) model, where the SYK model is coupled to Markovian reservoirs with jump operators that are either linear or quadratic in the Majorana fermion operators. Here, the linear jump operators are non-random while the quadratic jump operators are sampled from a Gaussian distribution. In the limit of large N, where N is the number of Majorana fermion operators, and also in the limit of large N and M, where M is the number of jump operators, the SYK Lindbladians are analytically tractable, and we obtain their stationary Green's functions, from which we can read off the decay rate. For finite N, we also study the distribution of the eigenvalues of the SYK Lindbladians.
Sep.26	Wei	Zixia	Yukawa Institute for Theoretical Physics, Kyoto University	**Bootstrapping AdS/BCFT correspondence**	AdS/BCFT correspondence is duality between a (d+1)-D gravitational theory defined on an asymptotically AdS spacetime with an end-of-the-world brane and a d-D CFT defined on a manifold with boundary (BCFT). It has played important roles in recent developments of information paradox, by relating the above two pictures with an additional intermediate picture, in which a d-D black hole is coupled to a heat bath. However, the dictionary for AdS/BCFT is not well-established, partially because ambiguity in the gravitational setups, and hence it is known that there are many "problems" or puzzles in it. In this talk, we focus on the BCFT side and apply the conformal bootstrap method to study it, which helps us avoid ambiguities. By using the results from BCFT side as clues, we construct the corresponding AdS setups. We will see that aforementioned "problems" are automatically resolved in this approach.
Sep.26	Takasan	Kazuaki	University of Tokyo	**Ferromagnetism in tilted fermionic Mott insulators**	We investigate the magnetism in tilted fermionic Mott insulators. With a small tilt, the fermions are still localized and form a Mott-insulating state, where the localized spins interact via antiferromagnetic exchange coupling. While the localized state is naively expected to be broken with a large tilt, in fact, the fermions are still localized under a large tilt due to the Wannier-Stark localization and it can be regarded as a localized spin system. We find that the sign of the exchange coupling is changed and the ferromagnetic interaction is realized under the large tilt. To show this, we employ the perturbation theory and the real-time numerical simulation with the fermionic Hubbard chain. Our simulation exhibits that it is possible to effectively control the speed and time direction of the dynamics by changing the size of tilt, which may be useful for experimentally measuring the out-of-time ordered correlators. Finally, we address the experimental platforms, such as ultracold atoms in an optical lattice, to observe these phenomena. This talk is based on our recent preprint arXiv:2111.03857.
Sep.26	Oshima	Hisanori	Department of Applied Physics, The University of Tokyo	**Measurement-induced criticality and charge fluctuation in U(1) symmetric monitored circuits**	The entanglement entropy shows a phase transition from a volume-law phase to an area-law phase, called measurement-induced entanglement transition, when a pure quantum state evolved under unitary dynamics is subject to local projective measurements. It is intensively studied due to emergence of conformal invariance at the phase transition, which is rarely found in non-equilibrium systems. In this talk, I will discuss critical phenomena in unitary-projective hybrid quantum circuits with U(1) symmetry (charge conservation). Numerical results show that, in addition to the conventional entanglement transition, a new transition obeying the Tomonaga-Luttinger liquid theory appears. The latter transition is characterized by critical behaviors in a subsystem charge fluctuation, a charge correlator, and the entanglement resolved by conserved charges. I also show that a correlator of subsystem charges can be used to locate this new transition point.
Sep.26	Yamashita	Kazuya	Department of Physics, Kyoto University	**An experimental approach to quantum nonequilibrium phenomena using ultracold atoms in optical lattices**	Ultracold atoms are a good platform for experimental studies of quantum non-equilibrium phenomena because of their large degrees of freedom and high controllability. We will introduce our previous work on quantum phases in an optical anti-dot lattice. Then, we will give an overview and the current status of our new experiments on quantum nonequilibrium phenomena using ultracold atoms to promote the study of the quantum features of black holes which is the main aim of the B02 group.
Sep.26	Marmorini	Giacomo	Nihon University	**Quantum state tomography via compressed spiral sensing**	One of the fascinating aspects of the second quantum revolution is the inclusion of the quantum state 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. Riofr?o et al., Nat Commun 8, 15305 (2017). [3] W. Bakr et al., Nature 462, 74?77 (2009).
Sep.27	Tajima	Hiroyasu	University of Electro Communications	**Universal trade-off structure between symmetry, irreversibility and quantum coherence and its application to black hole physics**	Symmetry, irreversibility, and quantum coherence are foundational concepts in physics. Here, we present a universal trade-off relation that builds a bridge between these three concepts. This trade-off particularly reveals that (1) under a global symmetry, any attempt to induce local dynamics that change the conserved quantity will cause inevitable irreversibility, and (2) such irreversibility could be mitigated by quantum coherence. Our fundamental relation also admits broad applications in physics and quantum information processing. In the context of thermodynamics, we derive a trade-off relation between entropy production and quantum coherence in arbitrary isothermal processes. We also apply our relation to black hole physics and obtain a universal lower bound on how many bits of classical information thrown into a black hole become unreadable under the Hayden-Preskill model with the energy conservation law. This particularly shows that when the black hole is large enough, under suitable encoding, at least about $m/4$ bits of the thrown m bits will be irrecoverable until 99 percent of the black hole evaporates. As an application to quantum information processing, we provide a lower bound on the coherence cost to implement an arbitrary quantum channel. We employ this bound to obtain a quantitative Wigner-Araki-Yanase theorem that comes with a clear operational meaning, as well as an error-coherence trade-off for unitary gate implementation and an error lower bound for approximate error correction with covariant encoding. Our main relation is based on quantum uncertainty relation, showcasing intimate connections between fundamental physical principles and ultimate operational capability.
Sep.27	Nema	Aditya	Graduate School of Informatics, Nagoya University	**Distillation of local pure states from a single copy of a given bipartite mixed state, aka, one-shot purity distillation**	One of the most fundamental resources for any quantum communication protocol is local pure states. In this work we obtain one-shot achievable bounds on the rates for distilling local pure states from a given mixed state. We refer to the task of obtaining pure states from a single system or a single party as purity concentration. In a bipartite setting wherein the two parties, Alice and Bob, obtain local pure states from a shared arbitrary quantum state, using catalytic ancilla and one way classical communication from Alice to Bob is referred to as the purity distillation. We also show that we can recover the asymptotic iid. rates of Devetak (PRA, 2005) from our one-shot rates up to first order analysis, which is similar to the analysis using asymptotic equipartition property.
Sep.27	Mizuta	Kaoru	RIKEN RQC	**Optimal and nearly-optimal Hamiltonian simulation of time-periodic systems**	Implementing Hamiltonian dynamics is one of the most significant tasks for quantum computers. Recently, the qubitization technique provides an efficient protocol for time-independent Hamiltonians, whose resource is optimal both in time and desirable accuracy. In contrast, simulating time-dependent systems requires much more cost than it according to the truncated-Dyson-series-based method. In our study, we compose the best Hamiltonian simulation algorithm for time-periodic systems as far as we know; the scaling of the cost is equal to or slightly larger than that for time-independent Hamiltonians in spite of the existence of time-dependency. We also discuss its application to the prediction of nonequilibrium quantum many-body phenomena.

Sep.27	**Minagawa**	**Shintaro**	Graduate School of Informatics, Nagoya University	**Von Neumann's information engine without the spectral theorem**	Von Neumann obtained the formula of entropy of a quantum state by assuming the validity of the second law of thermodynamics and considering the required work for the process that separates particles in a mixed state into those in a pure state with semipermeable membranes [1]. His thought experiment relies on the fact that any mixed quantum states can be decomposed into orthogonal pure states using a unique probability distribution. This mathematical structure of quantum theory, i.e., the spectral theorem, however, makes von Neumann's argument away from an operational narrative. In our work [2], we extract assumptions used in von Neumann's thought experiment and operationally reconstruct his argument using the framework of general probabilistic theories, which do not assume concrete mathematical structures a priori. In this way, we remove the role of the spectral theorem from von Neumann's thought experiment and explore the properties of entropy as consequences of the second law?not from the mathematical structures of theories?by assuming the validity of the second law. [1] J. von Neumann, Mathematical Foundations of Quantum Mechanics (Princeton University Press, Princeton, NJ, 1955). [2] S. Minagawa, H. Arai, and F. Buscemi, von Neumann's information engine without the spectral theorem, arXiv:2203.05258 (2022).
Sep.28	**Kaku**	**Youka**	Department of Physics, Nagoya University	**Quantumness of gravity in harmonically trapped particles**	In this talk, I will propose how to test the quantumness of gravity under the setup of the atomic interferometry. We evaluated interference visibility considering a particle with internal energy levels in a harmonic trapping potential. As per the result, for a spatially superposed gravitational source mass, interference visibility exhibits collapse and revival behavior, which implies that an initial separable internal state evolves to the entangled state with respect to the degrees-of-freedom of the center of mass, the internal energy levels, and the external source state. In particular, it does not exhibit revival behavior when gravity is treated as a quantum interaction; however, it revives with a finite period for a semi-classical treatment of gravity. I will also discuss that the entanglement between the internal energy state and the external source state is uniquely created by the quantum interaction of gravity in accordance with the mass-energy equivalence and the weak equivalence principle.
Sep.28	**Kinoshita**	**Shunichiro**	Nihon University	**Dynamical stability in holographic conductors**	In this study, we analyze the dynamical stability of the D3-D7 model dual to a holographic conductor with a constant current under an external electric field. We particularly focus on the stability around the parameter region where the multivalued relation between the external electric field and the current is shown due to nonlinear conductivity. The dynamical stability of the states can be analyzed by considering linear perturbations in the background states and computing the quasinormal modes. In the multivalued region, we find that the states in one branch with a low electric current can be dynamically unstable.
Sep.28	**Matsuo**	**Yoshinori**	Department of Physics, Kindai University	**Fluid model of black hole/string transition**	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 [arXiv:hep-th/9707170]. 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.
Sep.28	**Parzygnat**	**Arthur**	Nagoya University, Department of Mathematical Informatics	**Quantum states over time**	Given a quantum state at a single time together with a quantum channel, Fullwood and I constructed a self-adjoint matrix on the tensor product of the initial and final Hilbert spaces in a way that satisfies many mathematically and physically important properties. Our construction bypasses a no-go theorem of Horsman, Heunen, Pusey, Barrett, and Spekkens. I will talk about the significance of our result for temporal and causal correlations of quantum states.
Sep.29	**Jahn**	**Alexander**	California Institute of Technology	**Time dynamics in holographic tensor networks**	Much insight into the quantum information side of holographic dualities has arisen from studying simple toy models based on tensor networks. Such toy models typically fall into two classes: Those that implement holographic error-correcting codes between bulk and boundary degrees of freedom, and those that faithfully represent discretizations of boundary CFTs and their correlation functions. In our work, we show that both approaches can be combined by constructing tensor networks as discretized imaginary-time path integrals that produce a CFT ground state, and then systematically implanting bulk degrees of freedom that correspond to low-energy boundary excitations. The resulting code becomes asymptotically exact in the scaling limit, and can thus be used to study the holographic map between bulk and boundary time evolution in a concrete tensor network model.
Sep.29	**Yamamoto**	**Kazuhiro**	Department of Physics, Kyushu University	**Leggett-Garg inequalities for testing quantumness of gravity**	We investigate a violation of the Leggett-Garg inequalities due to gravitational interaction in a hybrid system consisting of a harmonic oscillator and a spatially localized superposed particle. The violation of the Leggett-Garg inequalities is discussed using the two-time quasiprobability in connection with the entanglement negativity generated by gravitational interaction. It is demonstrated that the entanglement suppresses the violation of the Leggett-Garg inequalities when one of the two times of the quasiprobability t_1 is chosen as the initial time. Further, it is shown that the Leggett-Garg inequalities are generally violated due to gravitational interaction by properly choosing the configuration of the parameters, including t_1 and t_2, which are the times of the two-time quasiprobability. The feasibility of detecting violations of the Leggett-Garg inequalities in hybrid systems is also discussed.
Sep.29	**Sugishita**	**Sotaro**	Nagoya University	**Rindler Bulk Reconstruction and Subregion Duality in AdS/CFT**	We study the AdS-Rindler reconstruction. The CFT operators naively given by the holographic dictionary for the AdS-Rindler reconstruction contain tachyonic modes, which are inconsistent with the causality and unitarity of the CFT. Therefore, the subregion duality and the entanglement wedge reconstruction do not hold. We also find that the tachyonic modes in the AdS-Rindler patch lead to arbitrary high-energy or trans-Planckian modes in the global AdS. It means that the mode expansion of the Rindler patch is sensitive to the UV limit of the theory, that is, quantum gravity. In addition, the tachyonic modes are related to the existence of null geodesics connecting the past and future horizons.
Sep.29	**Espindola**	**Ricardo**	University of Amsterdam	**Islands and traversable wormholes**	In recent years, entanglement islands have brought new insights into the resolution of the black hole information paradox. We address the possibility of extracting information from an island region by means of a simple protocol. In the bulk, it involves a traversable wormhole geometry that connects the island with two asymptotic regions. A similar matter can be studied in the context of de Sitter. We study islands in 'Centaur' or flow geometries, and a similar boundary protocol.
Sep.30	**Matsumura**	**Akira**	Department of Physics, Kyushu University	**Role of matter coherence in entanglement due to gravity**	We investigate the quantum nature of gravitational interaction in terms of the coherence of quantum objects. As a basic setting, we consider two gravitating objects each in a superposition state of two paths. The evolution of objects is described by the completely positive and trace-preserving (CPTP) map with a population-preserving property. This property reflects that the probability of objects being on each path is preserved. We use the l1-norm of coherence to quantify the coherence of objects. The quantum nature of gravitational interaction is characterized by an entangling map, which is a CPTP map with the capacity to create entanglement. We introduce the entangling-map witness as an observable to test whether a given map is entangling. We show that, whenever the gravitating objects initially have a finite amount of the l1-norm of coherence, the witness tests the entangling map due to gravity. Interestingly, we find that the witness can capture the signature of the entangling map due to gravity, even when the objects do not get entangled. This means that the coherence of gravitating objects always becomes the source of the entangling map due to gravity.
Sep.30	**Pedersen**	**Juan William**	The University of Tokyo	**Conserved charges in the quantum simulation of integrable spin chains**	In this talk, we present the result of the quantum simulation of the spin-1/2 Heisenberg XXX spin chain. We implement the integrable Trotterization algorithm, which allows us to control the Trotter error with conserved charges remaining conserve, on a real quantum computer and classical simulators. We study the effects of quantum noise on the time evolution of several conserved charges and specifically observe the decay of the expectation values. Our work improves our understanding of quantum noises and can potentially be applied to benchmark quantum devices and algorithms.
Sep.30	**Furuya**	**Shunsuke**	Department of Basic Science, University of Tokyo	**Gapless symmetry-protected topological phase in geometrically frustrated quantum spin chains**	Symmetry-protected topological (SPT) phases are representative of topological phases in strongly interacting quantum many-body systems. The topological character of the SPT phase is protected by symmetries and the existence of a nonzero excitation gap in bulk. Recently, novel SPT phases, gapless SPT phases, have been drawing attention for their nontrivial mechanism of symmetry protection. Despite the absence of the excitation gap in bulk, the topologically nontrivial entanglement spectrum sustains under symmetric perturbations. In this presentation, we will discuss a gapless SPT phase in geometrically frustrated quantum spin chains. We show how the quantum entanglement is protected without the excitation gap based on numerical and field theoretical approaches.
Sep.30	**Yosprakob**	**Atis**	KEK/Sokendai	**Thimble simulations of real-time quantum tunneling**	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.
Sep.30	**Watanabe**	**Masataka**	Yukawa Institute for Theoretical Physics	**Going beyond ER=EPR in the SYK model**	We discuss generalizations of the TFD to a mixed-state density matrix for the SYK model. We suggest that a semiclassical wormhole corresponds to a certain class of such density matrices, and specify how they are constructed using the chord diagram prescription for the double-scaled SYK. Time permitting I will also talk about generalisations to the SYK model with N=2 SUSY.

Sep.30	Taki	Yusuke	Yukawa Institute for Theoretical Physics	CFT duals of three-dimensional de Sitter gravity	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.
Sep.30	Shimada	Kengo	KEK Theory Center	Quantum/classical correlation and decoherence induced by relativistic quantum field	Motivated by BMV experiment to detect the quantum superposition of spacetime geometries, we consider a system of two spins interacting through a dynamical scalar field. Spin correlations are caused by the quantum entanglement between the scalar field and the spins. Evaluating the negativity and the mutual information, we discuss how the relativistic causality and the particle creation due to non-adiabaticity affect the spin correlations in various limiting cases.
Sep.30	ZHANG	Tingyu	The University of Tokyo	Information-Mirroring Andreev Reflection through Nonlinear Radio-Frequency Transport	We propose a laser-induced Andreev reflection between two-component Fermi superfluid and normal states via spatially-uniform Rabi couplings. We find that the Andreev current exhibits unconventional non-Ohmic transport at zero temperature. Remarkably, the Andreev current gives the only contribution in the synthetic junction system at zero detunings regardless of the ratio of the chemical potential bias to the superfluid gap, which is in sharp contrast to that in the conventional superconductor-normal metal junction. Our result may pave a way for understanding the black hole information paradox through the Andreev reflection as a quantum-information mirror.