# YITP Annual Report

**Yukawa Institute For**
**Theoretical Physics**
**Kyoto University**

**2021**

# Foreword

We present here an annual report of the scientific activities of Yukawa Institute for Theoretical Physics during the academic year 2021.

From the year 2007 we started our new project "Yukawa International program of Quark-Hadron Sciences (YIPQS)" funded by Japan Ministry of Education, Culture, Sports, Science and Technology. In this project we select a few research topics each year for long-term workshops and invite leading experts from abroad to stimulate discussion and to foster collaborations among workshop participants. In the year 2021, we planned two long-term work-shops "Novel Quantum States in Condensed Matter 2021" and "Gravity and Cosmology 2022", both of which, unfortunately, were cancelled due to the COVID-19 pandemic, and have been postponed to year 2022 or later, except YKIS2022a "Gravity - The Next Generation" held during 14-18, February, 2022. In order to enhance face-to-face communications among scientists even under the COVID-19 pandemic, we have newly established the domestic molecule workshop in 2021, which is similar to but more flexible than the international molecule workshop. We have six workshops of this type in 2021, which turned out to be very successful.

Not only has our institute pushed forward the research in contemporary theoretical physics, but also we encourage activities in creating new interdisciplinary fields of research involving the forefront of modern physics. On April 2016, we newly established a research organization "Center for Gravitational Physics (CGP)", and has developed collaborative researches among particle physics, astrophysics and cosmology. In January, 2018, we newly established a quantum information theory group as our 5th main research group in YITP, in addition to high energy physics, nuclear physics, astrophysics and cosmology, and condensed matter groups. In April 2020, we started to operate "International Research Unit of Quantum Information" in collaboration with 10 research organizations in Kyoto University. Finally, as CGP has stoped its activity at the end of this fiscal year, we plan to start a new project in the next year.

Since its foundation in 1953, our institute has played a role of international hub for the researchers in theoretical physics. I hope that this report makes our activities more accessible to researchers in the world, and helps them to visit us in the future.

Finally I hope that we will enhance our activities in research after (or with) the COVID-19 pandemic.

Director
Sinya Aoki

# Contents

## Chapter 1

# Members

# 1.1 Regular Staff, Visiting Professors and International Research Unit of Quantum Information Researchers (2021 April – 2022 March)

## Regular Staff

**Sinya Aoki**
Professor (E)

**Tadashi Takayanagi**
Professor (E)

**Hisao Hayakawa**
Professor (C)

**Akira Ohnishi**
Professor (N)

**Masaru Shibata**
Professor (A)

**Shigeki Sugimoto**
Professor (E)

**Shinji Mukohyama**
Professor (A)

**Masatoshi Sato**
Professor (C)

**Kunihito Ioka**
Professor (A)

**Masatoshi Murase**
Associate Professor (C)

**Hiroshi Kunitomo**
Associate Professor (E)

**Naoki Sasakura**
Associate Professor (E)

**Keisuke Totsuka**
Associate Professor (C)

**Naoyuki Itagaki**
Associate Professor (N) [2010.4.1 – 2022.3.31]

**Fumihiro Takayama**
Associate Professor (E)

**Atsushi Taruya**
Associate Professor (A)

**Antonio De Felice**
Associate Professor (A)

**Tomoyuki Morimae**
Associate Professor (Q)

**Yasuaki Hikida**
Associate Professor (E)

**Takahiro Nishimichi**
Associate Professor (A)

**Tatsuma Nishioka**
Associate Professor (E) [2021.1.1 – 2022.3.31]

**Yuko Fujita**
Senior Lecturer (Project Manager)

**Seiji Terashima**
Assistant Professor (E)

**Ken Shiozaki**
Assistant Professor (C)

**Masazumi Honda**
Assistant Professor (E)

**Yuya Tanizaki**
Assistant Professor (N)

**Andrew Darmawan**
Assistant Professor (E)

**Atsushi Naruko**
Assistant Professor (A)

**Nobuyuki Okuma**
Assistant Professor (C)

In this list, the symbols A, C, E, N and Q in the parenthesis are the following abbreviations of research fields:

A: Astrophysics and Cosmology
C: Condensed Matter and Statistical Physics
E: Elementary Particle Theory
N: Nuclear Physics Theory
Q: Quantum Information

## Visiting Professors

**Prof. Adi Armoni**
(Swansea University)
[2021.9.16 – 2022.1.14]
*Research on AdS/CFT from the flow method*

# International Research Unit of Quantum Information

**Michele Dall'Arno**
Program-Specific Assistant Professor
[2020.4.1 – 2025.3.31]

**Prof. János Balog**
Visiting Fellow
(Wigner Research Centre for Physics)
[2021.8.15 – 2021.9.14]

# 1.2 Hakubi Researchers, PRESTO Researchers, Research Fellows and Graduate Students (2021 April – 2022 March)

## Hakubi Researchers

**Tomonori Ugajin**
Hakubi Project Assistant Professor (E) [2020.4.1 –]

## PRESTO Researchers

**Andrew Darmawan**
PRESTO Assistant Professor (E) [2020.4.1 –]

## Research Fellows

**Atsushi Watanabe** (Program Coordinator) [2016.4.1 – ]

**Shuuichi Yokoyama** (E) [2016.4.1 – ]

**Kazuya Takahashi** (A) [2017.11.1 – ]

**Hamid Hamidani** (A) [2018.4.1 – ]

**Katsuki Aoki** (A) [2019.4.1 – ]

**Wataru Ishizaki** (A) [2019.4.1 – 2021.3.31]

**Keita Nii** (E) [2019.10.1 – 2022.3.31]

**Shun Arai** (A) [2020.4.1 – 2021.10.31]

**Yusuke Namekawa** (N) [2020.4.1 – ]

**Hidehiko Shimada** (E) [2020.4.1 – ]

**Satoshi Tanaka** (A) [2020.4.1 – ]

**Terufumi Yamaguchi** (C) [2020.4.1 – 2022.3.31]

**Hiroaki Matsunaga** (E) [2020.10.16 – 2022.3.31]

**Francesco Di Filippo** (A) [2020.11.1 – 2021.10.31]

**Ali Molabashi** (E) [2020.11.16 – 2021.11.30]

**Yuri Fukaya** (C) [2021.4.1 – 2021.5.31]

**Naotaka Kubo** (E) [2021.4.1 – 2022.3.31]

**Hidefumi Matsuda** (N) [2021.4.1 – 2022.2.28]

**Hiroki Matsui** (A) [2021.4.1 – 2022.3.31]

**Ryota Mizuno** (C) [2021.4.1 – ]

**Koichi Murase** (N) [2021.4.1 – ]

**Ken Osato** (A) [2021.4.1 – ]

**Kenta Suzuki** (E) [2021.4.1 – ]

**Kazufumi Takahashi** (A) [2021.4.1 – ]

**Takashi Yoshida** (A) [2021.4.1 – ]

**Hidekatsu Nemura** (E) [2021.6.1 – ]

**Hiroyuki Kitamoto** (E) [2021.7.1 – ]

**Inori Ueba** (E) [2021.7.1 – ]

**Masroor Chandhanapparambil Pookkillath** (A) [2021.10.1 – 2022.3.31]

**Saikat Das** (A) [2021.10.1 – ]

**Norita Kawanaka** (A) [2021.10.1 – ]

**Bing Zhang** (A) [2021.10.16 – ]

**Ibrahim Akal** (E) [2021.11.1 – ]

**Ben Quinn Baragiola** (Q) [2021.11.1 – ]

**Osmin Derius Lacombe** (A) [2021.11.1 – ]

**Shanming Ruan** (E) [2021.11.1 – ]

**Amit Kumar Chatterjee** (C) [2021.11.16 – ]

**Mohammad Ali Gorji** (A) [2021.11.27 – ]

## Graduate Students

**Yukihisa Imamura** (C) [2014.4.1 – ]

**Chen Hua** (E) [2015.10.1 – ]

**Yutaro Akahoshi** (E) [2017.4.1 – 2022.3.31]

**Takumi Bessho** (C) [2017.4.1 – 2022.3.31]

**Haruki Kasuya** (N) [2017.4.1 – ]

**Taigen Kawano** (E) [2017.4.1 – 2022.3.31]

**Tomoki Wada** (A) [2017.4.1 – 2022.3.31]

**Pradipto** (C) [2017.10.1 – ]

**Kota Hayashi** (A) [2018.4.1 – ]

**Daisuke Ishima** (C) [2018.4.1 – ]

**Fumiya Kato** (A) [2018.4.1 – 2020.9.30]

**Kazutaka Kimura** (A) [2018.4.1 – ]

**Riku Masui** (C) [2018.4.1 – ]

**Taisuke Matsuda** (A) [2018.4.1 – ]

**Kotaro Murakami** (E) [2018.4.1 – ]

**Masahiro Ogura** (C) [2018.4.1 – ]

**Zixia Wei** (E) [2018.4.1 – ]

**Ville Matias Mikael Paasonen** (C) [2018.10.1 – 2021.9.30]

**Masroor Chandhanapparambil Pookkillath** (A)

[2018.10.1 – 2021.9.30]

**Kenshiro Hara** (E) [2019.4.1 – ]

**Ryu Hayakawa** (Q) [2019.4.1 – ]

**Hayato Kanno** (E) [2019.4.1 – ]

**Daichi Nakamura** (C) [2019.4.1 – ]

**Naoto Oda** (C) [2019.4.1 – ]

**Hiroki Ohata** (N) [2019.4.1 – ]

**Shuhei Oyama** (C) [2019.4.1 – ]

**Dennis Obster** (E) [2019.10.1 – ]

**Masaya Amo** (A) [2020.4.1 – ]

**Takafumi Aoki** (E) [2020.4.1 – 2022.3.31]

**Taiga Hiroka** (Q) [2020.4.1 – ]

**Masashi Kawahira** (E) [2020.4.1 – ]

**Keiichiro Kubota** (A) [2020.4.1 – ]

**Yusuke Nakai** (C) [2020.4.1 – ]

**Hiroto Oka** (C) [2020.4.1 – ]

**Yusuke Taki** (E) [2020.4.1 – ]

**Misaki Yonekawa** (Q) [2020.4.1 – 2022.3.31]

**Paul Jeroen Laureis Martens** (A) [2020.10.1 – ]

**Kenya Ikeda** (E) [2021.4.1 – ]

**Kazuya Inaka** (C) [2021.4.1 – ]

**Takumi Kagitani** (Q) [2021.4.1 – ]

**Takafumi Kakehi** (A) [2021.4.1 – ]

**Taishi Kawamoto** (E) [2021.4.1 – ]

**Taiichi Nakanishi** (E) [2021.4.1 – ]

**Naoki Ogawa** (E) [2021.4.1 – ]

**Yuki Suzuki** (E) [2021.4.1 – ]

**Syuhei Toba** (A) [2021.4.1 – ]

**Takashi Tsuda** (E) [2021.4.1 – ]

**Takahiro Waki** (A) [2021.4.1 – ]

**Kazuki Doi** (E) [2021.10.1 – ]

# Ph.D Awarded

**Yutaro Akahoshi**
*Rho resonance from lattice QCD: Technical improvement and its application* (E)
(Sinya Aoki)
**Takumi Bessho**
*Extended Nielsen-Ninomiya theorem for Floquet and non-Hermitian systems* (C)
(Masatoshi Sato)
**Masroor Chandhanapparambil Pookkillath**
*Theoretical and Observational Constraints on the Cosmology of theories of Gravity* (A)
(Shinji Mukohyama)

**Ville Matias Mikael Paasonen**
*Pumping current in a non-Markovian N-state model* (C)
(Hisao Hayakawa)
**Tomoki Wada**
*Binary and Fireball as Possible Origins of Fast Radio Bursts* (A)
(Kunihito Ioka)

# 1.3 Affiliate Professors and Affiliate Associate Professors (2021 April – 2022 March)

## Affiliate Professors

**Nathalie DERUELLE**
Professor Emeritus, Astroparticule et Cosmologie - Université Paris Diderot

**Hideo KODAMA**
Professor Emeritus, Kyoto University

**Takahiro TANAKA**
Professor, Graduate School of Science, Kyoto University

**Yshai AVISHAI**
Professor, Department of Physics, Ben Gurion University

**Misao SASAKI**
Deputy director, Kavli Institute for the Physics and Mathematics of the Universe, The University of Tokyo

**Taichi KUGO**
Professor Emeritus, Kyoto University

**Jie MENG**
Professor, Peking University

**Masaki SHIGEMORI**
Affiliate Professor, Graduate School of Science, Nagoya University

## Affiliate Associate Professors

**Kohta MURASE**
Assistant Professor, Department of Physics, The Pennsylvania State University

**Shinji HIRANO**
Senior Lecturer, School of Physics, University of Witwatersrand

**Kenta KIUCHI**
Group Leader, Max Planck Institute for Gravitational Physics (Albert Einstein Institute)

**Yudai SUWA**
Associate Professor, The University of Tokyo, Graduate School of Arts and Sciences

**Takashi YAMAKAWA**
NTT Corporation

Chapter 2

# Research Activities

## 2.1 Research Summary

# Astrophysics and Cosmology Group

### Inflation and Early Universe

In our universe physical phenomena at various scales occur constantly, having mutual influence on each other. We consider it necessary for physics at the largest scales, i.e. cosmology, to be connected with physics at the shortest scales. For this reason we have been working on the early universe cosmology, where microscopic physics is essential, from various viewpoints by using every possible means such as general relativity, statistical physics, particle physics and superstring theory. For example, Gorji and Mukohyama proposed a new generation mechanism of dark photon dark matter during inflation. They also studied gravitational waves generated from axions, and obtained an analytical formula for the stochastic gravitational wave (GW) spectrum. Naruko and collaborators studied the fate of an axion cloud around a black hole in the presence of magnetic fields and estimated the decay rate of the axion cloud.

### Theory of Gravity

Massive gravity, the possibility that the graviton may have a non-vanishing mass, has a long history since Fierz and Pauli proposed a linear theory in 1939. It has nonetheless been rather difficult to establish a stable cosmological solution in the context of massive gravity. The minimal theory of massive gravity (MTMG) that De Felice and Mukohyama proposed in 2015 evades such difficulties and provides a fully stable nonlinear completion of the self-accelerating cosmological solution in massive gravity. De Felice, Mukohyama and Pookkillath studied cosmological consequences of MTMG and obtained the strongest observational bound on the graviton mass in the so-called normal branch of the theory. Recently the effective field theory (EFT) approach has been popular as a universal description of gravity on a given background and has been useful to interpret observational data in cosmology. Aoki, Gorji, Mukohyama and Takahashi for the first time constructed the EFT that universally describes all vector-tensor theories on homogeneous and isotropic cosmological backgrounds. This EFT is expected to act as the bridge between theories and observations. As for an observational test of modified gravity theories, Naruko and collaborators considered a binary system consisting of a black hole and a pulsar. They calculated the time of arrival of pulse signals emitted from the system and found that there is a possibility to distinguish between general relativity and a modified gravity theory with a future radio telescope such as the Square Kilometer Array.

### Observational Cosmology

The large-scale structure (LSS) observed via galaxy surveys carry ample cosmological information with which we can address various issues in cosmology. Toward the optimal cosmological parameter estimation, Osato, Nishimichi, Taruya and Bernardeau developed a fast computational method to predict the bispectrum based on perturbation theory (PT), and showed that it takes only few minitues to computure bispectra for $10^6$ triangles. Further, Taruya, Nishimichi and Jeong succeeded to incorporate the redshift-space distortions into the grid-based fast PT code called `GridSPT` for cosmological inference at the field level. These studies provide theoretical foundations to extract non-Gaussian information encoded in the LSS developed by nonlinearity of gravity, beyond the conventional methods based on two-point statistics, with which one can only access the Gaussian information. For more practical studies with observations, Kobayashi, Nishimichi and collaborators derive a tight constraint on the parameter $\sigma_8$, which quantifies the amplitude of cosmological fluctuations, from the largest 3D galaxy map by Sloan Digital Sky Survey (SDSS). They can improve the constraint from previous studies by using an accurate neural network-based theoretical template called an emulator trained by a large set of LSS simulations and tested against realistic mock galaxy catalogs. A similar emulator approach, but now based on Gaussian Process Regression, is used in a joint leansing-clustering analysis of Subaru Hyper Suprime Cam and SDSS by Miyatake and collaborators (incluing Nishimichi). These attempts are first applications of machine-learning techniques for cosmological inference problems. Furthermore, Yoshikawa, Tanaka and collaborators were selected as a finalist for the Gordon Bell Prize for their Vlasov simulation with $4 \times 10^{14}$ grid elements to reveal the impact of massive neutrinos on LSS conducted on Fugaku Supercomputer.

### Numerical relativity

Numerical relativity is a crucial tool to predict gravitational waveforms and electromagnetic signals of relativistic phenomena. It also plays an important role to interpret observational results for gravitational waves and their electromagnetic counterparts. In 2021, Hayashi, Shibata and their collaborators performed seconds-long neutrino-radiation-magnetohydrodynamics simulations for black hole-neutron star mergers for the first time. The simulations self-consistently show the tidal disruption of the neutron star, subsequent mass ejection and disk for-

mation, magnetohydrodynamical evolution of the disk and resulting post-merger mass ejection, and collimated Poynting flux generation along the rotation axis of the remnant black hole. This heralds the new era of numerical-relativity. Shibata and his collaborators also performed a resistive magnetohydrodynamics simulation for a post-merger remnant in which a long-lived massive neutron star survives for more than seconds. They showed that in the presence of efficient magnetic-field amplification by a dynamo effect, the post-merger ejected matter can have high kinetic energy, which generates characteristic signals in the radio and X-ray bands. Fujibayashi, Shibata, and their collaborators performed a simulation for the stellar core collapse of massive and rapidly rotating progenitor stars and showed that neutrino-driven explosion can take place in a late time after the core bounce because the rapidly rotating massive proto-neutron star becomes a very bright neutrino emitter.

## Gravitational-wave astronomy

Modeling electromagnetic counterparts of gravitational-wave sources is a required task in gravitational-wave astronomy. Kawaguchi, Shibata with collaborators explored electromagnetic counterparts of gravitational waves from low-mass binary neutron star mergers using a radiation transfer simulation and showed characteristic kilonova light curves. Shibata together with Carrasco and Reula performed a force-free electromagnetic simulation for inspiraling black hole-neutron star binaries and showed that strong electromagnetic waves are generated when the dipole-magnetic field lines of the neutron star are reconnected due to the formation of current sheets resulting from the strongly gravitational effects of the black hole. The associated emission of radio waves can be an observable precursor of black hole-neutron star mergers.

A detection of stochastic gravitational waves is prone to suffer from various systematics including a foreground noise. Himemoto, Nishizawa and Taruya investigated the impact of the overlapping gravitational waves from compact binaries on the subtraction of foreground gravitational waves. Despite the fact that there will be a non-negligible amount of overlapping signals expected from the third-generation detectors, they found that those signals do not produce a serious issue in the foreground removal.

## High Energy Astrophysics

Multi-messenger astrophysics and transient surveys are revealing new aspects of the high energy universe. It is very exciting to explore theoretically the mechanism of high-energy particles and relativistic jets produced by strong-gravity objects such as black holes and neutron stars, as well as newly discovered mysteries such as fast radio bursts (FRBs). Ishizaki, Ioka and their collaborators proposed a fallback accretion model for the X-ray counterpart to the gravitational wave event GW170817 at a few years. We also show that the usual fallback rate is halted by the r-process heating with hydrodynamic simulations, suggesting a possibility that future observations of fallback halting could constrain the r-process heating on the scale of years. Wada, Ioka and Zhang developed a binary model for the periodic and the first repeating FRB 121102, identifying two new modes and allowing the companion star to be a massive star, a massive black hole, or a supermassive black hole. Takahashi, Ioka and their collaborators investigated the basic statistics of the cosmological dispersion measure, such as its mean, variance, and correlation function, using the state-of-the-art hydrodynamic simulations, IllustrisTNG300, and provided the analytical fitting functions, which are the basis for the near-future FRB cosmology. Préau, Ioka and Mészáros presented a generic theoretical model for the structuring of a relativistic jet propagating through the ejecta of a binary neutron star merger event, introducing the effects of the neutron conversion-diffusion.

# Condensed Matter and Statistical Dynamics Group

## Topological Phases/Orders

*Nielsen-Ninomiya theorem in dynamical systems*

The Nielsen-Ninomiya theorem is a fundamental theorem on the realization of chiral fermions in static lattice systems in high-energy and condensed matter physics. Bessho and Sato extend the theorem in dynamical systems, which include the original Nielsen-Ninomiya theorem in the static limit. In contrast to the original theorem, which is a no-go theorem for bulk chiral fermions, the new theorem permits them due to bulk topology intrinsic to dynamical systems. The theorem is based on duality enabling a unified treatment of periodically driven systems and non-Hermitian ones. They also present the extended theorem for non-chiral gapless fermions protected by symmetry. Finally, as an application of our theorem and duality, they predict a new type of chiral magnetic effect – the non-Hermitian chiral magnetic skin effect.

*Ferromagnetism and symmetry-protected topological order in Kondo lattice systems*

The Kondo lattice model in which itinerant fermions interact with a periodic array of localized magnetic moments (spins) is one of the fundamental model for the heavy-fermion systems. Masui and Totsuka generalized the usual Kondo lattice model to the case of generic spin-$S$ magnetic moments, and rigorously showed that when the Kondo coupling is sufficiently strong, the ground state of the model is ferromagnetic (except for some special commensurate fillings) regardless of the value of $S$. They also considered the one-dimensional spin-1 Kondo-Heisenberg model to investigate how the symmetry-protected topological order in the absence of the Kondo coupling is destroyed by the (Kondo-)coupling to the fermionic environment.

The usual Kondo problem focuses on the competition between the magnetic ordering and singlet formation among the electron spins. Using the alkaline-earth-like cold fermionic gases, we can study similar physics in $N$-component ($N \leq 10$) systems in a clean and controlled way. Totsuka considered the SU($N$) Kondo lattice model that can be implemented with the so-called state-dependent optical lattice and showed that, via a generalized double-exchange mechanism, SU($N$) ferromagnetism is the ground state in a wide region of the phase diagram. He also pointed out that boson-fermion supersymmetry SU($N|1$) could be realized in the SU($N$) Kondo lattice model.

*Symmetry-Based Approach to Superconducting Nodes*

Determination of the symmetry property of superconducting gaps has been a central issue in studies of unconventional superconductivity. The existence of superconducting nodes, one of the few important experimental signatures of unconventional superconductivity, plays a vital role in exploring the possibility of unconventional superconductivity. Ono and Shiozaki developed a systematic framework to comprehensively classify superconducting nodes pinned to any line in momentum space, which enables systematic diagnoses of nodes in all nonmagnetic and magnetic space groups. Their framework can readily provide a highly effective scheme to detect nodes in a given superconductor by using density-functional theory and assuming symmetry properties of Cooper pairs.

*Non-Hermitian topological phenomena: A review*

The past decades have witnessed an explosion of interest in topological materials, and a lot of mathematical concepts have been introduced in condensed matter physics. Among them, the bulk-boundary correspondence is the central topic in topological physics, which has inspired researchers to focus on boundary physics. Recently, the concepts of topological phases have been extended to non-Hermitian Hamiltonians, whose eigenvalues can be complex. Besides the topology, non-Hermiticity can also cause a boundary phenomenon called the non-Hermitian skin effect, which is an extreme sensitivity of the spectrum to the boundary condition. In this paper, Okuma and Sato review developments in non-Hermitian topological physics by focusing mainly on the boundary problem. As well as the competition between non-Hermitian and topological boundary phenomena, they discuss the topological nature inherent in non-Hermiticity itself.

## Advanced Statistical Dynamics

The subjects of advanced statistical dynamics are nonequilibrium statistical mechanics, nonlinear sciences and biological physics. The main goal in this field is to understand how dynamical nonequilibrium structures are sustained in nature based on tools of statistical physics. Thus, the research areas are spreaded in variety of fields in social sciences, biology, chemistry, engineering, mathematics and physics. The current research activities of our group are quantum thermodynamics, granular physics, nonlinear rheology in glassy materials, biomechanics, and system biology.

*Rheology of dense granular and collodial particles*

Hayakawa together with Michio Otsuki of Osaka University numerically and theoretically study two-dimensional frictional and frictionless granular materials under oscillatory shear to clarify the mechanism of softening, i e. weakening of storage modulus and the behavior of loss modulus associated with this process. What they found are that (i) softening is not directly related to plastic events or yielding transition as many people believed but can be described by loop (and reversible) trajectories of grains, and (ii) loss modulus remains finite even in the low frequency limit. They also develop the theory to explain these results for frictionless cases. They have published the paper in PRL.

Hayakawa together with one of his students, Pradipto, have studied impact-induced hardening processes in dense suspensions numerically and theoretically. They have clarified the relationship between the elastic rebound of an impactor and relations among the impact speed $u_0$, maximum force acting on the impactor $F_{\max}$, and elapsed time tmax to reach $F_{\max}$. Introducing a phenomenology they succeed to reproduce the results of the simulation. They also investigate the dynamically jammed region (DJR) induced by an impact in dense suspensions and quantify its effective viscosity and elasticity. We propose a phenomenological model, called the DJR model, that contains the contributions from the effective viscosity and elasticity. They confirm good agreements between the results of the simulation and the DJR model for a free-falling impactor. They also discuss the impact of a foot-spring-body system in dense suspensions to mimic the running on the top of dense suspensions. The foot undergoes multiple rebounds and also hops multiple times due to the spring force and the rigidity of the suspensions. They then apply the DJR model to the foot-spring-body system and reproduces the results of the simulations. They also check the parameter dependences of the hopping motion and found that hopping and multiple rebounds are suppressed as the spring stiffness increases. They have published one paper and submitted one preprint on this subject.

Hayakawa together with one of his students, Daisuke Ishima, also numerically study the rheology of a two-dimensional frictional granular system confined by constant pressure under oscillatory shear to discuss scaling law and dilatancy. They have published one proceeding paper on this subject.

Hayakawa together with Satoshi Takada of Tokyo University of Agriculture and Technology with Spanish group have developed collaborating work on kinetic theory of a mixture of inertial suspensions. They have submitted one preprint on this subject.

*Exactly solvable non-equilibrium lattice model*

Hayakawa together with Amit Kumar Chatterjee who is a postdoc in this group have developed the theory of an exactly solvable model on lattice. They obtain an exact matrix product steady state for a class of multi species asymmetric simple exclusion process with impurities, under periodic boundary condition. Alongside the usual hopping dynamics, an additional flip dynamics is activated only in the presence of impurities. Although the microscopic dynamics renders the system to be non-ergodic, exact analytical results for observables are obtained in steady states for a specific class of initial configurations. Interesting physical features including negative differential mobility and transition of correlations from negative to positive with changing vacancy density, have been observed. They discuss plausible connections of this exactly solvable model with multi lane asymmetric simple exclusion processes as well as enzymatic chemical reactions. They have published one preprint on this subject.

*Theory of geometrical quantum thermodynamics in Thouless pumping process*

Hayakawa together with Ville Paasonen who is his student and has got PhD in September, 2021 and Ryohei Yoshii have developed the theory to describe a geometrical quantum thermodynamics in Thouless pumping processes. They have published two preprints and one published paper.

Hayakawa together with Paasonen have published a paper on a periodically modulated N-state model whose dynamics are governed by a time-convoluted generalized master equation. Based on this paper Paasonen has got PhD and has returned to Finland.

Hayakawa together with Paasonen and Yoshii have investigated a quantum engine under an adiabatic (Thouless) pumping process. They apply the formulation to the system for a quantum dot connected to external reservoirs under an isothermal condition. Thanks to the geometrical feature in this process, the entropy production is characterized by the geometric metric tensor which is connected to the Fisher information and Hessian of the density matrix in a nonequilibrium steady state. The existence of inequality between the thermodynamic length and entropy production is established. They also establish that the work done on this system characterized by a vector potential is equivalent to the thermodynamic flux. To characterize the engine, they introduce effective efficiency as the relation between the work and entropy production. Through the theoretical analysis of the quantum master equation for the Anderson model of a quantum dot within the wide-band approximation, they illustrate the explicit values of the work, thermodynamic length, and effective efficiency of the engine as functions of the phase difference of the externally controlled chemical potentials.

Hayakawa together with Yoshii developed the theory of an entropy production and a work extracted from a system connected to two reservoirs by periodic modulations of chemical potentials of the reservoirs and one parameter in the system Hamiltonian under an isothermal condition. They find that the modulation of parameters can drive a geometrical state, which is away from a nonequilibrium steady state. With the aid of this property, They construct a demon in which the relative entropy increases with time and we can extract the work, if they begin with the nonequilibrium steady state without modulations of parameters. They employ the Anderson model to demonstrate that the relative entropy can increase with time.

*What is life?*

Masatoshi Murase tried to challenge the long-standing problem: What is life? Of course, it is often mentioned that we will not be able to answer this problem satisfactorily even in the future. However, it is possible to provide an ostensive definition of life based on a self-consistent way. The details concerning Self-consistency, Self-transcendence, and Self-nonself Circulation would be available in the book on "Creative Complex Systems" published by Springer-Nature (Murase, 2021).

# Nuclear Theory Group

Nuclear theory group studies various aspects of the systems interacting via "strong interaction", covering three layers of the scale hierarchy. The relevant degrees of freedom in each layer are quarks and gluons also known as partons, hadrons such as mesons and nucleons, and nuclei composed of nucleons and hyperons. Study on diverse faces of nuclear physics revealing themselves in the different layers requires various theoretical knowledge and techniques in physics — quantum mechanics, relativity, field theories, and many-body theories. Main subjects discussed in nuclear theory group at present include the structure and dynamics of nuclei and hadrons, and hadronic and quark matter under extreme conditions. These are closely related to particle physics, astrophysical phenomena, condensed matter theories as well as to recent accelerator experiments in the world.

## Nuclear structure and dynamics

Nuclei sit at the center of atoms and specify the atomic element. Nuclei are composites made of nucleons (protons and neutrons) and have various structures and excitation schemes as quantum mechanical many-body systems. The primary goal of this area is to elucidate and predict the evolution of nuclear properties as functions of proton and neutron numbers — nuclear shape, density and mass of the ground and excited states, and the structure of the excited level spectrum. Especially, novel structures of neutron-rich nuclei are of particular interest.

### *Persistence of cluster structure in the ground state of $^{11}B$*

The $\alpha$ particles emitted from excited states of $^{12}$C could be utilized for cancer treatment and the method is called Proton Boron Capture Therapy (PBCT). The $\alpha$ particles are created by a clinical proton beam on the $^{11}$B target. The $^{11}$B+$p$ threshold corresponds to the excitation energy of 16.0 MeV in $^{12}$C, where the excited states decay by emitting $\alpha$ particles. For the nuclear structure side, whether the ground state of $^{11}$B contains the seeds of the cluster states is a crucial question. It has been known that one of the non-central interactions, the spin-orbit interaction, plays a role in nuclear systems of washing out the $\alpha$ clusters; it works as a driving force to stabilize the symmetry of the $jj$-coupling shell model. It is of special importance to show the persistence of $\alpha+\alpha+t$ cluster configuration in the ground state of $^{11}$B. In addition to the basis states with cluster configurations, Itagaki and collaborators included their breaking effects by employing the antisymmetrized quasi cluster model (AQCM). The cluster states and shell-model states are treated on the same footing and are coupled. The inclusion of the breaking effect of $\alpha+\alpha+t$ cluster structure is found to contribute to the lowering of the ground-state energy by about 2 MeV, and cluster structure is slightly broken. The third $3/2^-$ state has been suggested as a cluster state both theoretically and experimentally, and we confirmed the well-developed clustering. The ground state of $^{11}$B can be considered as a seed of the cluster states; it still keeps enough component of $\alpha+\alpha+t$ cluster. Assuming the typical three-$\alpha$ cluster state of $^{12}$C as an equilateral triangular configuration with the relative distances of $3-4$ fm, the ground state of $^{11}$B is found to have a certain squared overlap with such state when a proton approaches.

### *Role of Tensor Interaction as Salvation of Cluster Structure in $^{44}Ti$*

The $^{44}$Ti nucleus is believed to have a $^{40}$Ca+$\alpha$ cluster structure; however, $\alpha$ ($^4$He) cluster structure tends to be washed out when we allow its breaking due to the spin-orbit interaction. Nevertheless, $\alpha$ clustering in medium-heavy nuclei is quite a hot subject recently. The tensor interaction plays an essential role in the strong binding of the $^4$He, which induces the two-particle-two-hole (2p2h) excitation. This tensor effect is blocked when another nucleus approaches. Thus, Itagaki and collaborators have shown that this effect becomes the salvation of the $^{40}$Ca+$\alpha$ clustering in $^{44}$Ti. The competition of spin-orbit and tensor effects was investigated in the medium-heavy region for the first time.

## Quark-Hadron Sciences

Quarks and gluons are strongly interacting fundamental particles, but they are confined inside hadrons in vacuum. Nuclear theory group in YITP also studies the quark and hadron dynamics in nuclear physics, putting emphases on quark-gluon structure of hadrons, hadron resonances, hadron-hadron interactions, and the QCD matter properties under extreme conditions where the quark and gluons are liberated from hadrons.

### *Heavy-Ion Collisions and QCD matter*

At high temperature and/or density, a new form of matter consisting of quarks and gluons is expected to be realized. Actually, the experimental data accumulated at the Relativistic Heavy-Ion Collider (RHIC) and the Large Hadron Collider (LHC) imply the formation of the quark-gluon plasma (QGP). In the neutron star core and during the binary neutron star mergers, the baryon density significanlty exceeds the normal nuclear density and quarks may be deconfined.

While the QCD phase transition at zero baryon density is known to be crossover, the order of the transition is not known at finite density, where the Fermion determinant becomes complex and the sign problem arises

in the lattice QCD simulation and many other effects are expected from the formed Fermi sphere of quarks. Namekawa, Ohnishi and collaborators studied the sign problem of the 1+1D $U(1)$ gauge theory by using the path optimization method, in which the integration path is complexified and optimized to weaken the sign problem. While the optimization does not effectively proceed with the link variable input, the gauge invariant plaquette input was found to promote the optimization. This finding gives a basis to tackle the sign problem in more realistic cases. Namekawa and collaborators performed a lattice simulation using the complex Langevin equation for finite density QCD. Not only an artificial 4-flavor case but also a realistic 2+1-flavor case was explored. The quark number was found to have a plateau with its height proportional to the number of flavors, as expected from the quark degrees of freedom. An analytic study by the lattice perturbation theory is also accomplished for the color-superconductivity on the lattice. Namekawa and collaborators gave proof of the statistical analysis method for the worldvolume hybrid Monte Carlo algorithm, which is specific to control of the sign problem. A scaling law was predicted and confirmed numerically using a chiral random matrix model.

For the precise determination of the matter properties of the QGP created in the high-energy heavy-ion collisions, it is important to develop a quantitative dynamical model that describes the whole collision reaction including all the relevant effects. Hydrodynamic fluctuations, namely the thermal fluctuations of hydrodynamic systems, is one of the important effects. Murase and collaborators have studied the effect of the hydrodynamic fluctuations on the observables of heavy-ion collisions and shown for the first time that the centrality dependence of an observable called the longitudinal factorization ratio can be explained by considering both the hydrodynamic fluctuations and the initial longitudinal fluctuations.

## *Hadron structure and dynamics*

The structure of hadron resonances and the interactions between hadrons are the current subjects extensively studied both from experiments and theories. Hadron resonances around the threshold are well described within the effective field theory technique, and the recent lattice QCD data can be used to constrain the short distance behavior of the potentials. Ohnishi and collaborators studied the $S=-2$ baryon-baryon ($BB$) interactions, $\Xi N$-$\Lambda\Lambda$, using the $p\Xi^-$ and $\Lambda\Lambda$ correlation functions from high-energy nuclear collisions. By using the coupled-channel $S=-2$ $BB$ interactions from the lattice QCD, the correlation functions are calculated and are found to explain the recently observed data well. The agreement supports the correctness of the $BB$ interactions from lattice QCD. Namekawa and collaborators measured the $K_{l3}$ form factor by the lattice QCD simulation at the lattice spacings of 0.085 and 0.064 fm. The form factor characterizes the internal structure of $K \to \pi l \bar{\nu}_l$ process. The continuum extrapolation is executed using the two lattice spacings with two different current operators. Combining this form factor in the continuum limit with the decay rate in experiments, a Cabbibo-Kobayashi-Maskawa matrix element $|V_{us}|$ was extracted. The result is consistent with the value in Particle Data Group(2020), supporting 3.0 $\sigma$ tension from the standard model of the elementary particles.

## *Nonperturbative aspects of gauge theories*

Ground state of QCD itself is a consequence of rich dynamics of strong interactions. Understanding its properties requires us to be liberated from conventional Landau's criterion on phases of matters, and new field theoretic techniques are rapidly developing driven by curiosity on those quantum phenomena. Especially, the development of higher-form symmetries and related anomalies provides a systematic and powerful way to understand strongly-coupled systems in these days.

Tanizaki and collaborators developed a novel semiclassical description of 4d gauge theories by considering the $T^2$ compactification of the spacetime with the 't Hooft flux. The 't Hooft flux can be considered as a background magnetic field inside the compactified direction, and its presence plays the pivotal role to maintain the nontrivial anomaly of 4d Yang-Mills theory in the 2d effective theory. Furthermore, this technique is extended to the case with dynamical quarks, and the chiral effective Lagrangian is derived in a controllable semiclassical computation.

Strongly-coupled gauge theories also appear in the low-energy effective description of condensed matter systems, such as the quantum spin systems. Tanizaki and collaborators considered the $SU(3)$ spin systems on the triangular lattice and derived its nonlinear sigma model description. By considering the perturbation by monopole operators, the system is changed from the Néel phase to the valence-bond solid (VBS) phase, and this turns to be analogous to the Higgs-confinement phase transition. The 't Hooft anomaly is computed in this sigma-model description, and the trivially gapped phase is excluded by the anomaly matching condition.

Mechanism of color confinement in vacuum is one of the major nonperturbative characteristics of QCD. Ohata and a collaborator studied correlation among the chiral condensate, monopoles, and color magnetic fields in an Abelian gauge system of a static monopole-antimonopole pair and the Abelian projected QCD vacuum. In both cases, it was found that color magnetic fields have stronger local correlations with the chiral condensate than monopoles. This finding supports the magnetic catalysis scenario for a mechanism of the spontaneous chiral symmetry breaking, which was proposed by them last year.

Namekawa and collaborators developed an open-source code for the lattice gauge theory, named "Bridge++". In June of 2021, the latest version 1.6.1 was released. The benchmark result of the forthcoming version 2.0.0 was reported, which supports machine-dependent optimization especially for the flagship supercomputer Fugaku.

# Particle Physics Group

Particle physics is a branch of physics studying the origin of matter and space-time as well as their interactions, the most fundamental problems in Nature. Its final goal is to reveal the underlying physical laws and components of the nature. A lot of important mysteries are remaining unanswered, and this group has research activities in various directions to reach this goal. Here is a summary of main works of the members of the particle physics group in the academic year 2021.

## Particle Phenomenology and Supersymmetry

In particle phenomenology, the current experimental results are considered to be very accurately described by the Standard Model (SM) with $SU(3) \times SU(2) \times U(1)$ gauge group. The Higgs sector explains the origin of the particle masses through the mechanism of the spontaneous symmetry breaking. Since the discovery of the Higgs boson in the LHC experiments at CERN, the knowledge for the Higgs sector including the coupling with matters has been experimentally updated and it's consistent with SM at present. However, this model cannot be the final theory for the following reasons; it contains too many tunable parameters which can only be determined by experiments, it suffers from the hierarchy problem, and it does not contain the dark matter, neutrino masses. Thus particle physics beyond the SM is actively investigated by members of this group. Under the recent significant development of cosmological and astrophysical observations, seeking the fundamental solution to the dark matter and dark energy problem has become one of the leading topics.

The supersymmetry is a highly attractive idea, since it solves the hierarchy problem of the SM and unifies naturally the gauge couplings of the SM at a high energy scale, suggesting a Grand Unified Theory (GUT) of gauge fields and matters. The stability against quantum corrections by the symmetry solves some of difficulties lying on the model building such as inflation. However, no experimental evidence of the supersymmetry has been observed yet. Reconciliation of the present experimental situation with theoretical requirements is highly wanted and the mechanism of the supersymmetry breaking is the important topic. Supergravity, a local gauge theory of supersymmetry, is also investigated by some of our group members.

## Lattice QCD

Quantum Chromodynamics (QCD) is a non-Abelian gauge theory coupled with matter fields. This theory describes the hadronic systems, and has various applications in particle phenomenology as well as in astrophysics. Because of its strong interactions, understanding its properties requires non-perturbative approaches to quantum field theories. Lattice QCD gives a practical and powerful numerical method to analyze the non-perturbative aspects of QCD, and thus actively investigated by our group members.

In YITP, hadron interactions are investigated in lattice QCD, by using the HAL QCD potential method. This year ' s results are as follow. (1) We investigated a system of two baryons with the highest charm number and showed that the dibaryon appears near unitarity. (2) We calculated $I = 1$ $\pi\pi$ potential in the next-to-leading order of the derivative expansion and showed that the $\rho$ meson appears as a resonance in the $\pi\pi$ system. (3) We investigated properties of the derivative expansion in the HALQCD method, by using a solvable model with a separable potential in quantum mechanics.

## Quantum Gravity

It is yet unknown how to incorporate the principle of quantum mechanics into gravity or the general relativity. The application of the standard quantization procedure to the general relativity has serious problems, including uncontrollable UV divergences. A consistent theory of quantum gravity seems to require a new notion of spacetime, which replaces the classical space-time notion described by a continuous smooth manifold. There exists various proposals including non-commutative spacetimes, which actually appear in certain limits in string theory. Other than this, a few members of this group study a tensor model in the canonical formalism, which describes spacetimes in terms of tensors. A central idea of this model is to describe spacetimes in terms of tensors: Spacetimes do not exist at the basis of the model, and they are expected to emerge as a notion for effective description. The explicit correspondence between tensors and spaces can be constructed by using the recently developing mathematical techniques in data analysis, tensor-rank decomposition and persistent homology.

## String theory

String theory is a theory of one-dimensionally extended objects like string. The superstring theory is its extension with supersymmetry associating bosons and fermions, and has intensively been studied as a promising candidate of theories unifying all the interactions and matters. As a result, remarkably, now it is believed that the five known superstring theories, and also the eleven-dimensional supergravity theory as low-energy effective theory, are merely looking at different aspects of one hypothetical theory, the M-theory. It is important to clarify what the M-theory is, which is actively investigated by the group members. Meanwhile, it is also important issue

to study quantum phenomena in very strong gravitational field like Black hole by means of the superstring theory as a consistent theory of quantum gravity. Since such phenomena cannot be handled by perturbations, however, a non-perturbative formulation of the superstring theory is required. The superstring field theory is a strong candidate of such a non-perturbative formulation, and also studied by the group members.

## AdS/CFT Correspondence

The gauge/gravity correspondence, where gravitational theories are equivalent to non-gravitational theories which describe various matter systems, was first discovered by Juan Maldacena in 1997. The correspondence may play a key role to connect different fields in modern theoretical physics. On the other hand, the underlying principle why the correspondence occurs is not clear at present and we need to understand the basic principle of gauge/gravity correspondence. Recently the phenomenon called as quantum entanglement has been identified as the new tool and a novel expectation has been obtained which tells us that the structures of quantum entanglement in quantum systems correspond to the geometry of universe in gravity.

Intriguing connections between gauge/gravity correspondence and quantum information theory have been studied from the viewpoint of quantum entanglement and computational complexity. In particular, we found that the area of a minimal surface in Euclidean time-dependent asymptotically AdS space is equal to a quantity which call pseudo entropy. Pseudo entropy is a generalization of entanglement entropy and depends on both the initial and final state. We also studied properties of this quantity by computing it numerically in quantum field theories and spin systems. This revealed that this quantity is a useful order parameter which distinguishes different quantum phases.

The non-perturbative formulation of superstring (and quantum gravity) may be done using gauge/gravity correspondence. In order to apply string theory to real physics, supersymmetry should be spontaneously broken, however, it was difficult to show supersymmetry breaking in gauge theories which has gravity duals. In this year, we succeeded to show that certain supersymmetric gauge theory with a gravity dual has supersymmetry broken phase, for the first time. This may be important in the study of the string theory and the particle phenomenology.

A simplified version of gauge/gravity correspondence can be constructed with higher spin gravity, which is expected to describe the tensionless limit of superstring theory. Applying the simplified version, our group members have investigated the quantum effects of three dimensional higher spin gravity from corresponding two dimensional conformal field theory (CFT). Specifically, we examined the quantum asymptotic symmetry of three dimensional extended higher spin gravity and proposed a prescription to deal with quantum gravity effects perturbatively.

Moreover, we have proposed the method to derive the $d+1$ dimensional AdS geometry from CFT in $d$ dimensions using the flow method. This year, we proposed a new flow method, which converts the conformal symmetry at the boundary into the AdS isometry. We also proposed a new method to define the conserved charge in general relativity.

Historically the development of particle physics came hand in hand with that of field theory, which is not only a common language of particle physics but also a central tool in modern theoretical physics, including cosmology, condensed matter, and statistical physics. Thinking of this powerful generality of field theory, some of the group members study related topics in quantum information, condensed matter physics and integrable systems.

# Quantum Information Group

## Quantum supremacy

While large scale quantum computers may be many years off, it has been shown that relatively “weak" quantum computers can outperform classical computing. The goal of quantum supremacy is to show that sub-universal quantum computing models cannot be classically efficiently simulated unless some unlikely consequences in classical complexity theory occur. For example, quantum computing with non-interacting photonic qubits (Boson sampling) and with commuting gates (IQP) have been shown to exhibit such quantum supremacy. Morimae and his collaborators showed fine-grained quantum supremacy, which is a stronger version of the traditional quantum supremacy. The traditional quantum supremacy prohibit polynomial-time classical simulation based on the infiniteness of the polynomial-time hierarchy, but the fine-grained quantum supremacy excludes even exponential time classical simulations based on fine-grained complexity conjectures such as SETH.

## Quantum cryptography without one-way functions

The existence of one-way functions is one of the most essencial assumptions in (classical) cryptography. In fact, almost all cryptographi primitives imply one-way functions, and cryptographic primitives in minicrypto, such as commitments, signatures, and pseudorandom generators, are equivalent to one-way functions. Morimae and his collaborator showed that, on the other hand, in quantum cryptography, one-way function is not necessarily essential. They constructed commitments and signatures based on pseudorandom states generators whose existence can be shown to be possible even if all post-quantum classical cryptographic primitives (including one-way functions) are broken.

## Overcoming noise in quantum computers

The concept of a scalable quantum computer that can solve problems out of reach of classical computers has intrigued physicists for decades. Yet despite significant breakthroughs, many obstacles remain in the practical realization of quantum computers. The biggest hurdle that quantum computers must overcome is that the units of quantum information, the qubits, are noisy and prone to error. A method of protecting qubits from noise is called quantum error correction (QEC), however, realizing quantum error correction requires a large number additional qubits and also requires that the noise strength on these qubits is below a certain threshold value, which up to now has been challenging to reach.

This year, Andrew Darmawan and collaborators published two papers which proposed a new architecture for quantum computation, based on Kerr-can qubits and the XZZX code. In the first one, they showed that the noise tolerance of the scheme is very high, and achieves a very high threshold. In the second, they showed that the noise properties of this scheme allows some subroutines necesssary for universal quantum computation to be implemented much more efficiently. This could potentially greatly simplify practical implementation of quantum computers.

In another work (currently unpublished), Andrew Darmawan and colleagues illustrated a scheme for quantum error correction in which information is encoded using random low depth circuits. Unlike previous studies, the authors considered a random circuit that is local and low-depth and showed that it can tolerate realistic stochastic errors. This scheme could represent a new way to perform error correction which is practical due to its low depth, locality in 1D and high threshold to stochastic errors.

## Data-driven inference of quantum devices

In recent years, a protocol has been introduced for the inference of quantum devices only based on the correlations such devices can generate in experiments. Such a protocol is therefore referred to as data-driven inference of quantum devices. In particular, and in contrast to quantum tomographic reconstruction, data-driven inference is agnostic to the way in which the data has been generated. Data-driven inference is based upon a minimality principle, reminiscent of Jaynes' MAXENT principle, according to which the result of the inference is the least committal device, that is, the device that is compatible with the data and as little else as possible.

While the problem of the data-driven inference of single-qubit systems has already been conclusively settled, in the fiscal year 2021 Dall'Arno addressed the problem of the data-driven inference of quantum states and measurements for arbitrary-dimensional quantum systems. Through an outer approximation of the state space and the application of results in differential geometry by Fritz (1948), Dall'Arno derived the closed-form expression for the output of the data-driven inference of arbitrary-dimensional quantum measurements. These results provide the basis for the implementation of multi-qubit data-driven inference as a routine for the calibration of quantum computers.

## Guesswork of a quantum ensemble

The guesswork quantifies the minimum number of queries needed to correctly guess the value of an unknown classical random variable, when a single value can be queried at a time, in the presence of side information. The problem has been extensively studied in the case of classical side information, but only recently tackled in the case of quantum side information.

In the fiscal year 2021, Dall'Arno showed that, when the side information is encoded in a single qubit system, the guesswork can be computed exactly in time that is at worst factorial in the number of values the random variable can attain. He further showed a more-than-quadratic speedup in the presence of symmetries, and provided an implementation of such algorithm in the C programming language. These results allowed for the exact computation of the guesswork for regular and quasi-regular polyhedral qubit ensembles, and made it possible in principle the exact computation of the guesswork for any other given qubit ensemble.

# Yukawa International Program for Quark-Hadron Sciences

From the beginning of the academic year of 2007, Yukawa Institute for Theoretical Physics launched a new five-year project, "Yukawa International Program for Quark-Hadron Sciences (YIPQS)", sponsored by "Ministry of Education, Culture, Sports, Science and Technology, JAPAN (MEXT)". At the end of the academic year of 2010, the government approved to convert the YIPQS project budget into a more stable normal budget, and now we can run the program from a longer term point of view.

## Aim of the program

By the end of 1970's, the final understanding was reached that Quantum Chromodynamics (QCD) is the fundamental theory of the strong interaction which was originally discovered by Hideki Yukawa. Still, nevertheless, only little has been established from QCD on various possible forms of hadrons or quarks. For example, while scaling behaviors of the lepton-nucleon cross section in the deep-inelastic scattering region and some properties of ground state hadrons have been precisely understood in perturbative and lattice QCD calculations, respectively, we have not yet reached the stage to understand properties of excited hadrons above the threshold including the exotic hadrons, binding mechanism of nuclei with more than two nucleons, nuclear matter equation of state, and the vacuum structures at extremely high temperature in the Early Universe and at extremely high density in compact stars, from the fundamental theory, namely QCD. In other words, there is still a vast area of research interest which is to be explored. To advance our exploration, it is necessary not only to make full use of existing theoretical techniques but also to develop new theories and to establish new frameworks. The expected achievement would cast a strong impact on our understanding of various forms of matter at various levels in nature. One may face a situation that one should restructure the current understanding about possible forms of matter.

The primary purpose of the YIPQS is to establish a new area of research fields; the quark-hadron sciences. For this purpose, with cooperating with present and near-future experimental activities, Yukawa Institute for Theoretical Physics will advance theoretical research not only in quark-hadron physics but also in related areas, as listed below, which constitute indispensable building blocks for the quark-hadron sciences.

Examples of related areas include; quark-gluon plasma, hadron physics, lattice QCD, dark energy, dark matter, baryogenesis, CP violation, strongly-correlated systems, phase transition of internal degrees of freedom of matter, physics of the Early Universe, matter at extreme conditions, structure of unstable nuclei and nucleosynthesis, compact star physics, optical lattice, (super)string theory, AdS/CFT correspondence, non-perturbative and/or non-equilibrium dynamics, gravitational waves from compact star mergers, quantum information, etc.

## International collaboration program

As a core activity of the YIPQS, long-stay programs are organized on research topics ranging over quark-hadron physics and related fields of theoretical physics. The proposal of the program is open for the community, with a requirement that the organizing committee should include a member of Yukawa Institute. Yukawa Institute calls for the proposals of the long-stay programs annually. The theme of the long-stay program is selected and endorsed by the YIPQS executive committee with taking account of comments and opinions from the international advisory committee. The program is to be endorsed by the steering/advisory committee of the Yukawa Institute. The proposed program plan is also to be examined by the user's committee of the Yukawa Institute.

Two to three long-stay programs will be held annually; the duration of each program is one to three months. World-leading scientists are invited for each theme, and the Yukawa Institute provides participants with relaxed and at-home atmosphere so that there may be active discussions and fruitful collaborations, which we hope that will ultimately lead to Nobel-prize class results. To publicize the aim of creating and advancing the field of quark-hadron sciences, the activities and outcomes of the YIPQS will be announced regularly on the website.

**Long-stay programs**

In this academic year, the following two long-stay programs were planned, but unfortunately postponed or cancelled due to the outbreak of the coronavirus (COVID-19);

1. November 1 – December 3, 2021, (Postponed to 2022)
   "Novel Quantum States in Condensed Matter 2021 (NQS2021)"
   Chairman : Takami Tohyama (TUS)
   http://www2.yukawa.kyoto-u.ac.jp/~nqs2021/

2. January 31 – March 4, 2022, (Postponed to 2024 except for YKIS2022a "Gravity - The Next Generation -")
   "Gravity and Cosmology 2022"
   Chairman : Shinji Mukohyama
   http://www2.yukawa.kyoto-u.ac.jp/~gc2022/index.php

**Molecule-type workshops**

Smaller-size collaboration programs are also organized to cope with the rapid development of the research in this

field. The program is named a "molecule-type" program. It is expected that the group discussion in this small program will evolve to form a research collaboration. The proposal has been received anytime within the budget limit. This program should involve at least one core participant from abroad, and should be long for two weeks or more. The selection of this program is also made by the executive committee and the board member of the user's committee, and the selected program is examined by the user's committee of the Yukawa Institute.

In this academic year, there were six programs of this molecule-type as listed below;

1. July 26 – August 6, 2021,
   "Topological Phase and Quantum Anomaly 2021"
   Core members : Kantaro Ohmori, Yasunori Lee, Ken Shiozaki, Yuya Tanizaki

2. August 2 – August 6, 2021,
   "Chiral Anomaly in Periodically Driven Systems"
   Core members : Takuya Shimazaki, Hidetoshi Taya, Yoshimasa Hidaka, Kenji Fukushima

3. August 23 – August 27, 2021,
   "Extreme Outflows in Astrophysical Transients"
   Core members : Kunihito Ioka, Kazumi Kashiyama, Tatsuya Matsumoto, Masaru Shibata

4. November 29 – December 3, 2021,
   "Galaxy shape statistics and Cosmology"
   Core members : Kazuhiro Kogai, Toshiki Kurita, Atsushi Naruko, Takahiro Nishimichi, Teppei Okumura, Jingjing Shi, Masahiro Takada, Atsushi Taruya

5. February 21 – March 4, 2022,
   "Quantum computing for quantum field theories 2022"
   Core members : Masazumi Honda, Etsuko Itou, Yuta Kikuchi, Yuya Tanizaki

6. March 22 – March 30, 2022,
   "Upcoming CMB observations and Cosmology"
   Core members : Tomohiro Fujita, Shuichiro Yokoyama, Atsushi Naruko, Atsushi Taruya

Because of the outbreak of the coronavirus (COVID-19), some of these workshops were held online with a small number of local (on-site) participants. In the fiscal year of 2021, we have called and accepted molecule-type workshops without core participants from abroad (domestic molecule-type workshops), and all the workshops listed above belong to this category. We hope to hold international ones in 2022.

## Organization

The executive committee was organized in the Yukawa Institute to run the whole program. The committee members in the fiscal year of 2021 are:
Akira Ohnishi (chair), Sinya Aoki, Hisao Hayakawa, Yasuaki Hikida, Naoyuki Itagaki, Tomoyuki Morimae, Shinji Mukohyama, Takahiro Nishimichi, Masatoshi Sato, Shigeki Sugimoto, Takahiro Tanaka, Yuya Tanizaki.

The website of the program is;
http://www2.yukawa.kyoto-u.ac.jp/~yipqs/index_e.html.

# Center for Gravitational Physics

On 1st April, 2015, Yukawa Institute for Theoretical Physics established a new research organization, named the "Center for Gravitational Physics". This center has been supported by the Japanese MEXT since April, 2016. The initial appointment for this support is for 6 years (until the end of March, 2022).

## Purpose of this center

Understanding nature of gravity has long been one of the central issues in particle physics/string theory and astrophysics/cosmology. As a result of significant developments of these fields in the past decades, we are now in an exciting position to enhancing the research activity of gravity toward various directions. For example, by the recent development of string theory, in particular by the discovery of the so-called gauge/gravity correspondence, gravity has become a core subject in a wider area of theoretical physics. It is anticipated that a new perspective on nature may be gained by a deeper understanding of gravity. For example, gravity may be the very key for the understanding of basic phenomena in quantum theory such as quantum entanglement.

It should be also emphasized that gravitational-wave astronomy just began quite recently (in 2015) by the first direct detection of gravitational waves from binary black holes achieved by advanced LIGO in USA. A number of subsequent discoveries of astrophysical phenomena in strong gravitational fields in the near future will lead to deeper understanding of physics associated with strong gravitational fields.

The purpose of this center is to stimulate various fields in theoretical physics from new perspectives, with "gravity" as the keyword, and to establish an international center for gravitational physics in the wider sense through collaborations with researchers and institutions from all over the world. Since January, 2018, a new faculty (T.Morimae) has joined the center and started a new group studying quantum information theory.

## Primary research topics

This center has the following five sections. The research topics for each of them are as follows:

Quantum Graviy/String theory: At present, the most reliable theory of gravity is general relativity of Albert Einstein. However, it is notoriously difficult to be combined with the quantum theory, which describes the microscopic world, and the construction of the theory of quantum gravity is still a very important open problem. String theory is considered to be one of the most promising approaches for the quantum gravity. Many researchers believe that it is a candidate of an ultimate unified theory, because it describes all the elementary particles from just one type of "string". However, the complete formulation of string theory is not yet available. In our center, we are trying to develop non-perturbative formulation of string theory, understand strong coupling phenomena, and investigate applications to other fields. We also work on various related topics, such as matrix model, tensor model, higher spin gauge theory, non-perturbative effects in quantum field theory, elementary particles and the interactions among them, microscopic description of black hole, mathematical structure of supersymmetric gauge theory, etc.

Gauge-Gravity correspondence: Gauge/Gravity duality provides us a remarkable method that equivalently connects gravity (superstring theory, general relativity) with quantum matter (quantum field theories, quantum many-body systems). This enables us to reduce complicated analysis of strongly interacting quantum system to much simpler classical calculations in gravity. At the same time, we can convert difficult problems in quantum gravity into simpler ones. In our center, we are exploring various applications of gauge/gravity duality to QCD, Nuclear Physics and Condensed Matter Physics. Also, recent progresses have revealed a deep connection between gauge/gravity duality and quantum information theory, such as quantum entanglement and complexity of quantum computation. These ideas have been lead to remarkable progresses towards a solution to black hole information problem. We are also making progresses, aiming at a new description of gravity from the viewpoint of quantum information.

Gravitational-wave astronomy: Soon after its first science run was started in 2015, advanced LIGO detected gravitational waves from binary black holes and announced the opening of gravitational-wave astronomy. In 2017, a neutron star merger with electromagnetic counterparts from gamma rays to radio was also discovered, marking a significant breakthrough for multi-messenger astronomy and astrophysics. Together with Advanced VIRGO and KAGRA, a larger number of gravitational waves from binary black holes and neutron-star binaries will be detected. We are working in the precise prediction of gravitational waves from these sources aiming at extraction of new physical information associated with strong gravity from the detected gravitational-wave signals and also in the prediction of electromagnetic signals using numerical-relativity and astrophysical phenomenology.

Cosmology and gravity: Cosmology has been rapidly developing, based on precision observational data. It is fair to say that many parameters describing our universe have been determined, or at least are in the process of being determined, with good precision. However, the physics behind the values of these parameters is still hidden in a veil of mystery. For example, we do not know what

dark energy and dark matter really are, although our universe is thought to be filled mostly with them. Also, what made our universe so big? This question can be addressed by cosmic inflation, but again we do not know the physical origin of the inflaton field driving inflation. Three great mysteries, dark energy, dark matter and inflation, are standing in the way of cosmology with precision observational data. There also remain many other mysteries in cosmology such as the initial singularity and the origin of cosmic magnetic fields. In our center we tackle those mysteries by using every possible means such as general relativity, statistical physics, particle physics and superstring theory.

Quantum Information Theory: Quantum theory is known to exhibit many "strange" phenomena, such as entanglement, coherence, etc. One of the most central research goals of quantum information theory is to control these strange phenomena to realize new information processing tasks, such as secure crypto-communication and superfast computing. In fact, it is known that unconditionally secure key distribution is possible with entanglement (quantum key distribution), and some problems that are not known to be solved efficiently with classical computing can be solved with quantum computing in polynomial time. These theoretical ideas have recently been implemented by not only experimentalists in academia but also engineers in companies such as Google, IBM, and Microsoft. Another important goal of the quantum information theory group in the Center is to develop new ideas through interactions with other members at YITP. In fact, many new concepts, ideas, techniques have been imported to the traditional physics, such as statistical physics, condensed matter physics, particle physics, and gravity, etc.

## Achievements in the academic year 2021

Since the research of the members of the center are summarized in the other parts of this annual report, we only show some typical numbers that reflect the research activities and achievements of the center here.

We published 151 papers and 2 books. The number of workshops and schools organized by us and held at YITP was 24 (15 of them were international and 9 were domestic). The total number of participants of these workshops was 3,630. We were invited to give talks in various workshops. The total number of the invited talks given by our members was 82 (50 of them were international and 32 were domestic).

## Home page

The home page of the center is
http://www2.yukawa.kyoto-u.ac.jp/~cgp/en/index.html.
The current members and research achievements are shown in this page.

# International Research Unit of Quantum Information

*Overview*

The International Research Unit of Quantum Information was established on 2020 in collaboration of 10 Kyoto University research organizations and is operated by the Yukawa Institute for Theoretical Physics (YITP). The unit leader is Sinya Aoki, and the unit sub leaders are Tadashi Takayanagi and Tomoyuki Morimae. Michele Dall'Arno and Andres Ducuara at YITP join the unit as long-term visiting researchers (assistant professors).

Its aim is to enhance collaborations of quantum information science among different departments and institutes of Kyoto University, and create new research disciplines. The current research subjects are, for example, quantum computing, quantum cryptography, foundations of quantum physics, string theory and quantum information, quantum error correction, quantum simulation of field theory, and related subjects such as game theory, mathematics, supercomputing, physics, optics, and computer science.

*Activities*

1. Seminar by Prof. Ryuhei Mori (Tokyo Institute of Technology), Improved robustness of quantum supremacy for random circuit sampling, 2021/6/11
2. Seminar by Mr. Mikito Nanashima (Tokyo Institute of Technology), 2021/7/20
3. Second Kyoto Workshop on Quantum Information, Computation, and Foundation, 2021/9/13-17
4. Seminar by Prof. Takashi Yamakawa (NTT Social Informatics Laboratories), 2021/12/2
5. Seminar by Mr. Akihiro Mizutani (Mitsubishi Electric Corporation), Computational self-testing for entangled magic states, 2021/12/22

## 2.2 Publications

### 2.2.1 YITP reports (January – December 2020)

**21-1** Mendel Nguyen, Yuya Tanizaki, Mithat Ünsal
*Semi-Abelian gauge theories, non-invertible symmetries, and string tensions beyond N-ality*
arXiv:2101.02227 [hep-th] JHEP 03 (2021) 238 (January) .

**21-2** Raúl Carballo-Rubio, Francesco Di Filippo, Stefano Liberati, Costantino Pacilio, Matt Visser
*Inner horizon instability and the unstable cores of regular black holes*
arXiv:2101.05006 [gr-qc] JHEP 05 (2021) 132 (January) .

**21-3** Hironao Miyatake, Yosuke Kobayashi, Masahiro Takada, Takahiro Nishimichi, Masato Shirasaki, Sunao Sugiyama, Ryuichi Takahashi, Ken Osato, Surhud More, Youngsoo Park
*Cosmological inference from emulator based halo model I: Validation tests with HSC and SDSS mock catalogs*
arXiv:2101.00113 [astro-ph.CO] (January) .

**21-4** Tatsuma Nishioka, Yoshiki Sato
*Free energy and defect C-theorem in free scalar theory*
arXiv:2101.02399 [hep-th] JHEP 05 (2021) 74 (January) .

**21-5** Lento Nagano, Seiji Terashima
*A Note on Commutation Relation in Conformal Field Theory*
arXiv:2101.04090 [hep-th] JHEP 09 (2021) 187 (January) .

**21-6** Yan Lyu, Hui Tong, Takuya Sugiura, Sinya Aoki, Takumi Doi, Tetsuo Hatsuda, Jie Meng, Takaya Miyamoto
*Dibaryon with highest charm number near unitarity from lattice QCD*
arXiv:2102.00181 [hep-lat] Phys. Rev. Lett. 127, 072003 (2021) (February) .

**21-7** Naritaka Oshita, Niayesh Afshordi, Shinji Mukohyama
*Lifshitz scaling, ringing black holes, and superradiance*
arXiv:2102.01741 [gr-qc] JCAP 05 (2021) 005 (February) .

**21-8** Kohki Kawabata, Tatsuma Nishioka, Yoshitaka Okuyama, Kento Watanabe
*Probing Hawking radiation through capacity of entanglement*
arXiv:2102.02425 [hep-th] JHEP 05 (2021) 62 (February) .

**21-9** Yong-Seon Song, Yi Zheng, Atsushi Taruya
*Toward a more stringent test of gravity with redshift space power spectrum: simultaneous probe of growth and amplitude of large-scale structure*
arXiv:2102.01785 [astro-ph.CO] Phys. Rev. D 104, 043528 (2021) (February) .

**21-10** Tomoyuki Morimae, Takashi Yamakawa
*Classically Verifiable NIZK for QMA with Preprocessing*
arXiv:2102.09149 [quant-ph] (February) .

**21-11** Jared Fier, Xiongjun Fang, Bowen Li, Shinji Mukohyama, Anzhong Wang, Tao Zhu
*Gravitational wave cosmology I: high frequency approximation*
arXiv:2102.08968 [astro-ph.CO] Phys. Rev. D 103, 123021 (2021) (February) .

**21-12** Masazumi Honda, Etsuko Itou, Yuta Kikuchi, Lento Nagano, Takuya Okuda
*Classically emulated digital quantum simulation for screening and confinement in the Schwinger model with a topological term*
arXiv:2105.03276 [hep-lat] Phys. Rev. D 105, 014504, (2022) (February) .

**21-13** Toshiaki Fujimori, Masazumi Honda, Syo Kamata, Tatsuhiro Misumi, Norisuke Sakai, Takuya Yoda
*Quantum phase transition and Resurgence: Lessons from 3d $\mathcal{N} = 4$ SQED*
arXiv:2103.13654 [hep-th] Prog. Theor. Exp. Phys. (2021) 103B04 (February) .

**21-14** Yoshiaki Himemoto, Atsushi Nishizawa, Atsushi Taruya
*Impacts of overlapping gravitational-wave signals on the parameter estimation: Toward the search for cosmological backgrounds*
arXiv:2103.14816 [gr-qc] Phys. Rev. D 104, 044010 (2021) (February) .

**21-15** Kazuyuki Ogata, Tokuro Fukui, Yuki Kamiya, Akira Ohnishi

*Effect of deuteron breakup on the deuteron-$\Xi$ correlation function*
arXiv:2103.00100 [nucl-th] Phys. Rev. C 103, 065205 (2021) (February) .

**21-16** Yi-Fu Cai, Jie Jiang, Misao Sasaki, Valeri Vardanyan, Zihan Zhou
*Beating the Lyth bound by parametric resonance during inflation*
arXiv:2105.12554 [astro-ph.CO] Phys. Rev. Lett. 127, 251301 (2021) (March) .

**21-17** Ryohei Kobayashi, Yasunori Lee, Ken Shiozaki, Yuya Tanizaki
*Topological terms of (2+1)d flag-manifold sigma models*
arXiv:2103.05035 [hep-th] JHEP 08 (2021) 075 (March) .

**21-18** S. Aoki, Y. Aoki, H. Fukaya, S. Hashimoto, C. Rohrhofer, K. Suzuki
*Role of axial U(1) anomaly in chiral susceptibility of QCD at high temperature*
arXiv:2103.05954 [hep-lat] (March) .

**21-19** Masamichi Miyaji, Tadashi Takayanagi, Tomonori Ugajin
*Spectrum of End of the World Branes in Holographic BCFTs*
arXiv:2103.06893 [hep-th] JHEP 06 (2021) 23 (March) .

**21-20** Toshiya Namikawa, Atsushi Naruko, Ryo Saito, Atsushi Taruya, Daisuke Yamauchi
*Unified approach to secondary effects on the CMB B-mode polarization*
arXiv:2103.10639 [astro-ph.CO] JCAP 10 (2021) 029 (March) .

**21-21** Masato Nozawa
*An alternative to the Simon tensor*
arXiv:2103.06455 [gr-qc] Class. Quantum Grav. 38 155001 (2021) (March) .

**21-22** Edwan Préau, Kunihito Ioka, Peter Mészáros
*Neutron conversion-diffusion: a new model for structured short gamma-ray burst jets compatible with GRB 170817*
arXiv:2009.07507 [astro-ph.HE] Mon. Not. R. Astron. Soc. 503, 2499-2513 (2021) (March) .

**21-23** Chul-Moon Yoo, Atsushi Naruko, Yusuke Sakurai, Keitaro Takahashi, Yohsuke Takamori, Daisuke Yamauchi
*Axion Cloud Decay due to the Axion-photon Conversion with Background Magnetic Fields*
arXiv:2103.13227 [hep-ph] Pub. Astron. Soc. Japan 74, 64-72 (2021) (March) .

**21-24** Katsuki Aoki, Francesco Di Filippo, Shinji Mukohyama
*Non-uniqueness of massless transverse-traceless graviton*
arXiv:2103.15044 [gr-qc] JCAP 05 (2021) 071 (March) .

**21-25** Jan Boruch, Pawel Caputa, Dongsheng Ge, Tadashi Takayanagi
*Holographic Path-Integral Optimization*
arXiv:2104.00010 [hep-th] JHEP 07 (2021) 16 (March) .

**21-26** Hidehiko Shimada, Hirohiko Shimada
*Exact four-point function and OPE for an interacting quantum field theory with space/time anisotropic scale invariance*
arXiv:2107.07770 [hep-th] (March) .

**21-27** Akihiro Miyata, Tomonori Ugajin
*Evaporation of black holes in flat space entangled with an auxiliary universe*
arXiv:2104.00183 [hep-th] (March) .

**21-28** Ken Shiozaki, Seishiro Ono
*Symmetry indicator in non-Hermitian systems*
arXiv:2105.00677 [cond-mat.mes-hall] Phys. Rev. B 104, 035424 (2021) (April) .

**21-29** Mendel Nguyen, Yuya Tanizaki, Mithat Ünsal
*Non-invertible 1-form symmetry and Casimir scaling in 2d Yang-Mills theory*
arXiv:2104.01824 [hep-th] Phys. Rev. D 104, 065003 (2021) (April) .

**21-30** Katsuki Aoki, Tran Quang Loc, Toshifumi Noumi, Junsei Tokuda
*Is the Standard Model in the Swampland? Consistency Requirements from Gravitational Scattering*
arXiv:2104.09682 [hep-th] Phys. Rev. Lett. 127, 091602 (2021) (April) .

**21-31** Guillem Domènech, Misao Sasaki
*Cosmology of strongly interacting fermions in the early universe*
arXiv:2104.05271 [hep-th] JCAP 06 (2021) 030 (April) .

**21-32** Andrew S. Darmawan, Benjamin J. Brown, Arne L. Grimsmo, David K. Tuckett, Shruti Puri
*Practical quantum error correction with the XZZX code and Kerr-cat qubits*
arXiv:2104.09539 [quant-ph] Phys. Rev. X Quantum 2, 030345 (2021) (April) .

**21-33** Wataru Ishizaki, Kunihito Ioka, Kenta Kiuchi
*Fallback Accretion Model for the Years-to-Decades X-ray Counterpart to GW170817*
arXiv:2104.04433 [astro-ph.HE] ApJL 916, L13 (2021) (April) .

**21-34** Wataru Ishizaki, Kenta Kiuchi, Kunihito Ioka, Shinya Wanajo

*Fallback Accretion Halted by R-process Heating in Neutron Star Mergers and Gamma-Ray Bursts*
arXiv:2104.04708 [astro-ph.HE] ApJ 922, 185 (2021) (April) .

**21-35** Shuichi Yokoyama
*An analytic model for gravitational collapse of spherical matter under mixed pressure*
arXiv:2105.09676 [gr-qc] (April) .

**21-36** Naoki Sasakura
*Phase profile of the wave function of canonical tensor model and emergence of large spacetimes*
arXiv:2104.11845 [hep-th] Int. J. Mod. Phys. A 36, 2150222 (2021) (April) .

**21-37** Seiji Terashima
*Simple Bulk Reconstruction in AdS/CFT Correspondence*
arXiv:2104.11743 [hep-th] (April) .

**21-38** Kazufumi Takahashi, Hayato Motohashi
*Black hole perturbations in DHOST theories: Master variables, gradient instability, and strong coupling*
arXiv:2106.07128 [gr-qc] JCAP 08 (2021) 013 (April) .

**21-39** Vijay Balasubramanian, Arjun Kar, Tomonori Ugajin
*Entanglement between two gravitating universes*
arXiv:2104.13383 [hep-th] (April) .

**21-40** Taiga Hiroka, Tomoyuki Morimae, Ryo Nishimaki, Takashi Yamakawa
*Quantum Encryption with Certified Deletion, Revisited: Public Key, Attribute-Based, and Classical Communication*
arXiv:2105.05393 [quant-ph] In: Tibouchi M., Wang H. (eds) Advances in Cryptology - ASIACRYPT 2021 - LNCS 13090. Springer (April) .

**21-41** Hayato Kanno, Shigeki Sugimoto
*Anomaly and Superconnection*
arXiv:2106.01591 [hep-th] PTEP 2022 (2022) 1, 013B02 (April) .

**21-42** Jingjing Shi, Ken Osato, Toshiki Kurita, Masahiro Takada
*An Optimal Estimator of Intrinsic Alignments for Star-forming Galaxies in IllustrisTNG Simulation*
arXiv:2104.12329 [astro-ph.CO] ApJ 917, 109 (2021) (May) .

**21-43** Masashi Kimura, Tomohiro Harada, Atsushi Naruko, Kenji Toma
*Backreaction of Mass and Angular Momentum Accretion on Black Holes: General Formulation of the Metric Perturbations and Application to the Blandford-Znajek Process*
arXiv:2105.05581 [gr-qc] PTEP 2021 (2021) 9, 093E03 (May) .

**21-44** Guillem Domènech, Volodymyr Takhistov, Misao Sasaki
*Exploring Evaporating Primordial Black Holes with Gravitational Waves*
arXiv:2105.06816 [astro-ph.CO] Phys. Lett. B 823 (2021) 136722 (May) .

**21-45** Kohki Kawabata, Tatsuma Nishioka, Yoshitaka Okuyama, Kento Watanabe
*Replica wormholes and capacity of entanglement*
arXiv:2105.08396 [hep-th] JHEP 10 (2021) 227 (May) .

**21-46** Raúl Carballo-Rubio, Francesco Di Filippo, Stefano Liberati
*Hearts of Darkness: the inside out probing of black holes*
arXiv:2106.01530 [gr-qc] Int. J. Mod. Phys. D 30, 2142024 (2021) (May) .

**21-47** Masaki Shigemori
*Interpolating between multi-center microstate geometries*
arXiv:2105.11639 [hep-th] JHEP 09 (2021) 010 (May) .

**21-48** Yohsuke Takamori, Atsushi Naruko, Yusuke Sakurai, Keitaro Takahashi, Daisuke Yamauchi, Chul-Moon Yoo
*Testing the Non-circularity of the Spacetime around Sagittarius A* with Orbiting Pulsars*
arXiv:2108.13026 [gr-qc] Pub. Astron. Soc. Japan Novol., Nopage (2022) (May) .

**21-49** Atsushi Taruya, Kazuyuki Akitsu
*Lagrangian approach to super-sample effects on biased tracers at field level: galaxy density fields and intrinsic alignments*
arXiv:2106.04789 [astro-ph.CO] JCAP 11 (2021) 061 (June) .

**21-50** Yu-ki Suzuki
*One-Loop Correction to the AdS/BCFT Partition Function in the Three Dimensional Pure Gravity*
arXiv:2106.00206 [hep-th] Phys. Rev. D 105, 026023 (2022) (June) .

**21-51** Hidetoshi Omiya, Zixia Wei
*Causal Structures and Nonlocality in Double Holography*
arXiv:2107.01219 [hep-th] (June) .

**21-52** Ali Mollabashi, Noburo Shiba, Tadashi Takayanagi, Kotaro Tamaoka, Zixia Wei
*Aspects of Pseudo Entropy in Field Theories*
arXiv:2106.03118 [hep-th] Phys. Rev. Research 3, 033254 (2021) (June) .

**21-53** Ibrahim Akal, Yuya Kusuki, Noburo Shiba, Tadashi Takayanagi, Zixia Wei
*Holographic moving mirrors*

arXiv:2106.11179 [hep-th] Class. Quantum Grav. 38 (2021) 224001 (June) .

**21-54** Masaya Amo, Keisuke Izumi, Yoshimune Tomikawa, Hirotaka Yoshino, Tetsuya Shiromizu
*Asymptotic behavior of null geodesics near future null infinity: Significance of gravitational waves*
arXiv:2106.03150 [gr-qc] Phys. Rev. D 104, 064025 (2021) (June) .

**21-55** Jose C. N. de Araujo, Antonio De Felice, Suresh Kumar, Rafael C. Nunes
*Minimal theory of massive gravity in the light of CMB data and the $S_8$ tension*
arXiv:2106.09595 [astro-ph.CO] Phys. Rev. D 104, 104057 (2021) (June) .

**21-56** Pengyuan Gao, Kazufumi Takahashi, Asuka Ito, Jiro Soda
*Cosmic No-hair Conjecture and Inflation with an SU(3) Gauge Field*
arXiv:2107.00264 [hep-th] Phys. Rev. D 104, 103526 (2021) (June) .

**21-57** Yutaro Akahoshi, Sinya Aoki, Takumi Doi
*Emergence of the $\rho$ resonance from the HAL QCD potential in lattice QCD*
arXiv:2106.08175 [hep-lat] Phys. Rev. D 104, 054510 (2021) (June) .

**21-58** Hiroshi Kunitomo
*Type II superstring field theory revisited*
arXiv:2106.07917 [hep-th] PTEP 2021 (2021) 9, 093B03 (June) .

**21-59** Jacob Oost, Shinji Mukohyama, Anzhong Wang
*Spherically symmetric exact vacuum solutions in Einstein-aether theory*
arXiv:2106.09044 [gr-qc] Universe 7 (2021) 272 (June) .

**21-60** Priti Gupta, Béatrice Bonga, Alvin J. K. Chua, Takahiro Tanaka
*Importance of tidal resonances in extreme-mass-ratio inspirals*
arXiv:2104.03422 [gr-qc] Phys. Rev. D 104, 044056 (2021) (June) .

**21-61** Makoto Arimoto, Hideki Asada, Michael L. Cherry, Michiko S. Fujii, Yasushi Fukazawa, Akira Harada, Kazuhiro Hayama, Takashi Hosokawa, Kunihito Ioka, Yoichi Itoh, Nobuyuki Kanda, Koji S. Kawabata, Kyohei Kawaguchi, Nobuyuki Kawai, Tsutomu Kobayashi, Kazunori Kohri, Yusuke Koshio, Kei Kotake, Jun Kumamoto, Masahiro N. Machida, Hideo Matsufuru, Tatehiro Mihara, Masaki Mori, Tomoki Morokuma, Shinji Mukohyama, Hiroyuki Nakano, Tatsuya Narikawa, Hitoshi Negoro, Atsushi Nishizawa, Takayuki Ohgami, Kazuyuki Omukai, Takanori Sakamoto, Shigeyuki Sako, Mahito Sasada, Yuichiro Sekiguchi, Motoko Serino, Jiro Soda, Satoshi Sugita, Kohsuke Sumiyoshi, Hajime Susa, Teruaki Suyama, Hirotaka Takahashi, Kazuya Takahashi, Tomoya Takiwaki, Takahiro Tanaka, Masaomi Tanaka, Ataru Tanikawa, Nozomu Tominaga, Nami Uchikata, Yousuke Utsumi, Mark R. Vagins, Kei Yamada, Michitoshi Yoshida
*Gravitational Wave Physics and Astronomy in the nascent era*
arXiv:2104.02445 [gr-qc] (June) .

**21-62** Norichika Sago, Takahiro Tanaka
*Oscillations in the EMRI gravitational wave phase correction as a probe of reflective boundary of the central black hole*
arXiv:2106.07123 [gr-qc] Phys. Rev. D 104, 064009 (2021) (June) .

**21-63** Tatsuya Narikawa, Nami Uchikata, Takahiro Tanaka
*Gravitational-wave constraints on the GWTC-2 events by measuring the tidal deformability and the spin-induced quadrupole moment*
arXiv:2106.09193 [gr-qc] Phys. Rev. D 104, 084056 (2021) (June) .

**21-64** Takuya Takahashi, Takahiro Tanaka
*Axion clouds may survive the perturbative tidal interaction over the early inspiral phase of black hole binaries*
arXiv:2106.08836 [gr-qc] JCAP 10 (2021) 031 (June) .

**21-65** Ji-Yao Chen, Jheng-Wei Li, Pierre Nataf, Sylvain Capponi, Matthieu Mambrini, Keisuke Totsuka, Hong-Hao Tu, Andreas Weichselbaum, Jan von Delft, Didier Poilblanc
*Abelian $SU(N)_1$ Chiral Spin Liquids on the Square Lattice*
arXiv:2106.02115 [cond-mat.str-el] Phys. Rev. B 104, 235104 (2021) (June) .

**21-66** M. Reza Mohammadi Mozaffar, Ali Mollabashi
*On the Time Scaling of Entanglement in Integrable Scale-Invariant Theories*
arXiv:2106.14700 [hep-th] (June) .

**21-67** Taichiro Kugo
*Noether Currents and Maxwell-type Equations of Motion in Higher Derivative Gravity Theories*
arXiv:2107.11600 [hep-th] (June) .

**21-68** Thomas Creutzig, Yasuaki Hikida, Devon Stockall
*Correlator correspondences for subregular $\mathscr{W}$-algebras and principal $\mathscr{W}$-superalgebras*
arXiv:2106.15073 [hep-th] JHEP 10 (2021) 32 (June) .

**21-69** Tatsuma Nishioka, Tadashi Takayanagi, Yusuke Taki

*Topological pseudo entropy*
arXiv:2107.01797 [hep-th] JHEP 09 (2021) 015 (June) .

**21-70** Katsuki Aoki, Shinji Mukohyama, Ryo Namba
*Positivity vs. Lorentz-violation: an explicit example*
arXiv:2107.01755 [hep-th] JCAP 10 (2021) 079 (June) .

**21-71** Ken Osato, Takahiro Nishimichi, Atsushi Taruya, Francis Bernardeau
*Implementing spectra response function approaches for fast calculation of power spectra and bispectra*
arXiv:2107.04275 [astro-ph.CO] Phys. Rev. D 104, 103501 (2021) (July) .

**21-72** Jibril Ben Achour, Antonio De Felice, Mohammad Ali Gorji, Shinji Mukohyama, Masroor C. Pookkillath
*Disformal map and Petrov classification in modified gravity*
arXiv:2107.02386 [gr-qc] JCAP 10 (2021) 067 (July) .

**21-73** Ken Osato, Takahiro Nishimichi, Masahiro Takada
*Mock catalogues of emission line galaxies based on the local mass density in dark-matter only simulations*
arXiv:2107.13168 [astro-ph.GA] Mon. Not. R. Astron. Soc., 511, 1131-1140 (2022) (July) .

**21-74** Divya Rana, Surhud More, Hironao Miyatake, Takahiro Nishimichi, Masahiro Takada, Aaron S. G. Robotham, Andrew M. Hopkins, Benne W. Holwerda
*The Subaru HSC weak lensing mass-observable scaling relations of spectroscopic galaxy groups from the GAMA survey*
arXiv:2107.05641 [astro-ph.CO] Mon. Not. R. Astron. Soc. 510, 5408-5425 (2022) (July) .

**21-75** Masafumi Fukuma, Nobuyuki Matsumoto, Yusuke Namekawa
*Statistical analysis method for the worldvolume hybrid Monte Carlo algorithm*
arXiv:2107.06858 [hep-lat] (July) .

**21-76** Luca Buoninfante, Francesco Di Filippo, Shinji Mukohyama
*On the assumptions leading to the information loss paradox*
arXiv:2107.05662 [hep-th] JHEP 10 (2021) 081 (July) .

**21-77** Dennis Obster, Naoki Sasakura
*Counting tensor rank decompositions*
arXiv:2107.10237 [gr-qc] (July) .

**21-78** Y. Rasera, M-A. Breton, P-S. Corasaniti, J. Allingham, F. Roy, V. Reverdy, T. Pellegrin, S. Saga, A. Taruya, S. Agarwal, S. Anselmi
*The RayGalGroupSims cosmological simulation suite for the study of relativistic effects: an application to lensing-matter clustering statistics*
arXiv:2111.08745 [astro-ph.CO] A&A 661, A90 (2022) (July) .

**21-79** Y. Kamiya, K. Sasaki, T. Fukui, T. Hyodo, K. Morita, K. Ogata, A. Ohnishi, T. Hatsuda
*Femtoscopic study of coupled-channel $N\Xi$ and $\Lambda\Lambda$ interactions*
arXiv:2108.09644 [hep-ph] Phys. Rev. C 105, 014915 (2022) (August) .

**21-80** Masato Shirasaki, Ryuichi Takahashi, Ken Osato, Kunihito Ioka
*Probing cosmology and gastrophysics with fast radio bursts: Cross-correlations of dark matter haloes and cosmic dispersion measures*
arXiv:2108.12205 [astro-ph.CO] Mon. Not. R. Astron. Soc. 512, 1730-1750 (2022) (August) .

**21-81** Hiroyuki Kitamoto, Masaki Yamada
*Semiclassical analysis of axion-assisted and axion-driven pair production*
arXiv:2109.14782 [hep-ph] (August) .

**21-82** Cédric Deffayet, Shinji Mukohyama, Alexander Vikman
*Ghosts without runaway*
arXiv:2108.06294 [gr-qc] (August) .

**21-83** Naotaka Kubo, Shuichi Yokoyama
*Topological phase, spin Chern-Simons theory and level rank duality on lens space*
arXiv:2108.09300 [hep-th] JHEP 04 (2022) 74 (August) .

**21-84** Kanato Goto, Yuya Kusuki, Kotaro Tamaoka, Tomonori Ugajin
*Product of Random States and Spatial (Half-)Wormholes*
arXiv:2108.08308 [hep-th] JHEP 10 (2021) 205 (August) .

**21-85** Hideo Suganuma, Hiroki Ohata
*Local correlation among the chiral condensate, monopoles, and color magnetic fields in Abelian projected QCD*
arXiv:2108.08499 [hep-lat] Universe 2021, 7(9), 318 (August) .

**21-86** Shraddha Singh, Andrew S. Darmawan, Benjamin J. Brown, Shruti Puri
*High-Fidelity Magic-State Preparation with a Biased-Noise Architecture*
arXiv:2109.02677 [quant-ph] Phys. Rev. A 105, 052410 (2022) (August) .

**21-87** Taichiro Kugo, Ryuichi Nakayama, Nobuyoshi Ohta

*BRST Quantization of General Relativity in Unimodular Gauge and Unimodular Gravity*
arXiv:2108.11520 [hep-th] Phys. Rev. D 104, 126021 (2021) (August) .

**21-88** Kenta Suzuki, Tadashi Takayanagi
*JT Gravity Limit of Liouville CFT and Matrix Model*
arXiv:2108.12096 [hep-th] JHEP 11 (2021) 137 (August) .

**21-89** Tomoki Wada, Kunihito Ioka, Bing Zhang
*Binary comb models for FRB 121102*
arXiv:2105.14480 [astro-ph.HE] ApJ 920, 54 (2021) (August) .

**21-90** Ibra Akal
*Information storage and near horizon quantum correlations*
arXiv:2109.01639 [hep-th] (August) .

**21-91** Thomas Creutzig, Yasuaki Hikida
*Correlator correspondences for Gaiotto-Rapčák dualities and first order formulation of coset models*
arXiv:2109.03403 [hep-th] (September) .

**21-92** Itsuki Takahashi, Yuya Tanizaki
*Sigma-model analysis of $SU(3)$ antiferromagnetic spins on the triangular lattice*
arXiv:2109.10051 [cond-mat.str-el] Phys. Rev. B 104, 235152 (2021) (September) .

**21-93** Shohei Saga, Atsushi Taruya, Michel-Andrès Breton, Yann Rasera
*Detectability of the gravitational redshift effect from the asymmetric galaxy clustering*
arXiv:2109.06012 [astro-ph.CO] Mon. Not. R. Astron. Soc. 511, 2732-2754 (2022) (September) .

**21-94** Samuel Passaglia, Misao Sasaki
*Primordial Black Holes from CDM Isocurvature Perturbations*
arXiv:2109.12824 [astro-ph.CO] Phys. Rev. D 105 (2022), 103530 (September) .

**21-95** Atsushi Taruya, Takahiro Nishimichi, Donghui Jeong
*Grid-based calculations of redshift-space matter fluctuations from perturbation theory: UV sensitivity and convergence at the field level*
arXiv:2109.06734 [astro-ph.CO] Phys. Rev. D 105, 103507 (2022) (September) .

**21-96** Taiga Hiroka, Tomoyuki Morimae, Ryo Nishimaki, Takashi Yamakawa
*Certified Everlasting Zero-Knowledge Proof for QMA*
arXiv:2109.14163 [quant-ph] (September) .

**21-97** Yasushi Nara, Akira Ohnishi
*Mean-field update in the JAM microscopic model: Mean-field effects on collective flow in high-energy heavy-ion collisions at $\sqrt{s_{NN}} = 2-20$ GeV energies*
arXiv:2109.07594 [nucl-th] Phys. Rev. C105, 014911 (2022) (September) .

**21-98** Sinya Aoki, Koichi Yazaki
*Derivative expansion in the HAL QCD method for a separable potential*
arXiv:2109.07665 [hep-lat] (September) .

**21-99** Taigen Kawano, Naoki Sasakura
*Emergence of Lie group symmetric classical spacetimes in canonical tensor model*
arXiv:2109.09896 [hep-th] PTEP 2022 (2022) 4, 043A01 (September) .

**21-100** Shinji Hirano, Tsunehide Kuroki
*Replica Wormholes from Liouville Theory*
arXiv:2109.12539 [hep-th] JHEP 01 (2022) 94 (September) .

**21-101** Yusuke Namekawa, Kouji Kashiwa, Akira Ohnishi, Hayato Takase
*Gauge invariant input to neural network for path optimization method*
arXiv:2109.11710 [hep-lat] Phys. Rev. D 105, 034502 (2022) (September) .

**21-102** Antonio De Felice, Shinji Mukohyama, Masroor C. Pookkillath
*Minimal theory of massive gravity and constraints on the graviton mass*
arXiv:2110.01237 [astro-ph.CO] JCAP 12 (2021) 011 (September) .

**21-103** Masaya Amo, Tetsuya Shiromizu, Keisuke Izumi, Hirotaka Yoshino, Yoshimune Tomikawa
*Asymptotic behavior of null geodesics near future null infinity II: curvatures, photon surface and dynamically transversely trapping surface*
arXiv:2110.10917 [gr-qc] Phys. Rev. D 105, 064074 (2022) (September) .

**21-104** Antonio De Felice, Shinji Mukohyama, Kazufumi Takahashi
*Nonlinear definition of the shadowy mode in higher-order scalar-tensor theories*
arXiv:2110.03194 [gr-qc] JCAP 12 (2021) 020 (September) .

**21-105** Yasuaki Hikida, Tatsuma Nishioka, Tadashi Takayanagi, Yusuke Taki
*Holography in de Sitter Space via Chern-Simons Gauge Theory*
arXiv:2110.03197 [hep-th] (September) .

**21-106** Mikhail M. Ivanov, Oliver H. E. Philcox, Marko Simonović, Matias Zaldarriaga, Takahiro Nishimichi, Masahiro Takada
*Cosmological constraints without fingers of God*
arXiv:2110.00006 [astro-ph.CO] Phys. Rev. D 105, 043531 (2022) (September) .

**21-107** Yuki Takeuchi, Yasuhiro Takahashi, Tomoyuki Morimae, Seiichiro Tani
*Divide-and-conquer verification method for noisy intermediate-scale quantum computation*
arXiv:2109.14928 [quant-ph] (September) .

**21-108** Guido D'Amico, Leonardo Senatore, Pierre Zhang, Takahiro Nishimichi
*Taming redshift-space distortion effects in the EFTofLSS and its application to data*
arXiv:2110.00016 [astro-ph.CO] (October) .

**21-109** Misao Sasaki, Volodymyr Takhistov, Valeri Vardanyan, Ying-li Zhang
*Establishing the Non-Primordial Origin of Black Hole-Neutron Star Mergers*
arXiv:2110.09509 [astro-ph.CO] Astrophys.J. 931 (2022) 1, 2 (October) .

**21-110** Pisin Chen, Misao Sasaki, Dong-han Yeom, Junggi Yoon
*Solving information loss paradox via Euclidean path integral*
arXiv:2111.01005 [hep-th] (October) .

**21-111** Masazumi Honda, Etsuko Itou, Yuta Kikuchi, Yuya Tanizaki
*Negative string tension of higher-charge Schwinger model via digital quantum simulation*
arXiv:2110.14105 [hep-th] PTEP 2022 (2022) 3, 033B01 (October) .

**21-112** Yosuke Kobayashi, Takahiro Nishimichi, Masahiro Takada, Hironao Miyatake
*Full-shape cosmology analysis of SDSS-III BOSS galaxy power spectrum using emulator-based halo model: a 5% determination of $\sigma_8$*
arXiv:2110.06969 [astro-ph.CO] Phys. Rev. D 105, 083517 (2022) (October) .

**21-113** Teppei Okumura, Atsushi Taruya
*Tightening geometric and dynamical constraints on dark energy and gravity: galaxy clustering, intrinsic alignment and kinetic Sunyaev-Zel'dovich effect*
arXiv:2110.11127 [astro-ph.CO] (October) .

**21-114** Soichiro Isoyama, Ryuichi Fujita, Alvin J. K. Chua, Hiroyuki Nakano, Adam Pound, Norichika Sago
*Adiabatic waveforms from extreme-mass-ratio inspirals: an analytical approach*
arXiv:2111.05288 [gr-qc] (October) .

**21-115** Katsuki Aoki, Yusuke Manita, Shinji Mukohyama
*Shift-symmetric $SO(N)$ multi-Galileon*
arXiv:2110.05510 [gr-qc] JCAP12(2021)045 (October) .

**21-116** Masahide Manabe, Seiji Terashima, Yuji Terashima
*The colored Jones polynomials as vortex partition functions*
arXiv:2110.05662 [hep-th] JHEP 12 (2021) 197 (October) .

**21-117** K. Shizuya
*Orbital mixing in few-layer graphene and non-Abelian Berry phase*
arXiv:2110.08056 [cond-mat.mes-hall] Phys. Rev. B 104, 155417 (2021) (October) .

**21-118** Ryu Hayakawa
*Quantum algorithm for persistent Betti numbers and topological data analysis*
arXiv:2111.00433 [quant-ph] (October) .

**21-119** Hassan Firouzjahi, Mohammad Ali Gorji, Shinji Mukohyama, Alireza Talebian
*Dark Matter from Entropy Perturbations in Curved Field Space*
arXiv:2110.09538 [gr-qc] Phys. Rev. D 105, 043501 (2022) (October) .

**21-120** Mikhail M. Ivanov, Oliver H. E. Philcox, Takahiro Nishimichi, Marko Simonović, Masahiro Takada, Matias Zaldarriaga
*Precision analysis of the redshift-space galaxy bispectrum*
arXiv:2110.10161 [astro-ph.CO] Phys. Rev. D 105, 063512 (2022) (October) .

**21-121** Ken Shiozaki
*On adiabatic cycles of quantum spin systems*
arXiv:2110.10665 [cond-mat.str-el] (October) .

**21-122** Mohammad Ali Gorji, Hayato Motohashi, Shinji Mukohyama
*Inflation with $0 \leq c_s \leq 1$*
arXiv:2110.10731 [hep-th] JCAP 02 (2022) 030 (October) .

**21-123** unused

**21-124** Kanato Goto, Kenta Suzuki, Tomonori Ugajin
*Factorizing Wormholes in a Partially Disorder-Averaged SYK Model*
arXiv:2111.11705 [hep-th] (October) .

**21-125** Hironao Miyatake, Sunao Sugiyama, Masahiro Takada, Takahiro Nishimichi, Masato Shirasaki, Yosuke Kobayashi, Rachel Mandelbaum, Surhud More, Masamune Oguri, Ken Osato, Youngsoo Park, Ryuichi Takahashi, Jean Coupon, Chiaki Hikage, Bau-Ching Hsieh, Alexie Leauthaud, Xiangchong Li, Wentao Luo, Robert H. Lupton, Satoshi Miyazaki, Hitoshi Murayama, Atsushi J. Nishizawa, Paul A. Price, Melanie Simet, Joshua S. Speagle, Michael A. Strauss, Masayuki Tanaka, Naoki Yoshida
*Cosmological inference from the emulator based halo model II: Joint analysis of galaxy-galaxy weak*

*lensing and galaxy clustering from HSC-Y1 and SDSS*
arXiv:2111.02419 [astro-ph.CO] (October) .

**21-126** Sunao Sugiyama, Masahiro Takada, Hironao Miyatake, Takahiro Nishimichi, Masato Shirasaki, Yosuke Kobayashi, Surhud More, Ryuichi Takahashi, Ken Osato, Masamune Oguri, Jean Coupon, Chiaki Hikage, Bau-Ching Hsieh, Yotaka Komiyama, Alexie Leauthaud, Xiangchong Li, Wentao Luo, Robert H. Lupton, Hitoshi Murayama, Atsushi J. Nishizawa, Youngsoo Park, Paul A. Price, Melanie Simet, Joshua S. Speagle, Michael A. Strauss, Masayuki Tanaka
*HSC Year 1 cosmology results with the minimal bias method: HSC×BOSS galaxy-galaxy weak lensing and BOSS galaxy clustering*
arXiv:2111.10966 [astro-ph.CO] (October) .

**21-127** Antonio De Felice, Shinji Mukohyama, Masroor C. Pookkillath
*Static, spherically symmetric objects in Type-II minimally modified gravity*
arXiv:2110.14496 [gr-qc] Phys. Rev. D 105, 104013 (2022) (October) .

**21-128** Hiroki Matsui, Shinji Mukohyama, Atsushi Naruko
*DeWitt boundary condition is consistent in Hořava-Lifshitz quantum gravity*
arXiv:2111.00665 [gr-qc] (October) .

**21-129** unused

**21-130** Raúl Carballo-Rubio, Francesco Di Filippo, Stefano Liberati, Matt Visser
*Geodesically complete black holes in Lorentz-violating gravity*
arXiv:2111.03113 [gr-qc] JHEP 02 (2022) 122 (November) .

**21-131** Shi Pi, Misao Sasaki
*Primordial Black Hole Formation in Non-Minimal Curvaton Scenario*
arXiv:2112.12680 [astro-ph.CO] (November) .

**21-132** Katsuki Aoki, Mohammad Ali Gorji, Shinji Mukohyama, Kazufumi Takahashi
*The Effective Field Theory of Vector-Tensor Theories*
arXiv:2111.08119 [hep-th] JCAP 01 (2022) 059 (November) .

**21-133** Norihiro Iizuka, Akihiro Miyata, Tomonori Ugajin
*A comment on a fine-grained description of evaporating black holes with baby universes*
arXiv:2111.07107 [hep-th] (November) .

**21-134** Shohei Saga, Atsushi Taruya, Stéphane Colombi
*Cold dark matter protohalo structure around collapse: Lagrangian cosmological perturbation theory versus Vlasov simulations*
arXiv:2111.08836 [astro-ph.CO] (November) .

**21-135** Blayney W. Walshe, Rafael N. Alexander, Nicolas C. Menicucci, Ben Q. Baragiola
*Streamlined quantum computing with macronode cluster states*
arXiv:2109.04668 [quant-ph] Phys. Rev. A 104, 062427 (2021) (November) .

**21-136** Mattias T. Johnsson, Ben Q. Baragiola, Thomas Volz, Gavin K. Brennen
*Modified coherence of quantum spins in a damped pure-dephasing model*
arXiv:2112.11711 [quant-ph] Phys. Rev. B 105, 094308 (2022) (November) .

**21-137** Kazufumi Takahashi, Hayato Motohashi, Masato Minamitsuji
*Invertible disformal transformations with higher derivatives*
arXiv:2111.11634 [gr-qc] Phys. Rev. D 105, 024015 (2022) (November) .

**21-138** Joshua A. Kable, Giampaolo Benevento, Noemi Frusciante, Antonio De Felice, Shinji Tsujikawa
*Probing Modified Gravity with Integrated Sachs-Wolfe CMB and Galaxy Cross-correlations*
arXiv:2111.10432 [astro-ph.CO] (November) .

**21-139** Sinya Aoki, Yutaro Akahoshi
*HAL QCD potentials with non-zero total momentum and an application to the $I = 2$ $\pi\pi$ scattering*
arXiv:2112.00929 [hep-lat] (November) .

**21-140** Naotaka Kubo, Keita Nii
*3d $\mathcal{N} = 3$ Generalized Giveon-Kutasov Duality*
arXiv:2111.13366 [hep-th] JHEP 04 (2022) 158 (November) .

**21-141** Jonathan A. Gross, Ben Baragiola, T. M. Stace, Joshua Combes
*Master equations and quantum trajectories for squeezed wave packets*
arXiv:2109.05435 [quant-ph] Phys. Rev. A 105, 023721 (2022) (November) .

**21-142** Shuichi Yokoyama
*Gravitational collapse of spherical shells of fluid in the isotropic homogeneous universe*
arXiv:2111.15032 [gr-qc] (November) .

**21-143** Yi-Fu Cai, Xiao-Han Ma, Misao Sasaki, Dong-Gang Wang, Zihan Zhou
*One Small Step for an Inflaton, One Giant Leap for Inflation: a novel non-Gaussian tail and primordial black holes*
arXiv:2112.13836 [astro-ph.CO] (November) .

**21-144** Thomas Creutzig, Yasuaki Hikida
*FZZ-triality and large $\mathcal{N} = 4$ super Liouville theory*

arXiv:2111.12845 [hep-th] Nuclear Physics B 977, 115734 (2022) (November) .

**21-145** Kotaro Murakami, Yutaro Akahoshi, Sinya Aoki, Kenji Sasaki
*Investigations of decuplet baryons from meson-baryon interactions in the HAL QCD method*
arXiv:2111.15563 [hep-lat] (November) .

**21-146** Yutaro Akahoshi, Sinya Aoki, Takumi Doi
*Emergence of the rho resonance from the HAL QCD potential*
arXiv:2111.15138 [hep-lat] (November) .

**21-147** Kanato Goto, Ali Mollabashi, Masahiro Nozaki, Kotaro Tamaoka, Mao Tian Tan
*Information Scrambling Versus Quantum Revival Through the Lens of Operator Entanglement*
arXiv:2112.00802 [hep-th] (December) .

**21-148** Takumi Doi, Yan Lyu, Hui Tong, Takuya Sugiura, Sinya Aoki, Tetsuo Hatsuda, Jie Meng, Takaya Miyamoto
*Finite volume analysis on systematics of the derivative expansion in HAL QCD method*
arXiv:2112.04997 [hep-lat] (December) .

**21-149** Yan Lyu, Hui Tong, Takuya Sugiura, Sinya Aoki, Takumi Doi, Tetsuo Hatsuda, Jie Meng, Takaya Miyamoto
*Most charming dibaryon near unitarity*
arXiv:2112.01682 [hep-lat] (December) .

**21-150** Michele Dall'Arno, Francesco Buscemi, Takeshi Koshiba
*Classical computation of quantum guesswork*
arXiv:2112.01666 [quant-ph] (December) .

**21-151** Sinya Aoki, Yasumichi Aoki, Hidenori Fukaya, Shoji Hashimoto, Issaku Kanamori, Takashi Kaneko, Yoshifumi Nakamura
*2+1 flavor fine lattice simulation at finite temperature with domain-wall fermions*
arXiv:2112.11771 [hep-lat] (December) .

**21-152** JLQCD collaboration, S. Aoki, Y. Aoki, H. Fukaya, S. Hashimoto, C. Rohrhofer, K. Suzuki
*What is chiral susceptibility probing?*
arXiv:2111.02048 [hep-lat] (December) .

**21-153** Naotaka Kubo
*3d dualities with decoupled sectors and brane transitions*
arXiv:2112.07776 [hep-th] JHEP 05 (2022) 80 (December) .

**21-154** unused

**21-155** Tomoyuki Morimae, Takashi Yamakawa
*Quantum commitments and signatures without one-way functions*
arXiv:2112.06369 [quant-ph] (December) .

**21-156** Ken Osato, Daisuke Nagai
*Baryon Pasting Algorithm: Halo-based and Particle-based Pasting Methods*
arXiv:2201.02632 [astro-ph.CO] (December) .

**21-157** Shohei Saga, Atsushi Taruya, Michel-Andrès Breton, Yann Rasera
*Cosmological test of local position invariance from the asymmetric galaxy clustering*
arXiv:2112.07727 [astro-ph.CO] (December) .

**21-158** Ibrahim Akal, Taishi Kawamoto, Shan-Ming Ruan, Tadashi Takayanagi, Zixia Wei
*On the Page curve under final state projection*
arXiv:2112.08433 [hep-th] (December) .

**21-159** Benjamin Remy, Francois Lanusse, Niall Jeffrey, Jia Liu, Jean-Luc Starck, Ken Osato, Tim Schrabback
*Probabilistic Mass Mapping with Neural Score Estimation*
arXiv:2201.05561 [astro-ph.CO] (December) .

**21-160** Youngsoo Park, Tomomi Sunayama, Masahiro Takada, Yosuke Kobayashi, Hironao Miyatake, Surhud More, Takahiro Nishimichi, Sunao Sugiyama
*Cluster cosmology with anisotropic boosts: Validation of a novel forward modeling analysis and application on SDSS redMaPPer clusters*
arXiv:2112.09059 [astro-ph.CO] (December) .

**21-161** Chul-Moon Yoo, Tomohiro Harada, Shin'ichi Hirano, Hirotada Okawa, Misao Sasaki
*Primordial black hole formation from massless scalar isocurvature*
arXiv:2112.12335 [gr-qc] (December) .

**21-162** Max E. Lee, Tianhuan Lu, Zoltán Haiman, Jia Liu, Ken Osato
*Comparing weak lensing peak counts in baryonic correction models to hydrodynamical simulations*
arXiv:2201.08320 [astro-ph.CO] (December) .

**21-163** Katsuaki Asano, Yoichi Asaoka, Yosui Akaike, Norita Kawanaka, Kazunori Kohri, Holger M. Motz, Toshio Terasawa
*Monte Carlo Study of Electron and Positron Cosmic-Ray Propagation with the CALET Spectrum*
arXiv:2111.09636 [astro-ph.HE] ApJ 926, 5 (2022) (January) .

**21-164** Minori Shikauchi, Ataru Tanikawa, Norita Kawanaka
*Detectablity of Black Hole Binaries with Gaia: Dependence on Binary Evolution Models*
arXiv:2112.04798 [astro-ph.HE] ApJ 928, 13 (2022) (January) .

### 2.2.2 Publications and Talks by Regular Staff and Unit of Quantum Information Researchers (April 2021 — March 2022)

## Sinya Aoki

*Journal Papers*

1. S. Aoki, T. Onogi and S. Yokoyama, "Charge Conservation, Entropy Current, and Gravitation," International Journal of Modern Physics A Volume 36 (2021) 2150201 [arXiv:2010.07660 [gr-qc]].

2. S. Aoki *et al.* [JLQCD], "Study of the axial $U(1)$ anomaly at high temperature with lattice chiral fermions," Phys. Rev. D **103** (2021) no.7, 074506 [arXiv:2011.01499 [hep-lat]].

3. Y. Lyu, H. Tong, T. Sugiura, S. Aoki, T. Doi, T. Hatsuda, J. Meng and T. Miyamoto, "Dibaryon with Highest Charm Number near Unitarity from Lattice QCD," Phys. Rev. Lett. **127** (2021) no.7, 072003 [arXiv:2102.00181 [hep-lat]].

4. S. Aoki *et al.* [JLQCD], "Role of the axial U(1) anomaly in the chiral susceptibility of QCD at high temperature," PTEP **2022** (2022) no.2, 023B05 [arXiv:2103.05954 [hep-lat]].

5. Y. Akahoshi, S. Aoki and T. Doi, "Emergence of the $\rho$ resonance from the HAL QCD potential in lattice QCD," Phys. Rev. D **104** (2021) no.5, 054510 [arXiv:2106.08175 [hep-lat]].

6. S. Aoki and K. Yazaki, "Derivative expansion in the HAL QCD method for a separable potential," PTEP **2021**, 168 (2021) 033B04 [arXiv:2109.07665 [hep-lat]].

7. S. Aoki and J. Balog, "HKLL bulk reconstruction for small $\Delta$," JHEP02 (2022) 015 [arXiv:2112.04326 [hep-th]].

*Books and Proceedings*

1. Y. Akahoshi, S. Aoki, T. Aoyama, I. Kanamori, K. Kanaya, H. Matsufuru, Y. Namekawa, H. Nemura and Y. Taniguchi, "General purpose lattice QCD code set Bridge++ 2.0 for high performance computing," J. Phys. Conf. Ser. **2207** (2022) no.1, 012053 [arXiv:2111.04457 [hep-lat]].

2. Y. Akahoshi, S. Aoki and T. Doi, "Emergence of the rho resonance from the HAL QCD potential,", 38th International Symposium on Lattice Field Theory, 2021, [arXiv:2111.15138 [hep-lat]].

3. K. Murakami *et al.* [HAL QCD], "Investigations of decuplet baryons from meson-baryon interactions in the HAL QCD method," 38th International Symposium on Lattice Field Theory, 2021, [arXiv:2111.15563 [hep-lat]].

4. S. Aoki and Y. Akahoshi, "HAL QCD potentials with non-zero total momentum and an application to the $I = 2\pi\pi$ scattering," 38th International Symposium on Lattice Field Theory, 2021, [arXiv:2112.00929 [hep-lat]].

5. Y. Lyu, H. Tong, T. Sugiura, S. Aoki, T. Doi, T. Hatsuda, J. Meng and T. Miyamoto, "Most charming dibaryon near unitarity," 38th International Symposium on Lattice Field Theory, 2021, [arXiv:2112.01682 [hep-lat]].

6. T. Doi, Y. Lyu, H. Tong, T. Sugiura, S. Aoki, T. Hatsuda, J. Meng and T. Miyamoto, "Finite volume analysis on systematics of the derivative expansion in HAL QCD method," 38th International Symposium on Lattice Field Theory, 2021, [arXiv:2112.04997 [hep-lat]].

7. S. Aoki, Y. Aoki, H. Fukaya, S. Hashimoto, I. Kanamori, T. Kaneko and Y. Nakamura, "2+1 flavor fine lattice simulation at finite

temperature with domain-wall fermions," 38th International Symposium on Lattice Field Theory, 2021, [arXiv:2112.11771 [hep-lat]].

8. S. Aoki *et al.* [JLQCD], "Axial U(1) symmetry at high temperatures in $N_f = 2+1$ lattice QCD with chiral fermions," 38th International Symposium on Lattice Field Theory, 2021, [arXiv:2203.16059 [hep-lat]].

9. S. Aoki, J. Balog, T. Onogi and S. Yokoyama, "Bulk reconstruction from a scalar CFT at the boundary by the smearing with the flow equation," 14th International Workshop on Lie Theory and Its Applications in Physics, [arXiv:2204.01989 [hep-th]].

*Talks at International Conferences*

1. "Bulk reconstruction from scalar CFT at the boundary by the smearing with the flow equation" (Zoom), XIV. International Workshop "LIE THORY AND ITS APPLICATIONS IN PHYSICS", June 20-26, 2021, Sofia, Bulgaria

2. "HAL QCD potentials with non-zero total momentum and application to the $I = 2$ $\pi\pi$ scattering" (Zoom), The 38th International Symposium on Lattice Field Theory (Lattice 2021), July 26-30, 2021, Zoom/Gather@MIT, USA

3. "Recent progresses in the HAL QCD method for hadron interactions", YITP workshop "QCD phase diagram and lattice QCD", Invited, October 25-29, 2021 YITP, Koyo University, Japan

4. "An alternative bulk construction by the flow equation", East Asia Joint Symposium on Fields and Strings 2021, November 22-27, 2021, Osaka City University, Osaka, Japan

5. "Recent results for hadron interactions in the HAL QCD method" (Zoom), Invited, BNL-HET & RBC Joint workshop "DWQCD@25", December 13-18, 2021, Virtual Event

*Invited Seminars* (in Japan)

1. "Conserved non-Noether charge in general relativity: Physical definition vs. Noether's 2nd theorem" (Zoom), February 2, 2022, FTRT, R-CCS, Kobe, Japan,

2. "Conserved non-Noether charge in general relativity: Physical definition vs. Noether's 2nd theorem" (Zoom), March 29, 2022, KEK, Tsukuba, Japan

## Michele Dall'Arno

*Journal Papers*

1. M. Dall'Arno, F. Buscemi, T. Koshiba, "Guesswork of a quantum ensemble," IEEE Trans. Inform. Theory **68**, 3193 (2022), YITP-20-161, arXiv:2012.09350.

*Talks at International Conferences*

1. "Guesswork of a quantum ensemble," Invited (online), in "Second Kyoto Workshop on Quantum Information, Computation, and Foundation," Kyoto, Japan, September 2021.

## Andrew Darmawan

*Journal Papers*

1. A. S. Darmawan, B. J. Brown, A. L. Grimsmo, D. K. Tuckett, and S. Puri, "Practical Quantum Error Correction with the XZZX Code and Kerr-Cat Qubits," Phys. Rev. X Quantum **2** (2021) 030345 (21 pages), YITP-21-32, arXiv:2104.09539 [quant-ph].

2. S. Singh, A. S. Darmawan, B. J. Brown, and S. Puri, "High-fidelity magic-state preparation with a biased-noise architecture," Phys. Rev. **A105** (2022) 052410 (10 pages), YITP-21-86, arXiv:2109.02677 [quant-ph].

*Talks at International Conferences*

1. "Practical quantum error correction with the XZZX code and Kerr-cat qubits," Invited,

in "3rd International Symposium on Dymanics of Artificial Quantum Systems," Online,
Feb 2022.

*Invited Seminars* (Overseas)

1. "Practical quantum error correction with the XZZX code and Kerr-cat qubits,"
Quantum Code Design and Architectures, Online, July 2021.

*Invited Seminars* (in Japan)

1. "Practical quantum error correction with the XZZX code and Kerr-cat qubits,"
Koashi Lab, University of Tokyo, June 2021.

## Antonio De Felice

*Journal Papers*

1. A. De Felice, S. Mukohyama and K. Takahashi,
"Nonlinear definition of the shadowy mode in higher-order scalar-tensor theories,"
JCAP **12**, no.12, 020 (2021), YITP-21-104, arXiv:2110.03194 [gr-qc].

2. A. De Felice, S. Mukohyama and M. C. Pookkillath,
"Minimal theory of massive gravity and constraints on the graviton mass,"
JCAP **12**, no.12, 011 (2021), YITP-21-102, arXiv:2110.01237 [astro-ph.CO].

3. J. B. Achour, A. De Felice, M. A. Gorji, S. Mukohyama and M. C. Pookkillath,
"Disformal map and Petrov classification in modified gravity,"
JCAP **10**, 067 (2021), YITP-21-72, arXiv:2107.02386 [gr-qc].

4. J. C. N. de Araujo, A. De Felice, S. Kumar and R. C. Nunes,
"Minimal theory of massive gravity in the light of CMB data and the S8 tension,"
Phys. Rev. D **104**, no.10, 104057 (2021), YITP-21-55, arXiv:2106.09595 [astro-ph.CO].

5. A. De Felice, F. Larrouturou, S. Mukohyama and M. Oliosi,
"Minimal Theory of Bigravity: construction and cosmology,"
JCAP **04**, 015 (2021), YITP-20-157, arXiv:2012.01073 [gr-qc].

6. A. De Felice and S. Mukohyama,
"Weakening gravity for dark matter in a type-II minimally modified gravity,"
JCAP **04**, 018 (2021), YITP-20-145, arXiv:2011.04188 [astro-ph.CO].

7. A. De Felice, S. Mukohyama and M. C. Pookkillath,
"Addressing $H_0$ tension by means of VCDM,"
Phys. Lett. B **816**, 136201 (2021), YITP-20-117, arXiv:2009.08718 [astro-ph.CO].

*Talks at International Conferences*

1. "Minimal theory of bigravity: Construction and cosmology," Invited,
in "107th National Congress, Italian Physical Society," [Online] University of Bologna, Bologna, Italy,
September 2021.

## Hisao Hayakawa

*Journal Papers*

1. M. Otsuki, and H. Hayakawa,
"Shear modulus and reversible particle trajectories of frictional granular materials under oscillatory shear,"
Eur. Phys. J. E **44** (2021) 70 (7 pages).

2. V. M. M. Paasonen and H. Hayakawa,
"Pumping current in a non-Markovian N-state model,"
Phys. Rev. Research **3** (2021) 023238 (11 pages).

3. Pradipto and H. Hayakawa,
"Viscoelastic response of impact process on dense suspensions,"
Phys. Fluids **33** (2021) 093310 (13 pages).

4. M. Otsuki and H. Hayakawa,
"Pumping current in a non-Markovian N-state model,"

Phys. Rev. Lett. **128** (2022) 208002 (6 pages).

*Books and Proceedings*

1. D. Ishima and H. Hayakawa,
"Dilatancy of frictional granular materials under oscillatory shear with constant pressure,"
EPJ Web Conf. **249** (2021) 02011 (4 pages).

## Yasuaki Hikida

*Journal Papers*

1. T. Creutzig, Y. Hikida and D. Stockall,
"Correlator correspondences for subregular $\mathscr{W}$-algebras and principal $\mathscr{W}$-superalgebras,"
JHEP **10** (2021) 032 (29 pages), YITP-21-68, arXiv:2106.15073 [hep-th].

2. T. Creutzig and Y. Hikida,
"Correlator correspondences for Gaiotto-Rapčák dualities and first order formulation of coset models,"
JHEP **12** (2021) 144 (39 pages), YITP-21-91, arXiv:2109.03403 [hep-th].

3. T. Creutzig and Y. Hikida,
"FZZ-triality and large N=4 super Liouville theory,"
Nucl. Phys. B **977** (2022) 115734 (41 pages), YITP-21-144, arXiv:2111.12845 [hep-th].

*Talks at International Conferences*

1. "CFT realizations of Gaiotto-Rapcak dualities," Invited,
in "KIAS-YITP Joint Workshop 2021 String Theory and Quantum Gravity," Kyoto Univ. (online),
December 2021.

2. "3d de Sitter space/2d CFT correspondence," Invited,
in "Extreme Universe first annual meeting," Kyoto Univ. (online),
March 2022.

*Invited Seminars* (in Japan)

1. "Generalized Fateev-Zamolodchikov-Zamolodchikov dualities and Gaiotto-Rapcak ' s VOAs,"
RIMS, Kyoto Univ. (online), May 2021.

2. "dS3/CFT2 correspondence,"
KEK (online), February 2022.

## Masazumi Honda

*Journal Papers*

1. M. Honda and T. Yoda, "String theory, $\mathcal{N} = 4$ SYM and Riemann hypothesis," YITP-22-30, arXiv:2203.17091 [hep-th].

2. M. Honda, E. Itou, Y. Kikuchi and Y. Tanizaki, "Negative string tension of a higher-charge Schwinger model via digital quantum simulation," PTEP **2022** (2022) no.3, 033B01, YITP-21-111, arXiv:2110.14105 [hep-th].

3. M. Honda, E. Itou, Y. Kikuchi, L. Nagano and T. Okuda, "Classically emulated digital quantum simulation for screening and confinement in the Schwinger model with a topological term," Phys. Rev. D **105** (2022) no.1, 014504, YITP-21-12, arXiv:2105.03276 [hep-lat].

4. T. Fujimori, M. Honda, S. Kamata, T. Misumi, N. Sakai and T. Yoda, "Quantum phase transition and resurgence: Lessons from three-dimensional $\mathcal{N} = 4$ supersymmetric quantum electrodynamics," PTEP **2021** (2021) no.10, 103B04, YITP-21-13, arXiv:2103.13654 [hep-th].

5. H. Gharibyan, M. Hanada, M. Honda and J. Liu, "Toward simulating superstring/M-theory on a quantum computer," JHEP **07** (2021), 140, YITP-20-146, arXiv:2011.06573 [hep-th].

6. A. J. Buser, H. Gharibyan, M. Hanada, M. Honda and J. Liu, "Quantum simulation of gauge theory via orbifold lattice," JHEP **09** (2021), 034, YITP-20-146, arXiv:2011.06576 [hep-th].

7. M. Honda and N. Kubo, "Non-perturbative tests of duality cascades in three dimensional supersymmetric gauge theories," JHEP **07** (2021), 012, YITP-20-128, arXiv:2010.15656 [hep-th].

*Books and Proceedings*

1. A. Matsumoto, K. Hatakeyama, M. Hirasawa, M. Honda, Y. Ito, J. Nishimura and A. Yosprakob, "A new technique for solving the freezing problem in the complex Langevin simulation of 4D SU(2) gauge theory with a theta term," PoS **LATTICE2021** (2022), 087 arXiv:2112.01805 [hep-lat].

*Talks at International Conferences*

1. "Lectures and tutorials on quantum computation", Invited, INT Summer School on Problem Solving in Lattice QCD, online, July 2021

2. "Digital Quantum Simulation of the Schwinger Model with Topological Term", Invited, East Asia Joint Symposium on Fields and Strings 2021, Osaka City University, October 2021

3. "Digital Quantum Simulation of higher-charge Schwinger model with Topological term", Invited, Tensor Network States: Algorithms and Applications (TNSAA) 2021-2022 Online Workshop, online, January 2022

*Invited Seminars* (in Japan)

1. "Quantum Computation and Quantum Field Theory", Nagoya University Tagen Danwakai, December 2021

2. "Digital Quantum Simulation of the Schwinger Model with Topological Term", the 79th Tokyo Institute of Technology Quantum Physics and Nano science special seminar, October 2021

## Kunihito Ioka

*Journal Papers*

1. R. Takahashi, K. Ioka, A. Mori and K. Funahashi,
"Statistical modelling of the cosmological dispersion measure,"
Monthly Notices of the Royal Astronomical Society **502** (2021) 2615 (15 pages), YITP-20-141, arXiv:2010.01560.

2. M. Arimoto, et al.,
"Gravitational Wave Physics and Astronomy in the nascent era,"
Progress of Theoretical and Experimental Physics **ptab042** (2021) ( pages), arXiv:2104.02445.

3. E. Préau, K. Ioka and P. Mészáros,
"Neutron conversion-diffusion: a new model for structured short gamma-ray burst jets compatible with GRB 170817,"
Monthly Notices of the Royal Astronomical Society **503** (2021) 2499 (15 pages), YITP-21-22, arXiv:2009.07507.

4. W. Ishizaki, K. Ioka and K. Kiuchi,
"Fallback Accretion Model for the Years-to-Decades X-ray Counterpart to GW170817,"
The Astrophysical Journal Letters **916** (2021) L13 (9 pages), YITP-21-33, arXiv:2104.04433.

5. T. Wada, K. Ioka and B. Zhang,
"Binary comb models for FRB 121102,"
The Astrophysical Journal **920** (2021) 54 (15 pages), YITP-21-89, arXiv:2105.14480.

6. W. Ishizaki, K. Kiuchi, K. Ioka and S. Wanajo,
"Fallback Accretion Halted by R-process Heating in Neutron Star Mergers and Gamma-Ray Bursts,"
The Astrophysical Journal **922** (2021) 185 (16 pages), YITP-21-34, arXiv:2104.04708.

*Talks at International Conferences*

1. "High-Energy Astrophysics," Invited, Keynote talk,
in "NAOJ Future Planning Symposium 2021 – Thinking about Future Plans Across Wavelengths –," online, NAOJ, Japan, November 2021.

*Invited Seminars* (in Japan)

1. "Fast Radio Bursts,"
   online, YITP workshop, November 2021 (in Japanese).

2. "High Energy Astrophysics,"
   online, rironkon symposium, ICRR, December 2021 (in Japanese).

## Naoyuki Itagaki

*Journal Papers*

1. T. Otsuka, T. Abe, T. Yoshida, Y. Tsunoda, N. Shimizu, N. Itagaki, Y. Utsuno, J. Vary, P. Maris, H. Ueno
   "alpha-Clustering in atomic nuclei from first principles with statistical learning and the Hoyle state character",
   Nature Communications (2022) 13:2234.

2. M. Caamano, T. Roger, A. M. Moro, G. F. Grinyer, J. Pancin, S. Bagchi, S. Sambi, J. Gibelin, B. Fernandez-Dominguez, N. Itagaki, J. Benlliure, D. Cortina-Gil, F. Farget, B. Jacquot, D. Perez-Loureiro, B. Pietras, R. Raabe, D. Ramos, C. Rodriguez-Tajes, H. Savajols, and M. Vandebrouck,
   "Ground-state properties of $^{7}$H",
   Phys. Lett. **B829**, (2022) 13706.

3. Takatoshi Ichikawa and Naoyuki Itagaki,
   "Optimization of basis functions for the multi-configuration mixing using the Replica Exchange Monte-Carlo method and its application to $^{12}$C",
   Phys. Rev. C **105**, (2022) 024314.

4. Naoyuki Itagaki, Tomoya Naito, Yuichi Hirata,
   "Persistence of cluster structure in the ground state of $^{11}$B",
   Phys. Rev. C **105**, (2022) 024304.

5. T. Furumoto, T. Suhara and N. Itagaki,
   "Drastic change of inelastic scattering dependent on development of dineutron correlations in $^{10}$Be",
   Phys. Rev. C **104**, (2021) 034613.

6. M. Tsumura, T. Kawabata,, Y. Takahashi, S. Adachi, H. Akimune, S. Ashikaga, T. Baba, Y. Fujikawa, H. Fujimura, H. Fujioka, T. Furuno, T. Hashimoto, T. Harada, M. Ichikawa, K. Inaba, Y. Ishii, N. Itagaki, M. Itoh, C. Iwamoto, N. Kobayashi, A. Koshikawa, S. Kubono, Y. Maeda, Y. Matsuda, S. Matsumoto, K. Miki, T. Morimoto, M. Murata, T. Nanamura, I. Ou, S. Sakaguchi, A. Sakaue, M. Sferrazza, K. N. Suzuki, T. Takeda, A. Tamii, K. Watanabe, Y. N. Watanabe, H. P. Yoshida, and J. Zenihiro,
   "Revised triple alpha reaction rate in high temperature environments",
   Phys. Lett. **B817**, (2021) 136282.

7. Naoyuki Itagaki and Tomoya Naito,
   "Consistent description for cluster dynamics and single-particle correlation",
   Phys. Rev. C **103**, (2021) 044303.

## Hiroshi Kunitomo

*Journal Papers*

1. K. Kunitomo,
   "Type II superstring field theory revisited,"PTEP **2021** (2021) 093B03, YITP-21-58, arXiv:2106.07917 [hep-th].

*Talks at International Conferences*

1. "Type II superstring field theory revisited," Invited talk in "SFT@Cloud 2021," (Online), 20-24 Sep. 2021.

*Invited Seminars* (in Japan)

1. "String Field Theory and Homotopy Algebra," Intensive lecutre at Nara Women's Univ., Dec. 6-8 (2021).

## Tomoyuki Morimae

*Journal Papers*

1. T. Morimae,
   "Quantum randomized encoding, verification of quantum computing, no-cloning, and blind quantum computing,"
   Quant. Inf. Comput. **21** (2021) 1111-1134 (23 pages), YITP-20-140, arXiv:2011.03141 [quant-ph].

*Books and Proceedings*

1. T. Hiroka, T. Morimae, R. Nishimaki, and T. Yamakawa,
"Quantum Encryption with certified deletion, revisited: public key, attribute-based, and classical communication,"
In: Tibouchi, M., Wang, H. (eds) Advances in Cryptology - ASIACRYPT 2021. ASIACRYPT 2021. Lecture Notes in Computer Science, vol 13090. Springer, Cham. YITP-21-40, arXiv:2105.05393 [quant-ph].

*Talks at International Conferences*

1. Certified Deletion for Public Key Encryption, Zero-Knowledge, and More, Short plenary talk,
25th Annual Conference on Quantum Information Processing (QIP2022), Pasadena CA, USA,
March 7-11, 2022.

2. Quantum Encryption with Certified Deletion, Revisited: Public Key, Attribute-Based, and Classical Communication,
QCrypt 2021, Online,
August 23-27, 2021.

## Shinji Mukohyama

*Journal Papers*

1. B. Salehian, M. A. Gorji, S. Mukohyama, H. Firouzjahi,
"Analytic study of dark photon and gravitational wave production from axion,"
JHEP 05 (2021) 043, arXiv:2007.08148 [hep-ph].

2. A. De Felice, S. Mukohyama,
"Weakening gravity for dark matter in a type-II minimally modified gravity,"
JCAP 04 (2021) 018, arXiv: 2011.04188 [astro-ph.CO].

3. H. Firouzjahi, M. A. Gorji, S. Mukohyama, B. Salehian,
"Dark photon dark matter from charged inflaton,"
JHEP 06 (2021) 050, arXiv: 2011.06324 [hep-ph].

4. J. C. Feng, S. Mukohyama, S. Carloni,
"Minimal exponential measure model in the post-Newtonian limit,"
Phys.Rev.D 103 (2021) 8, 084055, arXiv: 2011.12305 [gr-qc].

5. R. Hagala, A. De Felice, D. F. Mota, S. Mukohyama,
"Non-linear dynamics of the minimal theory of massive gravity,"
Astron.Astrophys. 653 (2021) A148, arXiv: 2011.14697 [astro-ph.CO].

6. A. De Felice, F. Larrouturou, S. Mukohyama, M. Oliosi,
"Minimal Theory of Bigravity: construction and cosmology,"
JCAP 04 (2021) 015, arXiv: 2012.01073 [gr-qc].

7. N. Oshita, N. Afshordi, S. Mukohyama,
"Lifshitz scaling, ringing black holes, and superradiance,"
JCAP 05 (2021) 005, arXiv: 2102.01741 [gr-qc].

8. J. Fier, X. Fang, B. Li, S. Mukohyama, A. Wang,
"Gravitational wave cosmology: High frequency approximation,"
Phys.Rev.D 103 (2021) 12, 123021, arXiv: 2102.08968 [astro-ph.CO].

9. K. Aoki, F. Di Filippo, S. Mukohyama,
"Non-uniqueness of massless transverse-traceless graviton,"
JCAP 05 (2021) 071, arXiv: 2103.15044 [gr-qc].

10. J. Oost, S. Mukohyama, A. Wang,
"Spherically Symmetric Exact Vacuum Solutions in Einstein-Aether Theory,"
Universe 7 (2021) 8, 272, arXiv: 2106.09044 [gr-qc].

11. K. Aoki, S. Mukohyama, R. Namba,
"Positivity vs. Lorentz-violation: an explicit example,"
JCAP 10 (2021) 079, arXiv: 2107.01755 [hep-th].

12. J. Ben Achour, A. De Felice, M. A. Gorji, S. Mukohyama, , M. C. Pookkillath,
"Disformal map and Petrov classification in modified gravity,"

JCAP 10 (2021) 067, arXiv: 2107.02386 [gr-qc].

13. L. Buoninfante, F. Di Filippo, S. Mukohyama,
"On the assumptions leading to the information loss paradox,"
JHEP 10 (2021) 081, arXiv: 2107.05662 [hep-th].

14. C. Deffayet, S. Mukohyama, A. Vikman,
"Ghosts without Runaway Instabilities"
Phys.Rev.Lett. 128 (2022) 4, 041301, arXiv: 2108.06294 [gr-qc].

15. A. De Felice, S. Mukohyama, M. C. Pookkillath,
"Minimal theory of massive gravity and constraints on the graviton mass,"
JCAP 12 (2021) 12, 011, arXiv: 2110.01237 [astro-ph.CO].

16. A. De Felice, S. Mukohyama, K. Takahashi,
"Nonlinear definition of the shadowy mode in higher-order scalar-tensor theories,"
JCAP 12 (2021) 12, 020, arXiv: 2110.03194 [gr-qc].

17. K. Aoki, Y. Manita, S. Mukohyama,
"Shift-symmetric $SO(N)$ multi-Galileon,"
JCAP 12 (2021) 12, 045, arXiv: 2110.05510 [gr-qc].

18. H. Firouzjahi, M. Ali Gorji, S. Mukohyama, A. Talebian "Dark matter from entropy perturbations in curved field space,"
Phys.Rev.D 105 (2022) 4, 043501, arXiv: 2110.09538 [gr-qc].

19. M. A. Gorji, H. Motohashi, S. Mukohyama,
"Inflation with $0 \leq c_s \leq 1$,"
JCAP 02 (2022) 02, 030, arXiv: 2110.10731 [hep-th].

20. K. Aoki, M. A. Gorji, S. Mukohyama, K. Takahashi,
"The effective field theory of vector-tensor theories,"
JCAP 01 (2022) 01, 059, arXiv: 2111.08119 [hep-th].

*Books and Proceedings*

1. Shinji Mukohyama, "Gravity beyond general relativity and cosmology", SAIENSU - SHA Co., Ltd., ISBN: 4781915175.

*Talks at International Conferences*

1. "Minimalism in modified gravity," Invited,
in "Current challenges in gravitational physics," SISSA, Italy, (Online)
April 2021.

2. "Introduction to Modified Gravity," Invited,
in "QASTM zoominar," (Online)
May 2021.

3. "Minimalism in modified gravity," Invited,
in "Copernicus webinar," (Online)
June 2021.

4. "Minimalism in modified gravity," Invited,
in "Quarks," Russia, (Online)
June 2021.

5. "Gravity and Cosmology beyond General Relativity and Gravitational Waves," Invited,
in the session "Gravitational Waves as Probes for New Physics," "SUSY2021," (Online)
August 2021.

6. "Gravity beyond general relativity and gravitational waves," Invited,
in "Particle physics and gravitational waves," Osaka City University, Japan, (Online)
Feburuary 2022.

*Invited Seminars* (Overseas)

1. "Minimalism in modified gravity,"
Imperial College, London, UK (Online), April 2021.

2. "Gravity Beyond General Relativity,"
Pabna University of Science and Technology, Pabna, Bangladesh (Online), June 2021.

3. "Gravity and Cosmology beyond General Relativity and Gravitational Waves,"
IPM, Tehran, Iran (Online), September 2021.

4. “Ghost condensation and related topics,” ITP-CAS, Beijin, China (Online), December 2021.

## Masatoshi Murase

*Journal Papers*

1. M. Murase,
“Lectures on Advanced Future Studies at Kyoto University - How can we learn creativity? How can we transfer creativity?,” Journal of Quality Education **11** (2021) 41-62.

2. M. Murase,
“Series Lectures on Creative Learning at Ritsumeikan University - Towards Meta-learning from Learning via Unlearning,” Journal of Quality Education **11** (2021) 63-78.

3. M. Murase, T. Murase
“Philosophy of Advanced Future Studies: Construction of "A Grand Unified Theory of Life" based on the Self-nonself Circulation Theory,” Studies in Japanese Philosophy. **Vol. 18** (2021) 62-117.

*Books and Proceedings*

1. Eds: Kazuo Nishimura, Masatoshi Murase, Kazuyoshi, Yoshimura,
“Creative Complex Systems,” Springer-Nature, pp.1-429, 2021.

2. Paul G. Mezey and Masatoshi Murase,
“Universality and the Role of Limitations Influencing Interdisciplinary Scientific and Cultural Advances,” In: Creative Complex Systems (Eds: Kazuo Nishimura, Masatoshi Murase, Kazuyoshi, Yoshimura) Springer-Nature, pp.121-128, 2021.

3. Paul G. Mezey and Masatoshi Murase,
“Some Conceptual Principles with Mathematical Background for Interdisciplinary Developments in the Sciences and Beyond,” In: Creative Complex Systems (Eds: Kazuo Nishimura, Masatoshi Murase, Kazuyoshi, Yoshimura) Springer-Nature, pp.129-141, 2021.

4. Masatoshi Murase and Paul G. Mezey,
“The Role of Paradox in the Development of Interdisciplinary Scientific and Cultural Advances,” In: Creative Complex Systems (Eds: Kazuo Nishimura, Masatoshi Murase, Kazuyoshi, Yoshimura) Springer-Nature, pp.143-161, 2021.

5. Stefan Büchi and Masatoshi Murase,
“Evolutionary perspective on Suffering: Murase‘s “Self-Nonself circulation theory of life” applied to PRISM (Pictorial Representation of Illness and Self Measure),” In: Creative Complex Systems (Eds: Kazuo Nishimura, Masatoshi Murase, Kazuyoshi, Yoshimura) Springer-Nature, pp.311-326, 2021.

6. van der Leeuw, S.E. and Masatoshi Murase,
“Ignorance, Creation, Destruction,” In: Creative Complex Systems (Eds: Kazuo Nishimura, Masatoshi Murase, Kazuyoshi, Yoshimura) Springer-Nature, pp.351-372, 2021.

7. Masatoshi Murase, Aine Mori and Tomoko Murase,
“A Unified Theory and Practice of Creative Complex Systems: Challenging to the Systemic Problems Spanning the Inside and Outside World,” In: Creative Complex Systems (Eds: Kazuo Nishimura, Masatoshi Murase, Kazuyoshi, Yoshimura) Springer-Nature, pp.373-424, 2021.

*Invited Seminars* (in Japan)

1. “Integrated Life Science and Medicine,”
Mie University, Graduate School of Medicine, July 18, 2021.

2. “Life Science and Biolgocal Physics,”
Kyoto University Lectures, Institute for Riberal Arts and Science, Kyoto University, April-July, 2021.

3. “Advanced Future Studies,”
Kyoto University Lectures, Institute for Riberal Arts and Science, Kyoto University, April-July, 2021.

4. “Life Science and Biolgocal Physics,”
Kyoto University Lectures for Graduate

Students, Institute for Riberal Arts and Science, Kyoto University, April-July, 2021.

5. "Origin and Evolution of Living Systems," Ritsumeikan University Advanced Lectures, at Ritsumeikan University, September 4, 2021.

6. "Integrated Biolgocal Physics 1," Japanese Red Cross Toyota College October-November, 2021.

7. "Structuralism and Living Systems," Japanese Red Cross Toyota College December 18, 2021.

## Atsushi Naruko

*Journal Papers*

1. R. Kimura, A. Naruko and D. Yamauchi, "On Lorentz-invariant bi-spin-2 theories," Phys. Rev. **D 104**, (2021) 044021 (20 pages), YITP-20-144, arXiv:2012.13461 [hep-th].

2. T. Namikawa, A. Naruko, R. Saito, A. Taruya and D. Yamauchi, "Unified approach to secondary effects on the CMB B-mode polarization," JCAP **10** (2021) 029, (52 pages), YITP-21-20, arXiv:2103.10639 [astro-ph.CO].

3. C.M. Yoo, A. Naruko, Y. Sakurai, K. Takahashi, Y. Takamori and D. Yamauchi, "Axion Cloud Decay due to the Axion-photon Conversion with Background Magnetic Fields," Publ. Astron. Soc. Japan **(2022)** 74 (1), (9 pages), YITP-21-23, arXiv:2103.13227 [hep-ph].

4. M. Kimura, T. Harada, A. Naruko and K. Toma, "Backreaction of Mass and Angular Momentum Accretion on Black Holes: General Formulation of the Metric Perturbations and Application to the Blandford-Znajek Process," Prog. Theor. Exp. Phys. **2021**, 093E03, (26 pages), YITP-21-43, arXiv:2105.05581 [gr-qc].

5. Y. Takamori, A. Naruko, Y. Sakurai, K. Takahashi, D. Yamauchi and C.M. Yoo, "Testing the Non-circularity of the Spacetime around Sagittarius A* with Orbiting Pulsars," Publ. Astron. Soc. Japan **(2022)** 00 (0), (15 pages), YITP-21-48, arXiv:2108.13026 [gr-qc].

*Talks at International Conferences*

1. "VHDM search & gravity sector," keynote, in "1st workshop: Multimessenger Study of Heavy Dark Matter," YITP, Kyoto, Japan, August 2021.

2. "Axion Cloud Decay due to the Axion-photon Conversion with Background Magnetic Fields," Invited, in "8th Korea-Japan workshop on Dark Energy," Online, October 2021.

3. "Axion Cloud Decay due to the Axion-photon Conversion with Background Magnetic Fields," Invited, in "The 30th Workshop on General Relativity and Gravitation in Japan," onlione, December 2021.

4. "Spatial gradient expansion approach for generic scalar-tensor theories," Invited, in "International Workshop "Dawn of Gravitational-wave Cosmology and Theory of Gravity"," Tohoku U., Miyagi, Japan, March 2022.

## Takahiro Nishimichi

*Journal Papers*

1. M. M. Ivanov, O. H. E. Philcox, T. Nishimichi, M. Simonović, M. Takada, and M. Zaldarriaga, "Precision analysis of the redshift-space galaxy bispectrum," Phys. Rev. D **105** (2022) 063512 (31 pages), YITP-21-120, arXiv:2110.10161 [astro-ph.CO].

2. K. Osato, T. Nishimichi, and M. Takada, "Mock catalogues of emission-line galaxies based on the local mass density in dark-matter only simulations,"

Mon. Not. Roy. Astron. Soc. **511** (2022) 1131-1140, YITP-21-73, arXiv:2107.13168 [astro-ph.GA].

3. D. Rana, S. More, H. Miyatake, T. Nishimichi, M. Takada, A. S. G. Robotham, A. M. Hopkins, and B. W. Holwerda,
"The Subaru HSC weak lensing mass-observable scaling relations of spectroscopic galaxy groups from the GAMA survey,"
Mon. Not. Roy. Astron. Soc. **510** (2022) 5408-5425, YITP-21-74, arXiv:2107.05641 [astro-ph.CO].

4. M. M. Ivanov, O. H. E. Philcox, M. Simonović, M. Zaldarriaga, T. Nishimichi, and M. Takada,
"Cosmological constraints without nonlinear redshift-space distortions,"
Phys. Rev. D **105** (2022) 043531 (17 pages), YITP-21-106, arXiv:2110.00006 [astro-ph.CO].

5. K. Osato, T. Nishimichi, A. Taruya, and F. Bernardeau,
"Implementing spectra response function approaches for fast calculation of power spectra and bispectra,"
Phys. Rev. D **104** (2021) 103501 (31 pages), YITP-21-71, arXiv:2107.04275 [astro-ph.CO].

6. R. Murata, T. Sunayama, M. Oguri, S. More, A. J. Nishizawa, T. Nishimichi, and K. Osato,
"Erratum: The splashback radius of optically selected clusters with Subaru HSC Second Public Data Release,"
Publ. Astron. Soc. Japan **73** (2021) 772-772.

7. M. Shirasaki, K. Moriwaki, T. Oogi, N. Yoshida, S. Ikeda, and T. Nishimichi,
"Noise reduction for weak lensing mass mapping: an application of generative adversarial networks to Subaru Hyper Suprime-Cam first-year data,"
Mon. Not. Roy. Astron. Soc. **504** (2021) 1825-1839, YITP-19-111, arXiv:1911.12890 [astro-ph.CO].

8. K. Akitsu, T. Kurita, T. Nishimichi, M. Takada, and S. Tanaka,
"Imprint of anisotropic primordial non-Gaussianity on halo intrinsic alignments in simulations,"
Phys. Rev. D **103** (2021) 083508 (8 pages), YITP-20-85, arXiv:2007.03670 [astro-ph.CO].

*Talks at International Conferences*

1. "The Dark Quest project for cosmological emulation,"
in "Debating the Potential of Machine Learning in Astronomical Surveys," IAP, Paris, France (online),
October 2021.

2. "On the nonlinear growth of anisotropic clustering,"
in "YITP molecule-type workshop on Galaxy shape statistics and cosmology," YITP, Kyoto University, Kyoto, Japan,
December 2021.

*Invited Seminars* (Overseas)

1. "Emulator Cosmology,"
Department of Astronomy, Shanghai Jiao Tong University, Shanghai, China (online), March 2022.

*Invited Seminars* (in Japan)

1. "Emulation for lensing and clustering observables of the cosmological large-scale structure,"
iTHEMS Dark Matter WG, RIKEN, Japan (online), May 2021.

## Tatsuma Nishioka

*Journal Papers*

1. T. Nishioka and Y. Sato,
"Free energy and defect $C$-theorem in free scalar theory,"
JHEP **05**, 074 (2021) (59 pages), YITP-21-04, arXiv:2101.02399 [hep-th].

2. K. Kawabata, T. Nishioka, Y. Okuyama and K. Watanabe,

"Probing Hawking radiation through capacity of entanglement,"
JHEP **05**, 062 (2021) (27 pages), YITP-21-08, arXiv:2102.02425 [hep-th].

3. K. Kawabata, T. Nishioka, Y. Okuyama and K. Watanabe,
"Replica wormholes and capacity of entanglement,"
JHEP **10**, 227 (2021) (40 pages), YITP-21-45, arXiv:2105.08396 [hep-th].

4. T. Nishioka, T. Takayanagi and Y. Taki,
"Topological pseudo entropy,"
JHEP **09**, 015 (2021) (46 pages), YITP-21-69, arXiv:2107.01797 [hep-th].

*Talks at International Conferences*

1. "Replica wormholes and capacity of entanglement, " Invited,
Workshop on Black Holes, BPS and Quantum Information, University of Lisbon, Portugal (online),
September 2021.

2. "Topological pseudo entropy, " Invited,
East Asia Joint Symposium on Fields and Strings 2021, Osaka City University, Japan (online),
November 2021.

3. "Topological pseudo entropy, " Invited,
Workshop on Quantum Information and Spacetime, Institute for Advanced Study, Princeton, USA (online),
November 2021.

## Akira Ohnishi

*Journal Papers*

1. K. Ogata, T. Fukui, Y. Kamiya, and A. Ohnishi,
"Effect of deuteron breakup on the deuteron-$\Xi$ correlation function",
Phys. Rev. C **103** (2021) 065205 (12 pages), YITP-21-15, arXiv:2103.00100 [nucl-th].

2. Y. Nara and A. Ohnishi,
"JAM mean-field update: mean-field effects on collective flow in high-energy heavy-ion collisions at $\sqrt{s_{NN}} = 2$-20 GeV energies",
Phys. Rev. C **105** (2022), 014911 (19 pages), YITP-21-97, arXiv:2109.07594 [nucl-th].

3. Y. Namekawa, K. Kashiwa, A. Ohnishi, and H. Takase,
"Gauge invariant input to neural network for path optimization method",
Phys. Rev. D **105** (2022), 034502 (7 pages), YITP-21-101, arXiv:2109.11710 [hep-lat].

4. Y. Kamiya, K. Sasaki, T. Fukui, T. Hyodo, K. Morita, K. Ogata, A. Ohnishi, T. Hatsuda,
"Femtoscopic study of coupled-channel $N\Xi$ and $\Lambda\Lambda$ interactions",
Phys. Rev. C **105** (2022), 014915 (13 pages) YITP-21-79, arXiv:2108.09644 [hep-ph].

5. A. Ohnishi, Y. Kamiya, K. Sasaki, T. Fukui, T. Hatsuda, T. Hyodo, K. Morita, K. Ogata,
"Femtoscopic study of $N\Xi$ interaction and search for the $H$ dibaryon state around the $N\Xi$ threshold",
Few-Body Syst. **62** (2021), 42 (5 pages).

*Talks at International Conferences*

1. "Theoretical approach to correlation functions of strange hadrons at accelerator experiments and search for exotic bound states", Invited,
in "16th International Workshop on Meson Physics (MESON2021)", Hybrid (Krakow, Poland / Online), May 2021.

2. "Femtoscopic study of coupled-channel baryon-baryon interactions with $S = -2$",
in "22nd Particle and Nuclei International Conference (PANIC2021)", Online, September 2021.

3. "Flavored hadron correlations and interactions from heavy ion collisions", Invited,
in "The 8th Asian Triangle Heavy-Ion Conference (ATHIC2021)", Hybrid (Inha U., Incheon, South Korea / Online), November 2021.

4. "Femtoscopic study of hadron interactions including charm",

in “J-PARC Hadron WS”, Hybrid (KEK J-PARC branch / Online), March 2022.

*Invited Seminars* (Overseas)

1. “Replica evolution of classical field in 4+1 dimensional spacetime as a simulator of quantum field evolution”,
   Heidelberg/Stavanger Lattice & ML seminar (online), April 2021.

*Invited Seminars* (in Japan)

1. “Femtoscopic approach to hadron-hadron interactions”,
   Hybrid (KEK / Online), July 2021 (KEK Theory Seminar [EX])

## Nobuyuki Okuma

*Journal Papers*

1. N. Okuma and Y. Nakagawa
   “Non-normal Hamiltonian dynamics in quantum systems and its realization on quantum computers,”
   Phys. Rev. B **105** (2022), 054304 (13 pages).

2. N. Okuma and M. Sato,
   “Non-Hermitian topological phenomena: A review,”
   To appear in Annual Review of Condensed Matter Physics (Apr. 2023).

3. N. Okuma
   “Boundary-dependent dynamical instability of bosonic Green’s function: Dissipative Bogoliubov–de Gennes Hamiltonian and its application to non-Hermitian skin effect,”
   Phys. Rev. B **105**, (2022) 224301 (7 pages).

*Talks at International Conferences*

1. “Topological aspects of non-Hermitian physics,”
   Online, October 2021 (International conference of “Theoretical studies of topological phases of matter”, Kyoto).

## Naoki Sasakura

*Journal Papers*

1. N. Sasakura, “Phase profile of the wave function of canonical tensor model and emergence of large space—times,” Int. J. Mod. Phys. A **36**, no.29, 2150222 (2021) doi:10.1142/S0217751X21502225 [arXiv:2104.11845 [hep-th]].

2. D. Obster and N. Sasakura, “Counting Tensor Rank Decompositions,” Universe **7**, no.8, 302 (2021) doi:10.3390/universe7080302 [arXiv:2107.10237 [gr-qc]].

3. T. Kawano and N. Sasakura, “Emergence of Lie group symmetric classical spacetimes in canonical tensor model,” PTEP **2022**, 043A01 (2022), doi:10.1093/ptep/ptac045 [arXiv:2109.09896 [hep-th]].

*Talks at International Conferences*

1. “Emergence of Lie group symmetries in oscillatory integrations,” on-line,
   in “XIV. International Workshop LIE THEORY AND ITS APPLICATIONS IN PHYSICS," Sofia, Bulgaria,
   June 2021.

2. “Emergence of classical spacetimes in canonical tensor model,” Invited, on-line,
   in “5th International Conference on Holography, String Theory and Discrete Approach", Hanoi, Vietnum,
   August 2021.

3. “Emergence of classical spacetimes in canonical tensor model,” Invited, on-line,
   in “Workshop on Quantum Geometry, Field Theory and Gravity", Corfu, Greece,
   September 2021.

*Invited Seminars* (in Japan)

1. “Emergence of classical spacetimes in canonical tensor model,”
   in “Discrete approaches to the dynamics of spacetime and fields,"
   Dept. of Phys., Kyoto University, January 2022.

## Masatoshi Sato

*Journal Papers*

1. M. Stålhammar, M. Stone, Masatoshi Sato, and T. H. Hansson,
"Electromagnetic response of topological superconductors",
Phys. Rev. B **103**, 235427 (2021).

2. Sayed Ali Akbar Ghorashi, Tianhe Li, Masatoshi Sato, and Taylor L. Hughes,
"Non-Hermitian higher-order Dirac semimetals",
Phys. Rev. B **104**, L161116 (2021).

3. Sayed Ali Akbar Ghorashi, Tianhe Li, and Masatoshi Sato,
Non-Hermitian higher-order Weyl semimetals, Phys. Rev. B **104**, L161117 (2021).

4. Yuri Fukaya, Tatsuki Hashimoto, Masatoshi Sato, Yukio Tanaka, and Keiji Yada,
"Spin susceptibility for orbital-singlet Cooper pair in the three-dimensional $Sr_2RuO_4$ superconductor",
Phys. Rev. Research **4**, 013135 (2022).

5. Takumi Bessho, Ken Mochizuki, Hideaki Obuse, and Masatoshi Sato,
"Extrinsic topology of Floquet anomalous boundary states in quantum walks",
Phys. Rev. B **105**, 094306 (2022).

6. Takumi Bessho and Masatoshi Sato,
"Nielsen-Ninomiya Theorem with Bulk Topology: Duality in Floquet and Non-Hermitian Systems",
Phys. Rev. Lett. **127**, 196404 (2021).

*Talks at International Conferences*

1. "Dissipation induced topological superconductivity", Invited
in "International Symposium on Recent Progress in Superconductivity" online APCTP, Korea,
August 23 2022.

2. "Criteria for topological superconductivity and applications", Invited in Tutorial session of America Physical Society March Meeting 2022, online, USA, March 13 2022.

*Invited Seminars* (Overseas)

1. "Non-Hermitian Topological Phases"
Soul National University, Korea, June 25 2021.

*Invited Seminars* (in Japan)

1. "Electromagnetic response of topological superconductors"
KEK, September 24 2021 (in English)

2. "Non-Hermitian Topological Phases" Osaka University, November 18 2021 (in Japanese)

## Masaru Shibata

*Journal Papers*

1. E. Zhou, K. Kiuchi, M. Shibata, A. Tsokaros, and K. Uryū, "Evolution of bare quark stars in full general relativity: Single star case", Phys. Rev. D **103** (2021) 123011 (18 pages).

2. K. Kawaguchi, S. Fujibayashi, M. Shibata, M. Tanaka, and S. Wanajo, "A low-mass binary neutron star: long-term ejecta evolution and kilonovae with weak blue emission", Astrophys. J. **913** (2021) 100 (24 pages).

3. S. Fujibayashi, K. Takahashi, Y. Sekiguchi, and M. Shibata, "Ultra-delayed neutrino-driven explosion of rotating massive stars", Astrophys. J. **919** (2021) 80 (8 pages).

4. F. Carroasco, M. Shibata, and O. Reula, "Magnetospheres of black hole-neutron star binaries", Phys. Rev. D **104** (2021) 063004 (16 pages).

5. M. Shibata, S. Fujibayashi, and Y. Sekiguchi, "Long-term evolution of neutron-star merger remnants in general relativistic resistive-magnetohydrodynamics with a mean-field dynamo term", Phys. Rev. D **104** (2021) 063026 (22 pages).

*Books and Proceedings*

1. M. Shibata,
"Numerical relativity and neutron star mergers (in Japanese: 数値相対論と中性子星の合体),"
共立出版.

*Talks at International Conferences*

1. "Merger and post-merger of neutron-star binaries," Invited,
in "Binary neutron star workshop at Rochester University," Rochester Univ., USA (online), July 12 2021.

2. "Post-merger mass ejection from neutron star merger," Invited,
in "Computational Challenge in Multimessanger Astrophysics," UCLA, USA (online),
October 5 2021.

3. "Toward self-consistent picture of neutron-star mergers based on numerical relativity," ËĘnvited,
in "IAU symposium 362," online, November 11 2021.

4. "Merger of binary neutron stars based on numerical relativity," Invited,
in "IAU symposium 363," online, November 30 2021.

5. "Predictive power of numerical relativity," Invited,
in "YKIS 2022a,", Kyoto (online), February 18 2022.

## Ken Shiozaki

*Journal Papers*

1. S. Ono, H. C. Po and K. Shiozaki,
"$\mathbb{Z}_2$-enriched symmetry indicators for topological superconductors in the 1651 magnetic space groups,"
Phys. Rev. Research **3**, 023086 (2021), arXiv:2008.05499.

2. K. Kawabata, K. Shiozaki and S. Ryu,
"Topological Field Theory of Non-Hermitian Systems,"
Phys. Rev. Lett. **126**, 216405 (2021), arXiv:2011.11449.

3. K. Shiozaki and S. Ono,
"Symmetry indicator in non-Hermitian systems,"
Phys. Rev. B **104**, 035424 (2021), YITP-21-28, arXiv:2011.11449.

4. R. Kobayashi, Y. Lee, K. Shiozaki and Y. Tanizaki, "Topological terms of (2+1)d flag-manifold sigma models,"
Journal of High Energy Physics **2021**, 75 (2021), YITP-21-17, arXiv:2103.05035.

5. S. Ono and K. Shiozaki, "Symmetry-Based Approach to Superconducting Nodes: Unification of Compatibility Conditions and Gapless Point Classifications,"
Phys. Rev. X **12**, 011021 (2022), arXiv:2102.07676.

*Talks at International Conferences*

1. "On the adiabatic pump in quantum spin systems," Invited,
in "Theoretical studies of topological phases of matter," Yukawa Institute for Theoretical Physics, Kyoto University, Japan (hybrid format),
October 2021.

## Shigeki Sugimoto

*Journal Papers*

1. H. Kanno and S. Sugimoto,
"Anomaly and superconnection,"
PTEP 2022 (2022) 1, 013B02 (35 pages), YITP-21-41, arXiv: 2106.01591 [hep-th].

*Invited Seminars* (in Japan)

1. "Anomaly of fermions with spacetime dependent mass,"
Dept. of Phys., Hokkaido Univ., April 2021 (in Japanese)

2. "Anomaly and Superconnection,"
Dept. of Phys., Rikkyo Univ., July 2021 (in Japanese)

## Tadashi Takayanagi

*Journal Papers*

1. T. Takayanagi and T. Uetoko,
"Chern-Simons Gravity Dual of BCFT,"
JHEP **04** (2021), 193, YITP-20-143, arXiv:2011.02513 [hep-th].

2. M. Miyaji, T. Takayanagi and T. Ugajin,
"Spectrum of End of the World Branes in Holographic BCFTs,"
JHEP **06** (2021), 023, YITP-21-19, arXiv:2103.06893 [hep-th].

3. J. Boruch, P. Caputa, D. Ge and T. Takayanagi,
"Holographic path-integral optimization,"
JHEP **07** (2021), 016, YITP-21-25, arXiv:2104.00010 [hep-th].

4. A. Mollabashi, N. Shiba, T. Takayanagi, K. Tamaoka and Z. Wei,
"Aspects of pseudoentropy in field theories,"
Phys. Rev. Res. **3** (2021) no.3, 033254, YITP-21-52, arXiv:2106.03118 [hep-th].

5. I. Akal, Y. Kusuki, N. Shiba, T. Takayanagi and Z. Wei,
"Holographic moving mirrors,"
Class. Quant. Grav. **38** (2021) no.22, 224001, YITP-21-53, arXiv:2106.11179 [hep-th].

6. T. Nishioka, T. Takayanagi and Y. Taki,
"Topological pseudo entropy,"
JHEP **09** (2021), 015, YITP-21-69, arXiv:2107.01797 [hep-th].

7. K. Suzuki and T. Takayanagi,
"JT gravity limit of Liouville CFT and matrix model,"
JHEP **11** (2021), 137, YITP-21-88, arXiv:2108.12096 [hep-th].

*Talks at International Conferences*

1. "A New Generalization of Entanglement Entropy: Pseudo Entropy", Invited,
in "Quantum Information in QFT and AdS/CFT-II" IIT Gandhinagar,India (online), August 2021.

2. "Holography and Quantum Information, " Invited,
Plenary Talk at IRCHEP 1400, Iran (online), November 2021.

3. "Holography in de Sitter Space via Chern-Simons Gauge Theory, " Invited,
Indian Strings Meeting 2021, IIT Roorkee, India (online), December 2021.

4. "Holography in de Sitter Space via Chern-Simons Gauge Theory, " Invited,
RIKKYO MathPhys. 2022, at Rikkyo U., Tokyo (online), January 2022.

5. "Extreme Universe of spacetime and matter from quantum information, " invited,
Physics Frontiers with Quantum Science and Technology, U. of Tokyo (online), Japan, March 2022.

6. "Emergence of Gravitational Spacetime from Quantum Information," Invited,
The Physical Society of Japan 2022 Annual (77th) Meeting, Plenary Session Program (online), March 2022.

7. "Holography and Quantum Entanglement, " Invited,
YITP international workshop: Quantum Information Entropy in Physics YITP, Kyoto, March 2022.

*Invited Seminars* (Overseas)

1. "Page Curve from Holographic Moving Mirror and End of the World brane,"
Nordic remote HET seminar (online), April 2021.

2. "A New Generalization of Entanglement Entropy: Pseudo Entropy,"
Jilin University (online), April 2021

3. "A new generalization of entanglement entropy,"
Colloquium at ICTS (online), January 2022

4. "Emergent Holographic Spacetimes from Quantum Information, "
Colloquium at Dept. of Physics and Astronomy, Seuol National Univ. (online), October 2021.

## Yuya Tanizaki

*Journal Papers*

1. Kenji Fukushima, Takuya Shimazaki, Yuya Tanizaki, Exploring the $\theta$-vacuum structure in the functional renormalization group approach, J. High Energy Phys. 04 (2022) 040, [arXiv:2202.00375[hep-th]]

2. Yuya Tanizaki, Mithat Ünsal, Center vortex and confinement in Yang-Mills theory and QCD with anomaly-preserving compactifications, Prog. Theor. Exp. Phys. 2022 04A108 (2022), [arXiv:2201.06166[hep-th]]

3. Masazumi Honda, Etsuko Itou, Yuta Kikuchi, Yuya Tanizaki, Negative string tension of higher-charge Schwinger model via digital quantum simulation, Prog. Theor. Exp. Phys. 2022 033B01 (2022), [arXiv:2110.14105[hep-th]]

4. Itsuki Takahashi, Yuya Tanizaki, Sigma-model analysis of SU(3) antiferromagnetic spins on the triangular lattice, Phys. Rev. B 104, 235152 (2021), [arXiv:2109.10051[cond-mat.str-el]]

5. Mendel Nguyen, Yuya Tanizaki, Mithat Ünsal, Non-invertible 1-form symmetry and Casimir scaling in 2d Yang-Mills theory, Phys. Rev. D 104, 065003 (2021), [arXiv:2104.01824[hep-th]]

6. Ryohei Kobayashi, Yasunori Lee, Ken Shiozaki, Yuya Tanizaki, Topological terms of (2+1)d flag-manifold sigma models, J. High Energy Phys. 08 (2021) 075, [arXiv:2103.05035[hep-th]]

*Talks at International Conferences*

1. "Confinement and chiral symmetry breaking of 4d QCD-like theories with 2-torus compactification", Invited, Paths to Quantum Field Theory, Durham, UK (online), 23-27 Aug. 2021.

2. "Modified instanton sum in 4d gauge theories", Invited, Decomposition 2021, Virginia Tech (online), USA, 22 May 2021.

3. "Non-invertible symmetry and string tensions beyond N-ality", A Virtual Tribute to Quark Confinement and the Hadron Spectrum 2021 (vConf2021) (online), 2-7 Aug. 2021

*Invited Seminars* (Overseas)

1. "Semiclassical description of confinement via center vortices and anomaly-preserving $T^2$ compactifications", RBRC seminar, Brookhaven National Laboratory, USA (online), 17 Mar. 2022.

2. "Flag-manifold sigma model for SU(3) antiferromagnets on the triangular lattice and NÃl'el-VBS transitions", High-energy physics group, Durham University, UK (online), 18 Oct. 2021.

*Invited Seminars* (in Japan)

1. "Semiclassical description of confinement via center vortices and anomaly-preserving $T^2$ compactifications", QCD theory Seminars, Keio-KEK-YITP-IMP joint online seminar series (online), 07 Mar. 2022.

2. "Non-invertible self-duality symmetry of Cardy-Rabinovici model and the mixed gravitational anomaly", Particle Theory Group, Tohoku University, Japan, 7 Dec. 2021.

3. "Non-invertible symmetry and string tensions beyond N-ality", Particle theory group, Osaka University, Japan (online), 12 Oct. 2021.

## Atsushi Taruya

*Journal Papers*

1. M. Shiraishi, A. Taruya, T. Okumura and K. Akitsu,
"Wide-angle effects on galaxy ellipticity correlations,"
MNRAS Lett. **503** (2021) L6-L10 (5 pages), YITP-20-162, arXiv:2012.13290 [astro-ph.CO].

2. G-B. Zhao, Y. Wang, A. Taruya, *et al.*,
"The completed SDSS-IV extended Baryon

Oscillation Spectroscopic Survey: a multi-tracer analysis in Fourier space for measuring the cosmic structure growth and expansion rate,"
MNRAS **504** (2021) p.33-52 (20 pages), arXiv:2007.09011 [astro-ph.CO].

3. Y-S. Song, Y. Zheng and A. Taruya,
"Toward a more stringent test of gravity with the redshift space power spectrum: Simultaneous probe of growth and amplitude of large-scale structure,"
Phys. Rev. **D104** (2021) 043528 (13 pages), YITP-21-09, arXiv:2102.01785 [astro-ph.CO].

4. Y. Himemoto, A. Nishizawa and A. Taruya,
"Impacts of overlapping gravitational-wave signals on the parameter estimation: Toward the search for cosmological backgrounds,"
Phys. Rev. **D104** (2021) 044010 (13 pages), YITP-21-14, arXiv:2103.14816 [gr-qc].

5. T. Namikawa, A. Naruya, R. Saito, A. Taruya and D. Yamauchi,
"Unified approach to secondary effects on the CMB B-mode polarization,"
JCAP **10** (2021) 029 (50 pages), YITP-21-20, arXiv:2103.10639 [astro-ph.CO].

6. A. Taruya and K. Akitsu,
"Lagrangian approach to super-sample effects on biased tracers at field level: galaxy density fields and intrinsic alignments,"
JCAP **11** (2021) 061 (47 pages), YITP-21-49, arXiv:2106.04789 [astro-ph.CO].

7. K. Osato, T. Nishimichi, A. Taruya and F. Bernardeau,
"Implementing spectra response function approaches for fast calculation of power spectra and bispectra,"
Phys. Rev. **D104** (2021) 103501 (31 pages), YITP-21-71, arXiv::2107.04275 [astro-ph.CO].

*Invited Seminars* (Overseas)

1. "Intrinsic alignment of galaxies as a novel cosmological probe," (online)
Laboratoire d'Astrophysique de Marseille, France, April 2021.

2. "Relativistic signature of large-scale structure observations Toward alternative test of gravity , (online)"
Shanghai Jiao Tong University, China, March 2022 (Astronomy colloquium).

*Invited Seminars* (in Japan)

1. "Intrinsic alignment of galaxies as a novel probe of cosmology," (online)
Dept. of Phys., Tokyo Insititute of Technology, July 2021 (The 319th Quantum Physics and Nanoscience Seminar).

2. "Nonlinear structure formation in the dark matter dominated universe," (online)
Dept. of Phys., Rikkyo Univ., September 2021 (in Japanese).

## Seiji Terashima

*Journal Papers*

1. S. Terashima "Bulk locality in the AdS/CFT correspondence,"
Phys. Rev. D **104** (2021) no.8, 086014 [arXiv:2005.05962 [hep-th]].

2. L. Nagano and S. Terashima, "A note on commutation relation in conformal field theory," JHEP **09** (2021), 187 [arXiv:2101.04090 [hep-th]].

3. M. Manabe, S. Terashima and Y. Terashima, "The colored Jones polynomials as vortex partition functions," JHEP **12** (2021), 197 [arXiv:2110.05662 [hep-th]].

*Talks at International Conferences*

1. "Simple Bulk Reconstruction in AdS/CFT Correspondence," Invited,
in "The 1st International Conference of Holography and its Applications," Damghan University, Iran, (Online)
March 2022.

## Keisuke Totsuka

*Journal Papers*

1. J-Y. Chen, J-W. Li, P. Nataf, S. Capponi, M. Mambrini, K. Totsuka, H-H. Tu, A. Weichselbaum, J. von Delft, and D. Poilblanc,

"Abelian SU($N$)$_1$ chiral spin liquids on the square lattice,"
Phys. Rev. **B104** (2021) 235104 (33 pages), arXiv:2106.02115.

2. S. Suetsugu, T. Yokoi, K. Totsuka, T. Ono, I. Tanaka, S. Kasahara, Y. Kasahara, Z. Chengchao, H. Kageyama and Y. Matsuda,
"Intrinsic suppression of the topological thermal Hall effect in an exactly solvable quantum magnet,"
Phys. Rev. **B105** (2022) 024415 (11 pages), arXiv:2107.11989.

3. R. Masui and K. Totsuka,
"Electric and magnetic properties of higher-spin Kondo-Heisenberg models at strong coupling, "
Phys. Rev. **B105** (2022) in press (12 pages), arXiv:2202.03708.

*Books and Proceedings*

1. K. Totsuka,
"Majorana excitations in quantum spin liquids,"
Suuri Kagaku **4** (2021) 50 (8 pages).

### 2.2.3 Publications and Talks by Hakubi Researchers, Research Fellows and Graduate Students (April 2021– March 2022)

## Masaya Amo

*Journal Papers*

1. M. Amo, K. Izumi, Y. Tomikawa, H. Yoshino, and T. Shiromizu,
"Asymptotic behavior of null geodesics near future null infinity: Significance of gravitational waves,"
Phys. Rev. D **104** (2021) 064025 (15 pages), YITP-21-54, arXiv:2106.03150 [gr-qc].

2. M. Amo, T. Shiromizu, K. Izumi, H. Yoshino, and Y. Tomikawa,
"Asymptotic behavior of null geodesics near future null infinity II: curvatures, photon surface and dynamically transversely trapping surface,"
Phys. Rev. D **105** (2022) 064074 (10 pages), YITP-21-103, arXiv:2110.10917 [gr-qc].

*Talks at International Conferences*

1. "Asymptotic behavior of null geodesics near future null infinity: Significance of gravitational waves,"
in "Black Holes Inside and Out," online,
September 2021.

2. "Asymptotic behavior of null geodesics near future null infinity: Relationship to gravitational waves and curvature,"
in "JGRG30," online,
December 2021.

3. "Asymptotic properties of null geodesics near null infinity,"
in "Asia-Pacific School and Workshop on Gravitation and Cosmology 2022," online,
March 2022.

## Katsuki Aoki

*Journal Papers*

1. K. Aoki, F. Di Filippo and S. Mukohyama, "Non-uniqueness of massless transverse-traceless graviton," JCAP **05** (2021), 071 (17 pages), YITP-21-24, arXiv:2103.15044 [gr-qc].

2. K. Aoki, T. Q. Loc, T. Noumi and J. Tokuda, "Is the Standard Model in the Swampland? Consistency Requirements from Gravitational Scattering," Phys. Rev. Lett. **127** (2021) no.9, 091602 (6 pages), YITP-21-30, arXiv:2104.09682 [hep-th].

3. K. Aoki, S. Mukohyama and R. Namba, "Positivity vs. Lorentz-violation: an explicit example," JCAP **10** (2021), 079 (50 pages), YITP-21-70, arXiv:2107.01755 [hep-th].

4. K. Aoki, Y. Manita and S. Mukohyama, "Shift-symmetric SO(N) multi-Galileon," JCAP **12** (2021) no.12, 045 (18 pages), YITP21-115, arXiv:2110.05510 [gr-qc].

5. K. Aoki, M. A. Gorji, S. Mukohyama and K. Takahashi, "The effective field theory of vector-tensor theories," JCAP **01** (2022) no.01, 059 (47 pages), YITP-21-132, arXiv:2111.08119 [hep-th].

*Talks at International Conferences*

1. "Non-linearly ghost-free higher curvature gravity", in "Geometric Foundations of Gravity 2021", University of Tartu (online), Estonia, June 2021.

2. "Is the Standard Model in the Swampland?", in "Strings and Fields 2021", YITP, Kyoto University (online), Japan, Aug. 2021.

3. "UV consistency of gravitational and cosmological EFTs", Invited, in "AAPPS-DACG Workshop 2021 on Astrophysics, Cosmology and Gravitation", online, Oct. 2021.

4. "Positivity vs. Lorentz-violation", Invited, in "8th Korea-Japan workshop on Dark Energy", online, Oct. 2021.

5. "Positivity vs. Lorentz-violation", JGRG30, online, Dec. 2021.

6. "The Effective Field Theory of Vector-Tensor Theories", Invited, in "Dawn of Gravitational-wave Cosmology and Theory of Gravity", Tohoku University, Mar. 2022.

*Invited Seminars* (Overseas)

1. "A consistent theory of four-dimensional Einstein-Gauss-Bonnet gravity: theory and cosmology", Majorana-Raychaudhuri Seminars (online), Italy and India, July 2021.

2. "Is the Standard Model in the Swampland? Consistency Requirement from Gravitational Scattering", NTU (online), Taiwan, Nov. 2021.

3. "Gravitational positivity bounds", TIFR (online), India, Mar. 2022.

*Invited Seminars* (in Japan)

1. "Is the Standard Model in the Swampland?", Waseda University (online), Japan, May 2021.

2. "Is the Standard Model in the Swampland?", YITP, Kyoto University, Japan, July 2021.

3. "Is the Standard Model in the Swampland? Consistency Requirement from Gravitational Scattering", RIKEN, Japan, Nov. 2021.

## Takumi Bessho

*Journal Papers*

1. T. Bessho and M. Sato,
"Nielsen-Ninomiya Theorem with Bulk Topology: Duality in Floquet and Non-Hermitian Systems,"
Phys. Rev. Lett. **127** (2021) 196404 (6 pages), arXiv:2006.04204 [cond-mat].

2. T. Bessho, K. Mochizuki, H. Obuse and M. Sato,
"Extrinsic topology of Floquet anomalous boundary states in quantum walks,"
Phys. Rev. B **105** (2022) 094306 (25 pages), arXiv:2112.03167 [cond-mat].

## Mohammad Ali Gorji

*Journal Papers*

1. B. Salehian, M. A. Gorji, S. Mukohyama and H. Firouzjahi,
"Analytic study of dark photon and gravitational wave production from axion,"
JHEP **05**, 043 (2021) (45 pages), YITP-20-90, arXiv:2007.08148 [hep-ph].

2. H. Firouzjahi, M. A. Gorji, S. Mukohyama and B. Salehian,
"Dark photon dark matter from charged inflaton,"
JHEP **06**, 050 (2021) (23 pages), YITP-20-139, arXiv:2011.06324 [hep-ph].

3. J. B. Achour, A. De Felice, M. A. Gorji, S. Mukohyama and M. C. Pookkillath,
"Disformal map and Petrov classification in modified gravity,"
JCAP **10**, 067 (2021) (30 pages), YITP-21-72, arXiv:2107.02386 [gr-qc].

4. H. Firouzjahi, M. A. Gorji, S. Mukohyama and A. Talebian,
"Dark matter from entropy perturbations in curved field space,"
Phys. Rev. D **105**, no.4, 043501 (2022) (20 pages), YITP-21-119, arXiv:2110.09538 [gr-qc].

5. M. A. Gorji, H. Motohashi and S. Mukohyama,
"Inflation with $0 \leq c_s \leq 1$,"
JCAP **02**, no.02, 030 (2022) (27 pages), YITP-21-122, arXiv:2110.10731 [hep-th].

6. K. Aoki, M. A. Gorji, S. Mukohyama and K. Takahashi,
"The effective field theory of vector-tensor theories,"
JCAP **01**, no.01, 059 (2022) (43 pages), YITP-21-132, arXiv:2111.08119 [hep-th].

*Talks at International Conferences*

1. “Dark Matter via Entropy Perturbations,"
   “ 8th Korea-Japan workshop on Dark Energy ”, (online), October 2021.

*Invited Seminars* (Overseas)

1. “Dark Matter via Entropy Perturbations,"
   “ 8th Korea-Japan workshop on Dark Energy ”, (online), October 2021.

2. “Dark Matter via Inflation,"
   “Shiraz University, Biruni Observatory webinar series ”, Iran (online), November 2021.

3. “Dark Matter via Inflation,"
   “Institute for Research in Fundamental Sciences, School of Particles and Accelerators ”, Iran (online), December 2021.

4. “Dark Matter from Inflation,"
   “ National Conference on Gravity and Cosmology 1400”, Iran (online), January 2022.

5. “Dark Matter via Inflation,"
   “Institute for Research in Fundamental Sciences, School of Physics ”, Iran (online), January 2022.

*Invited Seminars* (in Japan)

1. “Dark Matter from Inflation,"
   “ Area workshop 2022 Winter and Group A Winter Camp Kyoto University ”, Kyoto, January 2022.

2. “Dark Matter from Inflation,"
   “ Tokyo Institute of Technology ”, Tokyo, March 2022.

## Kota Hayashi

*Talks at International Conferences*

1. “General-relativistic neutrino-radiation magnetohydrodynamics simulations of black hole-neutron star mergers,”
   in “JGRG30,” Online,
   December 2021.

2. “General-relativistic neutrino-radiation magnetohydrodynamics simulations of black hole-neutron star mergers for seconds,”
   in “Black Hole Astrophysics with VLBI 2022,” Online,
   February 2022.

## Norita Kawanaka

*Journal Papers*

1. K. Asano, Y. Asaoka, Y. Akaike, N. Kawanaka, K. Kohri, H. M. Motz and T. Terasawa,
   “Monte Carlo Study of Electron and Positron Cosmic-Ray Propagation with the CALET Spectrum”,
   Astrophys. J. **926** (2022) 5 (10 pages), YITP-21-163, arXiv:2111.09636 [astro-ph.HE].

2. M. Shikauchi, A. Tanikawa and N. Kawanaka,
   “Detectability of Black Hole Binaries with Gaia: Dependence on Binary Evolution Models”,
   Astrophys. J. **928** (2022) 13 (10 pages), YITP-21-164, arXiv:2112.04798 [astro-ph.HE].

*Talks at International Conferences*

1. “Origin of Spectral Hardening of Secondary Cosmic Ray Nuclei”, contributed,
   in “XXVIII Cracow Epiphany Conference on Recent Advances in Astroparticle Physics”, online
   January 2022.

## Kazutaka Kimura

*Journal Papers*

1. K. Kimura, T. Hosokawa and K. Sugimura,
   “Growth of Massive Disks and Early Disk Fragmentation in Primordial Star Formation,”
   ApJ. (2021) 911 (52 pages), arXiv:2012.01452 [astro-ph].

*Talks at International Conferences*

1. "Feedback from the Vicinity of Massive Pro- tostars in the First Star Formation",
   in "IAU Symposium 362, THE PREDICTIVE POWER OF COMPUTATIONAL ASTROPHYSICS," (Online),
   November 2021.

*Invited Seminars* (in Japan)

1. "Structure around Protostars in First Star Formation,"
   Theoretical Astrophysics Group, Tohoku Univ., March 2022 (in Japanese).

## Hiroyuki Kitamoto

*Talks at International Conferences*

1. "Semiclassical analysis of axion-assisted and axion-driven pair production" in "YITP workshop on Strings and Fields 2021 (Online)", Yukawa Institute for Theoretical Physics, Japan, Aug. 2021.
2. "Semiclassical analysis of axion-assisted and axion-driven pair production" in "KEK Theory Workshop 2021 (Online)",
   High Energy Research Organization, Japan, Dec. 2021.

## Hiroki Matsui

*Journal Papers*

1. H. Matsui, S. Mukohyama, and A. Naruko, "DeWitt boundary condition is consistent in Hořava-Lifshitz quantum gravity,"
   YITP-21-128, arXiv:2111.00665 [gr-qc].

## Ryota Mizuno

*Journal Papers*

1. R. Mizuno, M. Ochi and K. Kuroki, "Development of an efficient impurity solver in dynamical mean field theory for multiband systems: Iterative perturbation theory combined with parquet equations,"
   Phys. Rev. **B104** (2021) 035160 (15 pages), arXiv:2101.04466 [hep-ph].
2. R. Mizuno, M. Ochi and K. Kuroki, "Simplification of the Local Full Vertex in the Impurity Problem in DMFT and Its Applications for the Nonlocal Correlation ,"
   J. Phys. Soc. Jpn. **91** (2022) 034002 (16 pages), arXiv:2108.09532 [hep-ph].

*Talks at International Conferences*

1. "Development of an efficient impurity solver in dynamical mean field theory for multi-band systems,"
   in "Oxide Superspin 2021," Kyoto, Japan, December 2021.

*Invited Seminars* (in Japan)

1. "Development of efficient approximation methods in dynamical mean field theory for multi-degree-of-freedom systems,"
   Dept. of Phys., Kindai Univ. , July 2021 (in Japanese).
2. 'DMFT の不純物問題におけるフルバーテックスの簡略化と非局所相関の取り込みのためのその応用,"
   Online CMT seminars , November 2021 (in Japanese).

## Hiroki Ohata

*Journal Papers*

1. H. Suganuma and H. Ohata,
   "Local Correlation among the Chiral Condensate, Monopoles, and Color Magnetic Fields in Abelian Projected QCD,"
   Universe, **7** (2021) 318 (17 pages), YITP-21-85, arXiv:2108.08499 [hep-lat].

## Ken Osato

*Journal Papers*

1. J. Shi, K. Osato, T. Kurita, and M. Takada, "An Optimal Estimator of Intrinsic Alignments for Star-forming Galaxies in IllustrisTNG Simulation",
   Astrophys. Journal, **917**, 109 (2021), YITP-21-42, arXiv:2104.12329 [astro-ph]

2. K. Osato, T. Nishimichi, A. Taruya, and F. Bernardeau,
"Implementing spectra response function approaches for fast calculation of power spectra and bispectra",
Phys. Rev. D, **104**, 103501 (2021), YITP-21-71, arXiv:2107.04275 [astro-ph]

3. K. Osato, T. Nishimichi, and M. Takada,
"Mock catalogues of emission-line galaxies based on the local mass density in dark-matter only simulations",
MNRAS, **511**, pp.1131-1140 (2021), YITP-21-73, arXiv:2107.13168 [astro-ph]

*Talks at International Conferences*

1. "Galaxy Formation Simulations for Cosmology with Emission Line Galaxies",
in "Challenges and Innovations in Computational Astrophysics - III", remote,
June 2021.

2. "Intrinsic alignments with numerical simulations",
in "Galaxy shape statistics and Cosmology", Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto,
November 2021.

3. "Galaxy Formation Simulations for Cosmology with Emission Line Galaxies",
in "Cosmic Cartography 2022: Exploring the Cosmic Web and Large-Scale Structure", Kavli IPMU, Chiba,
March 2022.

*Invited Seminars* (Overseas)

1. "Galaxy Formation Simulations for Cosmology with Emission Line Galaxies",
LPENS, Ecole Normale SupÃl'rieure, Paris, France, January 2022.

2. "Perturbation theory challenge in redshift space accelerated with response function approach",
Institut d'Astrophysique de Paris, Paris, France, January 2022.

3. "Galaxy Formation Simulations for Cosmology with Emission Line Galaxies",
South-Western Institute For Astronomy Research, Yunnan University, Kunming, China, April 2021.

## Hidehiko Shimada

*Journal Papers*

1. Masanori Hanada, Hidehiko Shimada, and Nico Wintergest,
"Color Confinement and Bose-Einstein Condensation",
JHEP **08** (2021) 039 (29 pages.), arxiv:2001.10459 [hep-th].

2. Hidehiko Shimada and Hirohiko Shimada,
"Exact four-point function and OPE for an interacting quantum field theory with space/time anisotropic scale invariance",
JHEP **10** (2021) 030 (59 pages.), YITP-21-26, arxiv:2107.07770 [hep-th].

## Kazufumi Takahashi

*Journal Papers*

1. K. Takahashi, H. Motohashi,
"Black hole perturbations in DHOST theories: Master variables, gradient instability, and strong coupling,"
JCAP **08** (2021) 013 (35 pages), YITP-21-38, arXiv:2106.07128 [gr-qc].

2. P. Gao, K. Takahashi, A. Ito, J. Soda,
"Cosmic No-hair Conjecture and Inflation with an SU(3) Gauge Field,"
Phys. Rev. D **104** (2021) 103526 (13 pages), YITP-21-56, arXiv:2107.00264 [hep-th].

3. A. De Felice, S. Mukohyama, K. Takahashi,
"Nonlinear definition of the shadowy mode in higher-order scalar-tensor theories,"
JCAP **12** (2021) 020 (14 pages), YITP-21-104, arXiv:2110.03194 [gr-qc].

4. K. Aoki, M. A. Gorji, S. Mukohyama, K. Takahashi,
"The Effective Field Theory of Vector-Tensor Theories,"
JCAP **01** (2022) 059 (43 pages), YITP-21-132, arXiv:2111.08119 [hep-th].

5. K. Takahashi, H. Motohashi, Masato. Minamitsuji,
"Invertible disformal transformations with

higher derivatives,"
Phys. Rev. D **105** (2022) 024015 (13 pages), YITP-21-137, arXiv:2111.11634 [gr-qc].

*Talks at International Conferences*

1. "Stealth solutions in scalar-tensor theories," in "8th Korea-Japan workshop on Dark Energy," Online,
October 2021.

2. "Perturbations of stealth black holes in modified gravity,"
in "The 30th Workshop on General Relativity and Gravitation in Japan," Online,
December 2021.

*Invited Seminars* (in Japan)

1. "Perturbations of stealth black holes in modified gravity,"
Waseda University, January 2022.

2. "Invertible disformal transformations with higher derivatives,"
JGRG Webinar Series, February 2022.

## Kazuya Takahashi

*Journal Papers*

1. M. Arimoto, H. Asada, M. L. Cherry, M. S. Fujii, Y. Fukazawa, A. Harada, K. Hayama, T. Hosokawa, K. Ioka, Y. Itoh, N. Kanda, K. S. Kawabata, K. Kawaguchi, N. Kawai, T. Kobayashi, K. Kohri, Y. Koshio, K. Kotake, J. Kumamoto, M. N. Machida, H. Matsufuru, T. Mihara, M. Mori, T. Morokuma, S. Mukohyama, H. Nakano, T. Narikawa, H. Negoro, A. Nishizawa, T. Ohgami, K. Omukai, T. Sakamoto, S. Sako, M. Sasada, Y. Sekiguchi, M. Serino, J. Soda, S. Sugita, K. Sumiyoshi, H. Susa, T. Suyama, H. Takahashi, K. Takahashi, T. Takiwaki, T. Tanaka, M. Tanaka, A. Tanikawa, N. Tominaga, N. Uchikata, Y. Utsumi, M. R. Vagins, K. Yamada & M. Yoshida,
"Gravitational wave physics and astronomy in the nascent era,"
Prog. Theor. Exp. Phys. **ptab042** (2021) (89 pages), arXiv:2104.02445 [gr-qc].

*Talks at International Conferences*

1. "Probing the particle acceleration at trans-relativistic shocks with gamma-ray burst afterglows,"
in "37th International Cosmic Ray Conference (ICRC 2021)," Berlin, Germany (virtual),
July 2021.

## Tomoki Wada

*Journal Papers*

1. T. Wada, K. Ioka and B. Zhang,
"Binary comb models for FRB 121102,"
ApJ, 920, 54 (2021) (15 pages), YITP-21-89, arXiv:2105.14480 [astro-ph.HE]

*Talks at International Conferences*

1. "Binary comb models for FRB 121102,"
in "FRB 2021," online,
July 2021.

## Shuichi Yokoyama

*Journal Papers*

1. S. Aoki, T. Onogi, and S. Yokoyama,
"Charge conservation, entropy current and gravitation,"
YITP-20-135, Int.J.Mod.Phys.A 36 (2021) 10, 2150201, e-Print: 2005.13233 [hep-th].

2. N. Kubo, and S. Yokoyama,
"Topological phase, spin Chern-Simons theory and level rank duality on lens space,"
YITP-21-83, JHEP 04 (2022) 074, e-Print: 2108.09300 [hep-th].

*Talks at International Conferences*

1. "On the definition of energy and a new conserved quantity in General Relativity," Invited,
in "Physics and Astronomy World Forum,"
Frankfurt, Germany (on-line)
December 2021.

*Invited Seminars* (in Japan)

1. "Topological phase, spin Chern-Simons theory and duality on lens space,"
   Dept. of Phys., Tokyo Institute of Technology., November 2021.

2. "On the definition of energy and a new conserved quantity in General Relativity,"
   Dept. of Phys., Univ. of Tokyo, December 2021.

## Takashi Yoshida

*Journal Papers*

1. T. Sato, K. Maeda, S. Nagataki, T. Yoshida, B. Grefenstette, B. J. Williams, H. Umeda, M. Ono, and J. P. Hughes,
   "High-entropy ejecta plumes in Cassiopeia A from neutrino-driven convection,"
   Nature **592** (2021) p.573-540, arXiv:2110.10384 [astro-ph.HE].

2. K. Hijikawa, A. Tanikawa, T. Kinugawa, T. Yoshida, and H. Umeda,
   "On the population III binary black hole mergers beyond the pair-instability mass gap,"
   Mon. Not. R. Astron. Soc.: Lett. **505** (2021) p.L69-L73, arXiv:2104.13384 [astro-ph.HE].

3. A. Tanikawa, T. Kinugawa, T. Yoshida, K. Hijikawa, and H. Umeda,
   "Population III binary black holes: effects of convective overshooting on formation of GW190521,"
   Mon. Not. R. Astron. Soc. **505** (2021) p.2170-2176, arXiv:2010.07616 [astro-ph.HE].

4. T. Yoshida, T. Takiwaki, D. R. Aguilera-Dena, K. Kotake, K. Takahashi, K. Nakamura, H. Umeda, and N. Langer,
   "A three-dimensional hydrodynamics simulation of oxygen-shell burning in the final evolution of a fast-rotating massive star,"
   Mon. Not. R. Astron. soc.: Lett. **506** (2021) p.L20-L25, arXiv:2106.09909 [astro-ph.SR].

5. C. Nagele, H. Umeda, K. Takahashi, T. Yoshida, and K. Sumiyoshi,
   "Neutrino emission from the collapse of $10^4$ $M_\odot$ Population III supermassive stars,"
   Mon. Not. R. Astron. Soc. **508** (2021) p.828-841, arXiv:2107.01761 [astro-ph.HE].

6. T. Luo, H. Umeda, T. Yoshida, and K. Takahashi,
   "Stellar Models of Betelgeuse Constrained Using Observed Surface Conditions,"
   Astrophys. J. **927** (2022) 115 (10 pages), arXiv:2202.02953 [astro-ph.SR].

*Books and Proceedings*

1. T. Yoshida, T. Takiwaki, K. Kotake, K. Takahashi, K. Nakamura, H. Umeda, D. R. Aguilera-Dena, and N. Langer,
   "Three-dimensional hydrodynamics simulations of shell burning in Si/O-rich layer of pre-collapse massive stars,"
   EPJ Web of Conf. **260** (2022) id.11038 (3 pages).

*Talks at International Conferences*

1. "Precollapse Shell Burning in the Silicon- and Oxygen-rich Layers in Massive Stars,"
   in "Nuclear burning in massive stars - towards the formation of binary black holes,"
   Online and YITP, Kyoto University, Japan, July 2021.

### 2.2.4 Publications and Talks by Affiliate Professors and Affiliate Associate Professors (April 2021– March 2022)

## Yshai Avishai

*Journal Papers*

1. Y. Avishai and Y. B. Band,
"Chiral tunneling in single layer graphene with Rashba spin-orbit coupling: spin currents,"
Phys. Rev. B **103** (2021) 134445, arXiv:2012.10971 [cond-mat].

2. Y. Avishai and Y. B. Band,
"Chiral Bloch states in single layer graphene with Rashba spin-orbit coupling: Spectrum and spin current density,"
Phys. Rev. B **104** (2021) 075414, arXiv:2101.09224 [cond-mat].

## Nathalie Deruelle

*Talks at International Conferences*

1. "Binary pulsars and precision tests of General Relativity," Invited,
First Conference of the National Institute of Physics, Tirana, Albania,
February 2022.

## Shinji Hirano

*Journal Papers*

1. S. Hirano, T. Nakajima and M. Shigemori,
"$T\bar{T}$ Deformation of Stress-tensor Correlators from Random Geometry,"
JHEP 04 (2021) 270 (35 pages), YITP-20-159, arXiv:2012.03972 [hep-th].

2. S. Hirano and T. Kuroki,
"Replica Wormholes from Liouville Theory,"
JHEP 01 (2022) 094 (21 pages), YITP-21-100, arXiv:2109.12539 [hep-th].

*Invited Seminars* (Overseas)

1. "Random geometry approach to TTbar-deformed conformal field theory," (Online),
Shing-Tung Yau Center of Southeast University, China, July 9, 2021

2. "Holographic dual of generalized symmetry, mixed anomaly, and interfaces in $N = 4$ SYM," (Online),
Kentucky University, USA, October 13, 2021.

*Invited Seminars* (in Japan)

1. "Random Geometry Approach to $T\bar{T}$-deformed Conformal Field Theory," (Online),
Dept. of Phys., Rikkyo University, May 12, 2021.

2. "Holographic dual of generalized symmetry, mixed anomaly, and interfaces in $N = 4$ SYM," (Online),
Dept. of Math. & Phys., Nagoya University, January 21, 2022

## Kenta Kiuchi

*Journal Papers*

1. W. Ishizaki, K. Ioka, and K. Kiuchi,
"Fallback Accretion Model for the Years-to-Decades X-ray Counterpart to GW170817 "
ApJ **916** (2021) L13, 2104.04433 [astro-ph.HE].

2. W. Ishizaki, K. Kiuchi, K. Ioka, and S. Wanajo,
"Fallback Accretion Halted by R-process Heating in Neutron Star Mergers and Gamma-Ray Bursts "
ApJ **922** (2021) 185, 2104.04708 [astro-ph.HE].

3. E. Zhou, K. Kiuchi, and M. Shibata,
"Evolution of bare quark stars in full general relativity: I. Single star case "

Phys. Rev. **D103** (2021) 123011, 2105.07498 [gr-qc].

*Talks at International Conferences*

1. "Recent progress of numerical relativity simulations of compact objects and its application to gravitational wave astrophysics", Invited lecturer,
in "RESCEU SUMMER SCHOOL," on-line,
August 2021.

2. "Numerical modeling of gravitational wave sources in multimessenger astronomy era", Invited,
in "JGRG,", on-line,
November 2021.

3. "Numerical modeling of gravitational wave sources in multimessenger astronomy era", Invited,
in "JPS Symposium,", on-line,
March 2022.

*Invited Seminars* (Overseas)

1. "Numerical modeling of gravitational wave sources in multimessenger astronomy era,", Invited Colloquium speaker
IAS, New Jersey, USA, November 2021.

## Taichiro Kugo

*Journal Papers*

1. T. Kugo,
"Noether Currents and Maxwell-Type Equations of Motion in Higher Derivative Gravity Theories,"
Symmetry **13** (2021) 1408 (22 pages), YITP-21-67, [arXiv:2107.11600 [hep-th]].

2. T. Kugo, R. Nakayama and N. Ohta,
"BRST quantization of general relativity in unimodular gauge and unimodular gravity,"
Phys. Rev. D **104** (2021) 126021 (11 pages), YITP-21-87, [arXiv:2108.11520 [hep-th]].

3. T. Kugo, R. Nakayama and N. Ohta,
"Covariant BRST quantization of unimodular gravity: Formulation with antisymmetric tensor ghosts,"
Phys. Rev. D **105** (2022) 086006 (20 pages), YITP-22-10, [arXiv:2202.03626 [hep-th]].

## Jie Meng

*Journal Papers*

1. Y. Lyu, H. Tong, T. Sugiura, S. Aoki, T. Doi, T. Hatsuda, J. Meng and T. Miyamoto,
"Dibaryon with Highest Charm Number near Unitarity from Lattice QCD,"
Phys. Rev. Lett. **127** (2021) 072003 (6 pages), arXiv:2102.00181 [hep-lat].

2. S. B. Wang, Q. Zhao, P. Ring, and J. Meng,
"Nuclear matter in relativistic Brueckner-Hartree-Fock theory with Bonn potential in the full Dirac space,"
Phys. Rev. **C 103** (2021) 054319 (12 pages), arXiv:2103.12960 [nucl-th].

3. Y. K. Wang, P. W. Zhao and J. Meng,
"Nuclear matrix elements of neutrinoless double-$\beta$ decay in the triaxial projected shell model,"
Phys. Rev. **C 104** (2021) 014320 (10 pages), arXiv:2105.02649 [nucl-th].

4. X. L. Ren, C. X. Wang, K. W. Li, L. S. Geng and J. Meng,
"Relativistic Chiral Description of the $^1S_0$ Nucleon-Nucleon Scattering,"
Chin. Phys. Lett. **38** (2021) 062101 (6 pages).

## Misao Sasaki

*Journal Papers*

1. Y. F. Cai, J. Jiang, M. Sasaki, V. Vardanyan and Z. Zhou, "Beating the Lyth Bound by Parametric Resonance during Inflation," Phys. Rev. Lett. **127**, no.25, 251301 (2021) [arXiv:2105.12554 [astro-ph.CO]].

2. G. Domènech, V. Takhistov and M. Sasaki, "Exploring evaporating primordial black holes with gravitational waves," Phys. Lett.

B **823**, 136722 (2021) [arXiv:2105.06816 [astro-ph.CO]].

3. G. Domènech and M. Sasaki, "Cosmology of strongly interacting fermions in the early universe," JCAP **06**, 030 (2021) [arXiv:2104.05271 [hep-th]].

4. A. Banerjee, E. Ó. Colgáin, M. Sasaki, M. M. Sheikh-Jabbari and T. Yang, "On problems with cosmography in cosmic dark ages," Phys. Lett. B **818**, 136366 (2021) [arXiv:2009.04109 [astro-ph.CO]].

5. Y. Akrami, M. Sasaki, A. R. Solomon and V. Vardanyan, "Multi-field dark energy: Cosmic acceleration on a steep potential," Phys. Lett. B **819**, 136427 (2021) [arXiv:2008.13660 [astro-ph.CO]].

*Talks at International Conferences*

1. "Primordial black holes," Invited, in "Quantum Gravity and Cosmology (A.D. Sakharov's centennial)," online, June 2021.

2. "Primordial black holes and gravitational waves," Invited, in "Lake Como School on Multi-Messenger in Astrophysics," online, June 2021.

3. "Primordial Black Holes and Cosmological Gravitational Waves," Invited, in "Gravitational Wave Probes of Physics Beyond Standard Model," online, July 2021.

4. "Primordial Black Holes: Roles of isocurvature perturbations," Invited, in "Black Holes Inside and Out," online, September 2021.

5. "Cosmology of Primordial Black Holes and Gravitational Waves," Invited, in "4th LeCosPA Symposium," NTU, Taiwan (hybrid), November 2021.

6. "Primordial Black Holes Review," Invited, in "AstroDark-2021," online, December 2021.

7. "Primordial black hole cosmology," in "Recent Advances in Theoretical Cosmology and Astrophysics," online, December 2021.

8. "PBHs from inflation and gravitational waves," Invited, in "New observational windows on the high-scale origin of matter-antimatter asymmetry," online, January 2022.

9. "Primordial Black Holes from Inflation," Invited, in "YKIS 2022a: Gravity - The Next Generation-," online, February 2022.

*Invited Seminars* (Overseas)

1. "Primordial black holes - a few recent topics -", APCTP (online), July 2021.

2. Lectures on "Inflation and cosmological perturbations,"APCTP (online), November 2021.

3. "Primordial Black Holes and Gravitational Waves," Indian Institute of Technology (online), January 2022.

*Invited Seminars* (in Japan)

1. "Primordial Black Holes and Gravitational Waves," Symposium at JPS Annual Meeting (online), March 2022.

## Yudai Suwa

*Journal Papers*

1. K. Nakazato, F. Nakanishi, M. Harada, Y. Koshio, Y. Suwa, K. Sumiyoshi, A. Harada, M. Mori, and R. A. Wendelli,
"Observing Supernova Neutrino Light Curves with Super-Kamiokande. II. Impact of the Nuclear Equation of State,"
Astrophys. J., **925** (2022), 98 (16 pages), arXiv:2108.03009 [astro-ph.SR].

2. R. Sawada, K. Kashiyama, and Y. Suwa,
"On the energy source of ultra-stripped supernovae,"
Astrophys. J., **927** (2022), 223 (10 pages), arXiv:2112.10782 [astro-ph.HE].

*Talks at International Conferences*

1. "Observing Supernova Neutrino Light Curves with Super-Kamiokande," Invited,
in "Probe into core-collapse SuperNovae via Gravitational-Wave and neutrino signals (SNeGWv2021)," Online,
December 2021.

*Invited Seminars* (Overseas)

1. "$^{56}$Ni as probes for supernova interior,"
   Aibert Einstein Institute, Potsdam, Germany, December 2021 (Online).

*Invited Seminars* (in Japan)

1. "Probing supernova interiors with neutrinos,"
   Dept. of Astron., Univ. of Tokyo, June 2021.
2. "Modeling supernova neutrino emissions toward physics and multi-messenger astronomy in the next Galactic supernova,"
   Dept. of Astron., Tohoku Univ., July 2021.
3. "Toward modeling complete supernova neutrino emissions,"
   RIKEN, March 2022 (in Japanese).

## Takashi Yamakawa

*Books and Proceedings*

1. T. Hiroka, T. Morimae, R. Nishimaki, and T. Yamakawa,
   "Quantum Encryption with certified deletion, revisited: public key, attribute-based, and classical communication,"
   In: Tibouchi, M., Wang, H. (eds) Advances in Cryptology - ASIACRYPT 2021. ASIACRYPT 2021. Lecture Notes in Computer Science, vol 13090. Springer, Cham. YITP-21-40, arXiv:2105.05393 [quant-ph].

*Talks at International Conferences*

1. Certified Deletion for Public Key Encryption, Zero-Knowledge, and More, Short plenary talk, 25th Annual Conference on Quantum Information Processing (QIP2022), March 7-11, 2022, Pasadena CA, USA.
2. Quantum Encryption with Certified Deletion, Revisited: Public Key, Attribute-Based, and Classical Communication, QCrypt 2021, 23-27 August 2021, Online.

## 2.3 Seminars, Colloquia and Lectures

### ▷ 2021.4.1 — 2022.3.31

4.1 David Tong (University of Cambridge) International Colloquium: Are We Living in the Matrix?

4.7 Tetsuo Yamaguchi (The University of Tokyo) Dynamic friction of soft solids at subsonic and intersonic sliding velocities

4.9 Masataka Watanabe (Weizmannn Institute of Science) Mixed-state density matrix for (non-traversable) wormholes in JT gravity

4.14 Soichi Sakamoto (Institute for Molecular Science) Numerical simulations of entropy production in open quantum theory: Boltzmann entropy vs von Neumann entropy

4.16 Wenliang Li (OIST) Analytic origin of conformal bootstrap kinks?

4.19 Tomoki Ozawa (AIMR, Tohoku University) K 辰 hler geometry and relations between Chern number and the quantum volume for Chern insulators

4.23 Yuki Fujimoto (University of Tokyo) EOS of high-density QCD matter via resummed perturbation

4.23 Tomoya Hayata (Keio University) Thermalization of Yang-Mills theory in a (3+1) dimensional small lattice system

4.27 Yuri Fukaya (YITP, Kyoto University) Interorbital topological superconductivity in spin-orbit coupled superconductors with inversion symmetry breaking

4.30 Koichi Murase (YITP, Kyoto University) Causal hydrodynamic fluctuations

5.11 Ryuta Mizuno (YITP, Kyoto University) Development of improved Iterative Perturbation Theory in Dynamical Mean Field Theory for multi-degree-of-freedom systems

5.21 Hiromasa Takaura (KEK) Perturbative computation of the electron g-2 using stochastic method

5.21 Kenta Suzuki (YITP, Kyoto University) JT gravity with defects and the Aharonov-Bohm effect

5.27 Sebastian Garcia-Saenz (Imperial College London) Destabilization of black holes and stars by generalized Proca fields

5.28 Teppei Kitahara (Nagoya University) Massive Scattering Amplitudes and Electroweak Effective Field Theory

6.2 Norihiro Oyama (Department of Basics Science, Univ. of Tokyo) Rheology and Diffusivity of Sheared Glasses - Perspective from the non-eq. criticality

6.4 Koji Hashimoto (Kyoto University) An attempt for building a holographic path to nuclear physics

6.4 Kanato Goto (RIKEN) Replica Wormholes for an Evaporating Black Hole

6.4 Karim Noui (Universit 辿 Paris Diderot Paris 7 / Universit 辿 de Tours) Black Hole Perturbations in Modified Gravity

6.10 Alberto Nicolis (Columbia University) A Technical Analog of the Cosmological Constant Problem: Vacuum Energy in Framids

6.11 Shinichiro Akiyama (University of Tsukuba) Tensor renormalization group approach to (1+1)-dimensional Hubbard model

6.14 Metin Ata (Kavli IPMU, University of Tokyo) Predicting the Fate of high Redshift Galaxy Protoclusters with Constrained Simulations

6.17 Lam Hui (Columbia University) Ladder symmetries of black holes - implications for Love numbers and no hair theorems.

6.24 Tomohiro Fujita (Waseda University) SU(N) gauge-natural inflation

6.25 Shai Chester (Weizmann Institute of Science) Derivation of AdS/CFT for Vector Models

6.28 Yosuke Kobayashi (Kavli IPMU, University of Tokyo) Cosmological analysis of SDSS-III galaxy power spectrum based on a machine learning-based theoretical model

6.30 Daichi Tsuna (The University of Tokyo) Peculiar optical transients from newborn black holes?

7.1 Sadra Jazayeri (IAP / Sorbonne Universit 辿) Cosmological Correlators from Locality and Unitarity

7.2 Robert de Mello Koch (University of the Witwatersrand) Quantum Error Correction and Holographic Information from Bilocal Holography

7.5 Ville Matias Mikael Paasonen (YITP, Kyoto University) Pumping current in a non-Markovian N-state model

7.8 Daniela Saadeh (Portsmouth University) Massive Galileons and Vainshtein screening: a numerical perspective

7.9 Yasuhiro Yamaguchi (JAEA) Pc pentaquarks with pion exchange and five-quark couplings

7.9 Katsuki Aoki (YITP, Kyoto University) Is the Standard Model in the Swampland?

7.15 Mich 竪 le Levi (Niels Bohr Institute) QFT for Gravity at All Scales

7.16 Yasunori Nomura (University of California, Berkeley) YITP Colloquium: From the Black Hole Conundrum to the Structure of Quantum Gravity

7.19 Kohta Murase (The Pennsylvania State University) YITP Colloquium: High-Energy Neutrino Astrophysics in the Multimessenger Era

7.20 Mikito Nanashima (Tokyo Institute of Technology) Hardness of Learning, Auxiliary-Input Cryptography, and Meta-Complexity

7.20 Shota Kanasugi (Kyoto University) Anapole superconductivity in multi-band systems

7.26 Ryuhei Mori (Tokyo Institute of Technology) Improved robustness of quantum supremacy for random circuit sampling

7.30 Shota Fujiwara (Tokyo Institute of Technology) Superconformal index at finite N via the AdS/CFT correspondence

8.10 Yasuhiro Tada (Hiroshima University) Lieb-Schultz-Mattis theorem in higher dimensions from approximate magnetic translation symmetry

8.17 Ryohei Kobayashi (ISSP, The University of Tokyo) Lattice construction and classification of exotic invertible topological phases

9.16 Yuta Suzuki (The University of Tokyo) Tunneling spin current in a two-band system with spin degeneracy

9.28-9.30 Toshifumi Noumi (Kobe University) Lecture series: Quantum gravity and phenomenology

10.1 Hidekatsu Nemura (YITP, Kyoto University) Hyperon-nucleon interaction from lattice QCD

10.7 Enrico Trincherini (Scuola Normale Superiore) Hairy black holes in shift-symmetric theories

10.8 Hiroyuki Kitamoto (YITP, Kyoto University) Semiclassical analysis of axion-assisted and axion-driven pair production

10.11-10.13 Kenji Fukushima (The University of Tokyo) Lecture series: YITP Intensive Lecture 1 "Theory of hot and dense chiral spin matter"

10.12 Mao Yoshii (The University of Tokyo) Topological phenomenon in quasiperiodic systems

10.13 Kenji Fukushima (The University of Tokyo) Various realization of vortices and its implication to dense QCD matter

10.14 Lotte ter Haar (SISSA) Kinetic Screening in the Strong-Field Regime

10.15 Inori Ueba (YITP, Kyoto University) Correspondence of topological classification between quantum graph and topological matter

10.21 Masato Minamitsuji (University of Lisbon) Black holes in the extended vector-tensor theories

10.22 Shi Chen (The University of Tokyo) A baryonic topological phase: $\pi^0$ domain wall revisited

10.22 Adi Armoni (Swansea University / YITP, Kyoto University) Part I: Large N QCD3, field theory analysis

10.28 Sravan Kumar (Tokyo Institute of Technology) Non-local early Universe cosmology

10.29 Itaru Nakagawa (RIKEN) Exploring Gluons with the World First Electron-Ion Collider

10.29 Adi Armoni (Swansea University / YITP, Kyoto University) Part II: The holographic dual of large N QCD3

11.2 Daisuke Yoshida (Kobe University) Spacetime singularity in accelerated universe

11.5 Matteo Baggioli (Wilczek Quantum Center, School of Physics and Astronomy, Shanghai Jiao Tong University) What can we learn about amorphous solids from effective theories & black holes ?

11.5 Takato Mori (SOKENDAI) Entanglement entropy in interacting field theories

11.5 Yuliang Jin (Inst. of theoretical physics, Chinese Academy of Sciences / U. of Chinese Academy of Sciences) Non-linear elasticity, yielding and theory in simulated amorphous solids

11.8 Saikat Das (YITP, Kyoto University) The origin and propagation of ultrahigh-energy cosmic rays

11.8-11.10 Kazumi Okuyama (Shinshu University) Lecture series: Matrix model of JT gravity

11.11 Beatriz Elizaga Navascues (Waseda University) Telling apart GR from LQC on the primordial power spectrum

11.12 Satoshi Yamaguchi (Osaka University) Non-invertible topological defects in 4-dimensional $Z_2$ pure lattice gauge theory

11.16 Kei'ichi Maeda (Waseda University) YITP Colloquium: Relativistic Dynamical System and Gravitational Waves

11.19 Shan-Ming Ruan (YITP, Kyoto University) Complexity Equals Anything?

11.25 Nava Gaddam (Utrecht University) Page curve and more from black hole scattering

11.26 Yasuhiro Yamamoto (National Center for Theoretical Sciences) Search for the new force with the generalized King relation

11.26 Yoshio Kikukawa (The University of Tokyo) Two approaches to non-abelian chiral gauge theory on the lattice with exact gauge invariance

12.1-12.3 Takashi Yamakawa (NTT Social Informatics Laboratories) Lecture series: YITP Intensive Lecture 1 "Basics of quantum cryptography"

12.2 Takashi Yamakawa (NTT Social Informatics Laboratories) Quantum computing and quantum cryptography

12.3 Amit Kumar Chatterjee (YITP, Kyoto University) Stochastic finite range processes: non-equilibrium steady state and observables

12.3 Tsunehide Kuroki (Toyota Technological Institute) Replica wormholes from Liouville theory

12.8 Kento Yasuda (RIMS, Kyoto University) Statistical property of the stochastic system with odd elasticity

12.10 Tomoki Nosaka (RIKEN) M2-branes and discrete Painlev 辿 systems

12.10 Shoichiro Tsutsui (RIKEN) Cooper triples in atomic fermi gas: Implication for dense quark matter

12.10 Sotaro Sugishita (Nagoya University) Gauge invariant dressed S-matrix and decoherence problem in QED

12.17 Dorin Weissman (OIST) Hard scattering and holographic QCD

12.17 Philip Boyle Smith (Kavli IPMU, The University of Tokyo) Exploring the Space of Irrational Boundary States

12.20 Ruth Gregory (King's College London) International Colloquium: Catalysing Vacuum Decay with Black Holes

12.22 Akihiro Mizutani (Mitsubishi Electric Corportation) Computational self-testing for entangled magic states

1.7 Yuki Kamiya (HISKP, Bonn University) Femtoscopic study on the hadron-hadron interaction

1.13 Daneng Yang (University of California, Riverside) New probes for the structure of self-interacting dark matter halos

1.21 Hidetoshi Taya (RIKEN) Dynamically assisted Schwinger mechanism and its application

1.27 Yi Wang (Hong Kong University of Science and Technology) Multi-stream inflation, clustered primordial black holes and standard timers

2.3 Osmin Lacombe (YITP, Kyoto University) Topics in Cosmology from moduli stabilisation in Type IIB superstrings

2.4 Junichi Haruna (Kyoto University) Fixed Point Structure of Gradient Flow Exact Renormalization Group for Scalar Field Theories

2.10 Naritaka Oshita (RIKEN) On the most probable process of vacuum decay

2.18 Yoshihiko Abe (Kyoto University) Origin of pseudo-Nambu-Goldstone dark matter

3.9 Shuta Tanaka (Aoyama Gakuin University) 3D hydrodynamic simulations of the interaction between interstellar accretion flow and stellar outflow

3.10 Pedro De la Torre Luque (The Oskar Klein Centre, Dept. of Physics, Stockholm University) The diffuse gamma-ray sky and its connection with the propagation of charged particles in the Galaxy

3.11 Milad Delfan Azari (Waseda University) Neutrino flavor conversions and their role in supernova explosions

3.11 Antonio Garcia-Garcia (Shanghai Jiao Tong University) Sachdev-Ye-Kitaev model: from quantum chaos to quantum gravity

3.18 Shoma Kamijima (The University of Tokyo) Cosmic-ray Escape from Supernova Remnants in the Circumstellar Medium

3.23 Ryosuke Yoshii (Sanyo-Onoda City University) Geometrical Quantum Chemical Engine and Maxwell's demon

3.24 Yun-Long Zhang (National Astronomical Observatories Chinese Academy of Sciences (NAOC)) Pulsar Timing Residual induced by Wideband Ultralight Dark Matter with Spin 0, 1, 2

## 2.4 Visitors (April 2021 – March 2022)

**Atom-type Visitors**

**Shimazaki, Takuya** (N)
The University of Tokyo
2021-05-24 – 2021-06-04

**Fujiwara, Shota** (E)
Tokyo Institute of Technology
2021-07-28 – 2021-08-27

**Suzuki, Yuta** (C)
The University of Tokyo
2021-09-15 – 2021-10-15

**Chen, Shi** (N)
The University of Tokyo
2021-09-23 – 2021-12-02

**Mori, Takato** (E)
The Graduate University for Advanced Studies
2021-10-03 – 2021-12-18

**Yoshii, Mao** (C)
Univ. of Tokyo
2021-10-11 – 2021-12-25

**Okabayashi, Kazumasa** (A)
Osaka City University
2021-11.15 – 2022-01-31

**Kamijima, Shoma** (A)
The University of Tokyo
2022-03-07 – 2022-03-31

**Visitors**

**Ono, Seishiro** (C)
The University of Tokyo
2021-04-06 – 2021-04-28

**Fujimoto, Yuki** (N)
Univ. of Tokyo
2021-04-23 – 2021-04-27

**Buoninfante, Luca** (A)
Tokyo Institute of Technology
2021-04-25 – 2021-04-30

**Murase, Kohta** (A)
The Pennsylvania State University
2021-05-18 – 2021-08-06

**Yamanaka, Masato** (A)
Osaka City University
2021-05-24 – 2021-05-28

**Hiroshima, Nagisa** (A)
University of Toyama
2021-05-24 – 2021-05-28

**Takhistov, Volodymyr** (A)
Kavli IPMU, University of Tokyo
2021-05-26 – 2021-06-16

**Vardanyan, Valeri** (A)
Kavli IPMU, University of Tokyo
2021-05-30 – 2021-06-18

**Fukushima, Kenji** (N)
The University of Tokyo
2021-05-31 – 2021-06-04

**Passaglia, Samuel Charles** (A)
Kavli IPMU, University of Tokyo
2021-05-31 – 2021-06-18

**Ata, Metin** (A)
Kavli IPMU, University of Tokyo
2021-05-31 – 2021-06-19

**Kobayashi, Yosuke** (A)
Kavli IPMU, University of Tokyo
2021-06-07 – 2021-07-09

**Fujita, Tomohiro** (A)
Waseda University
2021-06-21 – 2021-06-25

**Hattori, Koichi** (N)
RCNP, Osaka University
2021-06-21 – 2021-10-21

**Tsuna, Daichi** (A)
Univ. of Tokyo
2021-06-23 – 2021-07-02

**Nomura, Yasunori** (E)
University of California, Berkeley
2021-07-05 – 2021-08-13

**Kawai, Hiroki** (E)
Boston University
2021-07-12 – 2021-09-10

**Lee, Yasunori** (C)
Kavli IPMU, University of Tokyo
2021-07-26 – 2021-08-06

**Hiroshima, Nagisa** (A)
University of Toyama
2021-07-30 – 2021-08-06

**Shimazaki, Takuya** (N)
The University of Tokyo
2021-08-02 – 2021-08-06

**Taya, Hidetoshi** (N)
RIKEN
2021-08-02 – 2021-08-06

**Fukushima, Kenji** (N)
The University of Tokyo
2021-08-02 – 2021-08-06

**Yoneta, Yasushi** (E)
Univ. of Tokyo
2021-08-10 – 2021-08-31

**Matsumoto, Tatsuya** (A)
RESCEU, University of Tokyo
2021-08-19 – 2021-09-29

**Hougaard, Hector** (Q)
Osaka University
2021-08-31 – 2021-08-31
**Balog, Janos** (E)
Wigner Research Centre for Physics
2021-09-15 – 2021-09-27
**Minamitsuji, Masato** (A)
Instituto Superior Tecnico, Universidade de Lisboa
2021-09-18 – 2021-10-29
**Otsuka, Takaharu** (N)
RIKEN
2021-09-21 – 2021-09-22
**Buoninfante, Luca** (A)
Tokyo Institute of Technology
2021-09-26 – 2021-10-04
**Noumi, Toshifumi** (E)
Kobe University
2021-09-28 – 2021-09-30
**Maeda, Kei'ichi** (A)
Waseda University
2021-10-01 – 2021-11-30
**Fukushima, Kenji** (N)
The University of Tokyo
2021-10-11 – 2021-10-13
**Fujita, Tomohiro** (A)
Waseda University
2021-10-11 – 2021-10-15
**Kamada, Kohei** (E)
RESCEU, University of Tokyo
2021-10-18 – 2021-10-22
**Yamamoto, Yasuhiro** (E)
National Center for Theoretical Sciences
2021-10-18 – 2021-11-30
**Murase, Kohta** (A)
The Pennsylvania State University
2021-10-21 – 2021-11-12
**Hattori, Koichi** (N)
RCNP, Osaka University
2021-10-22 – 2021-12-24
**Kumar, Sravan** (A)
Tokyo Institute of Technology
2021-10-25 – 2021-10-29
**Nakagawa, Itaru** (N)
RIKEN
2021-10-29 – 2021-10-30
**Hiroshima, Nagisa** (N)
University of Toyama
2021-11-01 – 2021-11-03
**Yoshida, Daisuke** (A)
Kobe University
2021-11-02 – 2021-11-04
**Okuyama, Kazumi** (E)
Shinshu University
2021-11-07 – 2021-11-10
**Elizaga Navascues, Beatriz** (A)
Waseda University
2021-11-08 – 2021-11-16
**Hiroshima, Nagisa** (A)
University of Toyama
2021-11-09 – 2021-11-10
**Ono, Seishiro** (C)
Univ. of Tokyo
2021-11-09 – 2021-11-26
**Yamanaka, Masato** (A)
Osaka City University
2021-11-10 – 2021-11-10
**Saga, Shohei** (A)
Observatoire de Paris
2021-11-15 – 2021-12-03
**Nosaka, Tomoki** (E)
SISSA
2021-11-16 – 2021-11-23
**Hayashi, Yui** (N)
Chiba University
2021-11-22 – 2021-12-03
**Takeuchi, Shingo** (E)
Duy Tan University
2021-11-30 – 2021-12-31
**Tamaoka, Kotaro** (E)
Nihon University
2021-12-02 – 2021-12-04
**Weissman, Dorin** (E)
OIST
2021-12-06 – 2021-12-29
**Yamamoto, Yasuhiro** (E)
National Center for Theoretical Sciences
2021-12-07 – 2022-03-10
**Sugishita, Sotaro** (E)
Nagoya University
2021-12-10 – 2021-12-10
**Sato, Yoshinori** (E)
Tohoku University
2021-12-13 – 2021-12-24
**Tokuda, Junsei** (A)
Kobe University
2021-12-14 – 2021-12-15
**Ono, Seishiro** (C)
Univ. of Tokyo
2021-12-14 – 2021-12-17
**Himemoto, Yoshiaki** (A)
Nihon Univ.
2021-12-27 – 2021-12-28
**Nishizawa, Atsushi** (A)
Univ. of Tokyo
2021-12-27 – 2021-12-28
**Kashiwa, Koji** (N)
Fukuoka Institute of Technology
2021-12-27 – 2021-12-28
**Takeuchi, Shingo** (E)
Duy Tan University
2022-01-03 – 2022-03-31
**Weissman, Dorin** (E)
OIST
2022-01-03 – 2022-03-31

**Murase, Kohta** (A)
The Pennsylvania State University
2022-01-07 – 2022-01-18
**Yamanaka, Masato** (A)
Osaka City University
2022-01-11 – 2022-01-14
**Hiroshima, Nagisa** (A)
University of Toyama
2022-01-11 – 2022-01-14
**Hayasaki, Kimitake** (A)
Chungbuk National University
2022-01-19 – 2022-01-31
**Kobayashi, Ryohei** (C)
ISSP, University of Tokyo
2022-01-20 – 2022-02-02
**Manabe, Masahide** (C)
University of Melbourne
2022-01-24 – 2022-03-05
**Ono, Seishiro** (C)
Univ. of Tokyo
2022-01-31 – 2022-02-11
**Nosaka, Tomoki** (E)
University of Chinese Academy of Sciences
2022-02-01 – 2022-02-10
**Oshita, Naritaka** (E)
RIKEN
2022-02-08 – 2022-02-11
**Hayashi, Takumi** (E)
University of Tokyo
2022-02-08 – 2022-02-11
**Okabayashi, Kazumasa** (A)
Osaka City University
2022-02-09 – 2022-02-15
**Bahamonde, Sebastian** (A)
Tokyo Inst. of Tech.
2022-02-10 – 2022-02-24
**Terasawa, Ryo** (A)
Univ. of Tokyo
2022-02-14 – 2022-02-25
**Itou, Etsuko** (E)
RIKEN
2022-02-17 – 2022-03-08
**Kikuchi, Yuta** (N)
CAMBRIDGE QUANTUM JAPAN
2022-02-21 – 2022-03-04
**Hayashi, Yui** (N)
Chiba University
2022-02-24 – 2022-02-28
**Tanaka, Shuta** (A)
Aoyama Gakuin University
2022-03-06 – 2022-03-12
**Inotani, Daisuke** (E)
RIKEN
2022-03-07 – 2022-03-08
**Hyodo, Tetsuo** (N)
Tokyo Metropolitan University
2022-03-08 – 2022-03-08
**Hashiba, Soichiro** (A)
The University of Tokyo
2022-03-09 – 2022-03-11
**Delfan Azari, Milad** (A)
Waseda University
2022-03-10 – 2022-03-12
**Maeda, Kei'ichi** (A)
Waseda University
2022-03-15 – 2022-03-31
**Ichiki, Kiyotomo** (A)
Nagoya University
2022-03-22 – 2022-03-29
**Chinone, Yuji** (A)
University of Tokyo
2022-03-22 – 2022-03-29
**Fujita, Tomohiro** (A)
Waseda University
2022-03-22 – 2022-03-30
**Minami, Yuto** (A)
Osaka University
2022-03-22 – 2022-03-30
**Yokoyama, Shuichiro** (A)
Nagoya University
2022-03-22 – 2022-03-30
**Takahashi, Tomo** (A)
Saga University
2022-03-24 – 2022-03-30
**Takahashi, Ryuichi** (A)
Hirosaki Univ.
2022-03-28 – 2022-03-30

## 2.5 Highlighted Papers

1. Springer Theses
   “Fluctuations and Non-Equilibrium Phenomena in Strongly-Correlated Ultracold Atoms"
   Dr. Kazuma Nagao (University of Hamburg, former graduate student in our institute)
   (https://www.springer.com/jp/book/9789811571701)

2. “Editor’s Suggestion" of Physical Review D
   “Codimension-two holography for wedges ”
   Ibrahim Akal (Post-doc fellow), Yuya Kusuki (Graduate Student), Zixia Wei (Graduate Student) and Tadashi Takayanagi (Professor)
   (https://journals.aps.org/prd/issues/102/12)

3. Physical Review X
   A paper by Prof. Sato, Prof. Shiozaki and their collaborators was selected as one of the seminal articles for the 10th anniversary of Physica Review X.
   “Symmetry and Topology in Non-Hermitian Physics”
   (https://physics.aps.org/articles/v14/158)

4. Editor’s Choice" of Progress of Theoretical and Experimental Physics
   “Quantum phase transition and resurgence: Lessons from three-dimensional N=4 supersymmetric quantum electrodynamics”
   Toshiaki Fujimori, Masazumi Honda (Assistant Professor), Syo Kamata, Tatsuhiro Misumi, Norisuke Sakai, Takuya Yoda
   (https://academic.oup.com/ptep/article/2021/10/103B04/6321242)

## 2.6 Awards

1. Prof. Tatsuma Nishioka won the Yukawa-Kimura Prize 2021.

2. Prof. Tomoyuki Morimae won IPSJ Yamashita SIG Research Award.

3. Dr. Koichi Murase, Dr. Masamichi Miyaji, Dr. Tokuro Fukui, and Dr. Satoshi Takada won the Young Scientist Award of the Physical Society of Japan 2022.

4. Success in numerical simulation of cosmic neutrinos using supercomputer "Fugaku"
   Finalist for the 2021 Gordon Bell Prize

5. Mr. Taiga Hiroka received the Student Presentation Award at the 45th Quantum Information Technology symposium.

Chapter 3

# Workshops and Conferences

# 3.1 International Workshops and Conferences

Since 1978, a series of international physics workshops, called *Yukawa International Seminar (YKIS)* are held annually or bi-annually. *The Nishinomiya Yukawa Memorial Project* was initiated by Nishinomiya city where the late Prof. Hideki Yukawa lived when he wrote his famous papers on the meson theory. As one of the major programs of this project, an international symposium open to public was held every year in Nishinomiya city, and its post/pre-workshop held at YITP. In recent years both the Nishinomiya Yukawa Symposium and its post/pre-workshops are held at YITP, Kyoto.

As of the academic year 2007, Yukawa Institute for Theoretical Physics launched a new five-year project, "*Yukawa International Program for Quark-Hadron Sciences* (YIPQS)." A few research topics are selected each year and a long-term workshop focused on each topic, extending over a period of a few months, is organized by inviting leading experts from the world. Emphasis is laid on fostering fruitful collaboration among the workshop participants.

For the academic year 2021, the following two coferences were held in hybrid form due to the COVID-19 pandemic.

## Yukawa International Seminar (YKIS2021)

**Yukawa International Seminar 2022a "Gravity - The Next Generation-"**

February 14 - February 18. 2022, Chaired by Shinji Mukohyama

For details, see https://www2.yukawa.kyoto-u.ac.jp/~gc2022/YKIS/index.php

## Nishinomiya-Yukawa Symposium 2021

**Domestic Molecule-type Workshop "Quantum computing for quantum field theories 2022"**

February 21 - March 4, 2022, Chaired by Etsuko Itoh

For details, see

https://www2.yukawa.kyoto-u.ac.jp/~qc-qft/qcqft-2022-molecule/index.php

# 3.2 YITP Workshops

YITP workshops are one of the main activities of Yukawa Institute. The aim of them is to open new research fields and stimulate nationwide collaborations. Workshop plans can be proposed by any researcher and are approved by the Committee on Research Projects of the Institute. Small workshops, summer schools and regional schools to educate young researchers are positively supported.

In the past 5 years, more than 20 workshops are held each year with 1500 strong participants visiting YITP. The list of the workshops together with the number of participants for the last academic year is given below.

## ▷ 2021.4.1 — 2022.3.31

In this list, the symbols W, T, X after "YITP-" are as follows :

W : YITP Workshop
T : YIPQS Workshop
X : Workshop Organized by the Staff Members

**YITP-W-21-01**
*Nuclear burning in massive stars: towards the formation of binary black holes* Jul.26 - Jul.30
R.Hirai, K.Ioka, N.Itagaki, N.Iwamoto, K.Kyutoku, I.Mandel, N.Nishimura, S.Stevenson . *162-participants*

**YITP-W-21-02**
*The 66th YONUPA Summer School* Aug.6 - Aug.10
"T.Hirose, K.Nishimura, J.Haruna, R.Kuramochi, T.Inoue, K.Yamashiro, G.Takei, S.Ogawa, K.Sakai". *370-participants*

**YITP-W-21-03**
*The 51st Summer School on Astronomy and Astrophysics* Aug.23 - Aug.26
"H.Furugori, J.Tsujimura, H.Asami, I.Watanabe, S.Ogawa, D.Saito, R.Yamada, A.Sata, G.Tomei, K.Fukushima, M.Yoshimoto, Y.Kaku, Y.Tsuji, K.Numajiri ". *351-participants*

**YITP-W-21-04**
*Strings and Fields 2021* Aug.23 - Aug.27
"H.Kunitomo, T.Sakai, M.Sakamoto, S.Sugimoto, T.Takayanagi, Y.Tachikawa, K.Nii, T.Noumi, K.Hashimoto, M.Hamanaka, Y.Hikida, K.Hosomichi, M.Honda, K.Maruyoshi, S.Yamaguchi, K.Yoshida". *449-participants*

**YITP-W-21-05**
*66th Condensed Matter Physics Summer School* Aug.2 - Aug..5
"R.Masuki, R.Sakurai, F.Kobayashi, K.Nunotani, Y.Tamura, K.Yamaguchi, K.Arimoto, M.Seki, H.Tanaka, M.Shigefuji, K.Shimizu, S.Takahashi". *279-participants*

**YITP-W-21-06**
*Progress in Particles Physics 2021* Sep.6 - Sep.10
T.Abe, H.Ohki, Y.Omura, K.Kamada, K.Teppei, F.Takayama, N.Nagata, T.Higaki, S.Matsuzaki,L,Yagyu. *297-participants*

**YITP-W-21-07**
*The 61st Summer School of Young Researchers Society for Biophysics* Sep.7 - Sep.10
K.Akiyama, Y.Inutsuka, R.Uesugi, F.Kueda, S.Senoo, K.Narita, N.Hamaguchi, H.Masukawa, A.Murata, N.Yamato, T.Yoshida . *311-participants*

**YITP-W-21-08**(postponed)
*25th Anniversary Symposium of German-Japanese Joint Research Project on Nonequilibrium Statistical Physics Perspectives for Future Collaboration*M.Tanaka, R.Yamamoto, M.Sano, H.Loewen, H.Brand, H.Hayakawa

**YITP-W-21-09**
*QCD phase diagram and lattice QCD* Oct.25 - Oct.29
Y.Aoki, H.Fukaya, Y.Nakamura. *84-participants*

**YITP-W-21-10**
*Macroscopic Quantum Phenomena and Quantum Gravity* Oct.11 - Oct.14
S.Kanno, J.Soda, Y.Nambu, M.Fuwa, N.Matsumoto, K.Yamamoto, Y.Onuma. *44-participants*

**YITP-W-21-11**
*Theoretical studies of topological phases of matter* Oct.18 - Oct.22
Y.Kawahigashi, M.Sato, A.Furusaki, K.Shiozaki, K.Totsuka . *290-participants*

**YITP-W-21-12**(postponed)
*Japan-France joint seminar on "Physics of nonequilibrium systems: fromdense disordered materials to active matter"*H.Hayakawa, M.Kobayashi,

K.Miyazaki, H.Yoshino, K.A.Takeuchi, L.F. Cugliandolo, M.Picco

**YITP-W-21-13**
*Forefront of superconducting phenomena caused by non-trivial electronic states: new challenges and prospects* Dec.22 - Dec.24
"R.Arita, H.Ikeda, Y.Ono, H.Kontani, M.Sato, T.Tohyama, Y.Matsuda, Y.Yanase, K.Kuroki ". *78-participants*

**YITP-W-21-14**
*Nuclear structure and reaction based on the realistic force* Dec.7 - Dec.10
T.Abe, N.Itagaki, T.Fukui, W.Horiuchi, Y.Yamaguchi. *66-participants*

**YITP-W-21-15**(postponed)
*New frontiers in cosmology with the intrinsic alignments of galaxies* A.Naruko, T.Nishimichi, A.Taruya

**YITP-W-21-16**
*Black Holes Inside and Out* Sep.27 - Oct.1
L.Buoninfante, R.Carballo-Rubio, F.Di Filippo. *746-participants*

**YITP-W-21-17**
*Recent Progress of Quantum Cosmology* Nov.8 - Nov.10
K.Maeda, H.Matsui, S.Mukohyama, A.Naruko, K.Noui. *227-participants*

**YITP-W-21-18**
*KIAS-YITP 2021 String Theory and Quantum Gravity* Dec.13 - Dec.16
" S.Sugimoto, T.Takayanagi, M.Honda, T.Nishioka, S.J.Lee, K.Y.Lee,P.J.Yi". *241-participants*

**YITP-W-21-19**
*Quantum Information Entropy in Physics* Mar. 21 - Mar. 25
K.Kato, Y.Nakata, T.Ugajin, M.Tezuka, T.Kuwahara. *275-participants*

**YITP-W-21-20**
*Elementary particle physics in the past 50 years and the future - in memory of Prof. Maskawa* Mar.12 - Mar.13
T.Kugo, S.Aoki, S.Sugimoto, K.Hashimoto, J.Hisano, S.Nojiri. *164-participants*

**YITP-T-21-01**(postponed)
*YITP long-term workshop "Novel Quantum States in Condensed Matter 2021"*T.Tohyama, A.Furusaki, M.Ogata, S.Murakami, S.Miyashita, T.Oka, T.Ozawa, M.Sato, K.Totsuka, K.Shiozaki, N.Okuma, S.Ryu, A.Schnyder162

**YITP-T-21-02**(postponed)
*YITP long-term workshop "Gravity and Cosmology 2022"*K.Aoki, A.De Felice, F. Di Filippo, T.Fujita, M.A.Gorji, K.Ioka, S.Kanno, T.Kobayashi, S.Kuroyanagi, S.Mukohyama, A.Naruko, T.Nishimichi, K.Takahashi, T.Tanaka, A.Taruya

**YITP-T-21-03**
*Domestic Molecule-type Workshop "Topological Phase and Quantum Anomaly 2021"* Jul.26 - Aug.6
K.Ohmori, Y.Lee, K.Shiozaki, Y.Tanizaki . *18-participants*

**YITP-T-21-04**
*Domestic Molecule-type Workshop "Chiral Anomaly in Periodically Driven Systems"* Aug.2 - Aug.6
"T.Shimazaki, H.Taya, Y.Hidaka, K.Fukushima ". *83-participants*

**YITP-T-21-05**
*Domestic Molecule-type Workshop "Extreme Outflows in Astrophysical Transients"* Aug.23 - Aug.27
T.Matsumoto, K.Ioka, M.Shibata . *60-participants*

**YITP-T-21-06**
*Domestic Molecule-type Workshop "Galaxy shape statistics and Cosmology"* Nov.29 - Dec.3
J.Blazek, J-G Lee, A.Naruko, T.Nishimichi, T.Okumura,U-L Pen, J-J Shi, M.Takada, A. Taruya,K. Osato, S.Saga. *37-participants*

**YITP-T-21-07**
*Domestic Molecule-type Workshop "Quantum computing for quantum field theories 2022"* Feb.21-Mar.4
M.Honda, E.Itou, Y.Kikuchi, Y.Tanizaki. *70-participants*

**YITP-T-21-08**
*Domestic Molecule-type Workshop "Upcoming CMB observations and Cosmology"* Mar.22 - Mar.30
T.FUJITA, S.YOKOYAMA, A.NARUKO, A.TARUYA. *34-participants*

**YITP-X-21-01**no use

**YITP-X-21-02**
*Brain-storming workshop on Primordial Black Holes and Gravitational Waves* Jun.1 - Jun.4
"A.Naruko, A.Taruya, M.Sasaki ". *52-participants*

**YITP-X-21-03**
Lecture for YITP Computer system Yukawa-21May18 - May 1864 *-participants*

**YITP-X-21-04**
*Pulsars, black holes and the theory of gravity*

Jun.29 - Jun.29
Y.Takamori, A.Naruko, K.Takahashi, D.Yamauchi, C.-M.Yoo. *46-participants*

**YITP-X-21-05**(postponed)
*Dreaming future nuclear research -Meeting around Tetsuya Murakami*-T.NAGAE, M.NARUKI, J.ZENIHIRO, T.GOGAMI, N.ITAGAKI, T.KAWABATA

**YITP-X-21-06**
*1st workshop: Multimessenger Study of Heavy Dark Matter* Aug.2 - Aug.3
T.Fujii, N.Hiroshima, K.Murase, A.Naruko, M.Yamanaka. *15-participants*

**YITP-X-21-07**
*Quantum Kyoto 2* Sep.13 - Sep.17
"T.Morimae, M.Dall'Arno ". *217-participants*

**YITP-X-21-08**
*8th Korea-Japan Workshop on Dark Energy* Oct.18 - Oct.22
A.De Felice, S.Mukohyama. *143-participants*

**YITP-X-21-09**
*The 10th Workshop on Observational Cosmology* Nov.17 - Nov.19
M.Oguri, M.Takada, T.Takahashi, A.Taruya, A.Naruko, T.Nishimichi, T.Hamana, C.Hikage. *149-participants*

**YITP-X-21-10**
*Open Topology* Nov.23 - Nov. 26
M.Sato, T.Oka. *50-participants*

**YITP-X-21-11**
*First Annual Meeting of MEXT-KAKENHI- Grant-in-Aid for Transformative Research Areas (A) "Extreme Universe"* Mar. 7 - Mar. 8
N.Iizuka, A.Ishibashi, K.Okunishi, T.Shiromizu, M.Tezuka, T.Nishioka, T.Morimae, G. Yusa. *45-participants*

**YITP-X-21-12**no use

**YITP-X-21-13**
*KAKENHI PROJECT 1st Regular Kakenhi Meeting* Dec.2 - Dec.3
"H.Hayakawaa ". *53-participants*

**YITP-X-21-14**
*It from Qubit - Extreme Universe Joint Online Workshop:Extreme Universe from Qubits* Dec.16 - Dec.18
Y.Sekino, T.Takayanagi, T.Ugajin. *170-participants*

**YITP-X-21-15**
*First School of the Grant-in-Aid for Transformative Research Areas (A) "Extreme Universe"* Mar.3 - Mar. 5
K.IZUMI, K.OKUNISHI, T.TAKAYANAGI, M.TEZUKA, Y.NAKATA, M.HONDA, D.YAMAMOTO . *434-participants*

**YITP-X-21-16**
*Dawn of Gravitational-wave Cosmology and Theory of Gravity* Feb.28 - Mar.4
A.Naruko, R.Kimura, N.Kitajima, R.Namba, K.Toma. *18-participants*

## 3.3 Regional Schools supported by YITP

### ▷ 2021.4.1—2022.3.31

No Regional Schools supported by YITP were held due to the COVID-19 pandemic in the academic year 2021.

Chapter 4

# Public Lectures and Outreach

## 4.1 Public lecture series

As an outreach activity, we are holding public lecture series co-hosted with Division of Physics and Astronomy (DPA), Graduate School of Science, Kyoto University. All lectures are free and open to the public. This has been held every year in the autumn, and taken over those held as an activity of the 21st Century COE Program, “Center for Diversity and Universality in Physics” (2003 - 2007), and the Global COE Program, “The Next Generation of Physics, Spun from Universality and Emergence” (2008 - 2012). Every time, three professors of Division of Physics and Astronomy and Yukawa Institute for Theoretical Physics explain their research for general audience at Kyoto University Clock Tower Centennial Hall. From the academic year 2020, this public lecture series is held online due to the COVID-19 pandemic.

In this academic year, we held

Online Public Lecture Series "Physics & Astrophysics"

July 6, 2021
Youichi Yanase (DPA)
“Future Stories Drawn by New Kinds of Superconductor” [1]

July 17, 20210
Koutaro Kyutoku (DPA)
“Multi-particle Astronomy” [1]

## 4.2 Other outreach activities

July, 2021
Prof. Takayanagi was interviewed by the Nikkei Newspaper on the recent developments of black hole information problem.

July 19, 2021
A regular exhibition on “Hideki Yukawa and his favorite books : Origins of a Nobel prize physicist” at the Yukawa Hall Archival Library opened.

July, 2021
Prof. Shinji Mukohyama edited a new book titled “Theories of gravity and cosmology beyond general relativity” (in Japanese).

August, 2021
Prof. Masaru Shibata edited a new book titled “Numerical relativity and neutron-star mergers” (in Japanese).

October, 2021
Professor Masatoshi Murase edited a new book titled “Creative Complex Systems".

[1] The original titles of these lectures are given in Japanese. They are translated in English by our responsibility.