ANNUAL REPORT

2020-2022

April 2020 - March 2022

Nambu Yoichiro Institute of Theoretical and Experimental Physics (NITEP), Osaka Metropolitan University

NITEP

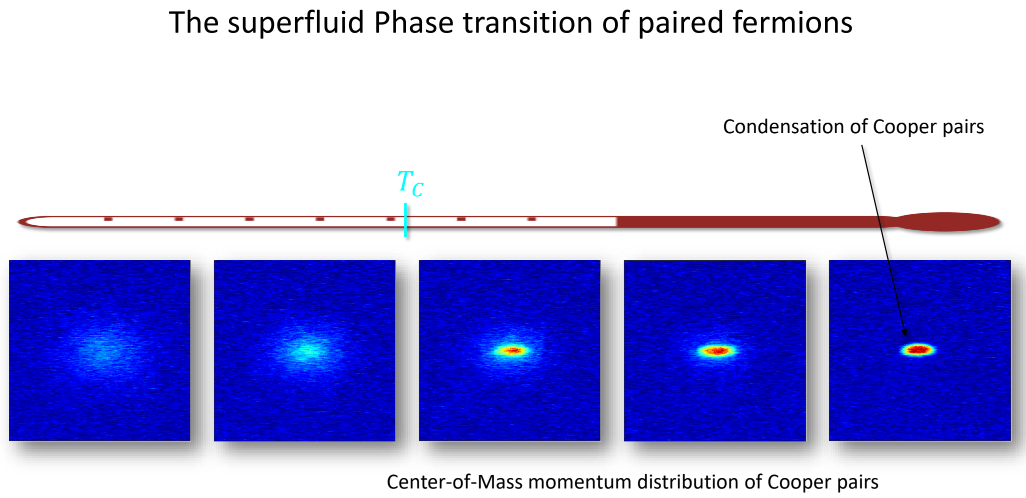
Nambu Yoichiro Institute of Theoretical and Experimental Physics

31 October 2023

Editors: Hiroshi Itoyama, Masako Iwasaki, Nobuyuki Kanda, Katsuichi Kanemoto, Nobuhito Maru, Takashiro Nishinaka, Akira Oguri, Mitsuyo Suzuki and Hiromitsu Takeuchi

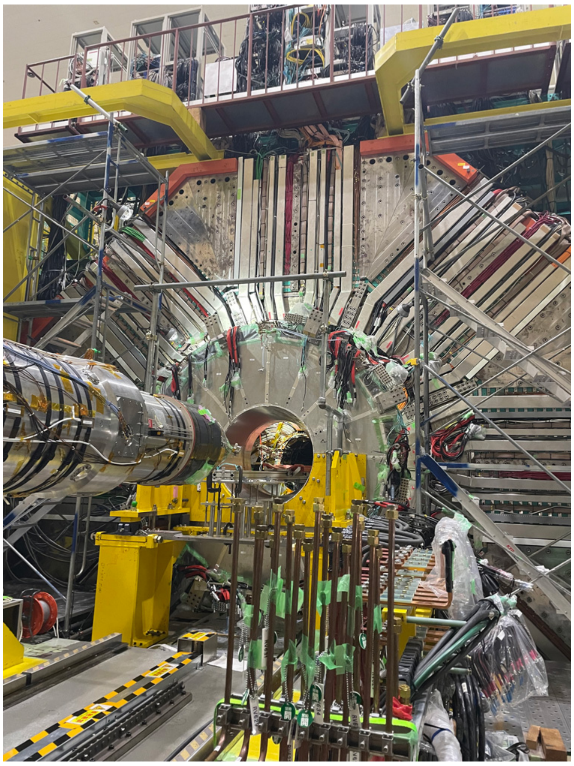
FRONTPIECE

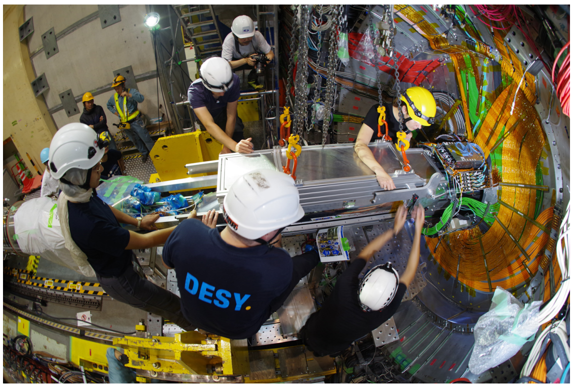
form recent researches activities



A series of absorption images show the temperature dependence of the center-of-mass momentum distribution of Cooper pairs in the spin-1/2 Fermi-particle system in the unitary limit using ultracold ^{6}Li atomic gases. A significant increase in the zero-momentum component is observed near the superfluid transition temperature (T_c), providing direct evidence for Bose condensation of Cooper pairs.

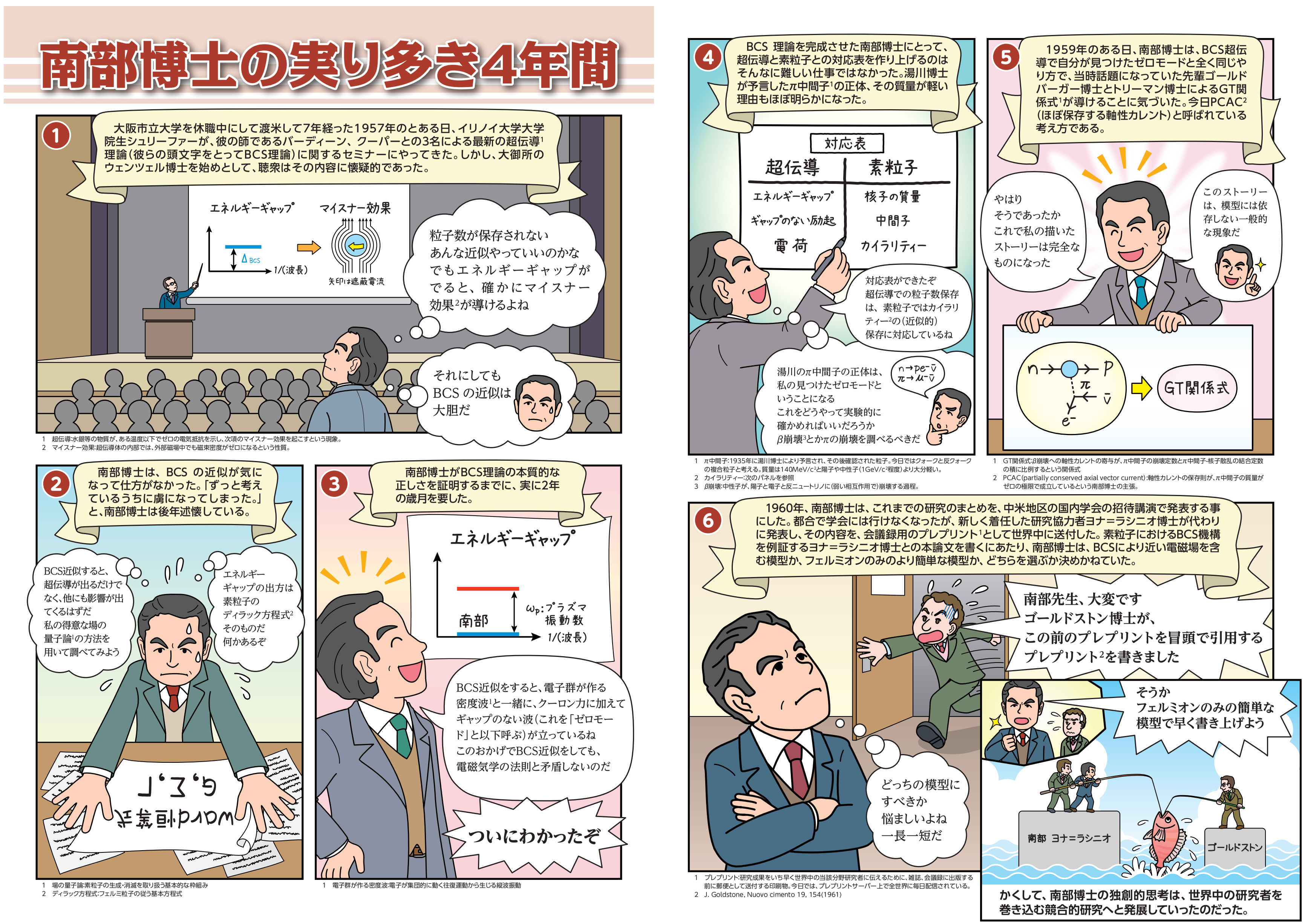
Belle II : installation of VerteX Detector (VXD)





The Belle II detector is constructed at the colliding point of SuperKEKB electron-positron collider at KEK, the High Energy Accelerator Research Organization, Japan. The photo shows the VerteX Detector (VXD) detector installation.

FRONTPIECE



1 超伝導:水銀等の物質が、ある温度以下でゼロの電気抵抗を示し、次項のマイスナー効果を起こすという現象。
2 マイスナー効果:超伝導体の内部では、外部磁場中でも磁束密度がゼロになるという性質。

1 場の量子論:素粒子の生成・消滅を取り扱う基本的な枠組み
2 ディラック方程式:フェルミ粒子の従う基本方程式

1 電子群が作る密度波:電子が集団的に動く往復運動から生じる縦波振動

1 π中間子:1935年に湯川博士により予言され、その後確認された粒子。今日ではクォークと反クォークの複合粒子と考える。質量は140MeV/c^2と陽子や中性子(1GeV/c^2程度)より大分軽い。
2 カイラリティー:次のパネルを参照
3 β崩壊:中性子が、陽子と電子と反ニュートリノに(弱い相互作用で)崩壊する過程。

1 GT関係式:β崩壊への軸性カレントの寄与が、π中間子の崩壊定数とπ中間子-核子散乱の結合定数の積に比例するという関係式
2 PCAC(partially conserved axial vector current):軸性カレントの保存則が、π中間子の質量がゼロの極限で成立しているという南部博士の主張。

1 プレプリント:研究成果をいち早く世界中の当該分野研究者に伝えるために、雑誌、会議録に出版する前に郵便として送付する印刷物。今日では、プレプリントサーバー上で全世界に毎日配信されている。
2 J. Goldstone, Nuovo cimento 19, 154(1961)

PREFACE

Five years have passed since Nambu Yoichiro Institute of Theoretical and Experimental Physics (NITEP) was founded and we present our annual report, summarizing scientific accomplishments made during the period of April 2020 through March 2022, namely 2020 and 2021 academic years.

On April 1st, 2022, Osaka City University and Osaka Prefectural University were put together to become Osaka Metropolitan University. The number of current research members of NITEP has now significantly increased, many of us being co-members from our new physics department.

Throughout 2020-2021 AY, while we had to persevere with the spell of COVID-19, we aimed at the formation of NITEP as an international research basis, fostering the research atmosphere of emphasizing free imagination and originality which Professor Nambu left to us. We accomplished a lot of noteworthy results in original research coming out from our on-campus activities that involved the participation of graduate students, as well as from international collaborations which are already well-known in the world. Several international conferences/workshops were held by us, which are both interdisciplinary and borderless, following the research discipline of Nambu. These are annually or biannually held in the fields and communities of cosmic ray and gravitational wave physics, elementary particle physics (both theory and experiments) and physical, mathematical sciences of the integrable systems, quantum field theory and string theory. Some of them were held at our Sugimoto campus while others are jointly held with other institutions.

Beginning with January 2021, we realized the big memorable event of 100th birthday of Nambu for two months, collaborating with the science museum of Osaka city: it was a successful corporation between a university and a museum. It has now become possible to make interdisciplinary investigations more systematically than before in several fields: they are elementary particle physics that are both theoretical and experimental, many-body problem of nuclear physics and modern atomic physics and fusion of gravitational wave probes and physics beyond the standard model. The special lecture series, which were going on but discontinued for a while, have now come back and we hope to make them more active. Please look at our website for more details.

The public lectures, which we have poured a lot of efforts into even before NITEP was founded, have now become well-known events which people ranging from retired citizens to high-school students look forward to.

We would like to proceed in several directions mentioned above for further developments.

Opinions and participations from outside NITEP are very important. Feel free to express your opinions to us.

Hiroshi Itoyama, the director of NITEP

Contents

1 ABOUT NITEP

Nambu Yoichiro Institute of Theoretical and Experimental Physics (NITEP), Osaka City University was founded on Novermber 1, 2018.

Osaka City University (OCU) is known to be the only university in Japan where Yoichiro Nambu taught as professor before he left for the United States. Since then, our physics department has been recognized as a first-rate research institute in physics till today, emphasizing free spirit and imagination fostered by the group led by Professor Nambu in early fifties. In 2013, OCU awarded Professor Nambu a Special Emeritus Professor for his Novel prize in Physics in 2008. In 2018, the President Tetsuo Arakawa decided to open a new research institute in physics on our campus crowned under Nambu to promote our activities and foster human resources further, aiming at the formation of an international center where scientists both from abroad and inside Japan gather regularly. International presence of our university has thus been strengthened.

2 NEWS

1. Masako Iwasaki was introduced as a role model for women researchers. (30 April 2020)

2. The work of Makoto Tsubota and his colleagues (NITEP preprint # 41) was reported in the May 4 morning edition of the Nihon Keizai Shimbun, The Nikkei. (4 May 2020)

3. Osaka City University's 140th Anniversary Exhibition Room was open on 3 November (*Open to the public after mid-December). There is a corner with Yoichiro Nambu. (3 November 2020)

4. Hiroshi Itoyama (Director of NITEP) gave a lecture at the Special Night "Physicist Yoichiro Nambu and the Universe" at the Osaka Science Museum. (23 January 2021)

5. In commemoration of the 100th anniversary of the birth of Yoichiro Nambu, NITEP and the Osaka Science Museum held a special exhibition, "Hogarakani: The Life and Research of Yoichiro Nambu," at the Osaka Science Museum. (13 January - to 28 March 2021.)

6. Annual Report 2018-2019 was released. (16 January 2021.)

7. The project "Application of Machine Learning to the Elementary Physics Experiments" by Masako Iwasaki (NITEP) got the acceptance of FY2021 Osaka Univ. Cybermedia Center Large-Scale Computer system Exploratory Research Project for Young or Women Scientists.. (16 January 2021.)

8. The article "First cryogenic test operation of underground km-scale gravitational-wave observatory KAGRA" by KAGRA collaboration that Yousuke Itoh and Nobuyuki Kanda belong has been selected for the Highlights of 2019-20 of the "Classical and Quantum Gravity" journal. (16 March 2021.)

9. NITEP on-line public lecture (in Japanese) was open. (30 March 2021.)

10. The project "Application of Machine Learning to the Elementary Physics Experiments" by Masako Iwasaki (NITEP) got the acceptance of FY2021 Joint Usage/Research Center for Interdisciplinary Large-scale Information Infrastructures (JHPCN) Exploratory Research Project. (23 April 2021.)

11. An article on the 100th anniversary of the birth of Yoichiro Nambu was published in the Asahi Shinbun. In the article, NITEP and a comment by Director Itoyama were introduced. (10 Augusut 2021.)

12. An article on the 100th anniversary of the birth of Yoichiro Nambu was published in "RONZA" (Asahi Shinbun). In the article, NITEP was introduced and Director Itoyama commented on Prof. Nambu.(16 Augusut 2021.)

13. NITEP is mentioned at the end of Akira Nakashima's book "The Story of Yoichiro Nambu–The Man Who Came Too Early" (Kodansha Ltd., 2021).(31 October 2021.)

14. Takahiro Nishinaka gave a commemorative lecture at the award ceremony of the Yoichiro Nambu Memorial Young Scientist Award for 2021. (29 November 2021.)

15. The project "Application of Machine Learning to the Elementary Physics Experiments" by Masako Iwasaki got the acceptance of FY2022 Joint Usage/Research Center for Interdisciplinary Large-scale Information Infrastructures (JHPCN) Exploratory Research Project. (15 March 2022.)

16. Nobuyuki Kanda gave a lecture at the JPSJ Online Physics Lectures. (18 June 2022.)

17. Wataru Horiuchi gave a commemorative lecture at the award ceremony of the Yoichiro Nambu Memorial Young Scientist Award for 2022. (19 December 2022.)

3 AWARDS

1. **Rosa Mayta Palacios** was selected as a winner of the **7th Osaka City University Special Award for Female Researchers [Okamura Prize]** on 23 October 2020.

2. **Takahiro Nishinaka** was selected as a winner of the **Yoichiro Nambu Memorial Young Scientist Award for 2021** on 26 July 2021.

3. **Takuya Hirose** (second year student in the Graduate School of Science, Osaka City University) was awarded **the Student Presentation Award of the Physical Society of Japan at 2021 Autumn Meeting** based on the joint research with Associate Professor Nobuhito Maru (NITEP) on 23 October 2021.

4. **Wataru Horiuchi** was selected as a winner of the **Yoichiro Nambu Memorial Young Scientist Award for 2022** on 19 December 2022.

4 INTERNATIONAL COLLABORATION

NITEP has been putting forward international collaborations in several directions strongly since its foundation.

In high energy experiments, Y. Seiya and K. Yamamaoto have been working at the long baseline neutrino oscillation experiment T2K, concluding that the angle δ_{CP} may be around the $-\pi/2$. They are also working at the DeeMe experiment in preparation to search for the charged lepton flavor violating process, μ-e conversion. M. Iwasaki and E. Nakano have been working on the international B factory experiments of Belle and Belle II. M. Iwasaki has also been working for the future ILC experiment on the SiD R&D and physics feasibility studies.

In high energy theory, N. Maru has been working with N. Okada and S. Okada on the collider physics and the dark matter physics related to the Higgs sector in the standard model. M. Yamanaka has collaborated with people at Laboratoire Univers et Particules de Montpellier (LUPM) on muon-electron conversion in nuclei. In quantum field theory and string theory, H. Itoyama has continued to collaborate with A. Mironov and A. Morozov, the two renowned Russian scientists at ITEP, Moscow and produced three papers on tensor models and their algebraic properties. S. Moriyama collaborates intermittently with Heng-Yu Chen at National Taiwan University on various aspects of conformal field theories.

In gravitational wave observations, N. Kanda, Y. Itoh, and T. Sawada are the members of the KAGRA collaboration, which consists of more than 400 researchers from more than 110 institutions in 15 countries and regions around the world (as of August 2020). Kanda serves as an executive office member of the KAGRA collaboration, Itoh is a liaison member of several LIGO-Virgo-KAGRA joint committees from the KAGRA collaboration, and Sawada is a coordinator of the LIGO-Virgo-KAGRA observing runs. In cosmic ray observations, S. Ogio and Y. Tsunesada are principal researchers of the Telescope Array experiment, the largest cosmic ray observatory in the northern hemisphere. Ogio is the spokesperson, and Tsunesada serves as the analysis coordinator leading the science team of this Japan-US-Korea-Russian collaboration

In theory of gravitation and astrophysics, K. Nakao has been in contact with P. S. Joshi Charotar University of Science and Technology (CHARUSAT) on strong gravity.

M. Tsubota conducted the joint research of low temperature physics with the scientists of Yale University, Florida State University, Florida University, USA, University of Cambridge, UK, Leiden University, the Nertherlands, Yangzhou University, China, National Taiwan Normal University, Taiwan, and University of Konstanz, Germany, Technology Innovation Institute, UAE, publishing five papers. In the field of strongly-correlated electron systems, A. Oguri and Y. Nishikawa have been collaborating with an experimental group of CNRS, Univ. Paris-Sud, Universite Paris Saclay, France, and a theoretical group of Imperial College London. In quantum dynamics physics, S. Tanaka, K. Kanki, S. Garmon, and K. Noba have collaborated with T. Petrosky at University of Texas at Austin, USA for the study of non equilibrium statistical mechanics in terms of complex spectral analysis. S. Tanaka and K. Kanki have collaborated with R. Passante and L. Rizzuto at Palermo University, Italy on studies of the dynamical Casimir effect. S. Garmon has collaborated with G. Ordonez at Butler University, USA, on topological properties and dynamics of quantum systems exhibiting chiral symmetry. Y. Hosokoshi and T. Ono have conducted a Joint research project of neutron and SR experiments with University of Zaragoza Spain, in order to determine the magnetic structure of organic radical crystals.

5 RESEARCH HIGHLIGHTS

5.1 Exploring the internal structure of particles

Takahiro Sawada [1]

I have been a member of the gravitational wave experimental physics laboratory at OCU and OMU NITEP from 2018 to 2022, and have promoted the research on the gravitational wave experiment KAGRA. The primary target sources for gravitational wave observations are the merger of compact binaries; black holes and/or neutron stars, which are matters under extreme conditions. We are still far from a complete understanding of the fundamental matter of the universe, e.g., the proton and neutron, even under normal conditions in which we live. Here I present the research on the internal structure of these fundamental particles that we have performed during my career at this institute.

The quark model is successful in classifying hadrons. Considering that a baryon is composed of three constituent quarks, we can describe the baryon's mass, magnetic moment, charge, spin, parity, etc. These describe the long-range properties of hadrons, while the partonic picture, with elements of quarks, antiquarks, and gluons, describes the short-range properties. Nonetheless, there is still only incomplete theoretical and experimental understanding of how these particles and their dynamics give rise to the hadron's quantum bound states, spin, and other physical properties, even for the proton, which is the simplest baryon. It is not sufficient to simply add quark spin to explain the proton spin 1/2 at the parton level. This is called the proton spin crisis, in which quark spin contributes only about 30%, with the remaining 70% considered to originate from gluon spin and the orbital angular momentum of the quark-gluon. Confirming its origin by experiment has been a crucial topic for long years. Furthermore, only about 1% of the proton mass is generated by interactions with the Higgs field, while the rest is thought to arise from the nature of the strong interactions; chiral symmetry breaking and quark confinement. The study of proton partonic structures will also lead to an understanding of the interesting properties involved in these strong interactions.

The parton distribution function within a proton has been measured by many experiments so far. The distribution quantities for $\bar{u}$- and $\bar{d}$-quarks, $\bar{u}(x)$ and $\bar{d}(x)$, here x is the Bjorken scaling variable, were previously thought to be flavor symmetric, i.e., $\bar{u} = \bar{d}$. This is because $\bar{u}$ and $\bar{d}$ inside the proton should arise from gluon branches $g \to u + \bar{u}$ and $g \to d + \bar{d}$, and $\bar{u}$ and $\bar{d}$ with comparable masses should have almost the same production probabilities. The NMC experiment (1990) at CERN measured the proton and neutron structure functions and was the first to suggest flavor asymmetry. The NA51 experiment at CERN (1994) and the Fermi E866/NuSea experiment (1998) revealed the flavor asymmetry by directly measuring the particle distribution function. Various theoretical models were proposed to explain the mechanism of this large $\bar{d}/\bar{u}$ asymmetry. Most theoretical models approximately reproduced the measured x-dependence of its asymmetry at the relatively small x region, but failed to explain the phenomenon of the asymmetry abruptly dropping to zero at $x \sim 0.3$. In particular, the measurements showed a tendency for the asymmetry to invert, a phenomenon in which the asymmetry reverses its size relationship at $x > 0.3$, which could not be reproduced by any theoretical model.

We conducted a SeaQuest/E906 experiment at Fermi National Accelerator Laboratory, and has provided the most accurate measurement to date of the antiquark distribution inside the proton as a function of Bjorken-x through observations of the Drell-Yang reaction, in which quark-antiquark pairs annihilate, virtual photons are produced, and decay into a pair of oppositely charged leptons [[1],[2]]. Our results show that there is an asymmetry between the abundances of anti-down and anti-up quarks, but is qualitatively different from earlier experiments. This has implications for current and future

[1] present address: Institute for Cosmic Ray Research (ICRR), KAGRA Observatory, The University of Tokyo, 238 Higashi-Mozumi, Kamioka-cho, Hida City, Gifu 506-1205, Japan

experimental data and suggests that a convincing theoretical explanation for this phenomenon has not yet been established.

We also investigated the nucleon and pion gluon distribution functions in the framework of holographic QCD, focusing on the small x region [[3]]. Based on an approximate relation, the gluon distributions were extracted from structure functions of the unpolarized deep inelastic scattering which could be calculated with a holographic QCD model, assuming the Pomeron exchange. We explicitly showed that the extracted proton gluon distributions were consistent with the recent global QCD analysis results. The structure functions of the π-meson (pion) could be computed without any additional parameter, which also enabled us to predict its gluon distribution. We showed that the resulting pion gluon density is smaller than the proton's and agrees with the recent global QCD analysis result within the uncertainties.

The pion, as the Goldstone boson of dynamical chiral symmetry breaking of the strong interaction, is the lightest QCD bound state. Because of its light mass, the pion plays a dominant role in the long-range nucleon-nucleon inter- action. Understanding the pion's internal structure is important to investigate the low-energy, nonperturbative aspects of QCD. Even though the pion is theoretically simpler than the proton, its partonic structure is much less explored because the scattering off a pion target is not feasible due to the inability to create material targets made of pions. Therefore, the study of structure of pion is also very interesting, as is the study of proton structure, and it is worthwhile to make this possible by the approach in [[3]] to extract the structure of pion. We also investigated and provided the useful constraints for the pion partonic structure in the framework of the color evaporation model [[4]] and non-relativistic QCD (NRQCD) [[5],[6]], and also compiled one review article [[7]].

The kaons are the lightest mesons containing $\bar{s}$- or s- quarks, and these properties are considered to be important in characterizing the properties of interior of neutron stars. We investigated the partonic structure of Kaon in the framework of the chiral constituent quark model [[8]]. We judiciously choosed the bare distributions at the initial scale to generate the dressed distributions at the higher scale, considering the meson cloud effects and the QCD evolution, which agreed with the phenomenologically satisfactory valence quark distribution of the pion and the experimental data. We showed how the meson cloud effects affect the bare distribution functions in detail and found that a smaller SU(3) flavor symmetry breaking effect was observed, compared with results of the preceding studies based on other approaches.

References

[1] J. Dove et al. "The asymmetry of antimatter in the proton". In: *Nature* 590.7847 (Feb. 2021), pp. 561–565. DOI: 10.1038/s41586-021-03282-z. URL: https://doi.org/10.1038%2Fs41586-021-03282-z.

[2] J. Dove et al. *Measurement of flavor asymmetry of light-quark sea in the proton with Drell-Yan dimuon production in $p+p$ and $p+d$ collisions at 120 GeV*. 2023. arXiv: 2212.12160 [hep-ph].

[3] Akira Watanabe, Takahiro Sawada, and Mei Huang. "Extraction of gluon distributions from structure functions at small x in holographic QCD". In: *Physics Letters B* 805 (June 2020), p. 135470. DOI: 10.1016/j.physletb.2020.135470. URL: https://doi.org/10.1016%2Fj.physletb.2020.135470.

[4] Wen-Chen Chang et al. "Constraining gluon density of pions at large x by pion-induced J/ψ production". In: *Phys. Rev. D* 102 (5 Sept. 2020), p. 054024. DOI: 10.1103/PhysRevD.102.054024. URL: https://link.aps.org/doi/10.1103/PhysRevD.102.054024.

[5] Wen-Chen Chang et al. "Fixed-target charmonium production and pion parton distributions". In: *Physical Review D* 107.5 (Mar. 2023). DOI: 10.1103/physrevd.107.056008. URL: https://doi.org/10.1103%2Fphysrevd.107.056008.

[6] Chia-Yu Hsieh et al. “NRQCD analysis of charmonium production with pion and proton beams at fixed-target energies”. In: *Chinese Journal of Physics* 73 (2021), pp. 13–23. ISSN: 0577-9073. DOI: https://doi.org/10.1016/j.cjph.2021.06.001. URL: https://www.sciencedirect.com/science/article/pii/S0577907321001258.

[7] Wen-Chen Chang et al. “Pion PDFs confronted by fixed-target charmonium production”. In: *AAPPS Bulletin* 33.1 (July 2023). DOI: 10.1007/s43673-023-00085-4. URL: https://doi.org/10.1007%2Fs43673-023-00085-4.

[8] Akira Watanabe, Takahiro Sawada, and Chung Wen Kao. “Kaon quark distribution functions in the chiral constituent quark model”. In: *Phys. Rev. D* 97 (7 Apr. 2018), p. 074015. DOI: 10.1103/PhysRevD.97.074015. URL: https://link.aps.org/doi/10.1103/PhysRevD.97.074015.

5.2 Quantum corrections to Wilson-line scalar masses in flux compactification

Takuya Hirose

Recently, magnetic flux compactification has attracted attention from the viewpoint of the hierarchy problem. In [1, 2], we have shown that quantum corrections to the masses of zero-mode of the scalar field induced from extra component of higher dimensional gauge field (called Wilson-line (WL) scalar field) are canceled in a six-dimensional Yang-Mills theory with flux compactifiaction. In [3], we have investigated the possibility to realize nonvanishing finite WL scalar mass in flux compactification, and illustrated the finite quantum correction to the WL scalar mass in a certain case. We have also applied the result in [3] to inflationary theory [4].

We consider a six-dimensional U(1) gauge theory with a constant magnetic flux. We assume that compact space is a two-dimensional torus T^2. Here, the magnetic flux is given by the nontrivial background (or vacuum expectation value (VEV)) of the fifth and the sixth components of the gauge field. This background must satisfy their classical equation of motion $\partial^m \langle F_{mn} \rangle = 0$, where F_{mn} is a field strength and $m, n = 5, 6$ denotes index of compact space. In flux compactification, the background of $A_{5,6}$ is chosen as

$$\langle A_5 \rangle = -\frac{1}{2} f x_6, \quad \langle A_6 \rangle = \frac{1}{2} f x_5, \tag{1}$$

which introduces a constant magnetic flux density $\langle F_{56} \rangle = f$ with a real number f. Note that this solution breaks an extra-dimensional translational invariance spontaneously. Integrating over T^2, the magnetic flux is quantized as follows

$$\frac{g}{2\pi} \int_{T^2} dx_5 dx_6 \, \langle F_{56} \rangle = \frac{g}{2\pi} L^2 f = N \in \mathbb{Z}, \tag{2}$$

where L^2 is an area of two-dimensional torus.

To compute one-loop correction to WL scalar mass in flux compactification, we need information of Kaluza-Klein (KK) mass eigenvalues for fields propagating in a loop. Summarizing KK mass spectrums, the KK mass of scalar field is obtained by $m^2_{\text{scalar}} = \alpha(n + 1/2)$ and that of fermion field is obtained by $m^2_{\text{fermion}} = \alpha(n + 1)$, where $\alpha = 2gf$ and $n = 0, 1, 2 \cdots$ is a Landau level. Note that the KK mass of Yang-Mills theory is similar to the KK mass of fermion.

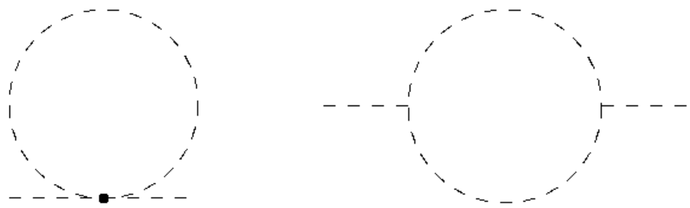


Figure 1: Example of quantum corrections to the WL scalar mass at 1-loop

We systematically analyze the divergence structure of the quantum corrections to WL scalar mass and classify possible interactions providing a finite mass. We investigate two types of Feynman diagrams in figure 1. The general form of loop integral in the quantum correction can be written as

$$\begin{aligned} I(x; a, b) &= \sum_{n=0}^{\infty} \int \frac{d^4 k}{(2\pi)^4} \frac{k^{2a}}{\left(k^2 + \alpha\,(n + x)\right)^b} \\ &= \frac{1}{\alpha^{b-a}} \left(\frac{4\pi}{\alpha} \right)^{\epsilon - 2} \frac{\Gamma\,(a + 2 - \epsilon)\,\Gamma\,(\epsilon + b - a - 2)}{\Gamma(b)\Gamma\,(2 - \epsilon)} \zeta[\epsilon + b - a - 2, x], \end{aligned} \tag{3}$$

where the dimensional regularization was employed for loop integral in the second line. $\Gamma(z)$ is a gamma function, $\zeta[s,a]$ is Hurwitz zeta function, and $d = 4 - 2\epsilon$ dimensions. x is the part of KK mass characterized by the field running in the loop. $x = 1/2$ corresponds to the KK mass of scalar field. $x = 1$ mainly corresponds to the KK mass of fermion field. a denotes the number of derivatives acting on the single field and b corresponds to the number of the propagator.

Using eq.(3), we can classify the interaction terms providing finite correction to WL scalar mass at one-loop. Of these interaction terms, we consider the simplest interaction term in six-dimensional scalar QED. The Lagrangian is given by

$$\mathcal{L} = -\frac{1}{4}F_{MN}F^{MN} - D_M\overline{\Phi}D^M\Phi + \kappa(\bar{\phi}\overline{\Phi}\Phi + \phi\overline{\Phi}\Phi), \tag{4}$$

where Φ is a bulk scalar field and κ is a new dimensionless coupling constant. From new interaction term, the quantum correction to WL scalar mass at one-loop can be obtained as

$$\delta m^2 = \frac{|N|\ln 2}{32\pi^2}\frac{\kappa^2}{L^2}. \tag{5}$$

If $\kappa = 0$, the quantum correction (5) would be zero. This physical reason is that the zero-mode of φ is a Namub-Goldstone (NG) boson of translational invariance in extra space. If $\kappa \neq 0$, the quantum correction (5) would not be canceled and the zero-mode of φ would be a pseudo NG boson since the new interaction term $\varphi\overline{\Phi}\Phi$ explicitly break the translational invariance.

References

[1] T. Hirose and N. Maru, "Cancellation of One-loop Corrections to Scalar Masses in Yang-Mills Theory with Flux Compactification," JHEP **08**, 054 (2019) [arXiv:1904.06028 [hep-th]].

[2] T. Hirose and N. Maru, "Cancellation of One-loop Corrections to Scalar Masses in Flux Compactification with Higher Dimensional Operators," J. Phys. G **48**, no.5, 055005 (2021) [arXiv:2012.03494 [hep-th]].

[3] T. Hirose and N. Maru, "Nonvanishing finite scalar mass in flux compactification," JHEP **06**, 159 (2021) [arXiv:2104.01779 [hep-th]].

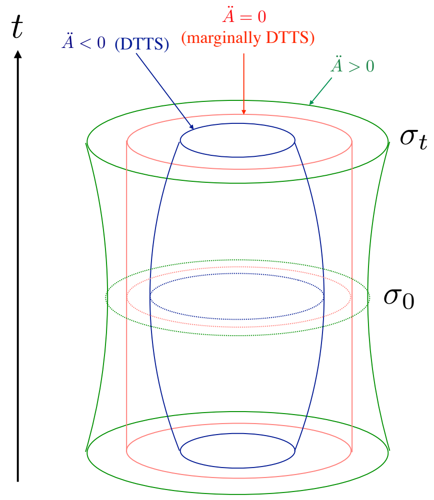
[4] T. Hirose and N. Maru, "Extranatural flux inflation," JHEP **09**, 124 (2021) [arXiv:2105.11782 [hep-th]].

5.3 Development of concepts to characterize the gravity strength

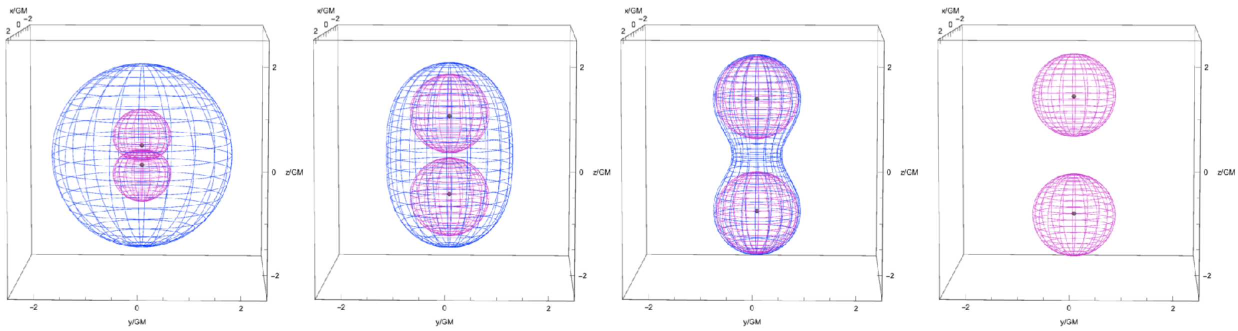
Hirotaka Yoshino

Black holes are fascinating: From inside of a black hole, anything (even a photon) cannot escape from it. Although we cannot see black holes themselves by definition, many observations strongly indicate the existence of black holes. Gravitational waves generated during a merger of two black holes were detected for the first time in 2015 by the aLIGO (the event GW150914), and today there are also several gravitational wave observatories in operation such as the aVIRGO and the KAGRA. Also, the "black hole shadows" around supermassive black holes at the centers of the galaxy M87 and of our galaxy were observed by electromagnetic observations by the Event Horizon Telescope collaboration.

The properties of black holes are predicted by the theory of general relativity. In order to deepen our understanding on theoretical aspects of black holes, it is important to introduce appropriate concepts. Such concepts were often invented as generalizations of a particular concept in a simple situation. The Schwarzschild spacetime is a well-known spherically symmetric static black hole spacetime, and it has a horizon at $r = 2GM$ where r is the radial coordinate, G is the gravitational constant, and M is the mass (in the unit $c = 1$). Penrose introduced two important concepts as the generalizations of the horizon to general spacetimes: the *event horizon* and the *apparent horizon*. The event horizon is determined as the outer boundary of the region where photons cannot escape to infinity, and it is widely accepted as the definition of the black hole. Since the location of the event horizon is determined after the whole spacetime structure is clarified, it is a global concept. By contrast, the apparent horizon is determined with local behavior of photons. Consider photons emitted from a surface in outside directions. The collection of photons forms a surface, and if its area does not change instantaneously, that surface is called the apparent horizon. Note that in the case where gravity is weak, the emitted photons expand and the area increases. Therefore, the existence of an apparent horizon indicates that gravity is extremely strong there, and in fact, the formation of an apparent horizon is proven to be the sufficient condition for the formation of an event horizon. For this reason, the apparent horizon is widely used especially in numerical simulations to check the black hole formation. This example illustrates the power of appropriately defined concepts.



Let us now describe the motivation of our study. In a Schwarzschild spacetime, a photon makes circular motion around a Schwarzschild black hole at $r = 3GM$ due to strong gravity. This surface is called the *"photon sphere"*, and this is an interesting surface as well as $r = 2GM$. Such circular orbits of photons are known to determine the shape of a black hole shadow. Therefore, it is natural to consider generalized concepts of the photon sphere: if properly defined, such a generalized concept would characterize the strong gravity region around a black hole. In 2019, the present author proposed one of such generalized concepts, the *dynamically transversely trapping surface (DTTS)* with collaborators [1]. This is a generalization that has a similarity to the apparent horizon in the sense that it is defined in terms of local behavior of photons. Roughly speaking, the idea is as follows (please see [1] for the more precise definition). Consider a two-dimensional closed surface σ_0 and photons emitted from that surface in the tangential directions. Such photons propagate in the spacetime and we consider the outer boundary σ_t of the collection of those photons at time $t > 0$. Then, we focus on the area $A(t)$ of σ_t. At $t = 0$, the value of $\dot{A}$ is zero where dot denotes the derivative with respect to t. On the other hand, the value of $\ddot{A}$ is not zero in general. If $\ddot{A} > 0$, the photons tend to expand and gravity is not so strong there, while if $\ddot{A} \leq 0$, the photons tend to shrink, and thus, gravity is strong there. The surface σ_0 is called a DTTS if $\ddot{A} \leq 0$, and it is called the marginally DTTS if the equality holds. In the above figure, the blue one is the DTTS and the red one is the marginally DTTS. Please enjoy the sceneries of the marginally DTTSs in a two black hole system below. When two black holes are separated, there are two marginally DTTSs each of which encloses only one black hole. As the distance between the two black holes is made smaller, the "common" marginally DTTS which encloses both black holes forms.



In fiscal year 2022, we published three papers [2–4] that are related to the generalization of the photon sphere and to the nontrivial behavior of photons around a gravitational source with Prof. Tetsuya Shiromizu (Nagoya University), Dr. Keisuke Izumi (Nagoya University), Dr. Tomikawa Yoshimune (Tokyo Denki University), Mr. Masaya Amo (YITP at Kyoto University), and Mr. Kanjae Lee (Nagoya University). Also in the fiscal year 2023, we submitted two works [5, 6] whose progress was made mainly in 2022. Other than the DTTS, my collaborators have invented several generalized concepts of the photon sphere, and each of them depicts different aspects of the gravity strength (in fact, each collaborator considers that his own concept would be the best). In [2], we further extended our concepts of the generalized photon sphere to include one parameter to specify the gravity intensity, and summarized them. In that paper, the DTTS is extended to the concept of the *"transverse attractive gravity probe surface (TAGPS)"*, which has an intensity parameter γ_T of gravity. In that concept, we consider the same situation as the case of the DTTS, but now we focus attention to the value of $\ddot{A}/A$ itself. For example, consider a situation where $\ddot{A}/A$ is negative. As its absolute value becomes larger, gravity can be considered to become stronger. Mathematically, a two-dimensional closed surface σ_0 is said to be a TAGPS with the parameter γ_T if the inequality

$$\ddot{A}/A \leq {}^{(2)}R(1 - \gamma_T)$$

holds, where ${}^{(2)}R$ is the Ricci scalar of σ_0. The parameter is adjusted so that the case $\gamma_T = 1$ is reduced to the definition of the DTTS, and a surface with smaller γ_T corresponds to a surface in weaker gravity region (that is, located in a distant region from the gravitational source).

We consider the concept of the TAGPS to be actually meaningful, because it possesses some universal feature. Before explaining this, I would like to introduce the *Penrose inequality*,

$$A \leq 4\pi(2GM)^2,$$

where A is the area of an apparent horizon. This inequality was conjectured by Penrose through a physical argument (1973), and it indicates that the area of an apparent horizon is bounded by that of the horizon area of a Schwarzschild black hole with the same mass. Later, this inequality has been proved to hold in time-symmetric initial data. In the proof, the technique of the inverse mean curvature flow, which was introduced by Geroch in 1973, is used. Geroch introduced this technique to prove the positive energy theorem (which states that the gravitational energy must be nonnegative under some assumption), and it was pointed out that this technique can be used to prove the Penrose inequality as well by Jang and Wald (1977). Although Geroch's technique was mathematically incomplete at that time, the complete proof was given by Huisken and Ilmanen in 2001. Applying the same technique, we have succeeded in obtaining the *areal inequality*,

$$A \leq \frac{4\pi(3GM)^2}{\gamma_T^2},$$

for the area A of the TAGPS in time-symmetric initial data. In particular, in the case of $\gamma_T = 1$, the area of the DTTS is bounded by that of the photon sphere of a Schwarzschild spacetime with the same mass. The interpretation of this result is that since the strong gravity region is bounded, the area of the boundary of that region is also bounded. As gravity becomes weaker (that is, as γ_T is decreased), its region becomes larger and the area of its boundary becomes larger. Note that in more general situations (e.g., in a space with the angular momentum), we can prove a similar areal inequality, although its form is more complicated compared to the above one [2].

To summarize, we have succeeded in developing well-defined concepts, the TAGPS and the DTTS, to characterize the strength of gravity. It can be expected that these concepts would play an important role to understand the properties of spacetimes. Because of these works, the present author received the award of Osaka Central Advanced Mathematical Institute (OCAMI) Association Special Prize in 2022.

References

[1] H. Yoshino, K. Izumi, T. Shiromizu, and Y. Tomikawa, "Transversely trapping surfaces: Dynamical version," Prog. Theor. Exp. Phys. (2020) 023E02.

[2] K. Lee, T. Shiromizu, K. Izumi, H. Yoshino, Y. Tomikawa, "Four types of attractive gravity probe surfaces" Phys. Rev. D **106** (2022) 064028.

[3] M. Amo, K. Izumi, Y. Tomikawa, H. Yoshino, T. Shiromizu, "Asymptotic behavior of null geodesics near future null infinity III: Photons towards inward directions," Phys. Rev. D **106** (2022) 084007 [Erratum: *ibid* 107 (2023) 029902].

[4] K. Izumi, Y. Tomikawa, T. Shiromizu, H. Yoshino, "Attractive gravity probe surfaces in higher dimensions," arXiv:2209.14124[gr-qc], accepted for publication in PTEP.

[5] M. Amo, K. Izumi, Y. Tomikawa, T. Shiromizu, H. Yoshino, "Asymptotic behavior of null geodesics near future null infinity IV: Null-access theorem for generic asymptotically flat spacetime," Phys. Rev. D **107** (2023) 124050.

[6] M. Amo, K. Izumi, H. Yoshino, Y. Tomikawa, T. Shiromizu, "A generalization of photon sphere based on escape/capture cone," arXiv:2305.11208[gr-qc].

5.4 Spatially-resolved observations of giant molecular clouds in the nearest spiral galaxy M33

Kazuyuki Muraoka

The understanding of the formation process of high-mass stars (typically $> 8\,M_\odot$) is one of the most important issues in modern astronomy because high-mass star formation eventually drives galaxy evolutions through the feedbacks such as radiation pressure, photoionization, and supernova explosions. In the past few decades, many observational studies toward the Local Group of galaxies suggested that giant molecular clouds (GMCs) are major sites of high-mas star formation. Thus, the detailed study of GMC properties and the evolution of GMCs is indispensable.

The Atacama Large Millimeter/submillimeter Array (ALMA) is the most powerful instrument to promote spatially-resolved (i.e., parsec-scale) studies for extragalactic GMCs owing to its exquisite sensitivity and angular resolution. We performed ALMA 1 pc-resolution observations including ^{12}CO($J = 2-1$), ^{13}CO($J = 2-1$), and C^{18}O($J = 2-1$) emission lines toward three massive GMCs ($> 10^6\,M_\odot$) in M33, which is one of the nearest spiral galaxies in the Local Group. The targeted GMCs are NGC 604-GMC, GMC-8, and GMC-16, which show different star-formation environments. NGC 604-GMC is associated with the most luminous giant HII (ionized gas) region in the Local Group, and is also associated with young (< 5 Myr) stellar clusters. GMC-16 is associated with small HII regions and old ($10-30$ Myr) clusters, while high-mass star formation does not occur in GMC-8. The overall distribution in ^{12}CO($J = 2-1$) line for each GMC, which is previously observed by the IRAM 30 m telescope at 49 pc resolution, is displayed in the top panel of Figure 1.

The ALMA 1 pc-resolution maps in ^{12}CO($J = 2-1$) line emission clearly depict internal molecular-gas structures within the target GMCs as shown in the bottom panel of Figure 1. In the NGC 604-GMC, several shell- or arc-like CO structures in the northern field, and there exists a lot o molecular filaments with a length of $5-20$ pc elongated toward various directions and small (typically less than 10 pc) clumps in the southern field. In addition, we found C^{18}O($J = 2-1$) emissions, which corresponds to dense clumps, in some CO shells/filaments. We examined the velocity structures of the ^{12}CO($J = 2-1$) line emission in the shells and filaments containing dense clumps, and suggested that cloud-cloud collisions induced by an external atomic gas flow and the galaxy's rotation compressed the molecular material into dense filaments/shells which are ongoing high-mass star formation sites.

In GMC-8, the overall internal molecular-gas structure is less filamentary: one of the remarkable features in ^{12}CO($J = 2-1$) line emission is a widely extended and round-shaped structure with a diameter of ~ 50 pc. Such a morphological feature of molecular gas in GMC-8 is quite diffeferent from that in NGC 604-GMC. In addition, we found that the fraction of the relatively dense gas traced by the ^{13}CO($J = 2-1$) line with respect to the total molecular mass is only ∼2Considering the inactive star formation in GMC-8, we suggest that the onset of high-mass star formation needs the growth of characteristic (such as filamentary) molecular-gas structures and the increase in molecular gas density.

GMC-16 is composed of several filamentary structures both in ^{12}CO($J = 2-1$) and ^{13}CO($J = 2-1$) lines. The typical length and width of the filaments are $50-70$ pc and $5-6$ pc, and the total mass is $\sim 10^6\,M_\odot$, which are consistent with those of giant molecular filaments (GMFs) as seen in the Galactic GMCs. We found that the elongations of the GMFs are roughly perpendicular to the direction of the galaxy's rotation, and several HII regions are located at the downstream side relative to the filaments with an offset of $10-20$ pc. These observational results indicate that the GMFs are considered to be produced by a galactic spiral shock.

Our ALMA observations successfully revealed the parsec-scale local star formation activity in which the galactic scale kinematics may induce the formation of the parental filamentary clouds. The details of these studies are reported in our series of papers ([1], [2], [3]).

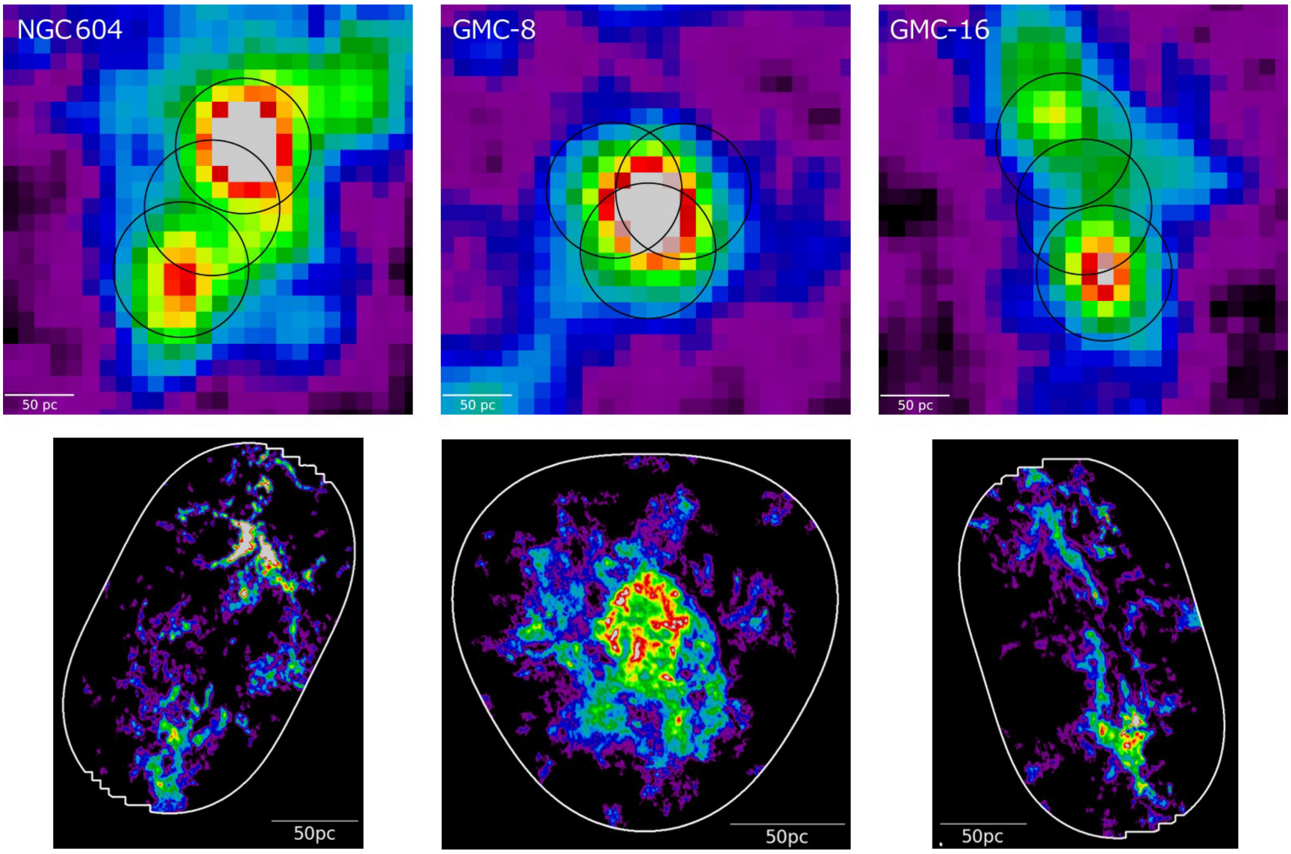


Figure 1: (top) Molecular-gas distributions in ^{12}CO($J = 2-1$) line emission for NGC 604-GMC (left), GMC-8 (center), and GMC-16 (right), which are observed with the IRAM 30 m telescope at 49 pc resolution. The circles in black indicate the observed field by the ALMA. (bottom) Integrated intensity maps in ^{12}CO($J = 2-1$) line emission for NGC 604-GMC (left), GMC-8 (center), and GMC-16 (right) observed by the ALMA. Internal molecular-gas structures within each GMC are clearly seen.

[1] Tokuda, K., Muraoka, K., Kondo, H., et al. "ALMA Observations of Giant Molecular Clouds in M33. I. Resolving Star Formation Activities in the Giant Molecular Filaments Possibly Formed by a Spiral Shock", 2020, ApJ, 896, 36

[2] Muraoka, K., Kondo, H., Tokuda, K., et al. "ALMA Observations of Giant Molecular Clouds in M33. II. Triggered High-mass Star Formation by Multiple Gas Colliding Events at the NGC 604 Complex", 2020, ApJ, 903, 94

[3] Kondo, H., Tokuda, K., Muraoka, K., et al. "ALMA Observations of Giant Molecular Clouds in M33. III. Spatially Resolved Features of the Star-Formation Inactive Million-solar-mass Cloud", 2021, ApJ, 912, 16

5.5 Direct spectroscopic observations of operation processes in ionic liquid-based LECs

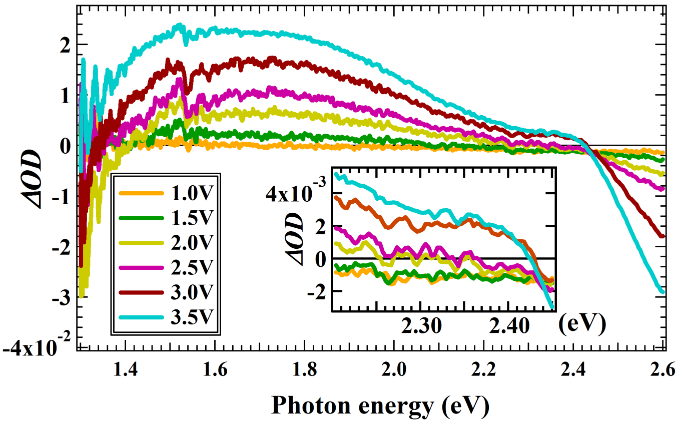
Katsuichi Kanemoto

In light-emitting devices including organic light emitting diodes (OLEDs), the recombination process where electrons and holes meet is the most fundamental and important process. Although there are some methods to evaluate the recombination process of OLEDs, the techniques to evaluate time-resolved measurement of the operation process has not been fully established, and its realization is important for the development of the field of semiconductor physics. In this study, we report on the development of a technique to directly observe the change of electronic states in a phosphorus-based ionic liquid-based light-emitting electrochemical cell (LEC), one of the most established light emitting devices, during the operation process when a driving bias is applied by spectroscopic measurements.

An LEC consisting of a mixed film of luminescent polymer Super Yellow (SY) and phosphorus ionic liquid ((P816Mes: Nippon Chemical Industry) was sandwiched between a transparent ITO electrode and a translucent Al electrode. OD) was obtained. Time-resolved measurements were performed by amplifying the output from the photodiode and then directly capturing it with a high-resolution oscilloscope.

Figure 1 shows the results of CCD detector measurements of optical absorption when each voltage is applied at steady state device operation. In this LEC, the current and emission rise around 0.6 V and 2.7 V, respectively, and each voltage corresponds to the injection start voltage of holes and electrons. Therefore, the absorption signal from 1.5 to 1.7 eV that appears around 1.5 V corresponds to the hole absorption transition. Such measurements under steady-state excitation are useful for observing holes and electrons existing with relatively long lifetimes [1].

Figure 2 shows the results of the experiment in which the device was kept in a steady state at 2.2 V for about 5 minutes and then a square wave voltage was applied from 2.2 V to 3.8 V. The signal at 1.8 eV and the signal at 2.35-2.40 eV slightly increased after 3 V, and this transition was identified as an electron signal. The hole signal around 1.5 eV was generated before the luminescence became steady, and then it reached steady state. On the other hand, the electron signal appeared at around 2.3 eV with a delay from the hole signal. From these results, it is inferred that in this LEC, luminescence is generated under well-doped holes, and that electron doping progresses gradually in parallel with the luminescence. Such generation processes of holes and electrons have not ever been experimentally observed. The establishment of these observation methods is expected to contribute to the development of semiconductor physics in the future.



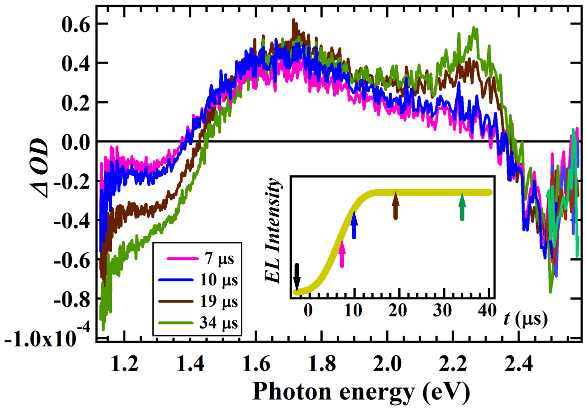


Figure 1: (Left) Absorption spectra during steady-state bias application in LEC. The inset is an enlarged view. Figure 2: (Right) Time-resolved absorption spectra of LEC after the bias is increased from 2.2V to 3.8V. The inset is the intensity of time-resolved electroluminescence.

[1] K. Yasuji, T. Sakanoue, F. Yonekawa, K. Kanemoto, Nat. Commu. **14**, 992 (2023).

5.6 Collaborative works on superdiffusion scaling law and vortex-ring decay in quantum fluid

Satoshi Yui

We have studied quantum hydrodynamics in a superfluid helium-4 using theoretical and numerical methods. In our recent papers [1,2] we collaborated with the cryogenic group of Wei Guo at Florida State University and studied (1) the superdiffusion scaling law of quantum turbulence and (2) vortex-ring decay in a quantum fluid. In the following, I briefly explain the two collaborative works.

Universal superdiffusion of quantized vortices [1].— If you stir the coffee with a spoon, the milk will be quickly mixed. The eddies in turbulence can rapidly transport embedded particles. In classical fluid dynamics, turbulent diffusion has been extensively studied. However, for quantum turbulence, the knowledge on turbulent diffusion is very limited. Recent developments of visualization enable us to observe individual quantized vortices by using tracer particles. The tracer particles can be trapped by vortex filaments (core of quantized vortices) and move with the vortex filaments. Preceding experiments visualized some simple events (e.g., reconnection and Kelvin wave), but the vortex diffusion in quantum turbulence remained unknown. The vortex diffusion could be a new way to understand the physics of quantum turbulence.

In 2021, the cryogenic group of Wei Guo at Florida State University observed the diffusion of quantized vortices in quantum turbulence of superfluid helium-4 [3]. In the experiment, quantum turbulence was generated by thermal counterflow and solidified deuterium particles were used to visualize the motion of vortex filaments. The mean-square displacement $\left\langle \Delta x^2 \right\rangle (t)$ of vortex filaments was analyzed, where Δx denotes the displacement for the diffusion time t. The scaling law is expressed as

$$\left\langle \Delta x^2 \right\rangle \propto t^\gamma \qquad (6)$$

with the scaling exponent γ. The diffusion scaling is classified as the following:

$$\gamma = 1 \quad \text{(normal diffusion)},$$
$$\gamma > 1 \quad \text{(superdiffusion)}.$$

The well-known Brownian motion belongs to normal diffusion because of its random motion. The experiment found that the vortex filaments exhibit the superdiffusion with the exponent $\gamma = 1.6$ at small times. Interestingly, the scaling law transitions to normal diffusion at long times. They argued that this transition of diffusion comes from vortex reconnection, because the reconnection randomizes vortex motion. The scaling exponent were insensitive to the vortex line density and the temperature. Such a universal scaling law could be a new way to understand quantum turbulence. However, the origin of superdiffusion was not clear and the temperature range of the experiment was limited, specifically 1.7-2.0 K.

In such a situation, the cryogenic group of Wei Guo asked us to investigate the diffusion of quantized vortices by using numerical simulation. We performed the simulations of the vortex filament model to investigate the diffusion scaling. To investigate the diffusion in wide temperature range, we planed to perform the simulations of the two cases:

(a) vortex injection at 0 K (pure superfluid),

(b) thermal counterflow above 1 K.

First, we analyzed quantum turbulence at 0 K. In this case, the normal-fluid component vanishes, and the thermal counterflow cannot be induced. Then, we made quantum turbulence by a continuous

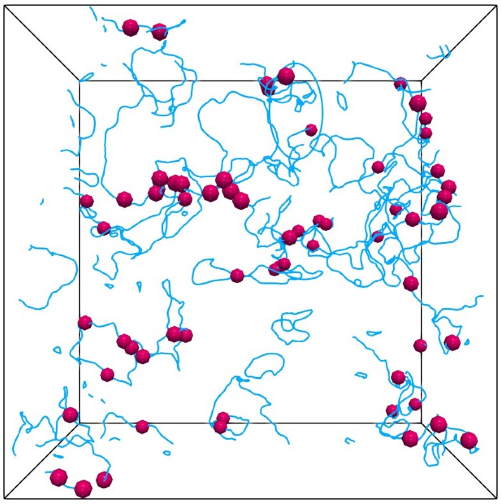


Figure 1: Quantum turbulence obtained by our simulation of the ring injection at 0 K. The blue lines show the vortex filaments and the red spheres show the tracer points.

injection of vortex rings. At 0 K, the motion of vortex filaments is described by the Biot–Savart law:

$$\frac{\mathrm{d}\boldsymbol{s}}{\mathrm{d}t} = \boldsymbol{v}_s(\boldsymbol{s}) = \frac{\kappa}{4\pi}\int_{\mathcal{L}} \frac{(\boldsymbol{s}_1 - \boldsymbol{s}) \times \mathrm{d}\boldsymbol{s}_1}{|\boldsymbol{s}_1 - \boldsymbol{s}|^3}. \tag{7}$$

Here, $\boldsymbol{s}$ denotes the position of vortex filaments, $\boldsymbol{v}_s$ denotes the superfluid velocity, κ denotes the quantum of circulation, and the integral is performed along the all vortex filaments. In these simulations, the tracer particles are injected into the computational box to trace the trajectories of vortex filaments. Figure 1 shows the typical snapshot of quantum turbulence (i.e., tangle of vortex filaments) obtained by our simulation. As a result, our simulations confirmed the superdiffusion scaling law $\langle \Delta x^2 \rangle \propto t^\gamma$ with the exponent $\gamma = 1.6$ at small times. The normal diffusion at large times was also obtained and was related to the reconnection. We further made the theoretical insight on the scaling law by connecting the temporal correlation of the vortex velocity to the diffusion scaling.

Second, we performed the simulation for a thermal counterflow above 1 K. At finite temperatures, the two-fluid components coexist and the mutual friction between them arises. Thus, above 1 K, the vortex motion becomes

$$\frac{\mathrm{d}\boldsymbol{s}}{\mathrm{d}t} = \boldsymbol{v}_s + \alpha \boldsymbol{s}' \times (\boldsymbol{v}_n - \boldsymbol{v}_s) - \alpha' \boldsymbol{s}' \times [\boldsymbol{s}' \times (\boldsymbol{v}_n - \boldsymbol{v}_s)], \tag{8}$$

where α and α' refer to the temperature-dependent parameters for the mutual friction, and $\boldsymbol{v}_n$ denotes the normal-fluid velocity. As a result, we confirmed that the scaling law is almost sustained above 1 K, and the obtained results were consistent with the experiment. Thus, we can conclude that the superdiffusion scaling law is a universal law for quantum turbulence.

Vortex-ring decay [2]. In superfluid helium-4, the two-fluid components coexist. When the vortex filaments move, the mutual friction between the two fluids occurs. The origin of the mutual friction is the scattering between the core of quantized vortex and the thermal excitations. Understanding the mutual friction should be important for fields of various quantum fluids. However, the details of the mutual friction remains unclear and there are various models for the mutual friction. Which model describes real dynamics of quantized vortex? This is a long standing problem in quantum hydrodynamics.

The cryogenic group of Wei Guo and we cooperatively studied a vortex-ring decay to evaluate the models of the mutual friction. The vortex ring propagates due to the self-induced velocity and shrinks due to the mutual friction. This vortex-ring decay is one of the most fundamental dynamics in quantum hydrodynamics. In the experiment, the solidified deuterium particles were injected to visualize the vortex ring. On the other hand, we performed the simulation using the different models. Here, we used the coupled simulation of the quantized vortices and the normal fluid, which has recently been developed [4,5]. We compared the simulation results of the different models with the visualization result. As a result, we found one model agrees well with the visualization results.

References

[1] S. Yui, Y. Tang, W. Guo, H. Kobayashi, and M. Tsubota, "Universal anomalous diffusion of quantized vortices in ultraquantum turbulence", Phys. Rev. Lett. **129**, 025301 (2022).

[2] Y. Tang, W. Guo, H. Kobayashi, S. Yui, M. Tsubota, and T. Kanai, "Imaging quantized vortex rings in superfluid helium to evaluate quantum dissipation", Nature Communications **14**, 2941 (2023).

[3] Y. Tang, S. Bao, and W. Guo, "Superdiffusion of quantized vortices uncovering scaling laws in quantum turbulence", PNAS **118**, e2021957118 (2021).

[4] S. Yui, H. Kobayashi, M. Tsubota, and W. Guo, "Fully coupled two-fluid dynamics in superfluid ^{4}He: Anomalous anisotropic velocity fluctuations in counterflow", Phys. Rev. Lett. **124**, 155301 (2020).

[5] L. Galantucci, A. W. Baggaley, C. F. Barenghi, and G. Krstulovic, "A new self-consistent approach of quantum turbulence in superfluid helium", Eur. Phys. J. Plus **135**, 547 (2020).

5.7 Three-body Fermi-liquid corrections in Kondo systems

Yoshimichi Teratani, Kazuhiko Tsutsumi, and Akira Oguri

Universal low-energy behavior of interacting Fermi systems has been one of the most fascinating properties in condensed matter physics. Landau's Fermi liquid theory [1,2] phenomenologically explains transport properties of electrons in a wide class of metals and normal liquid ^{3}He successfully, and may also be applied to exotic systems such as neutron stars and ultra-cold Fermi gases. It starts with an expansion of the excitation energy δE of many-body eigenstates with respect to the deviation of the momentum distribution function $\delta n_{\boldsymbol{p}\sigma}$ of quasiparticles from its ground-state value:

$$\delta E[n_{\boldsymbol{p}\sigma}] \;=\; \sum_{\boldsymbol{p}\sigma} \varepsilon_{\boldsymbol{p}} \delta n_{\boldsymbol{p}\sigma} + \frac{1}{2} \sum_{\substack{\boldsymbol{p}\sigma \\ \boldsymbol{p}'\sigma'}} f_{\boldsymbol{p}\,\sigma,\boldsymbol{p}'\sigma'}\, \delta n_{\boldsymbol{p}\sigma} \delta n_{\boldsymbol{p}'\sigma'} + \cdots .$$

The expansion coefficients, i.e., the single quasiparticle energy $\varepsilon_{\boldsymbol{p}}$ and the interaction between quasiparticles $f_{\boldsymbol{p}\,\sigma,\boldsymbol{p}'\sigma'}$, can be expressed microscopically in terms of the Green's function and the vertex corrections, defined in the quantum field theory.

In 1970s, Nozières extended the phenomenological Fermi-liquid description to the Kondo systems expanding the scattering phase shift in a way that is analogous to the above equation [3]. Fully microscopic description was also constructed by Yamada and Yosida [4,5], and it has been extended later to out-of-equilibrium quantum dots driven by a bias voltage V [6,7]. The phenomenology and microscopic theories complement each other and explain the universal behavior at temperatures T much lower than the Kondo energy scale T_K. In particular, these theories were successful in a highly symmetric case where the system has both the particle-hole (PH) and time-reversal (TR) symmetries: in this case the quadratic ω^2, T^2 and $(eV)^2$ corrections emerge only through the life time of quasiparticles, with ω the frequency. However, when the PH or TR symmetry is broken by external fields or other potentials, the quadratic corrections emerge also in the energy shifts of quasiparticles which are necessary to describe exactly the next-leading order terms around to the Fermi-liquid fixed point. What is it that determines the energy shifts of the quadratic order? It has been left as an unresolved problem for over forty years.

The answer to this long-standing problem has been given recently in two complemental ways: one along Nozières' description [8–10] and the other along that of Yamada and Yosida using the higer-order Ward identities [11]. It reveals the fact that the quadratic quasiparticle energy shift can be expressed completely in terms of the static two-body $\chi_{\sigma\sigma'}$ and thee-body $\chi^{[3]}_{\sigma_1\sigma_2\sigma_3}$ correlation functions, defined with respect to the equilibrium ground state:

$$\chi_{\sigma\sigma'} \;=\; \lim_{T\to 0} \int_0^{1/T} d\tau \, \langle \delta n_{d\sigma}(\tau)\, \delta n_{d\sigma'} \rangle \,, \qquad\qquad \delta n_{d\sigma} = n_{d\sigma} - \langle n_{d\sigma} \rangle \,,$$

$$\chi^{[3]}_{\sigma_1\sigma_2\sigma_3} = \; - \lim_{T\to 0} \int_0^{1/T} d\tau_3 \int_0^{1/T} d\tau_2 \, \left\langle T_\tau \, \delta n_{d\sigma_3}(\tau_3)\, \delta n_{d\sigma_2}(\tau_2)\, \delta n_{d\sigma_1} \right\rangle \,.$$

Here, $n_{d\sigma}$ is the occupation number of an localized level with spin σ of the Anderson impurity model, and T_τ is the imaginary-time ordering operator. The quasiparticle energy shifts of order ω^2, T^2 and $(eV)^2$ contribute to the next leading-order terms of the transport coefficients, such as the nonlinear conductance, the current noise, and thermal conductivity. We gave a complete microscopic Fermi-liquid description for the low-energy transport, which is asymptotically exact up to the next-leading order and has potential applications [11–15]. We have also carried out calculations of the three-body correlation functions for a wide class of quantum impurity systems, using Wilson's numerical normalization group approach. Recently, the three-body contributions have experimentally been deduced from the nonlinear conductance at finite magnetic fields, and the results show a reasonable agreement with the theory [16].

[1] L. D. Landau, Sov. Phys. JETP **3**, 920 (1957).
[2] A. J. Leggett, Rev. Mod. Phys. **47**, 331 (1975).
[3] P. Nozières, J. Low Temp. Phys. **17**, 31 (1974).
[4] K. Yosida and K. Yamada, Prog. Theor. Phys. **53**, 1286 (1975).
[5] K. Yamada, Prog. Theor. Phys. **54**, 316 (1975).
[6] S. Hershfield, J. H. Davies, and J. W. Wilkins, Phys. RevB **46**, 7046 (1992).
[7] A. Oguri, Phys. Rev. B **64**, 153305 (2001).
[8] C. Mora, P. Vitushinsky, X. Leyronas, A. A. Clerk, and K. Le Hur, Phys. Rev. B **80**, 155322 (2009).
[9] C. Mora, C. P. Moca, J. von Delft, and G. Zaránd, Phys. Rev. B **92**, 075120 (2015).
[10] M. Filippone, C. P. Moca, A. Weichselbaum, J. von Delft, and C. Mora, Phys. Rev. B **98**, 075404 (2018).
[11] A. Oguri and A. C. Hewson, Phys. Rev. Lett. **120**, 126802 (2018).
[12] Y. Teratani, R. Sakano, and A. Oguri, Phys. Rev. Lett. **125**, 216801 (2020).
[13] K. Tsutsumi, Y. Teratani, R. Sakano, and A. Oguri, Phys. Rev. B **104**, 235147 (2021).
[14] A. Oguri, Y. Teratani, K. Tsutsumi, and R. Sakano, Phys. Rev. B **105**, 115409 (2022).
[15] K. Tsutsumi, Y. Teratani, K. Motoyama, R. Sakano, and A. Oguri, Phys. Rev. B **108**, 045109 (2023).
[16] T. Hata, Y. Teratani, T. Arakawa, S. Lee, M. Ferrier, R. Deblock, R. Sakano, A. Oguri, and K. Kobayashi, Nat. Commun. **12**, 3233 (2021).

6 CONFERENCES & WORKSHOPS

6.1 Conferences/Symposia/Workshops organized by NITEP

1. The international workshop Space-time topology behind formation of micro-macro magneto-vortical structure manifested by Nambu mechanics, 28 September - 1 October 2020, Media Center, Osaka Metropolitan University. (co-organized).
2. The international workshop "Elementary Particle Phenomenology Workshop 2020", 26-28 November 2020, Media Center, Osaka Metropolitan University.
3. The international workshop "Randomness, Integrability and Representation Theory in Quantum Field Theory 2021", 22-25 March 2021, Media Center, Osaka Metropolitan University.
4. The international workshop "Helicity and space-time symmetry   a new perspective of classical and quantum systems", 5-8 October 2021, Media Center, Osaka Metropolitan University. (co-organized)
5. The international workshop "Elementary Particle Phenomenology Workshop 2021", 6-8 November 2021, Media Center, Osaka Metropolitan University.
6. The international workshop "East Asia Symposium on Fields and Strings 2021", 22-27 November 2021, Media Center, Osaka Metropolitan University.
7. The international workshop "Particle Physics and Gravitational Waves", 22 February 2022, Media Center, Osaka Metropolitan University.
8. The international workshop "Geometry, Representation Theory and Quantum Field", 22-25 March 2022, Media Center, Osaka Metropolitan University. (co-organized by NITEP and OCAMI)
9. The international workshop "Recent progress in nuclear cluster physics", 19-20 October 2022, Media Center, Osaka Metropolitan University.
10. The international workshop "Elementary Particle Phenomenology Workshop 2022", 16-18 March 2023, Media Center, Osaka Metropolitan University.

6.2 Conferences/Symposia/Workshops supported by NITEP

1. The international workshop "Randomness, Integrability and Representation Theory in Quantum Field Theory 2021", 22-25 March 2021, Media Center, Osaka Metropolitan University. (co-sponsored by NITEP and OCAMI)
2. The international workshop "East Asia Symposium on Fields and Strings 2021", 22-27 November 2021, Media Center, Osaka Metropolitan University.

7 MEETINGS & SEMINARS

7.1 Lectures

1. 5th NITEP Lecture Series: Hideki Ishihara (NITEP), Introduction to Nuclear Reaction Theory. 6 February 2023, 9:45-18:45, Large Seminar Room of Umeda Satellite, Osaka Metropolitan University.

7.2 Seminars

1. dummyr:dummy

7.3 Joint Monthly Meetings of Nuclear Theory Lab. and Ultracold Quantum Gas Lab.

1. 9th Meeting: Kohei Kato, Study of a small number of systems with cooled atoms. (29 May 2020, 13:00-15:00, Zoom).

2. 10th Meeting: Yohei Chiba, α cluster structure in the ground state of atomic nucleus. (30 June 2020, 13:00-15:00, Zoom).

7.4 NITEP Joint Seminar of Mathematical Physics and Particle Physics

1. Nagisa Hiroshima (University of Toyama), Modeling evolution of dark matter substructure and annihilation boost, 1 December 2020, 16:30-, 4th Lecture Room (F205).

2. Takahiro Nishinaka (Osaka City University), Peculiar relations between Argyres-Douglas theories and Lagrangian theories, 13 May 2021, 10:00-, Zoom.

3. Toshifumi Noumi (Kobe University), Swampland conjectures and gravitational positivity, 1 July 2021, 10:00-, Zoom.

4. Nobuchika Okada (University of Alabama), Non-Local extension of the Standard Model, 5 August 2021, 10:00-, Zoom.

5. Tomoki Nosaka (SISSA), M2-branes and discrete Painleve systems, 9 September 2021, 9:00-, Zoom.

6. Teppei Kitahara (Nagoya University), Constructing Massive Scattering Amplitudes for Electroweak Effective Field Theory, 9 October 2021, 10:00-, Zoom.

7. Yutaka Yoshida (University of Tokyo), Monopole bubbling and BPS ’t Hooft operators in three, four, and five dimensions, 12 November 2021, 10:00-, Zoom.

8. Tatsuma Nishioka (Osaka University), CFT duals of three-dimensional de Sitter gravity, 13 June 2022, 9:00-, Zoom.

9. Tomo Takahashi (Saga University) , Probing the early Universe with 21cm line, 22 June 2022, 9:00-, Zoom.

10. Yuta Hamada (KEK) , Swampland conjectures of quantum gravity, 27 June 2022, 9:00-, Zoom.

11. Yoshifumi Nakata (University of Tokyo), Information Paradox of Black Holes and Quantum Information -Quantum Error Correction in Quantum Chaotic Systems-, 4 July 2022, 9:00-, Zoom.

12. Masaki Yamada (Tohoku University), On the origin of matter in the universe and transport equations: Spontaneous/wash-in baryogenesis, 6 July 2022, 9:00-, Zoom.

13. Masaki Yamada (Tohoku University), On the origin of (dark) matter in the universe and non-topological solitons: Affleck-Dine baryogenesis and Q-ball, 13 July 2022, 9:00-, Zoom.

14. Norihiro Iizuka (Osaka University), Black holes and superstring theory, 1 August 2022, 9:00-, Zoom.

15. Masako Iwasaki (Osaka Metropolitan University), Applying machine learning to particle physics experiments, 11 January 2023, 9:00-, Zoom.

7.5 NITEP Colloquium

1. 9th Colloquium: Futoshi Nimato (Japan Atomic Energy Agency), Frontiers and applications of nuclear physics via beta decay. 10 December 2020, 13:20-15:00, Zoom.

2. 10th NITEP Colloquium: Takeshi Mizushima (Osaka University), Thermal spin transport phenomena in topological superconductivity and superfluidity. 14 December 2020, 15:15-16:30, Zoom.

3. 11th NITEP Colloquium: Yu-ichiro Sekiguchi (Toho University), The universe explored by gravitational waves 15 December 2020, 15:30-17:00, Zoom.

4. 12th NITEP Colloquium: Jun Takeda (Yokohama National University), Extreme spatio-temporal spectroscopy with subcycle near-field. 17 December 2020, 16:30-18:00, Zoom.

5. 13th NITEP Colloquium: Atsuhiko Ochi (Kobe University), Particle beam analyzer for energy frontier experiments. 20 January 2021, 16:30-18:00, Zoom.

6. 14th NITEP Colloquium: Daisuke Ida (Gakushuin University), Why there is no black string in four-dimentional space-time. 27 January 2021, 13:20-15:00, Zoom.

7. 15th NITEP Colloquium: Yoshimichi Teratani (Osaka City University), Roles of three-body correlations on nonlinear current and noise through multilevel Anderson impurity. 28 April 2021, 16:00-17:30, Zoom.

8. 16th NITEP Colloquium: Takahiro Nishinaka (Osaka City University), Supersymmetry and mathematical physics. 27 October 2021, 17:10-18:40, the Room for Cultural Exchange of the Media Center.

9. 17th NITEP Colloquium: Yutaka Ohira (Tokyo University), Origin of first cosmic rays and cosmic magnetic fields. 10 November 2021, 16:00-18:00.

10. 18th NITEP Colloquium: Takashi Ino (KEK), Neutron lifetime measurements and neutron fundamental physics research at J-PARC. 14 December 2021, 16:00-17:30, E211 Lecture Room of the Faculty of Science.

11. 19th NITEP Colloquium: Wataru Horiuchi (Osaka Metropolitan Univercity), Study of nuclear structure and reactions using few-body quantum mechanical methods.

    Naoyuki Itagaki (Osaka Metropolitan Univercity), Mixing of different depictions of nuclear structure and the role of non-central forces. 7 July 2022, 10:45-12:25, Zoom.

12. 20th NITEP Colloquium: Ritsuki Inoue (Osaka Prefecture University), Search for solvable potentials by extensions of supersymmetric quantum mechanics.

    Zhanna Kuznetsova (Federal University of ABC (UFABC)) Beyond the tenfold way: 13 associative Z2*Z2-graded superdivision algebras.

    Francesco Toppan (Brazilian Center for Research in Physics (CBPF)) First quantization of braided Majorana fermions. 8 July 2022, 13:00-15:50, A13-306 Meeting Room of the Faculty of Science.

13. 21th NITEP Colloquium: Naoyuki Haba (Osaka Metropolitan Univercity), Exploring new physics beyond the Standard Model. 15 July 2022, 13:15-14:05, Zoom.

14. 22th NITEP Colloquium: Mikio Koyano (JAIST), Electron Transport Phenomena and Thermoelectric Properties of Transition Metal Dicargenides in Microdomains. 30 August 2022, 15:00-16:30, Science hall of A12.

15. 23th NITEP Colloquium: Hajime Nanjo (Osaka University), New particle physics probed by K mesons. 27 September 2022, 16:30-17:30, E108 Meeting Room of the Faculty of Science.

16. 24th NITEP Colloquium: Tetsuya Shiromizu (Nagoya University), The power and attractiveness of the positive energy theorem of space-time. 18 October 2022, 16:30-17:30, E211 Lecture Room of the Faculty of Science.

17. 25th NITEP Colloquium: Toshihiro Fujii (Osaka Metropolitan University), Toward the development of cosmic ray science. Hirotaka Yoshino (Osaka Metropolitan University), On the physics of gravitational fields. 31 October 2022, 16:45-18:25, Zoom.

18. 26th NITEP Colloquium: Ken-Ichiro Imura (Institute of Industrial Science, the University of Tokyo), Physics of non-hermitian quantum systems. 15 November 2022, 16:00-17:30, E211 Lecture Room of the Faculty of Science.

19. 27th NITEP Colloquium: Takeshi FUkuhara (RIKEN), Condensed matter research with quantum gas microscopy. 6 December 2022, 16:30-18:00, E108 Meeting Room of the Faculty of Science.

20. 28th NITEP Colloquium: Yoshiharu Kawamura (Shinshu University), On the mystery of generation in the standard model 7 December 2022, 15:00-16:30, E101 Lecture Room of the Faculty of Science.

21. 29th NITEP Colloquium: Saoshi Iso (KEK), Relativistic quantum observation problem and decoherence associated with particle generation 23 December 2022, 15:00-16:30, Science hall of A12.

22. 30th NITEP Colloquium: Shin-ichiro Iwai (Tohoku University), Strongly correlated attosecond electron dynamics pioneered by single-cycle 6 fs optical strong electric field 7 February 2023, 16:45-18:15, Science hall of A12.

7.6 Public Symposium

1. Special Seminar for Citizens 2022 “Physics in the 21st Century” was held on November 12, with three lectures by NITEP members Katsuichi Kanemoto, Nobuhito Maru, and Kazuyuki Muraoka. 12 November 2022, 15:00-17:40, the large lecture theater of Tanaka Memorial Hall, Osaka Metropolitan University.

8 PUBLICATIONS

8.1 Books

1. Sanefumi Moriyama, "M-Theory and the Matrix Model – SGC Library 158," SAIENSU-SHA Co., Ltd (2020), ISBN 4781914764

2. Nagisa Hiroshima (Chap.4), "Reading the World through the Window of Mathematics" Tetsuo Hatsuda et al. (eds.), Iwanami Shoten, Publishers (2021), ISBN 9784005009435

8.2 Research Papers

1. Yoshiko Kanada-En'yo, Yuki Shikata, Yohei Chiba, Kazuyuki Ogata, "Neutron dominance in excited states of ^{26}Mg and ^{10}Be probed by proton and α inelastic scattering," Phys. Rev. C **102**, 014607 [17 pages] (2020) `https://doi.org/10.1103/PhysRevC.102.014607`

2. Yoshiko Kanada-En'yo, Kazuyuki Ogata, "Microscopic calculation of proton and alpha-particle inelastic scattering to study the excited states of ^{6}He and ^{8}He," arXiv:2004.14597 [nucl-th]

3. Sosuke Inui, Makoto Tsubota, "Spherically symmetric formation of localized vortex tangle around a heat source in superfluid ^{4}He," Phys. Rev. B **101**, 214511 [8 pages] (2020) `https://doi.org/10.1103/PhysRevB.101.214511`

4. Nguyen Tri Toan Phuc, Mengjiao Lyu, Yohei Chiba, Kazuyuki Ogata, "Manifestation of the divergence between antisymmetrized-molecular-dynamics and container pictures of ^{9}Be via ^{9}Be$(p, pn)^{8}$Be knockout reaction," Phys. Lett. B **819**, 136466 [6 pages] (2021) `https://doi.org/10.1016/j.physletb.2021.136466`

5. Jagjit Singh, Takuma Matsumoto, Kazuyuki Ogata, "Systematic study on the role of various higher-order processes in the breakup of weakly-bound projectiles," PTEP **2021**, 073D01 [15 pages] (2021) `https://doi.org/10.1093/ptep/ptab055`

6. Sacha Davidson, Yoshitaka Kuno, Yuichi Uesaka, Masato Yamanaka, "Probing $\mu e\gamma\gamma$ contact interactions with $\mu \to e$ conversion," Phys. Rev. D **102**, 115043 [12 pages] (2020) `https://doi.org/10.1103/PhysRevD.102.115043`

7. Sanefumi Moriyama, "Spectral theories and topological strings on del Pezzo geometries," JHEP **2020**, 154 [55 pages] (2020) `https://doi.org/10.1007/JHEP10(2020)154`

8. Yoshiki Chazono, Kenichi Yoshida, Kazuki Yoshida, Kazuyuki Ogata, "Proton-induced deuteron knockout reaction as a probe of an isoscalar proton-neutron pair in nuclei," Phys. Rev. C **103**, 24609 [7 pages] (2021) `https://doi.org/10.1103/PhysRevC.103.024609`

9. R. U. Abbasi, et al. (Telescope Array Collaboration), including S. Ogio and Y. Tsunesada, "Search for point sources of ultra-high-energy photons with the Telescope Array surface detector," Monthly Notices of the Royal Astronomical Society **492**, Issue 3, 3984–3993 (2020) `http://dx.doi.org/10.1093/mnras/stz3618`

10. R. U. Abbasi, et al. (Telescope Array Collaboration), including S. Ogio and Y. Tsunesada, "Search for Ultra-High-Energy Neutrinos with the Telescope Array Surface Detector," JETP **158**, 8(2) (2020) `http://dx.doi.org/10.31857/S0044451020080052`

11. R. U. Abbasi, et al. (Telescope Array Collaboration), including S. Ogio and Y. Tsunesada, "Search for Large-scale Anisotropy on Arrival Directions of Ultra-high-energy Cosmic Rays Observed with the Telescope Array Experiment," The Astrophysical Journal Letters **898**, L28 (2020) http://dx.doi.org/10.3847/2041-8213/aba0bc

12. Shin Watanabe, Kazuyuki Ogata, Takuma Matsumoto, "Practical method for decomposing discretized breakup cross sections into components of each channel," Phys. Rev. C **103**, L031601 [6 pages] (2021) https://doi.org/10.1103/PhysRevC.103.L031601

13. Yoshiko Kanada-En'yo, Kazuyuki Ogata, "Probing negative-parity states of ^{24}Mg probed with proton and α inelastic scattering," Phys. Rev. C **103**, 24603 [14 pages] (2021) https://doi.org/10.1103/PhysRevC.103.024603

14. Yoshiko Kanada-En'yo, Kazuyuki Ogata, "Microscopic coupled-channel calculation of proton and alpha inelastic scattering to the 4_1^+ and 4_2^+ states of ^{24}Mg," PTEP **2021**, 043D01 [16 pages] (2021) https://doi.org/10.1093/ptep/ptab029

15. Tomohiro Furukawa, Keiichi Ishibashi, H. Itoyama, Satoshi Kambayashi, "Static force potential of a non-abelian gauge theory at a finite box in Coulomb gauge," Phys. Rev. D **103**, 056003 [10 pages] (2021) https://doi.org/10.1103/PhysRevD.103.056003

16. Sosuke Inui, Tomo Nakagawa, Makoto Tsubota, "Bathtub vortex in superfluid ^{4}He," Phys. Rev. B **102**, 224511 [8 pages] (2020) https://doi.org/10.1103/PhysRevB.102.224511

17. Tomohiro Furukawa, Sanefumi Moriyama, Tomoki Nakanishi, "Brane transitions from exceptional groups," Nucl. Phys. B **969**, 115477 [27 pages] (2021) https://doi.org/10.1016/j.nuclphysb.2021.115477

18. Hideki Ishihara, Satsuki Matsuno, "Solutions to the Einstein-Maxwell-Current System with Sasakian maifolds," arXiv:2012.02432v1 [gr-qc]

19. Takuya Hirose, Nobuhito Maru, "Cancellation of one-loop corrections to scalar masses in flux compactification with higher dimensional operators," J. Phys. G: Nucl. Part. Phys. **48**, 055005 (2021) https://doi.org/10.1088/1361-6471/abddce

20. Nobuhito Maru, Akira Okawa, "Non-Gaussianity from X, Y gauge bosons in Cosmological Collider Physics," arXiv:2101.10634v1 [hep-ph]

21. Kasumi Okazaki, Junsik Han, Makoto Tsubota, "Faraday waves in Bose–Einstein condensate: From instability to nonlinear dynamics," arXiv:2012.02391v1 [cond-mat.quant-gas]

22. Yasutaka Taniguchi, Kazuki Yoshida, Yohei Chiba, Yoshiko Kanada-En'yo, Masaaki Kimura, Kazuyuki Ogata, "Unexpectedly enhanced α-particle preformation in ^{48}Ti probed by the $(p, p\alpha)$ reaction," Phys. Rev. C **103**, L031305 [5 pages] (2021) https://doi.org/10.1103/PhysRevC.103.L031305

23. H. Itoyama, Sota Nakajima, "Marginal deformations of heterotic interpolating models and exponential suppression of the cosmological constant," Phys. Lett. B **816**, 136195 [7 pages] (2021) https://doi.org/10.1016/j.physletb.2021.136195

24. Yuichiro Kiyo, Michihisa Takeuchi, Yuichi Uesaka, Masato Yamanaka, "Charged lepton flavor violation associated with heavy quark production in deep inelastic lepton-nucleon scattering via scalar exchange," JHEP **2022**, 044 [38 pages] (2022) https://doi.org/10.1007/JHEP04(2022)044

25. Kazuyuki Ogata, Tokuro Fukui, Yuki Kamiya, Akira Ohnishi, “Effect of deuteron breakup on the deuteron-Ξ correlation function,” Phys. Rev. C **103**, 065205 [12 pages] (2021) `https://doi.org/10.1103/PhysRevC.103.065205`

26. Hiroshi Itoyama, Katsuya Yano, “Theory space of one unitary matrix model and its critical behavior associated with Argyres-Douglas theory,” Int. J. Mod. Phys. A **36**, 2150227.0 (2021) `https://doi.org/10.1142/S0217751X21502274`

27. Jagjit Singh, Takuma Matsumoto, Tokuro Fukui, Kazuyuki Ogata, “Three-body description of ^{9}C: Role of low-lying resonances in breakup reactions,” Phys. Rev. C **104**, 034612 [7 pages] (2021) `https://doi.org/10.1103/PhysRevC.104.034612`

28. N. Teshima, M. Aoki, Y. Higashino, H. Ikeuchi, K. Komukai, D. Nagao, Y. Nakatsugawa, H. Natori, Y. Seiya, N. M. Truong, K. Yamamoto, “Development of a multiwire proportional chamber with good tolerance to burst hits,” Nucl. Instrum. Meth. A **999**, 165228 [9 pages] (2021) `https://doi.org/10.1016/j.nima.2021.165228`

29. Hideki Ishihara, Tatsuya Ogawa, “A variety of nontopological solitons in a spontaneously broken U(1) gauge theory: Dust balls, shell balls, and potential balls,” Phys. Rev. D **103**, 123029 [12 pages] (2021) `https://doi.org/10.1103/PhysRevD.103.123029`

30. Shoya Ogawa, Takuma Matsumoto, Yoshiko Kanada-En’yo, Kazuyuki Ogata, “Investigation of multistep effects for proton inelastic scattering to the 2_1^+ state in ^{6}He,” Phys. Rev. C **104**, 044608 [7 pages] (2021) `https://doi.org/10.1103/PhysRevC.104.044608`

31. Takuya Hirose, Nobuhito Maru, “Nonvanishing finite scalar mass in flux compactification,” JHEP **2021**, 159 [18 pages] (2021) `https://doi.org/10.1007/JHEP06(2021)159`

32. Sanefumi Moriyama, Yasuhiko Yamada, “Quantum Representation of Affine Weyl Groups and Associated Quantum Curves,” SIGMA **17**, 075 [24 pages] (2021) `https://doi.org/10.3842/SIGMA.2021.076`

33. Junsik Han, Makoto Tsubota, “Annihilation and recurrence of vortex-antivortex pairs in two-component Bose-Einstein condensates,” Phys. Rev. A **103**, 053313 [8 pages] (2021) `https://doi.org/10.1103/PhysRevA.103.053313`

34. H. Itoyama, Yuichi Koga, Sota Nakajima, “Gauge Symmetry Enhancement by Wilson Lines in Twisted Compactification,” arXiv:2106.10629v1 [hep-th]

35. Satoshi Yui, Hiromichi Kobayashi, Makoto Tsubota, Rio Yokota, “Quantum Turbulence Coupled with Externally Driven Normal-Fluid Turbulence in Superfluid ^{4}He,” arXiv:2105.09499v1 [cond-mat.supr-con]

36. Takuya Hirose, Nobuhito Maru, “Extranatural flux inflation,” JHEP **2021**, 124 [16 pages] (2021) `https://doi.org/10.1007/JHEP09(2021)124`

37. The T2K Collaboration (including Y. Seiya, N. Teshima and K. Yamamoto), “First combined measurement of the muon neutrino and antineutrino charged-current cross section without pions in the final state at T2K,” Phys. Rev. D **101**, 112001 [44 pages] (2020) `http://dx.doi.org/10.1103/PhysRevD.101.112001`

38. The T2K Collaboration (including Y. Seiya, N. Teshima and K. Yamamoto), “Measurement of the charged-current electron (anti-)neutrino inclusive cross-sections at the T2K off-axis near detector ND280,” JHEP **2020**, 114 [42 pages] (2020) `http://dx.doi.org/10.1007/JHEP10(2020)114`

39. The T2K Collaboration (including Y. Seiya, N. Teshima and K. Yamamoto), "Simultaneous measurement of the muon neutrino charged-current cross section on oxygen and carbon without pions in the final state at T2K," Phys. Rev. D **101**, 112004 [32 pages] (2020) http://dx.doi.org/10.1103/PhysRevD.101.112004

40. The T2K Collaboration (including Y. Seiya, N. Teshima and K. Yamamoto), "Measurements of $\bar{\nu}_\mu$ and $\bar{\nu}_\mu + \nu_\mu$ charged-current cross-sections without detected pions nor protons on water and hydrocarbon at mean antineutrino energy of 0.86 GeV," PTEP **2021**, 043C01 [28 pages] (2021) http://dx.doi.org/10.1093/ptep/ptab014

41. The T2K Collaboration (including Y. Seiya, N. Teshima and K. Yamamoto), "T2K measurements of muon neutrino and antineutrino disappearance using 3.13×10^{21} protons on target," Phys. Rev. D **103**, L011101 [9 pages] (2021) http://dx.doi.org/10.1103/PhysRevD.103.L011101

42. The T2K Collaboration (including Y. Seiya, N. Teshima and K. Yamamoto), "Improved constraints on neutrino mixing from the T2K experiment with 3.13×10^{21} protons on target," Phys. Rev. D **103**, 112008 [59 pages] (2021) https://doi.org/10.1103/PhysRevD.103.112008

43. Hyper-Kamiokande Collaboration (including Y. Seiya and K. Yamamoto), "Supernova Model Discrimination with Hyper-Kamiokande," Astrophys. J. **916**, 15.0 (2021) https://doi.org/10.3847/1538-4357/abf7c4

44. The T2K Collaboration (including Y. Seiya, N. Teshima and K. Yamamoto), "First T2K measurement of transverse kinematic imbalance in the muon-neutrino charged-current single-π^+ production channel containing at least one proton," Phys. Rev. D **103**, 112009 [27 pages] (2021) https://doi.org/10.1103/PhysRevD.103.112009

45. Yuki Adachi, C. S. Lim, Nobuhito Maru, "The strong CP problem and higher-dimensional gauge theories," PTEP **2022**, 053B06 [15 pages] (2022) https://doi.org/10.1093/ptep/ptac070

46. Kazumasa Okabayashi, Tomohiro Harada, Ken-ichi Nakao, "Robustness of particle creation in the formation of a compact object," PTEP **2022**, 023E02 [18 pages] (2022) https://doi.org/10.1093/ptep/ptac006

47. Yosuke Minowa, Shota Aoyagi, Sosuke Inui, Tomo Nakagawa, Gamu Asaka, Makoto Tsubota, Masaaki Ashida, "Visualisation of quantised vortex reconnection enabled by laser ablation," Sci. Adv. **8**, eabn1143 [6 pages] (2022) https://doi.org/10.1126/sciadv.abn1143

48. Tomo Nakagawa, Sosuke Inui, Makoto Tsubota, "Internal structure of localized quantized vortex tangles," Phys. Rev. B **104**, 094510 [6 pages] (2021) https://doi.org/10.1103/PhysRevB.104.094510

49. Sosuke Inui, Makoto Tsubota, "Coupled dynamics of quantized vortices and normal fluid in superfluid ^{4}He based on the lattice Boltzmann method," Phys. Rev. B **104**, 214503 [10 pages] (2021) https://doi.org/10.1103/PhysRevB.104.214503

50. Y. Kamiya, K. Sasaki, T. Fukui, T. Hyodo, K. Morita, K. Ogata, A. Ohnishi, T. Hatsuda, "Femtoscopic study of coupled-channels $N\Xi$ and $\Lambda\Lambda$ interactions," Phys. Rev. C **105**, 014915 [13 pages] (2022) https://doi.org/10.1103/PhysRevC.105.014915

51. H. Itoyama, A. Mironov, A. Morozov, R. Yoshioka, "Review on the Operator/Feynman diagram/Dessins d'enfant Correspondence in Tensor Model," Int. J. Mod. Phys. A **37**, 2130019.0 (2022) https://doi.org/10.1142/S0217751X21300192

52. Nguyen Tri Toan Phuc, Kazuyuki Ogata, Nguyen Hoang Phuc, B. D. Linh, Vo Hong Hai, Le Xuan Chung, "Ambiguities from nuclear interactions in the ^{12}C(p,2p)^{11}B reaction," Commun. in Phys. **32**, 2 [16 pages] (2022) https://doi.org/10.15625/0868-3166/16496

53. K. Yoshida, M. C. Atkinson, K. Ogata, W. H. Dickhoff, "First application of dispersive optical model to (p,2p) reaction analysis within the distorted-wave impulse approximation framework," Phys. Rev. C **105**, 014622 [7 pages] (2022) https://doi.org/10.1103/PhysRevC.105.014622

54. Hideki Ishihara, Satsuki Matsuno, "Godel-type Solutions in Einstein-Maxwell-Scalar Field Theories," arXiv:2109.11740v1 [hep-th]

55. H. Itoyama, Yuichi Koga, Sota Nakajima, "Target space duality of non-supersymmetric string theory," Nucl. Phys. B **975**, 115667 [25 pages] (2022) https://doi.org/10.1016/j.nuclphysb.2022.115667

56. Kazuhiko Tsutsumi, Yoshimichi Teratani, Rui Sakano, Akira Oguri, "Nonlinear Fermi liquid transport through a quantum dot in asymmetric tunnel junctions," Phys. Rev. B **104**, 235147 [17 pages] (2021) https://doi.org/10.1103/PhysRevB.104.235147

57. Masashi Tokuda, Yunori Nishikawa, "Kondo effect in Lieb's minimal ferrimagnetic system on the T-shaped bipartite lattice," Phys. Rev. B **105**, 195120 [7 pages] (2022) https://doi.org/10.1103/PhysRevB.105.195120

58. Akira Oguri, Yoshimichi Teratani, Kazuhiko Tsutsumi, Rui Sakano, "Current noise and Keldysh vertex function of an Anderson impurity in the Fermi-liquid regime," Phys. Rev. B **105**, 115409 [37 pages] (2022) https://doi.org/10.1103/PhysRevB.105.115409

59. Hideki Ishihara, Satsuki Matsuno, "Inhomogeneous generalization of Einstein's static universe with Sasakian space," PTEP **2022**, 023E01 [9 pages] (2022) https://doi.org/10.1093/ptep/ptac013

60. Matthew Buican, Hongliang Jiang, Takahiro Nishinaka, "Spin Thresholds, RG Flows, and Minimality in 4D $\mathcal{N} = 2$ QFT," Phys. Rev. D **105**, 085021 [18 pages] (2022) https://doi.org/10.1103/PhysRevD.105.0850211

61. Tomohiro Furukawa, Kazunobu Matsumura, Sanefumi Moriyama, Tomoki Nakanishi, "Duality cascades and affine Weyl groups," JHEP **2022**, 132 [43 pages] (2022) https://doi.org/10.1007/JHEP05(2022)132

62. K. Hagino, K. Ogata, A. M. Moro, "Coupled-channels calculations for nuclear reactions: From exotic nuclei to superheavy elements," Progress in Particle and Nuclear Physics **125**, 103951 [62 pages] (2022) https://doi.org/10.1016/j.ppnp.2022.103951

63. Tomoatsu Edagawa, Kazuki Yoshida, Yoshiki Chazono, Kazuyuki Ogata, "Effective polarization in proton-induced α knockout reactions," Phys. Rev. C **107**, 054603 [7 pages] (2023) https://doi.org/10.1103/PhysRevC.107.054603

64. Chikako Ishizuka, Hiroki Takemoto, Yohei Chiba, Akira Ono, Naoyuki Itagaki, "Role of tensor interaction as salvation of cluster structure in ^{44}Ti," Phys. Rev. C **105**, 064314 [6 pages] (2022) https://doi.org/10.1103/PhysRevC.105.064314

65. Joe Sato, Kohei Sugawara, Yuichi Uesaka, Masato Yamanaka, "Determination of coupling patterns by parallel searches for $\mu^- \to e^+$ and $\mu^- \to e^-$ in muonic atoms," Phys. Lett. B **836**, 137617 [10 pages] (2023) https://doi.org/10.1016/j.physletb.2022.137617

66. Yota Endo, Hideki Ishihara, Tatsuya Ogawa, "Relativistic nontopological soliton stars in a U(1) gauge Higgs model," Phys. Rev. D **105**, 104041 [11 pages] (2022) https://doi.org/10.1103/PhysRevD.105.104041

67. Ken-ichi Nakao, Kazumasa Okabayashi, Tomohiro Harada, "Radiative gravastar with Gibbons-Hawking temperature Gibbons-Hawking temperature," Phys. Rev. D **106**, 105006 [17 pages] (2022) https://doi.org/10.1103/PhysRevD.106.105006

68. Yuki Adachi, C. S. Lim, Nobuhito Maru, "On the vacuum structure of gauge-Higgs unification models," PTEP **2022**, 093B04 [9 pages] (2022) https://doi.org/10.1093/ptep/ptac107

69. Nobuhito Maru, Haruki Takahashi, Yoshiki Yatagai, "Fermion Mass Hierarchy and Mixing in simplified Grand Gauge-Higgs Unification," arXiv:2205.05824v1 [hep-ph]

70. Tomohiro Furukawa, Sanefumi Moriyama, Hikaru Sasaki, "Duality cascades and parallelotopes," J. Phys. A: Math. Theor. **56**, 165401.0 (2023) https://doi.org/10.1088/1751-8121/acc2fb

71. Kento Akamatsu, Takuya Hirose, Nobuhito Maru, "Gauge symmetry breaking in flux compactification with a Wilson-line scalar condensate," Phys. Rev. D **106**, 035035 [17 pages] (2022) https://doi.org/10.1103/PhysRevD.106.035035

72. Nobuhito Maru, Akira Okawa, "Cosmological Collider Signals of Non-Gaussianity from Higgs boson in GUT," arXiv:2206.06651v1 [hep-ph]

73. Katsuhito Makiguchi, Wataru Horiuchi, "Incomplete absorption reactions at high energy," PTEP **2022**, 073D01 [10 pages] (2022) https://doi.org/10.1093/ptep/ptac089

74. Takuya Kimura, Takahiro Nishinaka, "On the Nekrasov partition function of gauged Argyres-Douglas theories," JHEP **2023**, 030 [32 pages] (2023) https://doi.org/10.1007/JHEP01(2023)030

75. Nobuhito Maru, Haruki Takahashi, Yoshiki Yatagai, "Gauge coupling unification in simplified grand gauge-Higgs unification," Phys. Rev. D **106**, 055033 [8 pages] (2022) https://doi.org/10.1103/PhysRevD.106.055033

76. Hiroyuki Tajima, Hajime Moriya, Wataru Horiuchi, Kei Iida, Eiji Nakano, "Resonance-to-bound transition of ^{5}He in neutron matter and its analogy with heteronuclear Feshbach molecules," Phys. Rev. C **106**, 045807 [7 pages] (2022) https://doi.org/10.1103/PhysRevC.106.045807

77. Daisuke Kadoh, Nobuhito Maru, Mitsuyo Suzuki, Naoya Ukita, "Perturbative calculation of supersymmetric gradient flow in $\mathcal{N} = 1$ supersymmetric QCD," PTEP **2023**, 013B02 [25 pages] (2023) https://doi.org/10.1093/ptep/ptac165

78. Hiroshi Itoyama, Takeshi Oota, Reiji Yoshioka, "Construction of irregular conformal/W block and flavor mass relations of $\mathcal{N} = 2$ SUSY gauge theory from the A_{n-1} quiver matrix model," Phys. Lett. B **841**, 137938 [10 pages] (2023) https://doi.org/10.1016/j.physletb.2023.137938

79. Hiroshi Itoyama, Takeshi Oota, Reiji Yoshioka, "A-D hypersurface of $su(n)$ $\mathcal{N} = 2$ supersymmetric gauge theory with $N_f = 2n-2$ flavors," Int. J. Mod. Phys. A **38**, 2350017 [6 pages] (2023) https://doi.org/10.1142/S0217751X23500173

80. Parth Bambhaniya, Ashok B. Joshi, Dipanjan Dey, Pankaj S. Joshi, Arindam Mazumdar, Tomohiro Harada, Ken-ichi Nakao, "Relativistic orbits of S2 star in the presence of scalar field," arXiv:2209.12610v2 [gr-qc]

81. W. Horiuchi, N. Itagaki, “Density profiles near nuclear surface of ^{44,52}Ti: An indication of α clustering,” Phys. Rev. C **106**, 044330 [8 pages] (2022) https://doi.org/10.1103/PhysRevC.106.044330

82. Tomoki Nakanishi, Takahiro Nishinaka, “S^1 Reduction of 4D $\mathcal{N} = 3$ SCFTs and Squashing Independence of ABJM Theories,” JHEP **2023**, 255 [20 pages] (2023) https://doi.org/10.1007/JHEP03(2023)255

83. Yuki Adachi, C. S. Lim, Nobuhito Maru, “Analytic construction of sphaleron-like solution invoking higher dimensional gauge theory,” arXiv:2211.12696v1 [hep-th]

84. Ken-ichi Nakao, Kazumasa Okabayashi, Tomohiro Harada, “Radiative gravastar with thermal spectrum; Sudden vacuum condensation without gravitational collapse,” Phys. Rev. D **107**, 084036 [11 pages] (2023) https://doi.org/10.1103/PhysRevD.107.084036

85. R. Takatsu, Y. Suzuki, W. Horiuchi, M. Kimura, “Microscopic study of the deformed neutron halo of ^{31}Ne,” Phys. Rev. C **107**, 024314 [7 pages] (2023) https://doi.org/10.1103/PhysRevC.107.024314

86. Naoyuki Itagaki, Emiko Hiyama, “Cluster-shell competition and effect of adding hyperons,” Phys. Rev. C **107**, 024309 [7 pages] (2023) https://doi.org/10.1103/PhysRevC.107.024309

87. Tatsuya Ogawa, Hideki Ishihara, “Solitonic Gravastars in a U(1) gauge Higgs model,” Phys. Rev. D **107**, L121501 [5 pages] (2023) https://doi.org/10.1103/PhysRevD.107.L121501

88. Hiroshi Kozaki, Tatsuhiko Koike, Yoshiyuki Morisawa, Hideki Ishihara, “Nambu-Goto Strings with a null symmetry and contact structure,” arXiv:2303.17969v1 [gr-qc]

89. W. Horiuchi, N. Itagaki, “Imprints of α clustering in the density profiles of ^{12}C and ^{16}O,” Phys. Rev. C **107**, L021304 [5 pages] (2023) https://doi.org/10.1103/PhysRevC.107.L021304

90. T. Furumoto, T. Suhara, N. Itagaki, “Systematic study for relation between nuclear structure and reaction in ^{10}Be nucleus,” PTEP **2023**, 063D02 [17 pages] (None) https://doi.org/10.1093/ptep/ptad070

91. H. Moriya, W. Horiuchi, J. Casal, L. Fortunato, “Three-α configurations of the second $J^\pi = 2^+$ state in ^{12}C,” Eur. Phys. J. A **59**, 37 [7 pages] (2023) https://doi.org/10.1140/epja/s10050-023-00947-3

92. V. Choudhary, M. Dan, R. Chatterjee, M. Kimura, W. Horiuchi, Shubhchintak, G. Singh, “The ^{19}N$(n,\gamma)^{20}$N capture rate in light of the probable bubble nature of ^{20}N,” arXiv:2302.06986v1 [nucl-th]

93. W. Horiuchi, T. Sato, Y. Uesaka, K. Yoshida, “Electron wave functions in beta-decay formulas revisited (II): Completion including recoil-order and induced currents,” arXiv:2303.08332v1 [nucl-th]

94. Kensuke Sueto, Hirotaka Yoshino, “Evaporation of a nonsingular Reissner-Nordström black hole and information loss problem,” arXiv:2301.10456v1 [gr-qc]

95. Junsik Han, Kenichi Kasamatsu, Makoto Tsubota, “Dynamics of Two Quantized Vortices Belonging to Different Components of Binary Bose–Einstein Condensates in a Circular Box Potential,” J. Phys. Soc. Jpn. **91**, 024401 [10 pages] (2022) https://doi.org/10.7566/JPSJ.91.024401

96. Satoshi Yui, Yuan Tang, Wei Guo, Hiromichi Kobayashi, Makoto Tsubota, “Universal Anomalous Diffusion of Quantized Vortices in Ultraquantum Turbulence,” Phys. Rev. Lett. **129**, 025301 [6 pages] (2022) `https://doi.org/10.1103/PhysRevLett.129.025301`

97. Yosuke Minowa, Shota Aoyagi, Sosuke Inui, Tomo Nakagawa, Gamu Asaka, Makoto Tsubota, Masaaki Ashida, “Visualisation of quantised vortex reconnection as enabled by laser ablation,” Sci. Adv. **8**, eabn1143 [6 pages] (2022) `https://doi.org/10.1126/sciadv.abn1143`

98. S. Sahar S. Hejazi, Juan Polo, Makoto Tsubota, “Formation of local and global currents in a toroidal Bose-Einstein condensate via an inhomogeneous artificial gauge field ,” Phys. Rev. A **105**, 053307 [10 pages] (2022) `https://doi.org/10.1103/PhysRevA.105.053307`

99. Yuto Sano, Nir Navon, Makoto Tsubota, “Emergent isotropy of a wave-turbulent cascade in the Gross-Pitaevskii model,” EPL **140**, 66002 [7 pages] (2022) `https://doi.org/10.1209/0295-5075/aca92e`

100. Wei-Can Yang, Chuan-Yin Xia, Hua-Bi Zeng, Makoto Tsubota, Jan Zaanen, “Motion of a superfluid vortex according to holographic quantum dissipation,” Phys. Rev. B **107**, 144511 [19 pages] (2023) `https://doi.org/10.1103/PhysRevB.107.144511`

101. Nobuhito Maru, Hiroki Tanaka, “Wilson-line Scalar Mass in Flux Compactification on an Orbifold T^2/Z_2,” arXiv:2303.01747v1 [hep-th]

102. Makoto Tsubota, “Studies on Quantum Turbulence with Vinen,” J. Low Temp. Phys. None, [9 pages] (2023) `https://doi.org/10.1007/s10909-023-02951-9`

103. Takuya Hirose, Hiroto Shibuya, “Relation between higher-dimensional gauge theories and gravitational waves from first-order phase transitions,” arXiv:2303.14192v1 [hep-ph]

104. R. Abbott et al. (The LIGO Scientific Collaboration, the Virgo Collaboration, and the KAGRA Collaboration), “Search for intermediate-mass black hole binaries in the third observing run of Advanced LIGO and Advanced Virgo”, Astron. Astrophys 659, A84 (2022),
https://doi.org/10.1051/0004-6361/202141452

105. R. Abbott et al. (LIGO Scientific Collaboration, Virgo Collaboration, and KAGRA Collaboration),
“Search for continuous gravitational waves from 20 accreting millisecond x-ray pulsars in O3 LIGO data”, Phys. Rev. D 105, 022002 – Published 19 January 2022,
DOI:https://doi.org/10.1103/PhysRevD.105.022002

106. R. Abbott et al. (The LIGO Scientific Collaboration, the Virgo Collaboration, and the KAGRA Collaboration), “Constraints on dark photon dark matter using data from LIGO’s and Virgo’s third observing run”,
Phys. Rev. D 105, 063030, (2022), https://doi.org/10.1103/PhysRevD.105.063030

107. R. Abbott et al. (The LIGO Scientific Collaboration, the Virgo Collaboration, and the KAGRA Collaboration), “All-sky search for short gravitational-wave bursts in the third Advanced LIGO and Advanced Virgo run”, Phys. Rev. D 104, 12200, (2021), https://doi.org/10.1103/PhysRevD.104.122004

108. R. Abbott et al. (The LIGO Scientific Collaboration, the Virgo Collaboration, and the KAGRA Collaboration), “Constraints from LIGO O3 Data on Gravitational-wave Emission Due to R-modes in the Glitching Pulsar PSR J0537-6910”, ApJ 922 71 , (2021),
https://doi.org/10.3847/1538-4357/ac0d52

109. R. Abbott et al. (The LIGO Scientific Collaboration, the Virgo Collaboration, and the KAGRA Collaboration), “Searches for Continuous Gravitational Waves from Young Supernova Remnants in the Early Third Observing Run of Advanced LIGO and Virgo”, ApJ 921 80, (2021), https://doi.org/10.3847/1538-4357/ac17ea

110. R. Abbott et al. (The LIGO Scientific Collaboration, the Virgo Collaboration, and the KAGRA Collaboration), “All-sky search for long-duration gravitational-wave bursts in the third Advanced LIGO and Advanced Virgo run”, Phys. Rev. D 104, 102001, (2021), https://doi.org/10.1103/PhysRevD.104.102001

111. M. Takeda, Y. Hiranuma, N. Kanda, K. Kotake, T. Kuroda, R. Negishi, K. Oohara, K. Sakai, Y. Sakai, T. Sawada, H. Takahashi, S. Tsuchida, Y. Watanabe, and T. Yokozawa, “Application of the Hilbert-Huang transform for analyzing standing-accretion-shock-instability induced gravitational waves in a core-collapse supernova”, Phys. Rev. D 104, 084063, https://doi.org/10.1103/PhysRevD.104.084063

112. KAGRA and VIRGO and LIGO Scientific Collaborations, R. Abbott et al. (Jul 1, 2021), “All-sky search for continuous gravitational waves from isolated neutron stars in the early O3 LIGO data”, Published in: Phys.Rev.D 104 (2021) 8, 082004, https://doi.org/10.1103/PhysRevD.104.082004

113. LIGO Scientific and KAGRA and VIRGO Collaborations, R. Abbott et al. (Jun 29, 2021), “Observation of Gravitational Waves from Two Neutron Star-Black Hole Coalescences”, Published in: Astrophys.J.Lett. 915 (2021) 1, L5, https://doi.org/10.3847/2041-8213/ac082e

114. KAGRA Collaboration, T. Akutsu(Natl. Astron. Observ. of Japan) et al. (Apr 19, 2021), “Radiative Cooling of the Thermally Isolated System in KAGRA Gravitational Wave Telescope”, Published in: J.Phys.Conf.Ser. 1857 (2021) 1, 012002, Contribution to: 10th ACASC / 2nd Asian-ICMC / CSSJ Joint Conference, https://doi.org/10.1088/1742-6596/1857/1/012002

115. Makoto Arimoto(Charles U. and Kanazawa U.), Hideki Asada(Hirosaki U.), Michael L. Cherry (Louisiana State U.), Michiko S. Fujii(Tokyo U.), Yasushi Fukazawa(Hiroshima U.) et al. (Apr 6, 2021), “Gravitational Wave Physics and Astronomy in the nascent era”, Prog. Theor. Exp. Phys. 2021, 0000 (83 pages) , https://doi.org/10.1093/ptep/ptab042

116. T. Akutsu et al.(KAGRA Collaboration), “An arm length stabilization system for KAGRA and future gravitational-wave detectors”, Class. Quantum Grav., 37 (2020) 35004, DOI: 10.1088/1361-6382/ab5c95

117. T. Akutsu et al.(KAGRA Collaboration), “Application of the independent component analysis to the iKAGRA data”, Prog. Theor. Exp. Phys., Volume 2020 (2020) Issue 5, 053F01, DOI: 10.1093/ptep/ptaa056

118. T. Akutsu et al.(KAGRA Collaboration), “Overview of KAGRA: Detector design and construction history”, Prog. Theor. Exp. Phys., (2020) ptaa125, DOI: 10.1093/ptep/ptaa125

119. T. Akutsu et al.(KAGRA Collaboration), “Overview of KAGRA: KAGRA science”, Prog. Theor. Exp. Phys., (2020) ptaa120, DOI: 10.1093/ptep/ptaa120

120. B. P. Abbott et al. (KAGRA Collaboration, LIGO Scientific Collaboration and Virgo Collaboration), “Prospects for observing and localizing gravitational-wave transients with Advanced LIGO, Advanced Virgo and KAGRA”, Living Rev Relativ, 23 (2020) Article number:3, DOI: 10.1007/s41114-020-00026-9

121. T. Akutsu et al.(KAGRA Collaboration), "The status of KAGRA underground cryogenic gravitational wave telescope", Journal of Physics: Conference Series, 1342 (2020) 12014, DOI: 10.1088/1742-6596/1342/1/012014

122. Takafumi Ushiba et al., "Cryogenic suspension design for a kilometer-scale gravitational-wave detector", Class. Quantum Grav., 38, 2021, 85013, DOI: 10.1088/1361-6382/abe9f3

123. T. Enoto et al., "NinjaSat: an agile CubeSat approach for monitoring of bright x-ray compact objects", Proceedings of the SPIE, Volume 11444, id. 114441V 20 pp. (2020), DOI:10.1117/12.2561152

124. T. Akutsu et al.(KAGRA Collaboration), "Vibration isolation systems for the beam splitter and signal recycling mirrors of the KAGRA gravitational wave detector", Classical and Quantum Gravity, Volume 38, Issue 6, id.065011, 33 pp (2021), DOI:10.1088/1361-6382/abd922

125. LIGO Scientific Collaboration, Virgo Collaboration, and KAGRA Collaboration, "Upper Limits on the Isotropic Gravitational-Wave Background from Advanced LIGO's and Advanced Virgo's Third Observing Run", arXiv:2101.12130 (2021)

126. LIGO Scientific Collaboration, Virgo Collaboration, and KAGRA Collaboration, "Search for anisotropic gravitational-wave backgrounds using data from Advanced LIGO's and Advanced Virgo's first three observing runs", arXiv:2103.08520 (2021)

127. Kangjae Lee, Tetsuya Shiromizu, Keisuke Izumi, Hirotaka Yoshino, and Yoshimune Tomikawa, "Four types of attractive gravity probe surfaces", Phys. Rev. D 106, 064028 – Published 14 September 2022, https://doi.org/10.1103/PhysRevD.106.064028

128. Masaya Amo, Keisuke Izumi, Yoshimune Tomikawa, Hirotaka Yoshino, and Tetsuya Shiromizu, "Asymptotic behavior of null geodesics near future null infinity. III. Photons towards inward directions", Phys. Rev. D 106, 084007 – Published 11 October 2022; Erratum Phys. Rev. D 107, 029902 (2023), https://doi.org/10.1103/PhysRevD.106.084007

129. Y. Yamaguchi, W. Horiuchi, T. Ichikawa, and N. Itagaki, "Dineutron-dineutron correlation in 8He", Phys. Rev. C 108 L011304 (2023).

130. Y. Yamaguchi, W. Horiuchi, and N. Itagaki, "Evidence of bicluster structure in the ground state of 20Ne", Phys. Rev. C 108 014322 (2023).

131. T. Furumoto, T. Suhara, and N. Itagaki, "Systematic study of the relationship between nuclear structure and reactions for the 10Be nucleus", Prog. Theor. Exp. Phys. 2023 063D02 (2023).

132. W. Horiuchi and N. Itagaki, "Imprints of clustering in the density profiles of 12C and 16O", Phys. Rev. C 107 L021304 (2023).

133. N. Itagaki and E. Hiyama, "Cluster-shell competition and effect of adding hyperons", Phys. Rev. C 107 024309 (2023).

134. W. Horiuchi and N. Itagaki, "Density profiles near the nuclear surface of 44,52Ti: An indication of clustering", Phys. Rev. C 106 044330 (2022).

135. Chikako Ishizuka, Hiroki Takemoto, Yohei Chiba, Akira Ono, Naoyuki Itagaki, "Role of Tensor Interaction as Salvation of Cluster Structure in 44Ti", Phys. Rev. C 105 064314 (2022).

136. 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 13 2234 (2022).

137. 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 7H", Phys. Lett. B829 13706 (2022).

138. Naoyuki Haba, Toshifumi Yamada, "Moderately suppressed dimension-five proton decay in a flipped SU(5) model", Published in: JHEP 01 (2022) 061

139. Naoyuki Haba, Nobuchika Okada, Toshifumi Yamada, "Are low-energy data already hinting at five dimensions?", Published in: Phys.Rev.D 105 (2022) 1, 015018

140. T. Hirose and N. Maru, "Nonvanishing Finite Scalar Mass in Flux Compactification", Journal of High Energy Physics 06 (2021) 159.

141. T. Hirose and N. Maru, "Extranatural Flux Inflation", Journal of High Energy Physics 09 (2021) 124.

142. Y. Adachi, C.S. Lim and N. Maru, "Strong CP Problem and Higher Dimensional Gauge Theories", Progress of Theoretical and Experimental Physics (2022) 5, 0530 B6.

143. K. Okabayashi, T. Harada, K. Nakao, "Robustness of particle creation in the formation of a compact object", Progress of Theoretical and Experimental Physics, Volume 2022, Issue 2, 023E02 (2022).

144. Yasutaka Koga, Nobuyuki Asaka, Masashi Kimura, Kazumasa Okabayashi, "Dynamical photon sphere and time evolving shadow around black holes with temporal accretion," arXiv:2202.00 201 (2022).

145. Ken-ichi Nakao, Kazumasa Okabayashi, Tomohiro Harada, "Quantum particle creation in grava star formation; Radiation with Gibbons-Hawking temperature", arXiv:2203.14519 (accepted in Oct. 2022, Physical Review D).

146. Norichika Sago, Takahiro Tanaka, "Oscillations in the extreme mass-ratio inspiral gravitational wave phase correction as a probe of a reflective boundary of the central black hole", Physical Review D 104 064009 (2021),

147. Norichika Sago, Soichiro Isoyama, Hiroyuki Nakano, "Fundamental Tone and Overtones of Quasinormal Modes in Ringdown Gravitational Waves: A Detailed Study in Black Hole Perturbation", Universe 2021, 7(10), 357 (2021)

148. Soichiro Isoyama, Ryuichi Fujita, Alvin J. K. Chua, Hiroyuki Nakano, Adam Pound, Norichika Sago, "Adiabatic waveforms from extreme-mass-ratio inspirals: an analytical approach", e-Print Archive: arXiv:2111.05288 [gr-qc], Physical Review Letters 128, 231101 (2022).

149. Norichika Sago, Takahiro Tanaka, "Efficient search method of anomalous reflection by the central object in an EMRI system by future space gravitational wave detectors", e-Print Archive: arXiv:2202.04249 [gr-qc], Physical Review D 106, 024032, (2022).

150. T. Hirose and N. Maru, "Cancellation of One-loop Corrections to Scalar Masses in Yang-Mills Theory in Flux Compactification with Higher Dimensional Operators", Journal of Physics G 48 (2021) 5, 055005.

151. N. Maru and A. Okawa. "Non-Gaussianity from X, Y gauge bosons in Cosmological Collider Physics", 2101.10634 [hep-ph].

152. S. Davidson, Y. Kuno, Y. Uesaka, M. Yamanaka: “Probing $\mu e\gamma\gamma$ contact interactions with $\mu \to e$ conversion”, Phys. Rev. D102 (2020) no.11, 115043.

153. N. Sago in KAGRA Collaboration (246), “Overview of KAGRA : KAGRA science”, Progress of Theoretical and Experimental Physics, 2021, 05A103 (2021).

154. K. Izumi, N. Sago et al., “The current status of contribution activities in Japan for LISA”, Progress of Theoretical and Experimental Physics, 2021, 05A106 (2021).

155. N. Sago, T. Tanaka, “Gravitational wave echoes induced by a point mass plunging to a black hole”, Progress of Theoretical and Experimental Physics, 2020, 123E01 (2020).

156. H. Nakano, R. Fujita, S. Isoyama, N. Sago, “Scope out multiband gravitational-wave observations of GW190521-like binary black holes with space gravitational wave antenna B-DECIGO”,Universe, 7, 53 (2021).

157. T.Andrade, R. Emparan, A. Jansen, D. Licht, R. Luna, R. Suzuki, “Entropy production and entropic attractors in black hole fusion and fission”, JHEP, 08, 098 (2020).

158. R. Suzuki, “Black hole interactions at large D: brane blobology”, JHEP, 02, 131 (2021).

159. K. Abe, Y. Seiya, K. Yamamoto et al. (The T2K Collaboration), “Scintillator ageing of the T2K near detectors from 2010 to 2021”, Journal of Instrumentation 17, P10028 (2022)., http://dx.doi.org/10.1088/1748-0221/17/10/p10028

160. T. Aaltonen , Y. Seiya, K. Yamamoto et al. (CDF Collaboration), “High-precision measurement of the W boson mass with the CDF II detector”, Science 376, 170-176 (2022)., http://dx.doi.org/10.1126/science.abk1781

161. T. Aaltonen, Y. Seiya, K. Yamamoto et al. (CDF Collaboration), “Measurement of the charge asymmetry of electrons from the decays of W bosons produced in $p\bar{p}$ collisions at $\sqrt{s}$ 1.96 TeV”, Physical Review D 104, 092002 (2021)., http://dx.doi.org/10.1103/PhysRevD.104.092002

162. K. Abe, Y. Seiya, K. Yamamoto et al. (Hyper-Kamiokande Collaboration), “Supernova Model Discrimination with Hyper-Kamiokande”, The Astrophysical Journal 916, 15 (2021)., http://dx.doi.org/10.38 4357/abf7c4

163. K. Abe, Y. Seiya, N. Teshima, K. Yamamoto et al. (T2K Collaboration), “First T2K measurement of transverse kinematic imbalance in the muon-neutrino charged-current single- + production channel containing at least one proton”, Physical Review D 103, 112009 (2021)., http://dx.doi.org/10.1103/PhysRevD.103.112009

164. K. Abe, Y. Seiya, N. Teshima, K. Yamamoto et al. (T2K Collaboration), “Improved constraints on neutrino mixing from the T2K experiment with 3.1×10^{21} protons on target”, Physical Review D 103, 112008 (2021)., http://dx.doi.org/10.1103/PhysRevD.103.112008

165. N. Teshima, M. Aoki, Y. Higashino, H. Ikeuchi, K. Komukai, D. Nagao, Y. Nakatsugawa, H. Natori, Y. Seiya, N. M. Truong, and K. Yamamoto, “Development of a multiwire proportional chamber with good tolerance to burst hits”, Nuclear Instruments and Methods in Physics Research A 999, 165228 (2021)., http://dx.doi.org/https://doi.org/10.1016/j.nima.2021.165228

166. K. Abe, Y. Seiya, N. Teshima, K. Yamamoto et al., “Measurements of $\bar{\nu}_\mu$ and $\bar{\nu}_\mu + \nu_\mu$ charged-current cross-sections without detected pions or protons on water and hydrocarbon at a mean anti-neutrino energy of 0.86 GeV”, Progress of Theoretical and Experimental Physics 2021, 043C01 (2021)., http://dx.doi.org/10.1093/ptep/ptab014

167. K. Abe, Y. Seiya, N. Teshima, K. Yamamoto et al. (The T2K Collaboration), "T2K measurements of muon neutrino and antineutrino disappearance using 3.13×10^{21} protons on target", Physical Review D 103, L011101 (2021)., http://dx.doi.org/10.1103/PhysRevD.103.L011101

168. K. Abe, Y. Seiya, N. Teshima, K. Yamamoto et al. (The T2K Collaboration), "Measurement of the charged-current electron (anti-)neutrino inclusive cross-sections at the T2K off-axis near detector ND280", Journal of High Energy Physics 2020, 114 (2020)., http://dx.doi.org/10.1007/JHEP10(2020)114

169. K. Abe, Y. Seiya, K. Yamamoto et al. (The T2K Collaboration), "First measurement of the charged current $\bar{\nu}_\mu$ double differential cross section on a water target without pions in the final state", Physical Review D 102, 012007 (2020)., http://dx.doi.org/10.1103/PhysRevD.102.012007

170. K. Abe, Y. Seiya, N. Teshima, K. Yamamoto et al. (T2K Collaboration), "Simultaneous measurement of the muon neutrino charged-current cross section on oxygen and carbon without pions in the final state at T2K", Physical Review D 101, 112004 (2020)., http://dx.doi.org/10.1103/PhysRevD.101.112004

171. K. Abe, Y. Seiya, N. Teshima, K. Yamamoto et al. (T2K Collaboration), "First combined measurement of the muon neutrino and antineutrino charged-current cross section without pions in the final state at T2K", Physical Review D 101, 112001 (2020)., http://dx.doi.org/10.1103/PhysRevD.101.112001

172. K. Abe, Y. Seiya, K. Yamamoto et al. (The T2K Collaboration), "Search for Electron Antineutrino Appearance in a Long-Baseline Muon Antineutrino Beam", Physical Review Letters 124, 161802 (2020)., http://dx.doi.org/10.1103/PhysRevLett.124.161802

173. K. Abe, Y. Seiya, K. Yamamoto et al. (The T2K Collaboration), "Constraint on the matter-antimatter symmetry-violating phase in neutrino oscillations", Nature 580, 339-344 (2020)., http://dx.doi.org/10.1038/s41586-020-2177-0

174. Konishi, R., Enokiya, R., Fukui, Y., Muraoka, K., Tokuda, K., Onishi, T., "Discovery of a Giant Molecular Loop in the Central Region of NGC 253", 2022, ApJ, 929, 63, DOI: 10.3847/1538-4357/ac58f7

175. Kondo, H., Tokuda, K., Muraoka, K., Nishimura, A., Fujita, S., Tosaki, T., Zahorecz, S., Miura, R. E., Kobayashi, M. I. N., Onodera, S., Torii, K., Kuno, N., Sano, H., Onishi, T., Saigo, K., Fukui, Y., Kawamura, A., Tsuge, K., & Tachihara, K., "ALMA Observations of Giant Molecular Clouds in M33. III. Spatially Resolved Features of the Star-Formation Inactive Million-solar-mass Cloud", 2021, ApJ, 912, 66 DOI: 10.3847/1538-4357/abeb65

176. Muraoka, K., Kondo, H., Tokuda, K., Nishimura, A., Miura, R. E., Onodera, S., Kuno, N., Zahorecz, S., Tsuge, K., Sano, H., Fujita, S., Onishi, T., Saigo, K., Tachihara, K., Fukui, Y., & Kawamura, A., "ALMA Observations of Giant Molecular Clouds in M33. II. Triggered High-mass Star Formation by Multiple Gas Colliding Events at the NGC 604 Complex", 2020, ApJ, 903, 94 DOI: 10.3847/1538-4357/abb822

177. Tokuda, K., Muraoka, K., Kondo, H., Nishimura, A., Tosaki, T., Zahorecz, S., Onodera, S., Miura, R. E., Torii, K., Kuno, N., Fujita, S., Sano, H., Onishi, T., Saigo, K., Fukui, Y., Kawamura, A., & Tachihara, K., "ALMA Observations of Giant Molecular Clouds in M33. I. Resolving Star Formation Activities in the Giant Molecular Filaments Possibly Formed by a Spiral Shock", 2020, ApJ, 896, 36
DOI: 10.3847/1538-4357/ab8ad3

178. H. Sasakura, Y. Akagi, T. Nakagawa, S. Noguchi,
"Superconductivity of (Pb0.75W0.25)Sr2(RE0.5Ca0.5)Cu2Oz (RE = Nd, Sm, Eu, Gd, Dy, Ho, Er, Tm, Yb, and Y) by Annealing in N2 Gas", Journal of Superconductivity and Novel Magnetism (2020) 33:3667–3672, https://doi.org/10.1007/s10948-020-05628-6

179. Ryohei Kamada, Tsuyoshi Mizuguchi, "Heterogeneity of Japanese Names", Journal of the Physical Society of Japan 89(7) 074802, DOI:10.7566/jpsj.89.074802

180. Takuya Yamamoto, Syunya Yamada, Tsuyoshi Mizuguchi, "Negative correlation of word rank sequence in written texts" , The European Physical Journal B 94(10), DOI:10.1140/epjb/s10051-021-00210-y

181. So Kitsunezaki, Akihiro Nishimoto, Tsuyoshi Mizuguchi, Yousuke Matsuo, Akio Nakahara, "X-ray computerized tomography observation of Lycopodium paste incorporating memory of shaking", Physical Review E 105(4) 044902, DOI:10.1103/PhysRevE.105.044902

182. Shotaro Ikemoto , Daisuke Izutsu , Tsuyoshi Mizuguchi, "Detection of Least Acceleration Fluctuation Point of Moving Object by Using Inertial Sensor", IEICE Proceeding series 585 - 588, DOI:10.34385/proc.71.C5L-E-02

183. "Limits to gauge coupling in the dark sector set by the non-observation of instanton-induced decay of Super-Heavy Dark Matter in the Pierre Auger Observatory data", Phys. Rev. Lett. 130 (2023) 061001

184. "Cosmological implications of photon-flux upper limits at ultra-high energies in scenarios of Planckian-interacting massive particles for dark matter", Phys. Rev. D 107 (2023) 042002

185. "A Catalog of the Highest-Energy Cosmic Rays recorded during Phase I of Operation of the Pierre Auger Observatory", Astrophys. J. Suppl. S. 264 (2023) 50

186. "Arrival Directions of Cosmic Rays above 32 EeV from Phase One of the Pierre Auger Observatory", The Astrophysical Journal 935 (2022)170

187. "Search for Spatial Correlations of Neutrinos with Ultra-High-Energy Cosmic Rays", The Astrophysical Journal 934 (2022)164

188. "A search for photons with energies above $2x10^{17}$ eV using hybrid data from the low-energy extensions of the Pierre Auger Observatory", The Astrophysical Journal 933 (2022)125

189. "Testing effects of Lorentz Invariance Violation in the propagation of astroparticles with the Pierre Auger Observatory", JCAP 01 (2022) 023

190. N. Aizawa, P. S. Isaac and J. Segar, "$\mathbb{Z}_2 \times \mathbb{Z}_2$ generalizations of infinite dimensional Lie superalgebra of conformal type with complete classification of central extensions.", Reports on Mathematical Physics, **85** (2020) 351-373.

191. N. Aizawa, K. Amakawa and S. Doi, "$\mathbb{Z}_2^n$-Graded extensions of supersymmetric quantum mechanics via Clifford algebras." Journal of Mathematical Physics, **61** (2020) 052105 (13pages).

192. N. Aizawa, Z. Kuznetsova and F. Toppan, "$\mathbb{Z}_2 \times \mathbb{Z}_2$-graded mechanics: the classical theory.", The European Physical Journal C **80** (2020) 668 (14 pages).

193. K. Amakawa and N. Aizawa, "A classification of lowest weight irreducible modules over $\mathbb{Z}_2^2$-graded extension of $osp(1|2)$.", Journal of Mathematical Physics, **62** (2021) 043502 (18 pages).

194. N. Aizawa, Z. Kuznetsova and F. Toppan, “$\mathbb{Z}_2 \times \mathbb{Z}_2$-graded mechanics: the quantization.”, Nuclear Physics, **B967** (2021) 115426 (30pages).

195. S. Doi and N. Aizawa, “$\mathbb{Z}_2^3$-Graded extensions of Lie superalgebras and superconformal quantum mechanics.”, Symmetry, Integrability and Geometry: Methods and Applications, **17** (2021) 071 (14 pages).

196. N. Aizawa, V. K. Dobrev and S. Doi, “Classification of the reducible Verma modules over the Jacobi algebra $\mathcal{G}_2$.”, Journal of Physics A: Mathematical and Theoretical, **54** (2021) 475202 (42 pages).

197. N. Aizawa, K. Amakawa and S. Doi, “Color algebraic extension of supersymmetric quantum mechanics.”, in “Quantum Theory and Symmetries”, M. Paranjape, R. MacKenzie, Z. Thomova, P. Winternitz, W. Witczak-Krempa (editors), Springer (2021) 199-207.

198. S. Doi and N. Aizawa, “Comments of $\mathbb{Z}_2^2$-supersymmetry in superfield formalism.”, Nuclear Physics, **B974** (2022) 115641 (17 pages).

199. N. Aizawa and V. K. Dobrev, “Invariant differential operators for the Jacobi algebra $\mathcal{G}_2$.”, Modern Physics Letters, **37** (2022) 2250067 (14 pages).

200. N. Aizawa and S. Doi, “Irreducible representations of $\mathbb{Z}_2^2$-graded $\mathcal{N} = 2$ supersymmetry algebra and $\mathbb{Z}_2^2$-graded supermechanics.”, Journal of Mathematical Physics, **63** (2022) 091704 (12 pages).

201. N. Harada, K. Tokuda, H. Yamasaki, A. Sato, M. Omura, S. Hirano, T. Onishi, K. Tachihara, & M. N. Machida, “Crescent-shaped Molecular Outflow from the Intermediate-mass Protostar DK Cha Revealed by ALMA”, ApJ 945, 63 [9 pages], http://dx.doi.org/10.3847/1538-4357/acb930

202. K. Tokuda, S. Zahorecz, Y. Kunitoshi, K. Higashino, K. E. I. Tanaka, A. Konishi, T. Suzuki, N. Kitano, N. Harada, T. Shimonishi, N. Neelamkodan, Y. Fukui, A. Kawamura, T. Onishi, & M. N. Machida, “The First Detection of a Protostellar CO Outflow in the Small Magellanic Cloud with ALMA”, ApJL 936, L6 [5 pages], http://dx.doi.org/10.3847/2041-8213/ac81c1

203. S. Nishimoto, S. Ueda, S. Fujita, A. Nishimura, T. Onishi, K. Tokuda, R. Yoneda, Y. Shimajiri, Y. Miyamoto, Y. Kawanishi, A. M. Ito, K. Nishikawa, D. Yoshida, H. Kaneko, T. Inoue, S. Takekawa, & S. Nakatani, “Development of a high-speed identification model for infrared-ring structures using deep learning”, SPIE 12189, 121891Q [11 pages], http://dx.doi.org/10.1117/12.2628664

204. A. Nishimura, K. Tachihara, S. Nishimoto, S. Fujita, K. Nishikawa, R. Yoneda, K. Handa, T. Kurakami, H. Ogawa, & T. Onishi, “Active surface measurements for large aperture millimeter/submillimeter-wave telescopes using a photogrammetry technique”, SPIE 12182, 1218222 [8 pages], http://dx.doi.org/10.1117/12.2629126

205. M. K. Finn, R. Indebetouw, K. E. Johnson, A. H. Costa, C.-H. R. Chen, A. Kawamura, T. Onishi, J. Ott, M. Sewiło, K. Tokuda, T. Wong, & S. Zahorecz, “Structural and Dynamical Analysis of the Quiescent Molecular Ridge in the Large Magellanic Cloud”, AJ 164, 64 [15 pages], http://dx.doi.org/10.3847/1538-3881/ac7aa1

206. K. Tokuda, T. Minami, Y. Fukui, T. Inoue, T. Nishioka, K. Tsuge, S. Zahorecz, H. Sano, A. Konishi, C.-H. Rosie Chen, M. Sewiło, S. C. Madden, O. Nayak, K. Saigo, A. Nishimura, K. E. I. Tanaka, T. Sawada, R. Indebetouw, K. Tachihara, A. Kawamura, & T. Onishi, “An ALMA Study of the Massive Molecular Clump N159W-North in the Large Magellanic Cloud: A Possible Gas Flow Penetrating One of the Most Massive Protocluster Systems in the Local Group”, ApJ 933, 20 [22 pages], http://dx.doi.org/10.3847/1538-4357/ac6b3c

207. T. Wong, L. Oudshoorn, E. Sofovich, A. Green, C. Shah, R. Indebetouw, M. Meixner, A. Hacar, O. Nayak, K. Tokuda, A. D. Bolatto, M. Chevance, G. De Marchi, Y. Fukui, A. S. Hirschauer, K. E. Jameson, V. Kalari, V. Lebouteiller, L. W. Looney, S. C. Madden, T. Onishi, J. Roman-Duval, M. Rubio, & A. G. G. M. Tielens, "The 30 Doradus Molecular Cloud at 0.4 pc Resolution with the Atacama Large Millimeter/submillimeter Array: Physical Properties and the Boundedness of CO-emitting Structures", ApJ 932, 47 [19 pages], http://dx.doi.org/10.3847/1538-4357/ac723a

208. M. Sewiło, M. Cordiner, S. B. Charnley, J. M. Oliveira, E. Garcia-Berrios, P. Schilke, J. L. Ward, J. Wiseman, R. Indebetouw, K. Tokuda, J. T. van Loon, Á. Sánchez-Monge, V. Allen, C.-H. R. Chen, R. Hamedani Golshan, A. Karska, L. E. Kristensen, S. E. Kurtz, T. Möller, T. Onishi, & S. Zahorecz, "ALMA Observations of Molecular Complexity in the Large Magellanic Cloud: The N 105 Star-forming Region", ApJ 931, 102 [61 pages], http://dx.doi.org/10.3847/1538-4357/ac4e8f

209. S. Barman, N. Neelamkodan, S. C. Madden, M. Sewilo, F. Kemper, K. Tokuda, S. Sanyal, & T. Onishi, "A Study of Photoionized Gas in Two H II Regions of the N44 Complex in the LMC Using MUSE Observations", ApJ 930, 100 [14 pages], http://dx.doi.org/10.3847/1538-4357/ac62ce

210. R. Konishi, R. Enokiya, Y. Fukui, K. Muraoka, K. Tokuda, & T. Onishi, "Discovery of a Giant Molecular Loop in the Central Region of NGC 253", ApJ 929, 63 [16 pages], http://dx.doi.org/10.3847/1538-4357/ac58f7

211. M. Kohno, A. Nishimura, S. Fujita, K. Tachihara, T. Onishi, K. Tokuda, Y. Fukui, Y. Miyamoto, S. Ueda, R. Kiridoshi, D. Tsutsumi, K. Torii, T. Minamidani, K. Saigo, T. Handa, & H. Sano, "Nobeyama 45 m Local Spur CO survey. I. Giant molecular filaments and cluster formation in the Vulpecula OB association", PASJ 74, 24 [26 pages], http://dx.doi.org/10.1093/pasj/psab107

212. K. Tokuda, H. Kondo, T. Ohno, A. Konishi, H. Sano, K. Tsuge, S. Zahorecz, N. Goto, N. Neelamkodan, T. Wong, M. Sewiło, H. Fukushima, T. Takekoshi, K. Muraoka, A. Kawamura, K. Tachihara, Y. Fukui, & T. Onishi, "An Unbiased CO Survey toward the Northern Region of the Small Magellanic Cloud with the Atacama Compact Array. I. Overview: CO Cloud Distributions", ApJ 922, 171 [16 pages], http://dx.doi.org/10.3847/1538-4357/ac1ff4

213. Y. Yamane, H. Sano, M. D. Filipović, K. Tokuda, K. Fujii, Y. Babazaki, I. Mitsuishi, T. Inoue, F. Aharonian, T. Inaba, S. Inutsuka, N. Maxted, N. Mizuno, T. Onishi, G. Rowell, K. Tsuge, F. Voisin, S. Yoshiike, T. Fukuda, A. Kawamura, A. Bamba, K. Tachihara, & Y. Fukui, "Associated Molecular and Atomic Clouds with X-Ray Shell of Superbubble 30 Doradus C in the LMC", ApJ 918, 36 [17 pages], http://dx.doi.org/10.3847/1538-4357/ac0adb

214. S. Zahorecz, I. Jimenez-Serra, L. Testi, K. Immer, F. Fontani, P. Caselli, K. Wang, & T. Onishi, "Singly and doubly deuterated formaldehyde in massive star-forming regions", A&A 653, A45 [13 pages], http://dx.doi.org/10.1051/0004-6361/201937012

215. Y. Yamasaki, S. Masui, H. Ogawa, H. Kondo, T. Matsumoto, M. Okawa, K. Yokoyama, T. Minami, R. Konishi, S. Kawashita, A. Konishi, Y. Nakao, S. Nishimoto, S. Yoneyama, S. Ueda, Y. Hasegawa, S. Fujita, A. Nishimura, T. Kojima, K. Kaneko, R. Sakai, A. Gonzalez, Y. Uzawa, & T. Onishi, "Development of a new wideband heterodyne receiver system for the Osaka 1.85 m mm-submm telescope: Corrugated horn and optics covering the 210-375 GHz band", PASJ 73, 1116 [12 pages], http://dx.doi.org/10.1093/pasj/psab062

216. S. Masui, Y. Yamasaki, H. Ogawa, H. Kondo, K. Yokoyama, T. Matsumoto, T. Minami, M. Okawa, R. Konishi, S. Kawashita, A. Konishi, Y. Nakao, S. Nishimoto, S. Yoneyama, S. Ueda, Y. Hasegawa, S. Fujita, A. Nishimura, T. Kojima, K. Uemizu, K. Kaneko, R. Sakai, A. Gonzalez, Y. Uzawa, & T. Onishi, "Development of a new wideband heterodyne receiver system for the

Osaka 1.85 m mm-submm telescope: Receiver development and the first light of simultaneous observations in 230 GHz and 345 GHz bands with an SIS-mixer with 4-21 GHz IF output", PASJ 73, 1100 [16 pages], http://dx.doi.org/10.1093/pasj/psab046

217. M. K. Finn, R. Indebetouw, K. E. Johnson, A. H. Costa, C.-H. R. Chen, A. Kawamura, T. Onishi, J. Ott, K. Tokuda, T. Wong, & S. Zahorecz, "Physical Conditions in the LMC's Quiescent Molecular Ridge: Fitting Non-LTE Models to CO Emission", ApJ 917, 106 [28 pages], http://dx.doi.org/10.3847/1538-4357/ac090c

218. K. Fujii, N. Mizuno, J. R. Dawson, T. Inoue, K. Torii, T. Onishi, A. Kawamura, E. Muller, T. Minamidani, K. Tsuge, & Y. Fukui, "Giant molecular cloud formation at the interface of colliding supershells in the large magellanic cloud", MNRAS 505, 459 [21 pages], http://dx.doi.org/10.1093/mnras/stab1202

219. R. Konishi, K. Muraoka, T. Onishi, K. Tokuda, R. Enokiya, & Y. Fukui, "Discovery of Molecular Loops in NGC 253", ASPC 528, 183 [pages], http://dx.doi.org/

220. A. Nishimura, T. Matsumoto, T. Yonetsu, Y. Nakao, S. Fujita, H. Maezawa, T. Onishi, & H. Ogawa, "Observational demonstration of a low-cost fast Fourier transform spectrometer with a delay-line-based ramp-compare ADC implemented on FPGA", PASJ 73, 692 [9 pages], http://dx.doi.org/10.1093/pasj/psab030

221. H. Kondo, K. Tokuda, K. Muraoka, A. Nishimura, S. Fujita, T. Tosaki, S. Zahorecz, R. E. Miura, M. I. N. Kobayashi, S. Onodera, K. Torii, N. Kuno, H. Sano, T. Onishi, K. Saigo, Y. Fukui, A. Kawamura, K. Tsuge, & K. Tachihara, "ALMA Observations of Giant Molecular Clouds in M33. III. Spatially Resolved Features of the Star formation Inactive Million-solar-mass Cloud", ApJ 912, 66 [11 pages], http://dx.doi.org/10.3847/1538-4357/abeb65

222. K. Torii, K. Tokuda, K. Tachihara, T. Onishi, & Y. Fukui, "ALMA view of the Galactic super star cluster RCW 38 at 270 au resolution", PASJ 73, 205 [15 pages], http://dx.doi.org/10.1093/pasj/psaa115

223. N. Neelamkodan, K. Tokuda, S. Barman, H. Kondo, H. Sano, & T. Onishi, "ALMA Reveals a Cloud-Cloud Collision that Triggers Star Formation in the Small Magellanic Cloud", ApJL 908, L43 [6 pages], http://dx.doi.org/10.3847/2041-8213/abdebb

224. O. Nayak, M. Meixner, Y. Okada, M. Y. Lee, M. Chevance, C. Buchbender, Y. Fukui, T. Onishi, A. Parikka, & J. Stutzki, "Stellar Feedback on the Earliest Stage of Massive Star Formation", ApJ 907, 106 [12 pages], http://dx.doi.org/10.3847/1538-4357/abcb89

225. M. Kohno, K. Tachihara, K. Torii, S. Fujita, A. Nishimura, N. Kuno, T. Umemoto, T. Minamidani, M. Matsuo, R. Kiridoshi, K. Tokuda, M. Hanaoka, Y. Tsuda, M. Kuriki, A. Ohama, H. Sano, T. Hasegawa, Y. Sofue, A. Habe, T. Onishi, & Y. Fukui, "FOREST unbiased Galactic plane imaging survey with the Nobeyama 45 m telescope (FUGIN). VI. Dense gas and mini-starbursts in the W 43 giant molecular cloud complex", PASJ 73, S129 [pages], http://dx.doi.org/10.1093/pasj/psaa015

226. H. Sano, K. Tsuge, K. Tokuda, K. Muraoka, K. Tachihara, Y. Yamane, M. Kohno, S. Fujita, R. Enokiya, G. Rowell, N. Maxted, M. D. Filipović, J. Knies, M. Sasaki, T. Onishi, P. P. Plucinsky, & Y. Fukui, "ALMA CO observations of a giant molecular cloud in M 33: Evidence for high-mass star formation triggered by cloud-cloud collisions", PASJ 73, S62 [pages], http://dx.doi.org/10.1093/pasj/psaa045

227. Y. Yamasaki, S. Masui, M. Okawa, K. Yokoyama, T. Minami, S. Ueda, Y. Hasegawa, A. Nishimura, T. Onishi, H. Ogawa, N. Okada, K. Kimura, A. Gonzalez, T. Kojima, K. Kaneko, & R. Sakai, "Optical design of the 1.85-m mm-submm telescope in 210-375 GHz band", SPIE 11453, 114534H [8 pages], http://dx.doi.org/10.1117/12.2561955

228. S. Masui, T. Minami, M. Okawa, Y. Yamasaki, K. Yokoyama, S. Ueda, Y. Hasegawa, A. Nishimura, T. Onishi, H. Ogawa, T. Kojima, & A. Gonzalez, "Development of a wideband waveguide diplexer for simultaneous observation at 210-375 GHz", SPIE 11453, 114534F [8 pages], http://dx.doi.org/10.1117/12.2561355

229. N. Okada, T. Matsumoto, H. Kondo, T. Takashima, S. Masui, S. Ueda, A. Nishimura, T. Manabe, T. Onishi, H. Ogawa, R. Amari, T. Tsutsumi, T. Aoki, S. Sawada-Satoh, K. Niinuma, K. Fujisawa, K. Kimura, T. Minamidani, C. Miyazawa, H. Kaneko, K. Torii, S. Takahashi, Y. Miyamoto, K. Miyazawa, T. Oyama, S. Kameno, & H. Imai, "Development of the multi-band simultaneous observation system of the Nobeyama 45-m Telescope in HINOTORI (Hybrid Installation project in NObeyama, Triple-band ORIented)", SPIE 11453, 1145349 [11 pages], http://dx.doi.org/10.1117/12.2562137

230. A. Nishimura, A. Ohama, K. Kimura, D. Tsutsumi, Y. Matsue, R. Yamada, M. Sakamoto, K. Matsunaga, Y. Hasegawa, T. Minami, T. Matsumoto, K. Shiotani, S. Okuda, K. Fujishiro, K. Sakasai, M. Suzuki, S. Saeki, K. Satani, K. Urushihara, C. Kato, T. Kondo, K. Okawa, D. Kurita, T. Inaba, S. Maruyama, M. Koga, K. Noda, M. Kohno, H. Iwamura, Y. Hori, K. Nishikawa, T. Nishioka, T. Pang, H. Sano, R. Enokiya, S. Yoshiike, S. Fujita, K. Hayashi, K. Torii, T. Hayakawa, A. Taniguchi, K. Tsuge, Y. Yamane, Y. Hattori, T. Ohno, S. Ueda, S. Masui, Y. Yamasaki, H. Kondo, K. Suzuki, K. Kobayashi, Y. Fujii, Y. Fujii, T. Minamidani, T. Okuda, H. Yamamoto, K. Tachihara, T. Onishi, A. Mizuno, H. Ogawa, & Y. Fukui, "Development of the new multi-beam receiver and telescope control system for NASCO", SPIE 11453, 114533Z [18 pages], http://dx.doi.org/10.1117/12.2562053

231. H. Kondo, T. Matsumoto, A. Nishimura, S. Ueda, R. Konishi, Y. Nakao, K. Nishikawa, S. Nishimoto, S. Fujita, A. Konishi, T. Tsutsumi, R. Yamada, T. Takashima, K. Tachihara, T. Onishi, & H. Ogawa, "Development of a new software system for radio telescope using robot operating system", SPIE 11452, 114523M [12 pages], http://dx.doi.org/10.1117/12.2562247

232. S. Ueda, S. Fujita, A. Nishimura, T. Onishi, Y. Shimajiri, Y. Miyamoto, K. Torii, A. M. Ito, S. Takekawa, H. Kaneko, D. Yoshida, T. Matsuo, T. Inoue, Y. Kawanishi, & K. Tokuda, "Identification of infrared-ring structures by convolutional neural network", SPIE 11452, 114522L [10 pages], http://dx.doi.org/10.1117/12.2560830

233. A. Nishimura, K. Tokuda, R. Harada, Y. Hasegawa, S. Ueda, S. Masui, R. Konishi, Y. Yamasaki, H. Kondo, K. Yokoyama, T. Matsumoto, T. Minami, M. Okawa, S. Fujita, A. Konishi, Y. Nakao, S. Nishimoto, S. Kawashita, S. Yoneyama, T. Takashima, K. Goto, N. Okada, K. Kimura, Y. Abe, K. Muraoka, H. Maezawa, T. Onishi, & H. Ogawa, "Current status and future plan of Osaka Prefecture University 1.85-m mm-submm telescope project", SPIE 11445, 114457F [13 pages], http://dx.doi.org/10.1117/12.2560955

234. Y. Tamura, R. Kawabe, Y. Fukasaku, K. Kimura, T. Ueda, A. Taniguchi, N. Okada, H. Ogawa, I. Hashimoto, T. Minamidani, N. Kawaguchi, N. Kuno, Y. Togami, M. Hagimoto, S. Nakano, K. Matsuda, S. Okumura, T. Nakamura, M. Kurita, T. Takekoshi, T. Oshima, T. Onishi, & K. Kohno, "Wavefront sensor for millimeter/submillimeter-wave adaptive optics based on aperture-plane interferometry", SPIE 11445, 114451N [9 pages], http://dx.doi.org/10.1117/12.2561885

235. K. Muraoka, H. Kondo, K. Tokuda, A. Nishimura, R. E. Miura, S. Onodera, N. Kuno, S. Zahorecz, K. Tsuge, H. Sano, S. Fujita, T. Onishi, K. Saigo, K. Tachihara, Y. Fukui, & A. Kawamura, “ALMA Observations of Giant Molecular Clouds in M33. II. Triggered High-mass Star Formation by Multiple Gas Colliding Events at the NGC 604 Complex”, ApJ 903, 94 [11 pages], http://dx.doi.org/10.3847/1538-4357/abb822

236. A. J. Nayana, N. Naslim, T. Onishi, F. Kemper, K. Tokuda, S. C. Madden, O. Morata, S. Nasri, & M. Galametz, “ALMA Observations of HCO⁺ and HCN Emission in the Massive Star-forming Region N55 of the Large Magellanic Cloud”, ApJ 902, 140 [10 pages], http://dx.doi.org/10.3847/1538-4357/abb466

237. H. Sano, P. P. Plucinsky, A. Bamba, P. Sharda, M. D. Filipović, C. J. Law, R. Z. E. Alsaberi, Y. Yamane, K. Tokuda, F. Acero, M. Sasaki, J. Vink, T. Inoue, S. Inutsuka, J. Shimoda, K. Tsuge, K. Fujii, F. Voisin, N. Maxted, G. Rowell, T. Onishi, A. Kawamura, N. Mizuno, H. Yamamoto, K. Tachihara, & Y. Fukui, “ALMA CO Observations of Gamma-Ray Supernova Remnant N132D in the Large Magellanic Cloud: Possible Evidence for Shocked Molecular Clouds Illuminated by Cosmic-Ray Protons”, ApJ 902, 53 [14 pages], http://dx.doi.org/10.3847/1538-4357/abb469

238. K. Fujishiro, K. Tokuda, K. Tachihara, T. Takashima, Y. Fukui, S. Zahorecz, K. Saigo, T. Matsumoto, K. Tomida, M. N. Machida, S.-. ichiro . Inutsuka, P. André, A. Kawamura, & T. Onishi, “A Low-velocity Bipolar Outflow from a Deeply Embedded Object in Taurus Revealed by the Atacama Compact Array”, ApJL 899, L10 [pages], http://dx.doi.org/10.3847/2041-8213/ab9ca8

239. K. Tokuda, K. Fujishiro, K. Tachihara, T. Takashima, Y. Fukui, S. Zahorecz, K. Saigo, T. Matsumoto, K. Tomida, M. N. Machida, S.-. ichiro . Inutsuka, P. André, A. Kawamura, & T. Onishi, “FRagmentation and Evolution of Dense Cores Judged by ALMA (FREJA). I. Overview: Inner ∼1000 au Structures of Prestellar/Protostellar Cores in Taurus”, ApJ 899, 10 [pages], http://dx.doi.org/10.3847/1538-4357/ab9ca7

240. K. Tokuda, K. Muraoka, H. Kondo, A. Nishimura, T. Tosaki, S. Zahorecz, S. Onodera, R. E. Miura, K. Torii, N. Kuno, S. Fujita, H. Sano, T. Onishi, K. Saigo, Y. Fukui, A. Kawamura, & K. Tachihara, “ALMA Observations of Giant Molecular Clouds in M33. I. Resolving Star Formation Activities in the Giant Molecular Filaments Possibly Formed by a Spiral Shock”, ApJ 896, 36 [10 pages], http://dx.doi.org/10.3847/1538-4357/ab8ad3

241. “Search for point sources of ultra-high energy photons with the Telescope Array surface detector”, MNRAS, 492, 3984 (2020)

242. “Search for Ultra-High-Energy Neutrinos with the Telescope Array Surface Detector”, JETP, 152, 282 (2020)

243. “Observation of the Origin of Downward Terrestrial Gamma-Ray Flashes”, J. Geophys.Res., 125, 031840 (2020)

244. “CALET on the International Space Station: the first three years of observations”, Physica Scripta, 95, 074012 (2020)

245. “Search for a large-scale anisotropy on arrival directions of ultrahigh-energy cosmic rays observed with the Telescope Array Experiment”, Astrophys. J. Lett., 898, L20 (2020)

246. “Evidence for a Supergalactic Structure of Magnetic Deflection Multiplets of Ultra-High Energy Cosmic Rays”, 899, 86 (2020)

247. “Using Deep Learning to Enhance Event Geometry Reconstruction for the Telescope Array Surface Detector”, Machine Learning: Science and Technology, 2, 015006 (2020)

248. “Measurement of the proton-air cross section with Telescope Array’s Black Rock Mesa and Long Ridge fluorescence detectors, and surface array in hybrid mode”, Phys. Rev. D, 102, 062004 (2020)

249. “Direct Measurement of the Cosmic-Ray Carbon and Oxygen Spectra from 10 GeV/n to 2.2 TeV/n with the Calorimetric Electron Telescope on the International Space Station”, Phys. Rev. Lett., 125, 251102 (2020)

250. M. Zuberi et al., “Simulation of atmospheric pressure dependence on GRAPES-3 particle density”, Experimental Astronomy 49, 61–71 (2020)

251. V.B.Jhansi et al., “The angular resolution of GRAPES-3 EAS array after improved timing and shower front curvature correction based on age and size”, Journal of Cosmology and Astroparticle Physics, 07 (2020)024

252. B.Hariharan et al., “Energy sensitivity of the GRAPES-3 EAS array for primary cosmic ray protons”, Experimental Astronomy, 50, 185–198 (2020)

253. “The Cosmic-Ray Composition between 2 PeV and 2 EeV Observed with the TALE De- tector in Monocular Mode”, Astrophys. J., 909, 178 (2021)

254. “Observation of variations in cosmic ray single count rates during thunderstorms and implications for large-scale electric field changes”, Phys. Rev. D, 105, 062002 (2021)

255. “Surface detectors of the TAx4 experiment”, Nuclear Instr. Meth. A, 1019, 165726 (2021)

256. “Detectability of southern gamma-ray sources beyond 100 TeV with ALPAQUITA, the prototype experiment of ALPACA”, Exp. Astron., 52, 82-107 (2021)

257. H. Yano, K. Hamazaki, N. Koizumi, K. Sato, K. Obara, and O. Ishikawa, “Size Distribution of Emission Vortex Rings in Turbulence Induced by Vibrating Wire in Superfluid 4He”, J. of Low Temp. Phys., 201, 18–24 (2020)

258. K.Obara, I.Matsumura, N.Tajima, K. Ohyama, H.Yano, and O. Ishikawa , “Vortex line density of superfluid suction vortex”, Phys. Rev. Fluids, 6, 064802 (2021)

259. N.Kakimoto, K.Obara, H.Yano and O. Ishikawa, “Circulation of Superfluid Suction Vortex”, J. of Low Temp. Phys., 208, 379–385 (2022)

260. Hideki Ishihara(Osaka City U.), Tatsuya Ogawa(Osaka City U.) , “Variety of nontopological solitons in a spontaneously broken U(1) gauge theory: Dust balls, shell balls, and potential balls”, (Mar 25, 2021) Published in: Phys.Rev.D 103 (2021) 12, 123029, e-Print: 2103.13732 [hep-th]

261. Hideki Ishihara(Osaka City U.), Satsuki Matsuno(Osaka City U.) , “Gödel-type solutions in Einstein–Maxwell–scalar field theories”, (Sep 24, 2021) Published in: PTEP 2022 (2022) 1, 013E02, e-Print: 2109.11740 [hep-th]

262. Hideki Ishihara(Osaka City U.), Satsuki Matsuno(Osaka City U.) , “Inhomogeneous generalization of Einstein’s static universe with Sasakian space”, (Dec 5, 2021) Published in: PTEP 2022 (2022) 2, 023E01, e-Print: 2112.02782 [hep-th]

263. Yota Endo(Osaka City U.), Hideki Ishihara(Osaka City U.), Tatsuya Ogawa(Osaka City U.) , "Relativistic nontopological soliton stars in a U(1) gauge Higgs model", (Mar 17, 2022) Published in: Phys.Rev.D 105 (2022) 10, 104041, e-Print: 2203.09709 [hep-th]

264. Kenichi Kasamatsu, Maki Okada, and Hiromitsu Takeuchi, "Kelvin wave in miscible two-component Bose-Einstein condensates", Physical Review A 107, 013309 (2023) 1-9, https://doi.org/10.1103/PhysRevA.107.013309,

265. Hiromitsu Takeuchi, "Spin-current instability at a magnetic domain wall in a ferromagnetic superfluid: A generation mechanism of eccentric fractional skyrmions", Physical Review A 105, 013328 (2022) 1-14, https://doi.org/10.1103/PhysRevA.105.013328,

266. Haruya Kokubo, Kenichi Kasamatsu, and Hiromitsu Takeuchi, "Vorticity Distribution in Quantum Kelvin–Helmholtz Instability of Binary Bose–Einstein Condensates", Journal of Low Temperature Physics 208, 410–417 (2022), https://doi.org/10.1007/s10909-021-02660-1,

267. Haruya Kokubo, Kenichi Kasamatsu, and Hiromitsu Takeuchi, "Pattern formation of quantum Kelvin-Helmholtz instability in binary superfluids", Physical Review A 104, 023312 (2021) 1-16, https://doi.org/10.1103/PhysRevA.104.023312,

268. Hiromitsu Takeuchi, "Phase diagram of vortices in the polar phase of spin-1 Bose-Einstein condensates", Physical Review A 104, 013316 (2021) 1-15, https://doi.org/10.1103/PhysRevA.104.013316,

269. Hiromitsu Takeuchi, "Quantum Elliptic Vortex in a Nematic-Spin Bose-Einstein Condensate", Physical Review Letters 126, 195302 (2021) 1-7, https://doi.org/10.1103/PhysRevLett.126.195302,

270. Andrew P. C. Underwood, D. Baillie, P. Blair Blakie, and H. Takeuchi, "Properties of a nematic spin vortex in an antiferromagnetic spin-1 Bose-Einstein condensate", Physical Review A 102, 023326 (2020) 1-10, https://doi.org/10.1103/PhysRevA.102.023326,

271. I-Kang Liu, Shih-Chuan Gou, Hiromitsu Takeuchi, "Phase Diagram of Solitons in the Polar Phase of a Spin-1 Bose-Einstein Condensate", Physical Review Research 2, 033506 (2020) 1-8, https://doi.org/10.1103/PhysRevResearch.2.033506,

272. H. Tsukiyama, S. Morota, S. Shimono, Y. Iwasaki, M. Hagiwara, Y. Hosokoshi, and H. Yamaguchi, "Crystal structures and magnetic properties of verdazyl-based complexes with transition metals", Phys. Rev. Mater., 6(9), 094417/1-8 (2022). DOI: 10.1103/PhysRevMaterials.6.094417

273. H. Yamaguchi, S. C. Furuya, S. Morota, S. Shimono, T. Kawakami, Y. Kusanose, Y. Shimura, K. Nakano, and Y. Hosokoshi, "Observation of thermodynamics originating from a mixed-spin ferromagnetic chain", Phys. Rev. B, 106(10), L100404/1-5 (2022). DOI: 10.1103/PhysRevB.106.L100404

274. Kazuya Nomura, Yasuhiro H. Matsuda, Akihiko Ikeda, Yoshimitsu Kohama, Hiroshi Tsuda, Naoki Amaya, Toshio Ono, and Yuko Hosokoshi, "Metastable magnetization plateaus in the S=1 organic spin ladder BIP-TENO induced by a microsecond-pulsed megagauss field", Phys. Rev. B, 105(21), 214430/1-8 (2022). DOI: 10.1103/PhysRevB.105.214430

275. H. Yamaguchi, N. Uemoto, T. Okubo, Y. Kono, S. Kittaka, T. Sakakibara, T. Yajima, S. Shimono, Y. Iwasaki, and Y. Hosokoshi, "Gapped ground state in a spin-1/2 frustrated square lattice", Phys. Rev. B, 104(6), L060411/1-5 (2021). DOI: 10.1103/PhysRevB.104.L060411

276. H. Yamaguchi, Y. Iwasaki, Y. Kono, T. Okubo, S. Miyamoto, Y. Hosokoshi, A. Matsuo, T. Sakakibara, T. Kida, and M. Hagiwara, "Quantum critical phenomena in a spin-1/2frustrated square lattice with spatial anisotropy", Phys. Rev. B, 103(22), L220407 /1-5 (2021), DOI:10.1103/PhysRevB.103.L220407

277. Hironori Yamaguchi, Taiki Okita, Yoshiki Iwasaki, Yohei Kono, Yuko Hosokoshi, Takanori Kida, Akira Matsuo, Takashi Kawakami, and Masayuki Hagiwara, "Magnetic Properties of a Mixed Spin-(1/2,5/2) Chain in (4-Cl-o-MePy-V)FeCl4", J. Phys. Soc. Jpn., 90(6), 064707/1-9 (2021). https://doi.org/10.7566/JPSJ.90.064707

278. H. Yamaguchi, Y. Iwasaki, Y. Kono, T. Okita, A. Matsuo, M. Akaki, M. Hagiwara, and Y. Hosokoshi, "Low-energy magnetic excitations in the mixed spin-(1/2, 5/2) chain", Phys. Rev. B, 102(6), 060408(R)/1-5 (2020). DOI: 10.1103/PhysRevB.102.060408

279. Hironori Yamaguchi, Taiki Okita, Yoshiki Iwasaki, Yohei Kono, Nao Uemoto, Yuko Hosokoshi, Takanori Kida, Takashi Kawakami, Akira Matsuo, Masayuki Hagiwara, "Experimental realization of Lieb-Mattis plateau in a quantum spin chain", Scientific Reports, 10, 9193/1-5 (2020) https://doi.org/10.1038/s41598-020-66336-8

280. Y. Iwasaki, T. Okabe, N. Uemoto, Y. Kono, Y. Hosokoshi, S. Nakamura, S. Kittaka, T. Sakakibara, M. Hagiwara, T. Kawakami, and H. Yamaguch, "Magnetic properties of a spin-2 antiferromagnet with metal-radical hybrid spins", Phys. Rev. B, 101(17), 174412/1-6 (2020). DOI: 10.1103/PhysRevB.101.174412

281. G. Caria *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of $\mathcal{R}(D)$ and $\mathcal{R}(D^*)$ with a semileptonic tagging method," Phys. Rev. Lett. **124**, no.16, 161803 (2020) doi:10.1103/PhysRevLett.124.161803 [arXiv:1910.05864 [hep-ex]].

282. R. Seidl *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Update of inclusive cross sections of single and pairs of identified light charged hadrons," Phys. Rev. D **101**, no.9, 092004 (2020) doi:10.1103/PhysRevD.101.092004 [arXiv:2001.10194 [hep-ex]].

283. Y. Q. Chen *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Dalitz analysis of $D^0 \to K^-\pi^+\eta$ decays at Belle," Phys. Rev. D **102**, no.1, 012002 (2020) doi:10.1103/PhysRevD.102.012002 [arXiv:2003.07759 [hep-ex]].

284. K. Chilikin *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "First search for the $\eta_{c2}(1D)$ in B decays at Belle," JHEP **05**, 034 (2020) doi:10.1007/JHEP05(2020)034 [arXiv:2003.08335 [hep-ex]].

285. S. Jia *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Evidence for a vector charmoniumlike state in $e^+e^- \to D_s^+ D_{s2}^*(2573)^- + c.c.$," Phys. Rev. D **101**, no.9, 091101 (2020) doi:10.1103/PhysRevD.101.091101 [arXiv:2004.02404 [hep-ex]].

286. Y. Ku *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for B^0 decays to invisible final states $(+\gamma)$ at Belle," Phys. Rev. D **102**, no.1, 012003 (2020) doi:10.1103/PhysRevD.102.012003 [arXiv:2004.03826 [hep-ex]].

287. Y. Li *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for a doubly-charged DDK bound state in $\Upsilon(1S, 2S)$ inclusive decays and via direct production in e^+e^- collisions at $\sqrt{s} = 10.520$, 10.580, and 10.867 GeV," Phys. Rev. D **102**, no.11, 112001 (2020) doi:10.1103/PhysRevD.102.112001 [arXiv:2008.13341 [hep-ex]].

288. J. Yelton *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Study of electromagnetic decays of orbitally excited Ξ_c baryons," Phys. Rev. D **102**, no.7, 071103 (2020) doi:10.1103/PhysRevD.102.071103 [arXiv:2009.03951 [hep-ex]].

289. P. Oskin *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for transitions from $\Upsilon(4S)$ and $\Upsilon(5S)$ to $\eta_b(1S)$ and $\eta_b(2S)$ with emission of an ω meson," Phys. Rev. D **102**, no.9, 092011 (2020) doi:10.1103/PhysRevD.102.092011 [arXiv:2009.11720 [hep-ex]].

290. D. Sahoo *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for lepton-number- and baryon-number-violating tau decays at Belle," Phys. Rev. D **102**, 111101 (2020) doi:10.1103/PhysRevD.102.111101 [arXiv:2010.15361 [hep-ex]].

291. K. H. Kang *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of time-dependent CP violation parameters in $B^0 \to K_0^S K_0^S K_0^S$ decays at Belle," Phys. Rev. D **103**, no.3, 032003 (2021) doi:10.1103/PhysRevD.103.032003 [arXiv:2011.00793 [hep-ex]].

292. J. Y. Lee *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of branching fractions of $\Lambda_c^+ \to \eta\Lambda\pi^+$, $\eta\Sigma^0\pi^+$, $\Lambda(1670)\pi^+$, and $\eta\Sigma(1385)^+$," Phys. Rev. D **103**, no.5, 052005 (2021) doi:10.1103/PhysRevD.103.052005 [arXiv:2008.11575 [hep-ex]].

293. S. Mohanty *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of branching fraction and search for CP violation in $B \to \phi\phi K$," Phys. Rev. D **103**, no.5, 052013 (2021) doi:10.1103/PhysRevD.103.052013 [arXiv:2101.07753 [hep-ex]].

294. C. Beleño *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of the branching fraction of the decay $B^+ \to \pi^+\pi^- l^+\nu_l$ in fully reconstructed events at Belle," Phys. Rev. D **103**, no.11, 112001 (2021) doi:10.1103/PhysRevD.103.112001 [arXiv:2005.07766 [hep-ex]].

295. Y. Teramoto *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Evidence for $X(3872) \to J/\psi\pi^+\pi^-$ Produced in Single-Tag Two-Photon Interactions," Phys. Rev. Lett. **126**, no.12, 122001 (2021) doi:10.1103/PhysRevLett.126.122001 [arXiv:2007.05696 [hep-ex]].

296. T. J. Moon *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "First determination of the spin and parity of the charmed-strange baryon $\Xi_c(2970)^+$," Phys. Rev. D **103**, no.11, L111101 (2021) doi:10.1103/PhysRevD.103.L111101 [arXiv:2007.14700 [hep-ex]].

297. S. H. Park *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for the dark photon in $B^0 \to A'A'$, $A' \to e^+e^-$, $\mu^+\mu^-$, and $\pi^+\pi^-$ decays at Belle," JHEP **04**, 191 (2021) doi:10.1007/JHEP04(2021)191 [arXiv:2012.02538 [hep-ex]].

298. J. T. McNeil *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of the resonant and nonresonant branching ratios in $\Xi_c^0 \to \Xi^0 K^+ K^-$," Phys. Rev. D **103**, no.11, 112002 (2021) doi:10.1103/PhysRevD.103.112002 [arXiv:2012.05607 [hep-ex]].

299. L. Cao *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurements of Partial Branching Fractions of Inclusive $B \to X_u\,\ell^+\,\nu_\ell$ Decays with Hadronic Tagging," Phys. Rev. D **104**, no.1, 012008 (2021) doi:10.1103/PhysRevD.104.012008 [arXiv:2102.00020 [hep-ex]].

300. S. Dubey *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for $B_s^0 \to \eta' X_{s\bar{s}}$ at Belle Using a Semi-Inclusive Method," Phys. Rev. D **104**, no.1, 012007 (2021) doi:10.1103/PhysRevD.104.012007 [arXiv:2102.10266 [hep-ex]].

301. S. X. Li *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurements of the branching fractions of $\Lambda_c^+ \to p\eta$ and $\Lambda_c^+ \to p\pi^0$ decays at Belle," Phys. Rev. D **103**, no.7, 072004 (2021) doi:10.1103/PhysRevD.103.072004 [arXiv:2102.12226 [hep-ex]].

302. Y. B. Li *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurements of the branching fractions of the semileptonic decays $\Xi_c^0 \to \Xi^- \ell^+ \nu_\ell$ and the asymmetry parameter of $\Xi_c^0 \to \Xi^- \pi^+$," Phys. Rev. Lett. **127**, no.12, 121803 (2021) doi:10.1103/PhysRevLett.127.121803 [arXiv:2103.06496 [hep-ex]].

303. Y. Guan *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of branching fractions and CP asymmetries for $D_s^+ \to K^+(\eta, \pi^0)$ and $D_s^+ \to \pi^+(\eta, \pi^0)$ decays at Belle," Phys. Rev. D **103**, 112005 (2021) doi:10.1103/PhysRevD.103.112005 [arXiv:2103.09969 [hep-ex]].

304. R. Mizuk *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of the energy dependence of the $e^+e^- \to B\overline{B}$, $B\overline{B}^*$ and $B^*\overline{B}^*$ exclusive cross sections," JHEP **06**, 137 (2021) doi:10.1007/JHEP06(2021)137 [arXiv:2104.08371 [hep-ex]].

305. F. Abudinén *et al.* [The Belle-II Collaboration, including M. Iwasaki and E. Nakano], "Search for $B^+ \to K^+\nu\bar{\nu}$ Decays Using an Inclusive Tagging Method at Belle II," Phys. Rev. Lett. **127**, no.18, 181802 (2021) doi:10.1103/PhysRevLett.127.181802 [arXiv:2104.12624 [hep-ex]].

306. Y. Li *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Evidence for the decay $\Omega_c^0 \to \pi^+\Omega(2012)^- \to \pi^+(\bar{K}\Xi)^-$," Phys. Rev. D **104**, no.5, 052005 (2021) doi:10.1103/PhysRevD.104.052005 [arXiv:2106.00892 [hep-ex]].

307. L. K. Li *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of branching fractions and search for CP violation in $D^0 \to \pi^+\pi^-\eta$, $D^0 \to K^+K^-\eta$, and $D^0 \to \phi\eta$ at Belle," JHEP **09**, 075 (2021) doi:10.1007/JHEP09(2021)075 [arXiv:2106.04286 [hep-ex]].

308. S. Jia *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for the $\eta_{c2}(1D)$ in $e^+e^- \to \gamma\eta_{c2}(1D)$ at $\sqrt{s}$ near 10.6 GeV at Belle," Phys. Rev. D **104**, 012012 (2021) doi:10.1103/PhysRevD.104.012012 [arXiv:2106.09224 [hep-ex]].

309. N. K. Nisar *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for the Decay $B_s^0 \to \eta'\eta$," Phys. Rev. D **104**, no.3, L031101 (2021) doi:10.1103/PhysRevD.104.L031101 [arXiv:2106.09695 [hep-ex]].

310. J. Yelton *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of the masses and widths of the $\Sigma_c(2455)^+$ and $\Sigma_c(2520)^+$ baryons," Phys. Rev. D **104**, no.5, 052003 (2021) doi:10.1103/PhysRevD.104.052003 [arXiv:2107.05615 [hep-ex]].

311. L. Cao *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of Differential Branching Fractions of Inclusive $B \to X_u\, \ell^+\, \nu_\ell$ Decays," Phys. Rev. Lett. **127**, no.26, 261801 (2021) doi:10.1103/PhysRevLett.127.261801 [arXiv:2107.13855 [hep-ex]].

312. F. Abudinén *et al.* [The Belle-II Collaboration, including M. Iwasaki and E. Nakano], "Precise measurement of the D^0 and D^+ lifetimes at Belle II," Phys. Rev. Lett. **127**, no.21, 211801 (2021) doi:10.1103/PhysRevLett.127.211801 [arXiv:2108.03216 [hep-ex]].

313. E. Kovalenko *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Study of $e^+e^- \to \Upsilon(1S, 2S)\eta$ and $e^+e^- \to \Upsilon(1S)\eta'$ at $\sqrt{s} = 10.866$ GeV with the Belle detector," Phys. Rev. D **104**, no.11, 112006 (2021) doi:10.1103/PhysRevD.104.112006 [arXiv:2108.04426 [hep-ex]].

314. S. X. Li *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of the branching fraction of $\Lambda_c^+ \to p\omega$ decay at Belle," Phys. Rev. D **104**, no.7, 072008 (2021) doi:10.1103/PhysRevD.104.072008 [arXiv:2108.11301 [hep-ex]].

315. H. Atmacan *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for $B^0 \to \tau^\pm \ell^\mp$ ($\ell = e, \mu$) with a hadronic tagging method at Belle," Phys. Rev. D **104**, no.9, L091105 (2021) doi:10.1103/PhysRevD.104.L091105 [arXiv:2108.11649 [hep-ex]].

316. R. van Tonder *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurements of q^2 Moments of Inclusive $B \to X_c \ell^+ \nu_\ell$ Decays with Hadronic Tagging," Phys. Rev. D **104**, no.11, 112011 (2021) doi:10.1103/PhysRevD.104.112011 [arXiv:2109.01685 [hep-ex]].

317. B. Wang *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurement of $\mathcal{B}(B_s \to D_s X)$ with B_s semileptonic tagging," Phys. Rev. D **105**, no.1, 012004 (2022) doi:10.1103/PhysRevD.105.012004 [arXiv:2106.11265 [hep-ex]].

318. F. Abudinén *et al.* [The Belle and Belle-II Collaborations, including M. Iwasaki and E. Nakano], "Combined analysis of Belle and Belle II data to determine the CKM angle ϕ_3 using $B^+ \to D(K_S^0 h^- h^+) h^+$ decays," JHEP **02**, 063 (2022), doi:10.1007/JHEP02(2022)063 [arXiv:2110.12125 [hep-ex]].

319. C. Hadjivasiliou *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for B^0 meson decays into Λ and missing energy with a hadronic tagging method at Belle," Phys. Rev. D **105**, no.5, L051101 (2022), doi:10.1103/PhysRevD.105.L051101 [arXiv:2110.14086 [hep-ex]].

320. E. Waheed *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Study of $\overline{B}^0 \to D^+ h^- (h = K/\pi)$ decays at Belle," Phys. Rev. D **105**, no.1, 012003 (2022), doi:10.1103/PhysRevD.105.012003 [arXiv:2111.04978 [hep-ex]].

321. Y. Li *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Measurements of the branching fractions of $\Xi_c^0 \to \Lambda K_S^0$, $\Xi_c^0 \to \Sigma^0 K_S^0$, and $\Xi_c^0 \to \Sigma^+ K^-$ decays at Belle," Phys. Rev. D **105**, no.1, L011102 (2022), doi:10.1103/PhysRevD.105.L011102 [arXiv:2111.08981 [hep-ex]].

322. B. Bhuyan *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for the decay $B_s^0 \to \eta\eta$," Phys. Rev. D **105**, no.1, 012007 (2022), doi:10.1103/PhysRevD.105.012007 [arXiv:2111.14437 [hep-ex]].

323. X. Y. Gao *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for tetraquark states $X_{cc\bar{s}\bar{s}}$ in $D_s^+ D_s^+$ ($D_s^{*+} D_s^{*+}$) final states at Belle," Phys. Rev. D **105**, no.3, 032002 (2022), doi:10.1103/PhysRevD.105.032002 [arXiv:2112.02497 [hep-ex]].

324. S. Jia *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "Search for a light Higgs boson in single-photon decays of $\Upsilon(1S)$ using $\Upsilon(2S) \to \pi^+\pi^-\Upsilon(1S)$ tagging method," Phys. Rev. Lett. **128**, no.8, 081804 (2022), doi:10.1103/PhysRevLett.128.081804 [arXiv:2112.11852 [hep-ex]].

325. S. X. Li *et al.* [The Belle Collaboration, including M. Iwasaki and E. Nakano], "First Measurement of the $\Lambda_c^+ \to p\eta'$ decay," JHEP **03**, 090 (2022), doi:10.1007/JHEP03(2022)090 [arXiv:2112.14276 [hep-ex]].

9 MEMBERS

Director

Hiroshi Itoyama, NITEP, Professor with term

Deputy Director

Nobuyuki Kanda, NITEP, Professor

Research Scientists

Hideki Ishihara, NITEP, Professor with term
Hiroshi Itoyama, NITEP, Professor with term (Director)
Nobuyuki Kanda, NITEP, Professor (Deputy Director)
Katsuichi Kanemoto, NITEP, Professor
Nobuhito Maru, NITEP, Professor
Takahiro Sawada, NITEP, Lecturer with term
Hiromitsu Takeuchi, NITEP, Lecturer

Concurrent Research Scientists

Naruhiko Aizawa, Graduate School of Science, Professor
Masaki Arima, Faculty of Liberal Arts, Sciences and Global Education, Professor
Yohei Chiba, Graduate School of Science, Assistant Professor with term
Toshihiro Fujii, Graduate School of Science, Associate Professor
Savannah Garmon, Graduate School of Science, Associate Professor
Naoyuki Haba, Graduate School of Science, Professor
Hiromitsu Hamabata, Graduate School of Science, Associate Professor
Wataru Horiuchi, Graduate School of Science, Associate Professor
Yuko Hosokoshi, Graduate School of Science, Professor
Takuya Iida, Graduate School of Science, Professor
Shin Inouye, Graduate School of Science, Professor
Hiroki Ishibashi, Graduate School of Science, Associate Professor
Osamu Ishikawa, Graduate School of Science, Professor
Naoyuki Itagaki, Graduate School of Science, Professor
Yousuke Itoh, Graduate School of Science, Associate Professor
Masako Iwasaki, Graduate School of Science, Associate Professor
Kazuki Kanki, Graduate School of Science, Associate Professor
Taketoshi Kawai, Graduate School of Science, Associate Professor
Atsuko Kosuga, Graduate School of Science, Associate Professor
Yoshiki Kubota, Graduate School of Science, Professor
Hiroyuki Maezawa, Graduate School of Science, Associate Professor
Chihiro Matsuoka, Graduate School of Engineering, Professor
Kohji Mizoguchi, Graduate School of Science, Professor
Tsuyoshi Mizuguchi, Graduate School of Science, Associate Professor
Sanefumi Moriyama, Graduate School of Science, Professor
Kazuyuki Muraoka, Graduate School of Science, Associate Professor
Eiichi Nakano, Graduate School of Science, Professor
Ken-ichi Nakao, Graduate School of Science, Professor
Yuunori Nishikawa, Graduate School of Science, Lecturer
Takahiro Nishinaka, Graduate School of Science, Associate Professor
Kenichi Noba, Graduate School of Science, Lecturer
Satoru Noguchi, Graduate School of Science, Professor
Ken Obara, Graduate School of Science, Lecturer

Kazuyuki Ogata, Graduate School of Science, Associate Professor
(Cross appointment with Research Center for Nuclear Physics, Osaka University)
Shoichi Ogio, Graduate School of Science, Professor
Akira Oguri, Graduate School of Science, Professor
Toshikazu Onishi, Graduate School of Science, Professor
Toshio Ono, Graduate School of Science, Associate Professor
Goro Oohata, Graduate School of Science, Associate Professor
Takeshi Oota, Graduate School of Science, Associate Professor with term
Koichi Sato, Graduate School of Science, Lecturer with term
Yoshihiro Seiya, Graduate School of Science, Professor
Mitsuru Sugisaki, Graduate School of Science, Associate Professor
Satoshi Tanaka, Graduate School of Science, Professor
Makoto Tsubota, Graduate School of Science, Professor
Yoshiki Tsunesada, Graduate School of Science, Professor
Kazuhiro Yamamoto, Graduate School of Science, Associate Professor
Masato Yamanaka, Graduate School of Science, Assistant Professor with term
Hideo Yano, Graduate School of Science, Associate Professor
Hirotaka Yoshino, Graduate School of Science, Associate Professor
Munekazu Horikoshi, Graduate School of Science, Associate Professor

Endowed Course: Laser Cooled Atom Lab

Shin Inouye, Graduate School of Science, Professor (Concurrent with the NITEP researcher)
Kohei Kato, Graduate School of Science, Assistant Professor with term

Concurrent Post Researchers

Hiroyuki Sakuragi, Vice President (Graduate School of Science)

Research Fellows

Yoshimichi Teratani, Graduate School of Science, Assistant Professor with term
Natsuki Teshima, Graduate School of Science, Assistant Professor with term
Kazuhiko Tsutsumi, NITEP, Assistant Professor with term
Satoshi Yui, Graduate School of Science, Assistant Professor with term

Special Researchers

Hidetoshi Awata, Graduate School of Mathematics, Nagoya University
Keitaro Fujita, Graduate School of Science
Takuya Hirose, NITEP
Nagisa Hiroshima, School of Science, University of Toyama
Hiroyuki Kanno, Graduate School of Mathematics, Nagoya University
Rosa Mayta Palacios,
Reiji Yoshioka, Osaka City Advanced Mathematical Institute

Nambu Yoichiro Institute of Theoretical and Experimental Physics (NITEP),
Osaka City University,
3-3-138, Sugimoto, Sumiyoshi-ku, Osaka, 558-8585, Japan

https://www.nitep.osaka-cu.ac.jp/en/index.html