Partner Institution
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1. Abstract

The Center for Nuclear Study (CNS) aims to elucidate the nature of nuclear system by producing the characteristic states where the Isospin, Spin and Quark degrees of freedom play central roles. These researches in CNS lead to the understanding of the matter based on common natures of many-body systems in various phases. We also aim at elucidating the explosion phenomena and the evolution of the universe by the direct measurements simulating nuclear reactions in the universe. In order to advance the nuclear science with heavy-ion reactions, we develop AVF upgrade, CRIB and SHARAQ facilities in the large-scale accelerators laboratories RIBF. The OEDO facility has been developed as an upgrade of the SHARAQ, where a RF deflector system has been introduced to obtain a good quality of low-energy beam. A new project for fundamental symmetry using heavy RIs has been starting to install new experimental devices in the RIBF. We promote collaboration programs at RIBF as well as RHIC-PHENIX and ALICE-LHC with scientists in the world, and host international meetings and conferences. We also provide educational opportunities to young scientists in the heavy-ion science through the graduate course as a member of the department of physics in the University of Tokyo and through hosting the international summer school.

2. Major Research Subjects

(1) Accelerator Physics
(2) Nuclear Astrophysics
(3) DONUTS/NUSPEQ
(4) Quark Physics
(5) Nuclear Theory
(6) OEDO/SHARAQ
(7) Exotic Nuclear Reaction
(8) Fundamental Physics

3. Summary of Research Activity

(1) Accelerator Physics

One of the major tasks of the accelerator group is the development of ion sources and the optimization of the beam transport system for the experimental devices installed in the E7 experiment room. In 2023, HyperECR ion source was operated for 1,888 hours. A novel stability control system for the ion source is currently under development using machine learning technology. For the first step, a beam current prediction model was developed using plasma images and control parameters. It was tested on several operation data and performed adequately in some cases. For the development of the pepper-pot emittance monitor, the experiment was planned and performed in the MALT (Micro Analysis Laboratory, Tandem accelerator, The University of Tokyo) to search the measurement error. The prototype of the beam shutter system to devoid heating the monitor while exposing ion beam was tested. The shutter speed was achieved within 0.27 second.

(2) Nuclear Astrophysics

The main activity of the nuclear astrophysics group is to study astrophysical reactions and special nuclear structures, using the low-energy RI beam separator CRIB. The experiments at CRIB with the presence of international collaborators on-site had been suspended since 2020, but restarted from the ^{14}O(α, p) reaction measurement performed in March, 2023. We carried out an experiment separated into two beamtimes in May 2023 and January 2024, using a ^{6}He beam at CRIB, for measuring ^{6}He+p elastic scattering and ^{6}He(p, t)/(p, d) transfer reactions. To obtain an improved detection efficiency of the ^{6}He beam, multi-wire drift chambers (MWDC) were first introduced for the main measurements at CRIB.

(3) DONUTS/NUSPEQ

The Low Energy Nuclear Reaction group studies exotic structures in high-isospin and/or high-spin states in nuclei. In the spring of 2023, we focus on the analysis of the experimental data which were obtained before. As a result, the parts of ImPACT17-02-01 and -2, the transmutation of the long-lived fission products with protons and detereons, and the surrogate reaction of the neutron capture reaction, have been published. The data analysis of the other experiments are in progress. In addition, as a pilot experiment of the fusion reaction measurement at OEDO in the future, we launched a new project to evaluate the fusion reaction cross sections of the near symmetric system at HIMAC. Also the ASAGI board for the readout of SR-PPAC is being developed. The CNS GRAPE (Gamma-Ray detector Array with Position and Energy sensitivity) is a major instrument for high-resolution in-beam gamma-ray spectroscopy. The digital signal processing equipment for the GRAPE is under development.

(4) Quark Physics

Main goal of the quark physics group is to understand the properties of many-body QCD system such as quark-gluon plasma at extremely high-temperatures and color-glass condensate at extremely high-energies. The group has been involved in the PHENIX experiment at Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory, the ALICE experiment at Large Hadron

Collider (LHC) at CERN, and the ePIC experiment at the Electron-Ion Collider (EIC) at BNL, where the EIC is the future collider project at BNL and will start its operation from 2030. As for ALICE, the group has involved in the data analyses, which include the measurement of low-mass lepton pairs in Pb-Pb collisions, the measurement of long range two particle correlations in p-Pb collisions, searches for thermal photons in high multiplicity pp collisions. The group has involved in the ALICE-TPC upgrade using a Gas Electron Multiplier (GEM), where the group is very active in the development and benchmarking of the online space-charge distortion corrections using machine learning techniques running on the Graphical Processing Unit (GPU). The group has started R&D for the MAPS silicon pixel detector for the ALICE ITS3 and ALICE3 upgrade. The group newly joined in the ePIC experiment for the EIC and started some activities for the development of streaming data acqusition system.

(5) Nuclear Theory

The nuclear theory group is conducting large-scale shell-model calculations, having a strong relationship to the project "Program for Promoting Researches on the Supercomputer Fugaku." One of the key achievements in FY2023 is investigation of triaxiality based on our calculations reproducing rotational bands of nuclei around ^{166}Er. We are also performing shell-model calculations for the structure of neutron-rich nuclei in collaboration with experiments carried out in RIBF, RIKEN, focusing on the region around ^{54}Ca. In FY2023, we have accepted two graduate students from the University of Oslo, and instructed them on skills of large-scale shell-model calculations for analyzing experimental data concerning the Oslo method.

(6) OEDO/SHARAQ

The OEDO/SHARAQ group pursues experimental studies with RI beams by using the high-resolution beamline and the SHARAQ spectrometer, and the OEDO for the decelerated RI beams. The uniqueness of the OEDO-SHARAQ system is its versatile performance in low-energy RI production and high-resolution spectroscopy. Since there is no experiment in 2023, we focus on the analysis of the data and maintaining the beam line. The result of SHARAQ11, the search for a trineutron state, has been submitted. The results of the mass-measurement of proton-drip line nuclei has been summarized as a PhD thesis of the University of Tokyo. The experimental study of 0^- strength in nuclei using the parity-transfer charge exchange (^{16}O, ^{16}F) is in the final stage. We are also discussing the future plan of OEDO/SHARAQ.

(7) Exotic Nuclear Reaction

The Exotic Nuclear Reaction group studies various exotic reactions induced by heavy-ion beams. We continued the data analysis of the the double charge exchange ^{48}Ca(^{12}C, ^{12}Be) reaction taken in 2021 for a search of double Gamow-Teller resonance.

(8) Fundamental Physics

The development of a quantum sensor to search for a permanent electric dipole moment (EDM) with an optical lattice interferometer is in progress at RIKEN RIBF. In this fiscal year, we have developed a thermal ^{221}Fr atom source for its magneto-optical trapping. This new device allows to continuously supply thermal ^{221}Fr atoms into a magneto optical trap system, as a consequence realizing a large amount of laser-cooled ^{221}Fr atoms used for the EDM measurement. As the measurement precision strongly depends on the number of trapped ^{221}Fr, the newly developed apparatus is essential towards searching the EDM with high precision.

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List of Publications & Presentations

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[Original Papers]

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Presentations

[International Conferences/Workshops]

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K. Kamakura (poster), "Status Report on the 14 GHz ECR Ion Source at CNS/UTokyo," UTokyo ETHZ UZH Symposium 2023, Hönggerberg (ETHZ), Zurich, Switzerland, October 15–17, 2023.

H. Yamaguchi (oral), "Nuclear Astrophysics with low-energy RI beams at CRIB," 17th International Symposium on Nuclei in the Cosmos (NIC XVII), Daejeon (Institute for Basic Science), Korea, September 17–22, 2023.

H. Yamaguchi (oral, invited), "Nuclear astrophysics with exotic beam; thick-target method measurements at CRIB," International Symposium on Nuclear Astrophysics (ISNA2023), Manipal (Manipal Centre for Natural Sciences, Manipal Academy of Higher Education), India, October 30–November 3, 2023.

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S. Hayakawa (poster), "Measurement and evaluation of the ^{7}Be + n reactions approaching the cosmological lithium problem," 17th International Symposium on Nuclei in the Cosmos (NIC XVII), Daejeon, Republic of Korea, September 17–22, 2023.

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R. Yokoyama (invited), "Future Programs at RIBF OEDO/SHARAQ: Utilizing Low Energy Heavy Ion Beams and Liq H_2 Targets," Direct reactions and spectroscopy with hydrogen targets: past 10 years at the RIBF and future prospects, Hilton York Hotel, July 31–August 4, 2023.

N. Imai (invited), "A new technique to determine gamma emission probability above the neutron threshold without gamma-ray detectors," 17th International Symposium on Capture Gamma-Ray Spectrosopy and Related Topics (CGS17), Grenoble, France, July 17–21, 2023.

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R. Yokoyama (invited), "Decay spectroscopy of exotic nuclei at RIBF," 6th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan, Hawaii (Hilton Waikoloa Village), USA, November 26–December 1, 2023.

S. Hanai (invited), "Development of detection systems in the OEDO-SHARAQ beamline for RI beam experiments," 6th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan, Hawaii (Hilton Waikoloa Village), USA, November 26–December 1, 2023.

R. Yokoyama (oral), "Study of the β-delayed multi-neutron emission process through γ-neutron spectroscopy of gallium isotopes," 6th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan, Hawaii (Hilton Waikoloa Village), USA, November 26–December 1, 2023.

N. Kitamura (invited), "OEDO-SHARAQ: achievements and prospects," 2023 Annual Meeting of JSPS/NRF/NSFC A3 Foresight Program "Nuclear Physics in the 21st Century," Xi'an, China, December, 2023.

N. Imai (invited), "Physics with the decelerated RI beams," Advancing physics at next RIBF (ADRIB24), Wako (RIKEN), Japan, January 23–24, 2024.

R. Yokoyama (invited), "Systematic beta3 measurement around octupole magic at $Z = 56$ and $N = 88$," A3F-Workshop on frontier nuclear studies with gamma-ray spectrometer arrays, Osaka University Minoh Campus, March 26–28, 2024.

N. Kitamura (invited), "Detailed in-beam gamma-ray spectroscopy using GRETINA: the case of ^{32}Mg," A3F-Workshop on frontier nuclear studies with gamma-ray spectrometer arrays, Osaka (Osaka University Minoh Campus), Japan, March 26–28, 2024.

S. Hanai (invited), "Mass measurement in the vicinity of 2 proton emitters," RCNP workshop Microscopic approach from pair correlation to pair condensation, Osaka (RCNP, Osaka University), Japan, September 26–28, 2023.

T. Chillery (oral), "Astrophysical Reactions Important in r- and νp processes Measured Using (d, p) Transfer Reactions at OEDO-SHARAQ," Nuclei in the Cosmos XVII, Daejeon, Korea, September 17–22, 2023.

N. Imai (oral), "Possible experiments with 8pi," A3F-Workshop on frontier nuclear studies with gamma-ray spectrometer arrays (gamma24), Osaka (Osaka University Minoh Campus), Japan, March 26–28, 2024.

S. Michimasa (oral), "OEDO-SHARAQ system: Its multifaceted performance and recent experimental achievements," The 4th International Conference on Advances in Radioactive Isotope Science (ARIS2023), Avignon, France, June 4–9, 2023.

J. T. Li (poster), "Development of a mosaic type array formed by Si photodiodes for charged-particle detection in heavy-ion collisions," International Conference on Heavy-Ion Collisions at near-barrier energies (FUSION23), Shizuoka, Japan, November 15–19, 2023.

J. T. Li (poster), "Performance of the Si photodiodes for the ancillary detector of in-beam γ experiments," A3F-Workshop on frontier nuclear studies with gamma-ray spectrometer arrays (gamma24), Osaka (Osaka University Minoh Campus), Japan, March 26–28, 2024.

S. Hanai (poster), "Direct mass measurement of neutron-deficient Fe isotopes," Advances in Radioactive Isotope Science (ARIS2023),

Avignon, France, June 4–9, 2023.

D. Sekihata (oral) for the ALICE Collaboration, "Electromagnetic radiation in pp and Pb–Pb collisions with dielectrons in ALICE," Quark Matter 2023-XXXth International Conference on Ultra-relativistic Nucleus-Nucleus Collisions (QM2023), September 3–9, 2023, Houston, Texas, USA

Y. Sekiguchi (poster) for the ALICE Collaboration, "Measurements of long-range two-particle correlation over a wide pseudorapidity range in p–Pb collisions at 5.02 TeV," Quark Matter 2023-XXXth International Conference on Ultra-relativistic Nucleus-Nucleus Collisions (QM2023), Houston, Texas, USA, September 3–9, 2023.

D. Sekihata (oral) for the ALICE Collaboration, "Electromagnetic radiation in ALICE at the LHC," 52nd International Symposium on Multiparticle Gyöngyös, Dynamics (ISMD2023), Hungary, August 21–26, 2023.

H. Murakami (oral) for the ALICE Collaboration, "Electromagnetic radiation in pp and Pb–Pb collisions with dielectrons in ALICE," European Physical Society Conference on High Energy Physics (EPS-HEP2023), Hamburg, Germany, August 21–25, 2023.

D. Sekihata (oral) for the ALICE Collaboration, "Low mass dielectron measurements in Pb–Pb collisions with ALICE at the LHC," 9th Asian Triangle Heavy-Ion Conference (ATHIC2023), Hiroshima, Japan, April 24–27, 2023.

H. Murakami (oral) for the ALICE Collaboration, "Dielectron production in high-multiplicity pp collisions at $\sqrt{s} = 13$ TeV with ALICE," 9th Asian Triangle Heavy-Ion Conference (ATHIC2023), Hiroshima, Japan, April 24–27, 2023.

H. Baba (oral) for the ALICE Collaboration, "Studies of space-charge distortion corrections using machine learning techniques," 9th Asian Triangle Heavy-Ion Conference (ATHIC2023), Hiroshima, Japan, April 24–27, 2023.

Y. Sekiguchi (invited), "QGP in small systems (Experiment)," 9th Asian Triangle Heavy-Ion Conference (ATHIC2023), Hiroshima, Japan, April 24–27, 2023.

T. Gunji (oral), "Hadron Physics at EIC," Fourth Internatinal Workshop on the Extention Project for the J-PARC Hadron Experimental Facility, Tokai, Japan, February 19–21, 2024.

D. Sekihata (oral), "Overview of direct photon measurements at the LHC," EMMI Rapid Reaction Task Force for Direct Photon Puzzle, Heidelberg University, Germany, July 24–27, 2023.

T. Gunji (invited), "Online data processing using hardware accelerators for nuclear physics experiments," 6th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan, Waikoloa, Hawaii, USA, November 26–December 1, 2023.

T. Gunji (invited), "Future prospects of hot and cold QCD physics at RHIC and LHC," 6th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan, Waikoloa, Hawaii, USA, November 26–December 1, 2023.

H. Murakami for the ALICE Collaboration (oral), "Dielectron production in high-multiplicity pp collisions at $sqrts = 13$ TeV with ALICE," 6th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan, Waikoloa, Hawaii, USA, November 26–December 1, 2023.

H. Baba (oral) for the ALICE Collaboration, "Application of machine learning techniques for the ALICE TPC space-charge distortion correction and for particle tracking in Si detectors," 6th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan, Waikoloa, Hawaii, USA, November 26–December 1, 2023.

S. Shindo (oral) for the ALICE Collaboration, "Simulation studies of Monolithic CMOS Si sensor with gain layer for timing measurements," 6th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan, Waikoloa, Hawaii, USA, November 26–December 1, 2023.

Y. Sekiguchi (oral) for the ALICE Collaboration, "Measurements of long-range correlations and $v_2(\eta)$ in small system with ALICE," 6th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan, Waikoloa, Hawaii, USA, November 26–December 1, 2023.

Y. Tsunoda (invited), "Large-Scale Shell-Model Calculations in Medium-Heavy Nuclei and Neutrinoless Double-Beta Decay Matrix Elements," The 2023 Gordon Research Conference on Nuclear Chemistry, New London, USA, June 11–16, 2023.

Y. Utsuno (invited), "Overview of shell evolution in the $N = 28 - 40$ region," Symposium on Direct reactions and spectroscopy with hydrogen targets: past 10 years at the RIBF and future prospects, York, UK, July 31–August 4, 2023.

Y. Tsunoda (invited), "Nuclear Structure in neutron-rich Ni region," Symposium on Direct reactions and spectroscopy with hydrogen targets: past 10 years at the RIBF and future prospects, York, UK, July 31–August 4, 2023.

T. Otsuka (oral), Y. Tsunoda, and N. Shimizu, "Structure of medium-mass nuclei studied by Monte Carlo shell model calculations," Sixth Joint Meeting of the Nuclear Physics Divisions of the APS and The JPS (HAWAII 2023), Hawaii, USA, November 26–December 1, 2023.

Y. Tsunoda (invited), "Nuclear structure studied by shell model calculations using two-nucleon amplitudes," Reimei Workshop "Intersection of Nuclear Structure and Direct Reaction," Tokai, Japan, February 28–March 1, 2024.

Y. Tsunoda (invited), "Nuclear shapes studied by Monte Carlo shell model calculations," The workshop on frontier nuclear studies with gamma-ray spectrometer arrays (gamma24), Minoh, Japan, March 26–28, 2024.

A. Sakaue (oral), "Search for double Gamow-Teller giant resonance using the double charge exchange (^{12}C,^{12} Be(0^+_2)) reaction," 6th Joint Meeting of the APS DNP and JPS, Hawaii, USA, November 27, 2023.

M. Fukase (oral), "Present status of high intensity Fr source development to search for the EDM," Symposium University of Tokyo - ETH Zurich - University of Zurich, ETH Zurich Hönggerberg Campus, October 15–17, 2023.

K. Nakamura (oral), "Current status of development of laser optics for Fr permanent electric dipole moment," Symposium University of Tokyo - ETH Zurich - University of Zurich, ETH Zurich Hönggerberg Campus, October 15–17, 2023.

T. Nakashita (poster), "Search for Fundamental Symmetry by Trapping francium Atoms," Summit of Mater. Science 2023 and GIMRT User Meeting 2023, Sendai, Japan, November 21, 2023.

H. Nagahama (oral), "Electron EDM search with laser-cooled heavy elements," 6th Joint Meeting of the APS Division of Nuclear Physics

and the Physical Society of Japan, Hawaii, USA, November 26–December 1, 2023.

H. Nagase (oral), "Development of a novel comagnetometer for high-precision measurement of the electron's electric dipole moment using laser-cooled francium atoms," 6th Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan, Hawaii, USA, November 26–December 1, 2023.

[Domestic Conferences/Workshops]

小高康照 (ポスター発表), 「理研 AVF サイクロトロンで加速される大強度イオンビーム用ペッパーポット型エミッタンス測定器開発の現状」, 第 20 回日本加速器学会年会, 船橋 (日本大学理工学部船橋校舎), 2023 年 8 月 29 日–9 月 1 日.

鎌倉恵太 (ポスター発表), 「機械学習を用いた HyperECR イオン源制御の準備状況」, 第 20 回日本加速器学会年会, 船橋 (日本大学理工学部船橋校舎), 2023 年 8 月 29 日–9 月 1 日.

小高康照 (口頭発表), 「AVF 入射ビーム横向き軌道に対する入射バンチャーの影響」, 第 21 回 AVF 合同打ち合わせ, 住友重機械工業西条工場, 2023 年 11 月 13 日.

鎌倉恵太 (口頭発表), 「東大 HyperECR イオン源の現状」, 第 21 回 AVF 合同打ち合わせ, 住友重機械工業西条工場, 2023 年 11 月 13 日.

鎌倉恵太 (口頭発表), 「東京大学 HyperECR イオン源機械学習制御に向けたビーム電流予測モデルの開発」, 加速器・ビーム物理の機械学習ワークショップ 2023, 和光市 (理化学研究所), 2023 年 11 月 27 日–29 日.

S. Hayakawa (oral), & "Recent Collaborations and activities at CRIB," RIBF Users Meeting 2023, Session 3, Wako (RIKEN), Saitama, Japan & Online, 2023 年 9 月 6–7 日.

S. Hayakawa (invited), 「CRIB で開拓する宇宙核反応測定」, 第 12 回停止・低速 RI ビームを用いた核分光研究会 (12th SSRI), Toshima, Tokyo, Japan, September 4–5, 2023.

N. Imai, "Study of the low-energy nuclear reaction at HIMAC," HIMAC における原子核物理学研究の展望, Wako (RIKEN), Saitama, November 17, 2023.

N. Kitamura, 「高分解能波形ディジタイザ FW 開発の現状と展望」, The 2nd Workshop on Signal processing and data acquisition infrastructure (SPADI2024), Wako (RIKEN), Saitama, March 2024.

郡司卓 (口頭発表), 「EIC/ePIC 実験での Streaming DAQ の開発と物理展望」, 日本物理学会 2024 年春季大会, オンライン, 2024 年 3 月 18–21 日.

関畑大貴 (口頭発表) for the ALICE Collaboration, 「LHC-ALICE 実験を用いた核子対あたり重心系エネルギー 5.02 TeV 鉛+鉛衝突における電子対生成」, 日本物理学会 2024 年春季大会, オンライン, 2024 年 3 月 18–21 日.

馬場仁志 (口頭発表) for the ALICE Collaboration, 「機械学習とハードウェアアクセラレータを用いた MAPS シリコン検出器における飛跡再構成」, 日本物理学会 2024 年春季大会, オンライン, 2024 年 3 月 18–21 日.

新堂柊二朗 (口頭発表) for the ALICE Collaboration, 「ALICE3 実験に向けた CMOS-LGAD 検出器の時間分解能に関するシミュレーションを用いた研究」, 日本物理学会 2024 年春季大会, オンライン, 2024 年 3 月 18–21 日.

小原遼太郎 (口頭発表) for the ALICE Collaboration, 「ALICE-ITS3 アップグレードに向けた babyMOSS の性能評価」, 日本物理学会 2024 年春季大会, オンライン, 2024 年 3 月 18–21 日.

関口裕子 (口頭発表), 「フロー, 粒子相関」, 第 41 回 Heavy Ion Cafe & 第 38 回 Heavy Ion Pub 合同研究会, 名古屋市（名古屋大学）, 2023 年 11 月 4 日.

村上ひかり (口頭発表), 「電磁プローブ」, 第 41 回 Heavy Ion Cafe & 第 38 回 Heavy Ion Pub 合同研究会, 名古屋市（名古屋大学）, 2023 年 11 月 4 日.

T. Gunji (oral), "ALICE3 and EIC," Platform B (Silicon) meeting : Semiconductor detectors for energy frontier experiments, KEK, Japan, July, 14, 2023.

宇都野穣（招待講演）, 「大規模殻模型計算による M1 バンドの解析」, RCNP 研究会「原子核におけるスピン自由度の織り成すダイナミクス 」, 吹田市（大阪大学), 2023 年 12 月 11–13 日.

宇都野穣（口頭発表）, 清水則孝, D. Patel, P. C. Srivastava, 「殻模型計算による中性子過剰カドミウム同位体の四重極モーメントと変形の解析」, 日本物理学会 2024 年春季大会, オンライン, 2024 年 3 月 18–21 日.

角田佑介（口頭発表), 「モンテカルロ殻模型とその発展的手法による核構造の研究」, 「成果創出加速」基礎科学合同シンポジウム, 文京区（筑波大学東京キャンパス), 2023 年 12 月 18–20 日.

Y. Tsunoda（招待講演), "Structure of medium-mass nuclei studied by Monte Carlo shell model," 日本物理学会 2024 年春季大会, オンライン, 2024 年 3 月 18–21 日.

阪上朱音, 「二重荷電交換反応 (^{12}C,^{12} Be(0^+_2)) を用いた二重ガモフ・テラー巨大共鳴の探索」, RCNP 研究会「原子核におけるスピン自由度の織り成すダイナミクス」, 吹田市 (RCNP), 2023 年 12 月 11 日.

S. Nagase (口頭発表), 「フランシウム永久電気双極子能率の精密測定に向けた光格子共存磁力計開発」, 第 5 回アトムの会, 名古屋市, 2023 年 8 月.

中村圭佑 (口頭発表), 「冷却 Fr 原子を用いた EDM 探索プロジェクトの開発状況」, 第 12 回停止・低速 RI ビームを用いた核分光研究会（12th SSRI), 豊島区（立教大学）, 2023 年 9 月.

佐藤幹 (口頭発表) , 「^{225}Ac を用いた ^{221}Fr 原子線源の開発」, 大洗アルファ合同研究会, 東京都 (東北大学東京分室), 2023 年 9 月 28 日.

[Seminars]

T. Gunji, "High energy QCD physics," International School for Strangeness Nuclear Physics, Tokai, Japan, December 11–15, 2023.

D. Sekihata, "Electromagnetic probes in ALICE at the LHC," Nuclear Physics Colloquium, Goete University Frankfurt, Germany, November 16, 2023.

N. Imai, "OEDO, the deceleration and focusing device at RIBF, and the nuclear astrophysics program with OEDO," GANIL, France, July 13, 2023.

N. Imai, "Direct reaction and *r*-process nucleosynthesis," Nuclear Physics School For Young Scientists (NUSYS-2023), Fudan University in Shanghai, China, August 7–12, 2023.

N. Imai, "Direct reaction and *r*-process nucleosynthesis," A3F-CNS Summer School 2023, August 4–10, 2023.

Award

J. T. Li, A3F-CNSSS23 Young Scientist Award, August 10, 2023.