

Nuclear Science Research Division
Nuclear Dynamics Research Group

1. Abstract

The Nuclear Dynamics Research Group (previous Spin Isospin Laboratory) pursues various aspects of nuclear reactions and dynamical phenomena in nuclear systems. At present, the laboratory is focusing on nucleon and cluster knockout reactions, charge exchange reactions, nuclear fissions, and meson-production, but will extend the research scope to other reactions such as transfer and fusion reactions at low energies.

The group studies dynamics in weakly bound and unbound states, particularly around and beyond the neutron drip line. In parallel, dynamical aspects of nuclear matter are investigated using knockout reactions, charge exchange reactions, and nuclear fissions.

We are also developing methodologies and devices necessary for the reaction/dynamics studies: the TOGAXSI telescope array specialized for inverse-kinematics knockout reactions, neutron detectors, the spin-polarized proton target, and storage rings.

2. Major Research Subjects

- (1) Studies of knockout reactions and their applications to the production and spectroscopy of exotic nuclei
- (2) Study of spin-isospin responses using charge exchange reactions
- (3) Study of atomic and nuclear systems with explicit meson degrees of freedom
- (4) Development of storage rings and their applications to the study of r -process nucleosynthesis
- (5) Development of techniques and devices for reaction studies with RI-beams

3. Summary of Research Activity

(1) Studies of knockout reactions and their applications to the production and spectroscopy of exotic nuclei

Knockout reactions are among the best reactions used in nuclear studies at RIBF energies. We are advancing experimental programs

(1-a) Multi-neutron correlations near the neutron dripline

The forms of existence of neutron-rich matter occurring in nuclei near the neutron dripline is the main subject of the program with large-acceptance SAMURAI spectrometer. By combining advanced devices such as MINOS (Saclay) and neutron detector arrays, we have revealed new aspects of multi-neutron correlations in nuclei: Dineutron correlation in ^{11}Li , ^{14}Be , ^{17}B [Y. Kubota *et al.*, PRL 125, A. Corsi *et al.*, PLB 840], halo structure in ^{17}B [Z. H. Yang *et al.*, PRL 126], and tetra-neutron [M. Duer *et al.*, Nature 606]. We have also taken data on ^7H populated with the $^8\text{He}(p, 2p)$ reaction.

(1-b) Nuclear cluster formation

Nuclear physicists know that the formation of clusters is essentially important at both edges of the nuclear chart: clusters are pronouncedly developed in light nuclei such as ^{12}C , and (pre-)formation of α clusters is essential in understanding decays of nuclei heavier than lead. What about in the other areas of the nuclear chart? We must admit that we have limited knowledge about it.

We attempted to answer this question by probing α clusters in tin isotopes using the $^{112-124}\text{Sn}(p, p\alpha)$ knockout experiment, conducted in close collaboration with the TU Darmstadt group. The excess-neutron ($N-Z$) dependence of the $(p, p\alpha)$ cross section shows a monotonic decrease with $N-Z$, which is in good agreement with relativistic mean-field predictions done by S. Typel [J. Tanaka, Z. H. Yang *et al.*, Science 371].

Triggered by the new knowledge obtained in this and other experiments, we have started a new research project named "ONOKORO" project, where we comprehensively investigate clustering in medium-to-heavy mass nuclei using (p, pX) cluster knockout reactions under normal and inverse kinematics. The project will probe d , t , ^3He , and α clustering in both stable and unstable nuclei in the mass region of $A = 36-220$. The TOGAXSI detector array is constructed to detect scattered protons and knocked-out clusters in a wide kinematical conditions.

(1-c) Fission barrier heights in neutron-rich heavy nuclei

The symmetry energy has a strong influence on fission barrier heights in neutron-rich nuclei. Knowledge of the fission barrier heights, which is relatively poor at present, is quite important for our proper understanding of the termination of the r -process. We are planning to perform, in collaboration with the TU Munich group, $(p, 2p)$ -delayed fission experiments at the SAMURAI to determine the fission barrier heights and fragment distributions in neutron-deficient and neutron-rich regions beyond Pb.

(1-d) Other knockout reaction-related activities

We have also applied (p, pN) reactions to gamma-ray spectroscopy (SEASTAR project in collaboration with the RI Beam Physics Group) and reaction mechanism studies [N. Paul *et al.*, PRL 122, A. Frotscher *et al.*, PRL 125].

(2) Study of spin-isospin responses using charge exchange reactions

The study of spin-isospin responses in nuclei forms one of the essential cores of nuclear physics. A variety of collective states, for example isovector giant dipole resonances, isobaric analogue states, Gamow-Teller resonances, have been extensively studied by use of electromagnetic and hadronic reactions from stable targets.

The research opportunities can be largely enhanced in light of availability of radioactive isotope (RI) beams and of physics of unstable nuclei. There are three possible directions to proceed. The first direction is studies of spin-isospin responses of unstable nuclei via inverse-kinematics charge exchange reactions. A neutron-detector array WINDS has been constructed, under a collaboration of CNS, Tokyo, and RIKEN, for inverse kinematics (p, n) experiments at the RIBF. We have already applied WINDS to the (p, n)

experiments for ^{11}Li , ^{132}Sn , and plan to extend this kind of study to other exotic nuclei.

(3) Study of atomic and nuclear systems with explicit meson degrees of freedom

(3-a) (1-3) Deeply bound pionic atoms and η' mesonic nuclei

We have been systematically working on precision spectroscopy of pionic atoms, which has led to an understanding of the nontrivial structure of the vacuum and the origin of hadron masses. The precision data set stringent constraints on the chiral condensate in nuclear media. We are currently preparing for precision systematic measurements at RIBF. In 2021, systematic high-precision spectroscopy of pionic Sn atoms was performed, and the analysis is ongoing.

We are also working on the spectroscopy of η' -mesonic nuclei at GSI/FAIR. In 2022, we performed a new experiment using a large solid angle detector of WASA at GSI to search for the η' -nucleus bound state with an enhanced signal-to-noise ratio. The analysis is being finalized.

(3-b) Deeply Bound Kaonic Nuclei

The J-PARC E15 experiment searched for the deeply bound kaonic nuclear state " K^-pp " via the in-flight $^3\text{He}(K^-, n)$ reaction. A binding energy of ~ 40 MeV was observed, indicating a compact (~ 0.6 fm) and dense state, suggesting a novel nuclear system where a meson ($\bar{q}q$) is embedded in a baryonic medium (qqq). To study heavier kaonic nuclei systematically, the new E80 experiment is planned, starting with the $\bar{K}\text{NNN}$ system. A new 4π Cylindrical Detector System composed of a superconducting solenoid magnet, a cylindrical drift chamber, and a cylindrical neutron counter is under construction.

(3-c) Study of Vector Mesons in Nuclei

J-PARC E16 investigates how vector mesons (ω, φ) change inside nuclei, aiming to understand chiral symmetry restoration in dense matter. e^+e^- decay channels are used to study in-medium modifications. After commissioning in 2020–2021, beam-related issues were resolved by 2024. Clear ω and φ peaks were observed, and full data-taking is expected to begin in 2025.

(4) Development of storage rings and their applications to the study of r -process nucleosynthesis

Storage rings will become mandatory experimental tools in future research programs with RI-beams. We have constructed the Rare RI Ring, in close collaboration with the Instrumentation Development Group, which is the first storage ring constructed at a cyclotron-based facility such as RIBF.

We have successfully published the first result from the Rare RI Ring in 2022: The mass of ^{123}Pd around the r -process second peak was measured together with ^{126}In , ^{125}Cd [H. F. Li, S. Naimi *et al.*, PRL 128]. The measurement was the first demonstration of the storage-ring application in a cyclotron facility and two novel methods, the individual injection of the preidentified rare nuclei and the isochronous mass spectroscopy in a cyclotron-type storage ring. Through detailed comparisons with r -process network calculations, it is concluded that the new ^{123}Pd mass increases the neutron capture cross section on ^{123}Pd by a factor of 2.2 and the β -delayed neutron emission probability of ^{123}Rh by 14%, and, at the same time, decreases the neutron capture cross section on ^{122}Pd by a factor of 2.6. This results in a pileup of material at $A = 122$ and reproduces the trend of the solar r -process abundances.

In parallel to the mass measurements using the Rare RI Ring, we are about to develop a storage ring specialized for nuclear reaction studies, named RUNBA.

(5) Development of techniques and devices for reaction studies with RI-beams

(5-a) TOGAXSI: a detector array specialized to inverse-kinematics cluster knockout reaction studies

As described in (1-c) and (1-d), the use of cluster knockout reactions will form a core of the research program in the Nuclear Dynamics Group. We started construction of a new detector array optimized for inverse-kinematics cluster knockout reactions, named TOGAXSI, with the KAKENHI support [KAKENHI Specially Promoted Research FY2021–2025]. The TOGAXSI consists of silicon strip detectors for tracking and GAGG:Ce scintillators for total energy measurements of scattered protons and knocked-out clusters. The demonstrator array will be completed in 2023, and the full array in 2024.

(5-b) Application of spin-polarization technique to RI-beam experiments and other fields

A technique to produce nuclear polarization by means of electron polarization in photo-excited triplet states of aromatic molecules can open new applications. The technique is called "Triplet-DNP". A distinguished feature of Triplet-DNP is that it works under a low magnetic field of 0.1–0.7 T and a temperature higher than 100 K, which exhibits a striking contrast to standard dynamic nuclear polarization (DNP) techniques working in extreme conditions of several Tesla and sub-Kelvin.

We have constructed a polarized proton target system for use in RI-beam experiments. Recent experimental and theoretical studies have revealed that spin degrees of freedom play a vital role in exotic nuclei. Tensor force effects on the evolution of the shell and possible occurrence of p-n pairing in the proton-rich region are good examples of manifestations of spin degrees of freedom. Experiments with the target system allow us to explore the spin effects in exotic nuclei. It should be noted that we have recently achieved a proton polarization of 40% at room temperature in a pentacene- d_{14} doped p -terphenyl crystal. Now the polarized target is being applied to the spin-correlation measurement of the proton-deuteron elastic scattering.

We plan to apply the same technique to other fields such as sensitivity enhancement in NMR spectroscopy of biomolecules and MRI. In close collaboration with the organic chemistry group in Kyushu University, lead by Prof. Yanai, we are developing several new molecules and techniques to open Triplet-DNP applications to NMR and MRI.

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List of Publications & Presentations**Publications****[Original Papers]**

- J. Kahlbow *et al.*, “Magicity versus superfluidity around ^{28}O viewed from the study of ^{30}F ,” *Phys. Rev. Lett.* **133**, 082501 (2024).
P. André *et al.*, “Evolution of the two-neutron configuration from ^{11}Li to ^{13}Li ,” *Phys. Lett. B* **857**, 138977 (2024).
M. Enciu *et al.*, “Spectroscopy of ^{52}K ,” *Phys. Rev. C* **110**, 064301 (2024).

- X. H. Sun *et al.*, “Production of neutron-rich nuclei in the vicinity of ^{78}Ni : Fragmentation reactions of unstable ^{81}Ga and ^{82}Ge beams,” *Phys. Lett. B* **858**, 139081 (2024).
- C. Y. Tsang *et al.*, “Constraining nucleon effective masses with flow and stopping observables from the SpiRIT experiment,” *Phys. Lett. B* **853**, 138661 (2024).
- Z. Elekes *et al.*, “Low-lying excited states in ^{62}Ge investigated by multinucleon knock-out reaction,” *J. Phys. G; Nucl. Part. Phys.* **51**, 105102 (2024).
- T. Yamaga *et al.*, “Measurement of the mesonic decay branch of the KbarNN quasibound state,” *Phys. Rev. C* **110**, 014002 (2024).
- B. Monteagudo *et al.*, “Mass, spectroscopy, and two-neutron decay of ^{16}Be ,” *Phys. Rev. Lett.* **132**, 082501 (2024).
- K. Miki *et al.*, “Precise spectroscopy of the $3n$ and $3p$ systems via the $^3\text{H}(t, ^3\text{He})3n$ and $^3\text{He}(^3\text{He}, t)3p$ Reactions at Intermediate Energies,” *Phys. Rev. Lett.* **133**, 012501 (2024).
- B. D. Linh *et al.*, “Onset of collectivity for argon isotopes close to $N = 32$,” *Phys. Rev. C* **109**, 034312 (2024).
- R. Zidarova *et al.*, “Gamma-ray spectroscopy of ^{55}Sc ,” *Phys. Scr.* **99**, 075309 (2024).
- P. Li, J. Lee *et al.*, “Spectroscopy of deeply bound orbitals in neutron-rich Ca isotopes,” *Phys. Lett. B* **855**, 138828 (2024).
- T. Uesaka, “On the kinematics of (p, pX) knockout reactions in normal and inverse kinematics,” *Prog. Theo. Exp. Phys.* **2024**, 083D01 (2024).
- A. Sakaue *et al.*, “Candidate for the Double Gamow-Teller Giant Resonance in ^{48}Ca Studied by the $(^{12}\text{C}, ^{12}\text{Be}(0_2^+))$ Reaction at 250 MeV/nucleon,” *Prog. Theo. Exp. Phys.* **2024**, 123D03 (2024).
- T. Naito, M. Kimura, and M. Sasano, “ ^{164}Pb : A possible heaviest $N = Z$ doubly magic nucleus,” *Phys. Rev. Research* **7**, 013050 (2025).
- Y. Kubota *et al.*, “ONOKORO project: Comprehensive research of cluster formation in medium-heavy and heavy nuclei,” *Nucl. Phys. A* **1060**, 123123 (2025).

[Review Articles]

- T. Uesaka and N. Itagaki, “Nuclear clustering—manifestations of nonuniformity in nuclei,” *Phil. Trans. R. Soc. A* **382**, 20230123 (2024).

[Proceedings]

- K. Itahashi *et al.*, *Acta. Phys. Polon. A* **146**, (2024), pp. 721–724.
- K. Itahashi *et al.*, *Nuovo Cim. C* **47**, (2024), p. 229.
- F. Sakuma *et al.*, “Light kaonic nuclei at J-PARC,” *PoS QNP2024* (2025), 211, 10th International Conference on Quarks and Nuclear Physics (QNP2024).
- R. Sekiya *et al.*, *Nuovo Cim. C* **47**, (2024), p. 230.
- K. Aoki *et al.*, “Experimental investigation of vector mesons in medium through dielectron decay at J-PARC,” *J. Subatomic Part. Cosmol.* **3**, (2025), p. 100019.
- M. Ichikawa, P. Gubler, M. Naruki, and S. Yokkaichi, “Analysis of spectral modification in nuclei using the PHSD transport approach,” *J. Subatomic Part. Cosmol.* **3**, (2025), p. 100018.
- H. Sako *et al.*, “Experimental studies of in-medium modification of meson mass through decays,” *J. Subatomic Part. Cosmol.* **3**, (2025), p. 100012.

Presentations

[International Conferences/Workshops]

- F. Sakuma (invited), “New kaonic nuclei project at J-PARC,” SPICE: Strange Hadrons as a Precision Tool for Strongly Interacting Systems, ECT*, Trento, Italy, May 13–17, 2024.
- Y. Kondo (invited), “Study of extremely neutron-rich oxygen isotopes,” HaloWeek’24, Gothenburg, Sweden, June 9–14, 2024.
- F. Sakuma (invited), “Present and future perspectives in hadron physics at J-PARC,” Present and Future Perspectives in Hadron Physics, Frascati, Italy, June 17–19, 2024.
- F. Sakuma (invited), “J-PARC and its hadron hall extension overview,” NSTAR 2024, York, UK, June 17–21, 2024.
- T. Uesaka (invited), “A nucleus—the core of matter and a system of entangled nucleons—,” HQI (Harvard)—FQSP (RIKEN) 1st Workshop “Perspectives of fundamental quantum science,” Wako, Japan, June 17–19, 2024.
- R. Tsuji (poster), “The study of the light cluster formation in Ca isotopes proved by the cluster knockout reactions,” 12th International Conference on Direct Reactions with Exotic Beams (DREB2024), Wiesbaden, Germany, June 24–28, 2024.
- R. Yoshida (poster), “Production cross-section measurement of ^{16}N isomer for proton elastic scattering experiment,” The 12th International Conference on Direct Reactions with Exotic Beams (DREB2024), Wiesbaden, Germany, June 24–28, 2024.
- T. Uesaka (invited), “Manifestation of non-uniformity in nuclei—challenges using knockout reactions,” The 10th International Conference on Quarks and Nuclear Physics (QNP2024), Barcelona, Spain, July 8–12, 2024.
- S. Koyama, “Charged particle decay from a highly excited state (report on SAMURAI08),” SAMURAI International Workshop 2024, Daejeon, Korea, July 14–16, 2024.
- S. Koyama, “New proposal,” SAMURAI International Workshop 2024, Daejeon, Korea, July 14–16, 2024.
- T. Uesaka, “SAMURAI management plan 2023—,” SAMURAI International Workshop 2024, Daejeon, Korea, July 14–16, 2024.
- F. Sakuma (oral), “Light kaonic nuclei at J-PARC,” QNP2024—The 10th International Conference on Quarks and Nuclear Physics, Barcelona, Spain, July 8–12, 2024.
- Y. Kondo (invited), “Study of oxygen isotopes at neutron-rich extreme,” Nuclear Structure 2024, IL, US, July 22–26, 2024.

- T. Hashimoto (invited), “Kaonic nuclei at J-PARC,” International workshop on J-PARC hadron physics 2024 (J-PARC Hadron 2024), Tokai, Japan, July 23–25, 2024.
- K. Itahashi (invited), NN2024, “Chiral symmetry in nuclear medium observed in pionic atoms,” Whistler, Canada, August 18–23, 2024.
- M. Iwasaki (invited), “Prospect of hadronic-molecule/cluster with strangeness,” XVIth Quark Confinement and the Hadron Spectrum Conference, Queensland, Australia, August 18–24, 2024.
- M. Iwasaki (invited), “Prospect of hadronic-molecule with strangeness,” International Conference on Exotic Atoms and Related Topics and Conference on Low Energy Antiprotons (EXA/LEAP 2024), Vienna August 25–30, 2024.
- F. Sakuma (invited), “J-PARC—future plans, hadron hall,” International Conference on Exotic Atoms and Related Topics and Conference on Low Energy Antiprotons (EXA/LEAP 2024), Vienna, Italy, August 25–30, 2024.
- T. Hashimoto (poster), “Lifetime measurements of light hypernuclei using K-beam at J-PARC,” International Conference on Exotic Atoms and Related Topics and Conference on Low Energy Antiprotons (EXA/LEAP 2024), Vienna, Austria, August 26–30, 2024.
- T. Uesaka, “Nuclear clustering—manifestations of nonuniformity in nuclei,” International School of Nuclear Physics 45th Course, Erice, Italy, September 16–22, 2024.
- T. Uesaka (invited), “Nucleon correlations at the limit of nuclear stability,” IBS Conference on Exotic Nuclei, Daejeon, Korea, September 25–27, 2024.
- T. Hashimoto (invited), “Status of kaonic-atom experiments at J-PARC,” ECT* workshop, KAMPAI—Kaonic, Antiprotonic, Muonic, Pionic and “onia” exotic Atoms: Interchanging knowledge and recent results, Trento, Italy, September 30–October 5, 2024.
- T. Uesaka (invited), “Quantum correlations at the limit of nuclear stability,” RIKEN-BNL Workshop, Wako, Japan, October 4, 2024.
- K. Itahashi (invited), “Chiral symmetry in nuclear medium observed in spectroscopy of pionic atoms,” Hadrons and Hadron Interactions in QCD 2024 (HHIQCD), Kyoto, October 14–November 15, 2024.
- T. Hashimoto (invited), “Exploring a new form of matter containing an anti-kaon,” the 4th J-PARC Symposium (J-PARC2024), Mito, Japan, October 14–18, 2024.
- Y. Kimura (poster), “The development of the new Cylindrical Detector System for the systematic investigation of light kaonic nuclei,” the 4th J-PARC symposium (J-PARC2024), Mito, Japan, October 14–18, 2024.
- T. Uesaka, “Correlation and dynamics near and beyond the neutron dripline—Challenges at SAMURAI—,” ANPhA Symposium 2024, Huizhou, China, November 15–16, 2024.
- T. Uesaka, “Overview of Sub-project 3: Multifaceted aspects of nuclear matter,” 1st TOPTIER Symposium, Seoul, Korea, December 16–17, 2024.
- S. Koyama (invited), “Quenching of spectroscopic factors in proton-rich p-shell nuclei,” advancing physics at next RI Beam Factory (ADRI25), Wako, Japan, January 22–23, 2025.
- F. Sakuma (invited), “Antikaon-nuclear bound states at J-PARC,” Bormio Conference—the 61st International Winter Meeting on Nuclear Physics, Bormio, Italy, January 27–31, 2025.
- T. Uesaka, “RIKEN’s fundamental quantum science and Nishina center’s view,” EIC RIKEN U-Tokyo Collaboration Meeting, New York, USA, February 3, 2025.
- T. Akaishi (oral), “Current status of hypertriton lifetime measurement via the (K^- , π^0) reaction,” REIMEI Workshop on Phi Meson, Exotic Hadrons, and Related Topics, Jeju Island, South Korea, February 27–March 1, 2025.
- T. Uesaka, “Few-nucleon correlations at the limit of nuclear stability,” The 4th Franco-Japanese Workshop on Few-body Problems in Physics from Atoms to Quarks, Caen, France, March 3–7, 2025.
- M. Sasano (invited) *et al.*, “Study of Gamow-Teller giant resonance at RIBF,” Single-particle and Collective Motions from Nuclear Many-body Correlation (PCM2025), March 4–7, 2025.
- F. Sakuma (invited), “New Frontier of Kaonic Nuclei at J-PARC,” The 21st International Conference on Hadron Spectroscopy and Structure (HADRON2025), Osaka, Japan, March 27–31, 2025.
- T. Akaishi (oral), “Precise determination of the hypertriton binding energy from the 3HL/4HL Production Ratio in the $^{3/4}\text{He}(K^-, \pi^0)$ $^{3/4}\text{HL}$ Reaction,” The 21st International Conference on Hadron Spectroscopy and Structure (HADRON2025), Osaka, Japan, March 27–31, 2025.

[Domestic Conferences/Workshops]

- 久保田悠樹 (招待講演), 「Clustering and SRC; Recent topics from low energy nuclear physics」, EIC で展開する新たな原子核・素粒子物理, 文京区 (東京大学), 2024 年 5 月 28–30 日.
- 久保田悠樹 (招待講演), 「2 中性子対 (ダイニュートロン) の原子核表面での局在化」, 日本物理学会第 79 回年次大会シンポジウム, 札幌市 (北海道大学), 2024 年 9 月 16–19 日.
- 久保田悠樹 (招待講演), 「低エネルギー原子核物理から見た EIC の物理」, 日本物理学会第 79 回年次大会シンポジウム, 札幌市 (北海道大学), 2024 年 9 月 16–19 日.
- 村上智紀 (口頭発表), 「J-PARC E16 実験における GEM 飛跡検出器の位置分解能と検出効率の評価」, 日本物理学会第 79 回年次大会, 札幌市 (北海道大学), 2024 年 9 月 16–19 日.
- 木村佑斗 (口頭発表), 「反 K 中間子束縛原子核探索のための円筒型ドリフトチェンバーの性能評価 (I)」, 日本物理学会第 79 回年次大会, 札幌市 (北海道大学), 2024 年 9 月 16–19 日.
- 立石健一郎 (ポスター), 「放射線損傷耐性をもった偏極固体標的の開発」, 日本量子医科学会第 4 回学術大会, 千葉市 (QST), 2024 年 12 月 6–7 日.
- 大塚脩司 (ポスター), 「室温で動作する偏極固体標的のためのジベンズアントラセン単結晶を用いた陽子偏極度の向上」, 日本量子

医科学会第4回学術大会, 千葉市 (QST), 2024年12月6-7日.

笹野匡紀 (招待講演), 「Solenoid spectrometer project at RIBF」, Advancing Physics at Next RIBF (ADRIB25), 2025年1月22-23日.

立石健一郎 (口頭), 「トリプレット DNP を用いた室温 1H 偏極率 60% の実現」, 第3回 DNP 研究会, 豊中市 (大阪大学), 2025年1月27-28日.

小山俊平 (招待講演), 「非束縛核 ^{13}C の分光測定によるドリフライン近傍における鏡映対称性の研究」, 日本物理学会 2025年春季大会 (オンライン), 2025年3月18-21日.

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[Seminar]

T. Uesaka, “In search of non-uniformity in nuclei—Physic of ONOKORO project—,” Seminar at Peking University, Beijing, China, May 21, 2024.

Press Releases

「中性子, 陽子それぞれ3個ずつは原子核として不安定と実験で証明—自然界の強い力を理解する重要なヒントが得られる—」, 2024年7月4日, https://www.riken.jp/press/2024/20240704_3/index.html.

「フッ素の新同位体, フッ素 30 の観測に成功—中性子過剰核での超流動の発生を示唆, 中性子星の謎解明にも期待—」, 2024年8月28日, https://www.riken.jp/press/2024/20240828_2/index.html.

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下浦享, 2024年度 (第70回) 仁科記念賞, 「4 中性子状態の実験的研究」

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小山俊平, 第19回 (2025年) 日本物理学会若手奨励賞, 第31回原子核談話会新人賞, 「非束縛核 ^{13}C の分光測定によるドリフライン近傍における鏡映対称性の研究」