NINS

National Institutes of Natural Sciences
SINCE APRIL 2004

2015

National Astronomical Observatory of Japan

National Institute for Fusion Science

National Institute for Basic Biology

National Institute for Physiological Sciences

Institute for Molecular Science

Okazaki Research Facilities

Center for Novel Science Initiatives

Astrobiology Center

Inter-University Research Institute Corporation
National Institutes of Natural Sciences
http://www.nins.jp/english/

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Message from the President

Inter-University Research Institute Corporation
National Institutes of Natural Sciences
President
Katsuhiko SATO

Aiming for Further Progress in the Natural Sciences

To our friends around the world, welcome to the National Institutes of Natural Sciences (NINS). The mission of our institute is to promote the world's cutting-edge research in natural sciences by working together hand-in-hand with researchers, graduate students, and university students of different nations. Consequently, we put leading-edge research facilities and infrastructures in place for university researchers in Japan and abroad to use, and carry out various joint research. We also energetically do the work of fostering and supporting young researchers here and abroad who are the bearers of the future including the graduate students of SOKENDAI (The Graduate University for Advanced Studies).

In particular, among the challenges to vigorously tackle from next fiscal year is the globalization of NINS. In an increasingly globalized world of research, if we are to promote state-of-the-art research and achieve results, international collaboration is essential. If each institute of NINS is to be constantly recognized by the world as a premium institute, internationalization constitutes a matter of immediate concern. We have established overseas offices in Germany (Bonn and Hiedelberg) from last year and deployed a resident University Research Administrator (URA) who is charged with supporting international joint research, obtaining new research information, people-to-people exchange, and finding leading young researchers. We will also set up an overseas office in the US (Princeton University) and put in a resident URA this year. Additionally, we have posted URAs who will handle international collaboration from this January in the NINS headquarters. We hope to make progress in the globalization of NINS at an accelerated rate in the future.

We are also setting numerical targets to increase the proportion of foreign researchers on a full-time basis across NINS to 5% within 5 years and 10% within 10 years. The "globalization project" was established from the presidential discretional budget from last year to initiate an approach to strengthen the acceptance system of foreign researchers including family support and children education. The environmental improvement for foreign researchers will further accelerate after next fiscal year.

The creation of new fields in natural sciences is also one of the big missions of our institute. We have fully utilized the merits of combining five institutes to establish NINS and made efforts to develop new fields in natural sciences so far. We have created the "NINS Program for Cross-Disciplinary Study" and supported exploratory research collaborations of young researchers along the way. The newly launched field of "Astrobiology" within the Center for Novel Science Initiatives in 2013 is one such example. Furthermore, we have established the "Astrobiology Center" this fiscal year to develop this field as an independent center within NINS.

In addition, we are setting numerical targets to boost the proportion of female researchers at NINS as a whole to 10% after 5 years and 15% after 10 years. A number of female researchers were hired at the discretion of the president as one of the measures. We need to encourage environmental improvement to bring the best out of female researchers and enhance the research capabilities of NINS even further with gender equality.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) has come out with many projects that prioritize (competititive) fund allocation in universities that advance university reforms to vigorously push forward university reforms. Amid bleak conditions where about a third of the nation's purse strings are financed by debt and in a situation where funds coming from the national budget cannot be expected, we are further bound to use grants received from taxpayer money at peak efficiency to fulfill our given missions.

Therefore, we must strive to improve the enhancement of the capabilities of NINS. Up to now, we have sought the enhancement of these capabilities through various ways, but we have to further accelerate. We have employed URAs under "The Program for Promoting the Enhancement of Research Universities" of MEXT which was adopted last year and have been seeking to boldly promote the enhancement of our capabilities. At the same time, we have also continued to appeal the importance and incentive of natural science research which forges the future of Japan and have reinforced efforts to gain the public's understanding and support in Japan and abroad.

We are grateful for your continued support on our vision.

What is an Inter-University Research Institute?

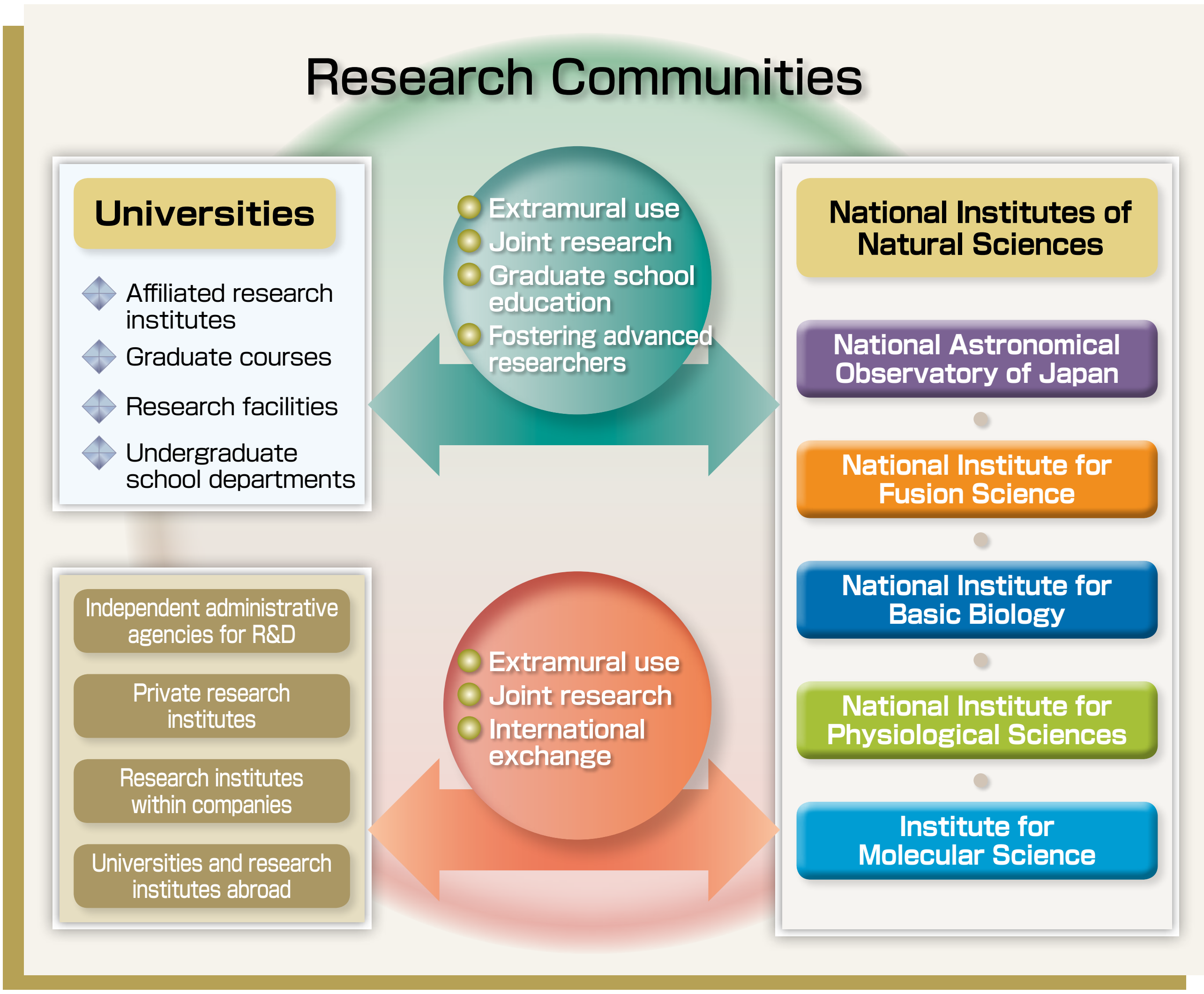
The World's Leading Research Institutes in Japan

The National Institutes of Natural Sciences (NINS) consists of five inter-university research institutes: the National Astronomical Observatory of Japan (NAOJ), the National Institute for Fusion Science (NIFS), the National Institute for Basic Biology (NIBB), the National Institute for Physiological Sciences (NIPS), and the Institute for Molecular Science (IMS). In addition to playing a leading role in its respective research field, each institute has a collaborative relationship with NINS with the common goal of creating an interdisciplinary and international research base.

An inter-university research institute is a "research institute operated by the research community," a type of world-class organization unique to Japan. The inter-university research institute was organized as a core base to provide a place for joint research and extramural use by researchers across Japan. One such institution originated as the Research Institute for Fundamental Physics (Yukawa Hall) in Kyoto University, which was opened to the community in 1953 in response to requests from theoretical physicists throughout Japan.

An inter-university research institute not only promotes pioneering studies on important research issues, but also provides opportunities for cutting-edge researchers throughout Japan to gather and engage in activities aimed at exploring future academic fields and creating new principles. New concepts of extramural use such as "joint usage of large-scale facilities" and "improvement of the intellectual foundation of academic materials" were later added to the original concept. While the research community's own management policy has been firmly maintained, many inter-university research institutes that do not belong to a specific university have been created.

While maintaining its uniqueness and diversity, each institute makes a great contribution to the development of academic research in Japan as a Center of Excellence in its respective research field. Together, they also serve as an international core base to promote cooperation and exchange with research institutes and researchers abroad.



History & Organization

History

NINS
- 2004 — NINS was established.
- 2009 — The Center for Novel Science Initiatives (CNSI) was established.
- 2013 — The Research Enhancement Promotion Headquarters and Research Enhancement Strategy Office were established.
- 2015 — The Astrobiology Center (ABC) was established.

NAOJ
- 1888 — The Tokyo Astronomical Observatory was established in the Faculty of Science, The University of Tokyo.
- 1924 — Facilities relocated from Azabu Iikura to Mitaka.
- 1988 — NAOJ was established.

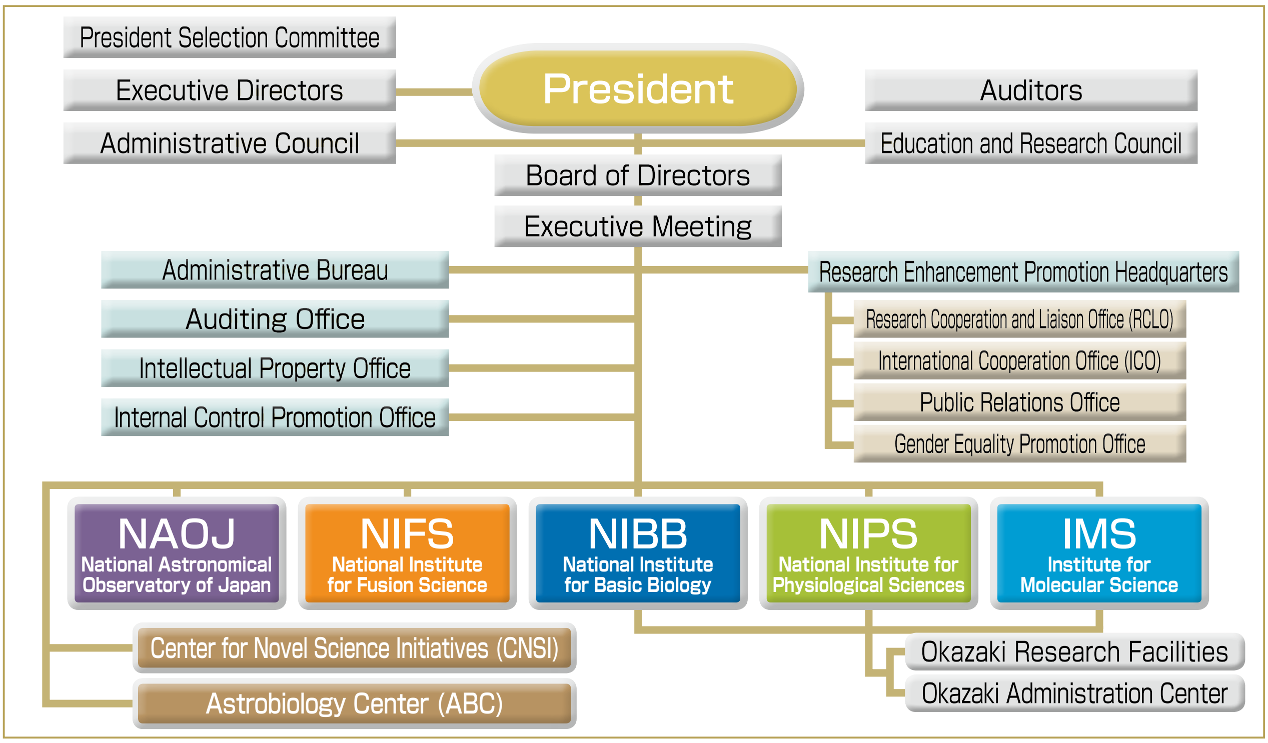
NIFS
- 1989 — NIFS was established.
- 1997 — NIFS was relocated from Nagoya to Toki.
- 1998 — NIFS started to perform LHD experiments.

NIBB
- 1977 — NIBB was established.
- 1977 — The National Center for Biological Sciences was established.

NIPS
- 1977 — NIPS was established.
- 1981 — The Okazaki National Research Institutes was established.
- 2000 — The Okazaki Research Facilities (Okazaki Institute for Integrative Bioscience, Research Center for Computational Science, Center for Experimental Animals, Center for Radioisotope Facilities) were established.

IMS
- 1975 — IMS was established.

Organization



NAOJ

National Astronomical Observatory of Japan

The protoplanetary disk around the young star HL Tauri taken with ALMA (© ALMA (ESO/NAOJ/NRAO))

NAOJ is the national center for astronomical research in Japan. It aims to develop astronomy and related sciences by promoting the open use of its state-of-the-art observation facilities such as the Subaru Telescope, organizing various joint-research programs, and encouraging versatile international cooperation.

NIFS

National Institute for Fusion Science

The LHD maintains high temperature plasmas in steady state.

NIFS conducts collaborative research in the basic science of high-temperature plasmas and fusion engineering. Our collaborators from all over the world conduct leading projects in Large Helical Device (LHD) experiments and computer simulations in order to realize "a sun on the earth," controlled fusion, which is a new, safe, and environmentally friendly energy source.

NIBB

National Institute for Basic Biology

The Medaka Bioresource Facility provides various strains and mutants of medaka to researchers worldwide.

The earth is filled with living organisms exhibiting various forms and demonstrating shapes and behaviors adapted to diverse environments. NIBB, in collaboration with outside researchers, studies the essential phenomena underlying the characteristics and abilities that animals and plants have acquired over the long course of evolution.

National Institute for Physiological Sciences

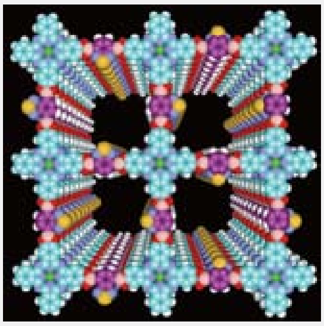
NIPS

NIPS' goals are to uncover the mechanisms by which the human body functions. This is the basis of medical science and links to clarifying the pathophysiology of various diseases. Presently our focus is on brain science as the main part of "body and mind" research. Furthermore, as a national center of physiological research, the institute provides facilities and research staff for collaborative studies to scientists from universities and research institutes.

The reconstructed 3D image of the human brain from fMRI data, color-coded according to function

Institute for Molecular Science

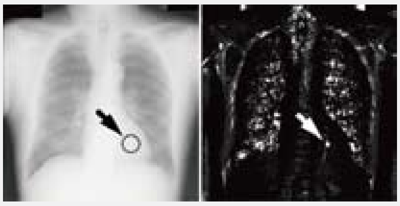
IMS



Stacked column-like polymer with novel functions

The aim of IMS is to investigate fundamental properties of molecules and molecular systems through both experimental and theoretical methods. Since its inception, IMS has made its facilities available to the worldwide scientific community, with a policy which has fostered many joint programs involving IMS scientists.

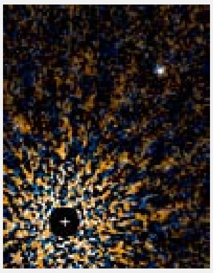
Center for Novel Science Initiatives (CNSI)



Software that can be used to detect lesion region was developed. The original image is shown at the left and the image after analysis is at the right (the lesion is indicated by an arrow).

Expanding research methods and inter-disciplinary exchange in natural sciences research is on the cusp of giving birth to new fields of research. NINS established the Center for Novel Science Initiatives (CNSI) and has been promoting research in the following two departments: the Department of Brain Sciences and Department of Imaging Science. CNSI is promoting the expansion of new creative research communities and research that is linked to academic development.

Astrobiology Center (ABC)



Discovery image of a giant planet (upper right) around a sun-like star (lower left).

As a result of developments in extrasolar planet observations, astrobiology research to explore "life in the Universe" and uncover its mysteries has become a pressing subject. ABC advances this field by combining disciplines, promotes research into extrasolar planets and life both within and outside of the Solar System, and develops observational instruments for these purposes.

Okazaki Research Facilities

The Okazaki Research Facilities consists of four centers: the Okazaki Institute for Integrative Bioscience, the Research Center for Computational Science, the Center for Experimental Animals, and the Center for Radioisotope Facilities. These facilities are intended for the common use of NIBB, NIPS, and IMS.

Spiral Galaxy NGC 6946

National Astronomical Observatory of Japan

Director General
Masahiko HAYASHI

Astronomy is one of the oldest yet most active sciences. This fact alone means that humans possess the fundamental desire to seek their origins and the reason for their existence through an understanding of the Universe. Since the establishment of the Big Bang Theory of the Universe in the 20th century, astronomers have been striving to describe the dynamics of the evolution of the Universe; from material production, the generation of stars and planets, and the creation of life forms, up to the birth of human beings. The 21st century will be the era for us to search for planets and life outside the Solar System.

NAOJ continuously seeks to develop new observational methods to gain a deeper understanding of the objects and phenomena in the Universe such as the Earth, Solar System objects, stars, galaxies, clusters of galaxies, and the expanding Universe. We hope to play a key role in establishing a new paradigm of nature.

ALMA

ALMA (Atacama Large Millimeter/submillimeter Array) is a partnership project between Europe, North America, and East Asia (Japan, Taiwan, and South Korea) in cooperation with the Republic of Chile to operate an international radio astronomical facility on the 5,000 m Chilean plateau. By combining signals obtained by 66 antennas, ALMA will unveil the mysteries of the Universe such as the formation of galaxies that are 13 billion light years away from us, the formation of stars and planets, and the synthesis of organic molecules. Science observations started in 2011 and ALMA's unparalleled sensitivity has provided us with new insights into the mysteries of planet formation and galaxy evolution.

Parabolic antennas located at the ALMA-Array Operations Site (5,000-meters above sea-level) in Chile

Subaru Telescope

The Subaru Telescope is our flagship observation facility. It is an 8.2 m optical/infrared telescope located at the top of Mauna Kea on Hawai'i Island in the U.S.A. Since 2000, its open use has produced a number of excellent achievements, from the discovery of the farthest galaxies and the observation of proto- and baby galaxies up to the mechanisms of proto-planetary systems.

The uniquely shaped enclosure of the Subaru Telescope located at the top of Mauna Kea on Hawai'i Island (Altitude: 4,200-meters)

TMT (Thirty Meter Telescope) project

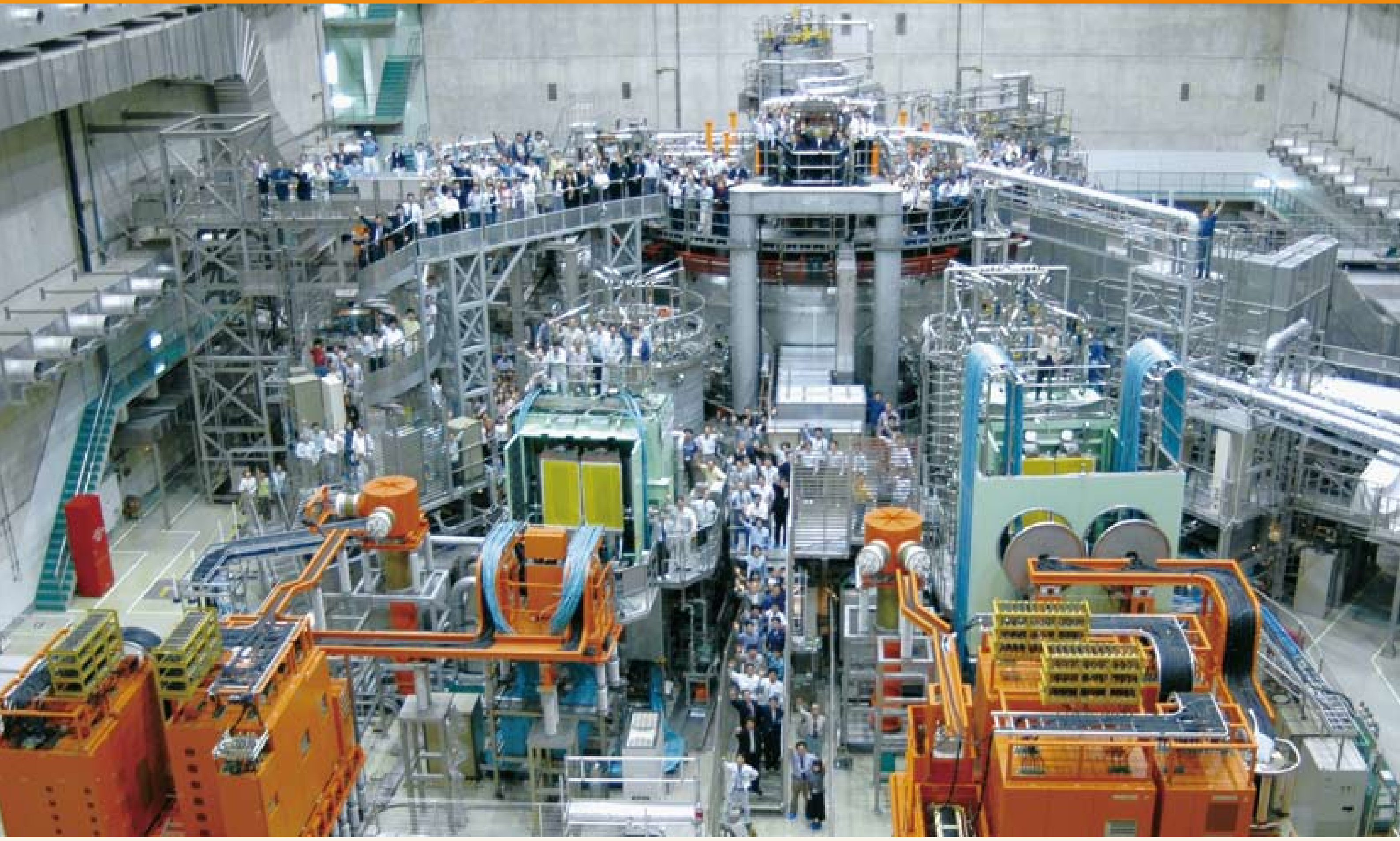
The TMT project is constructing an extremely large telescope with a 30 m aperture at the summit of Mauna Kea in Hawai'i through international collaboration. This telescope will explore the first stars and galaxies in the Universe and Earth-like planets around stars other than the Sun. Astronomers in Japan aim to lead astronomy in the 2020s with TMT collaborating with the Subaru Telescope and ALMA. The 30 m diameter primary mirror consisting of 492 mirror segments will achieve 4 times better resolution and 13 times larger light collecting power than the Subaru Telescope. The project is a collaboration by Japan, the U.S.A., China, India and Canada. Japan is playing an important role in the construction, providing the telescope structure and mirror segment blanks, as well as polishing 30% of the mirror segments and constructing some of the instruments.

Conceptual image of TMT on Mauna Kea in Hawai'i

Astronomical Simulation

Numerical simulation in astronomy is regarded as the third approach to astronomical research, alongside observational and theoretical astronomy. This approach is essential in astronomy, because it is practically impossible to perform laboratory experiments of the Universe. Astronomers recreate the Universe and astronomical phenomena in a computer and observe their behavior. Various types of high-performance computers, such as a massive parallel computer Cray XC30 "ATERUI" and a group of special-purpose computers for gravitational many-body problems (GRAPE), function as "telescopes for theoretical astronomy". These computers contribute to our endeavors to solve fundamental problems such as the formation of galaxies, the origin of the Solar System, and the evolution of black holes.

The fastest supercomputer for astronomy, Cray XC30 "ATERUI." Its peak performance is approximately 1 Pflops (1 quadrillion calculations per second).



Large Helical Device (LHD)

National Institute for Fusion Science

Director General

Yasuhiko TAKEIRI

NIFS considers its research to actualize fusion energy as one of the "big sciences" in Japan and strongly promotes academic research in this critical area.

By consuming fossil fuels, human beings have established an industrial world with highly-advanced technology and science. But it turns out the effort has generated a huge amount of carbon dioxide and begun imposing a serious impact on the global environment. Furthermore, the reserves of these fuels are not unlimited. The current power generation system using the reactions of nuclear fission still faces challenges such as the high-level of radioactive waste and the doubtful safety of the system, which came to light after the March 11 disaster in Japan. On the other hand, as the global population continues to grow, energy consumption also increases proportionately. In such circumstances, the research of safe, eco-friendly energy for the future is at the top of the agenda in the modern world. Supposing that we would actualize a fusion reaction, an energy source of the sun and stars, on earth, it would mean that humans will have secured a perpetual source of energy, since deuterium and lithium, the fuels for a fusion reaction, are abundantly available in seawater. Also, utilizing low-activation materials will make the materials of reactors reusable, leading to the realization of a "Recycling Society" in its truest sense.

NIFS carries out active collaborative research with domestic and international universities, as well as research organizations. While fostering the next generation of excellent human resources, NIFS will continue to actively promote fundamental research in fusion plasmas with a view to the actualization of safe, eco-friendly fusion energy in the near future.

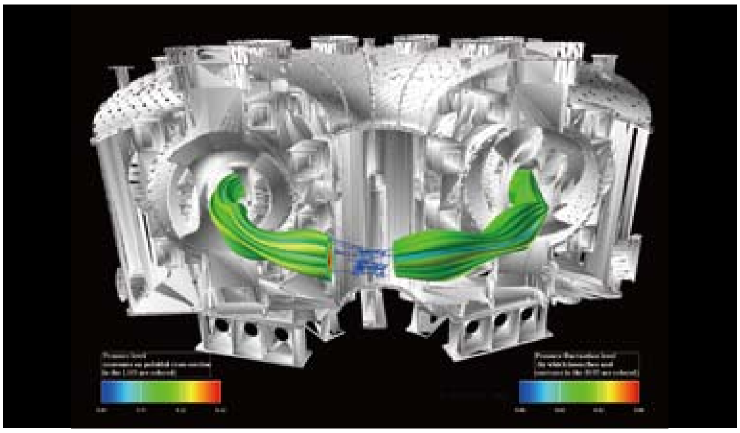
Research on high-temperature steady-state plasma utilizing the Large Helical Device

Large Helical Device (LHD) project employs the world's largest superconducting helical coils based on the heliotron magnetic configuration that was originally developed in Japan. The objectives are to conduct research into the physics of high-temperature steady-state plasmas and their related science and engineering, and to promote academic research aimed at the future actualization of a fusion reactor. Plasmas with temperatures of approximately 100 million degrees are produced several thousand times a year, providing many opportunities for a variety of scientific collaborations.

LHD vacuum vessel

Numerical simulation reactor research project

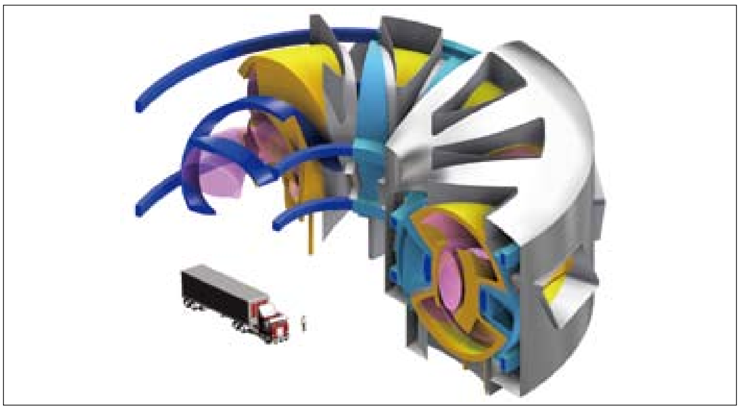
Computer simulation research is indispensable in studying high-temperature plasmas that have strong nonlinearities causing a variety of complexities. Using a large-scale computer simulation system, this project aims at systematizing plasma physics, clarifying the physical mechanisms of various phenomena in fusion and related plasmas. Complexity science is also explored to support such systematization. The ultimate goal of the project is to numerically simulate fusion reactors.



MHD simulation of LHD plasma

Fusion engineering research project

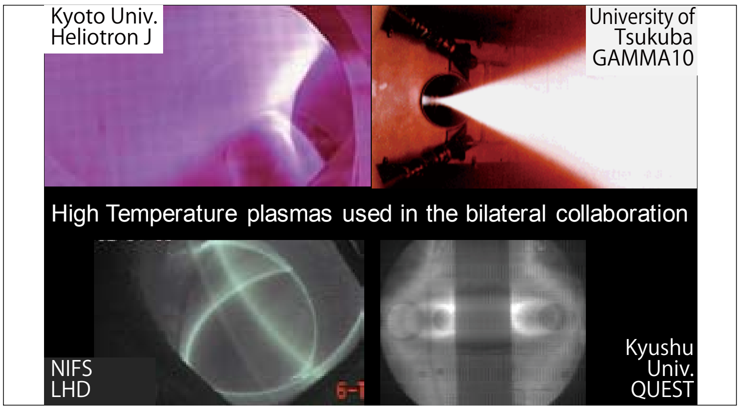
The project carries out both the conceptual design of an LHD-type fusion energy reactor and various engineering experiments to make it possible to construct the fusion reactor. Research is focused on key components in fusion reactors, such as the superconducting coil system, long-life blanket, low-activation materials, first wall, and divertor, while maintaining consistency with the reactor designs.



Helical-type fusion reactor FFHR-d1

Cooperative Research with Universities

The cooperative relationship between NIFS and universities allows us to make good use of plasma devices. By effectively sharing our LHD and other university-owned experimental facilities, we investigate the physics of steady-state ultra-high-temperature plasmas, and also work to meet engineering requirements for the realization of a fusion reactor. Providing numerous interactive opportunities at the forefront of fusion study, collaborative activities also help produce excellent young researchers, including graduate students.



High temperature plasmas in bilateral collaboration (Kyoto Univ., NIFS, University of Tsukuba, Kyushu Univ.)

National Institute for Basic Biology

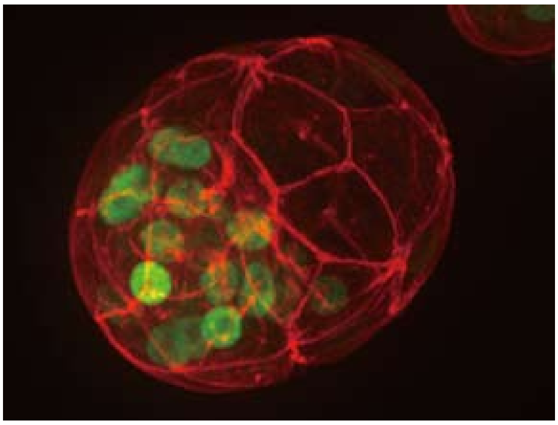
Director General
Masayuki YAMAMOTO

Among the innumerable celestial bodies in our universe, the earth appears unique in that it is filled with a variety of living organisms. Over the course of 4 billion years of evolution, animals and plants have acquired diverse forms as well as astonishing abilities and continue to survive on this remarkable planet through the propagation of their offspring. Living organisms are believed to have evolved by increasing the genetic information inherited from their ancestors and by changing the functions of those genes. We believe increased knowledge of the intricate processes of life and the adaptation mechanisms of living organisms will lead to solutions to many of the problems facing us, such as our planet's worsening environment.

To understand the survival strategies of organisms we study the basic principles common to all creatures, and the mechanisms that enable diversity and allow life to adapt to changing environments, by using model organisms in collaboration with worldwide researchers. In order to grow high quality experimental organisms and to enable state of the art data analyses we maintain the "NIBB Bioresource Center" and the "NIBB Core Research Facilities", and work to continually improve our collaborative facilities. Also, in order to prevent the loss of important biological resources during natural disasters, we operate as the core center of the "Inter-university Bio-Backup Project". As an inter-university research institute NIBB supports the progress of diverse fields of biological research in collaboration with universities and institutes throughout the world.

Understanding the shape of life

All the organisms on Earth, including all the multitudes of various plants and animals, have specific shapes based on their species. How is it that from the simple single celled ovum all of these complicated forms can arise? We focus on the functions of genes, the movement of cells, and intracellular signaling to study development, using arabidopsis, lotus, moss, frogs, and mice. We also study how the cells that create new life in future generations, eggs and sperm, are formed using medaka and mice.



Cell differentiation in a mouse blastocyst

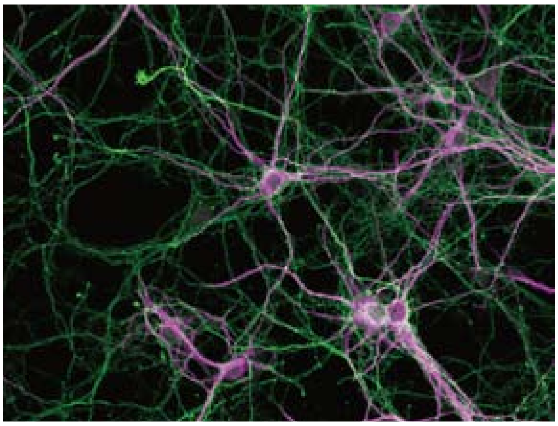
Mechanisms for adapting to a changing environment

Living creatures have the ability to accurately sense changes in their surrounding environment and adapt appropriately. We focus our research on proteins that act as sensors for detecting environmental changes, like photo-receptors and hormone receptors. We are also engaged in exploring the interactions between organisms known as 'symbiosis'. We use Next Generation Sequencers that can examine changes in vast numbers of genes, and mass spectrometry equipment that can comprehensively analyze proteins. In addition we have introduced environmental control systems that allow precise control over levels of light, humidity, CO_2, and temperature. This equipment is used in collaborative research by both Japanese and international scientists from around the world.

The NIBB Bioresource Center's plant environmental control system

Discovering the form and functions of the brain

The brain and nervous system act as the control tower of an animal. We study the functions of the brain using a variety of methods such as examining the composition of the nerves involved in sight, the actions of the neurons involved in memory, the neuronal circuits that determine behavior, etc. We also study the evolution of the brain to understand how we ourselves, humans, came to possess our higher brain functions.

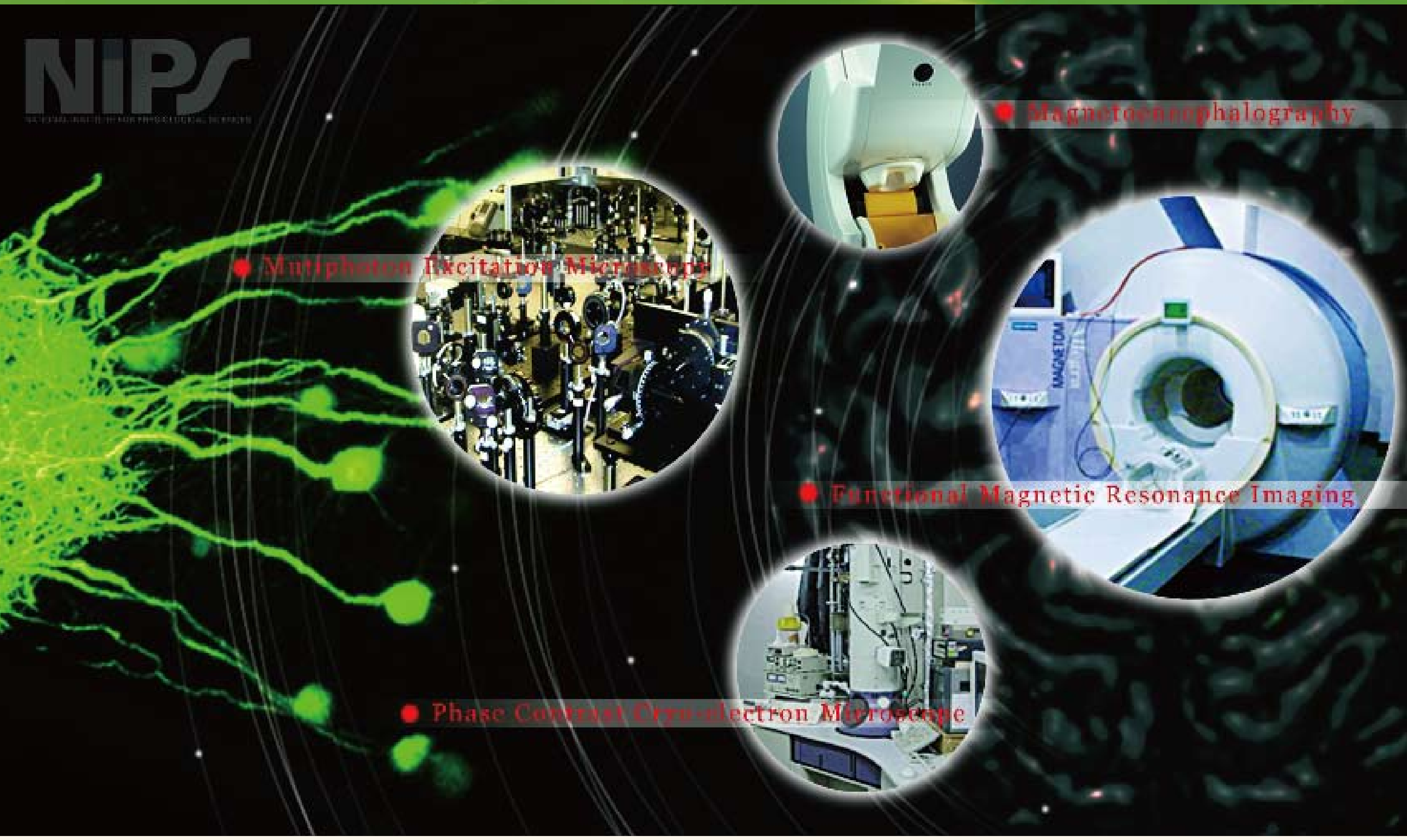


Primary cultured neurons from mouse brain

Research resources and education

In recent years the field of biology has advanced quickly through focused research on model organisms that are well-suited to study. As the core institution for the National Bioresource Project Medaka, as well as a sub-center for morning glory research, NIBB collects, preserves, and provides important biological resources to other institutes. In order to achieve wider, greater understanding of fundamental biological phenomena, NIBB is constantly working towards the development of new model organisms, as well as holding International Practical Courses to promote and disseminate advanced experimental techniques. Furthermore, NIBB is also actively involved in education through our Ph.D program, striving to give quality education to those students who will become the next generation of researchers.

International Practical Courses for research on Medaka and *Physcomitrella patens*



Specialized equipments and large-scale facilities for joint researches to promote brain science

National Institute for Physiological Sciences

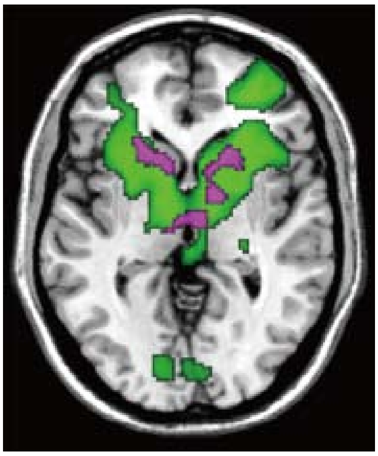
Director General
Keiji IMOTO

NIPS' mission is to conduct research at the forefront of physiological science by examining the living body at various levels of organization, thus leading to a holistic understanding of the functioning of the human body. Recent progress in life sciences has been truly remarkable, and there have been tremendous developments especially in molecular biology and genetic engineering. Non-invasive imaging techniques have also become very useful for clarifying the physiological functions of the human body. Recently, NIPS has been mainly focusing on brain science, and it is now considered to be one of the best brain research institutes not only in Japan but also in the world.

With the key phrase "Elucidation of the Functioning of the Human Body," NIPS is performing cutting-edge research in multiple fields involving not only physiology but also biochemistry, molecular biology, morphology, cognitive science, and medical engineering. NIPS provides its facilities and expert staff to domestic and foreign scientists for collaborative studies.

Exploring the higher functions of the human brain

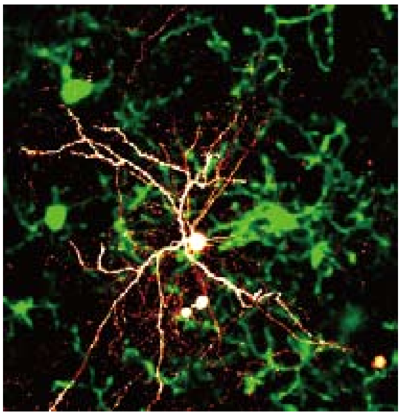
NIPS is promoting research on the higher functions of the human brain including language functions and value judgments, and interpersonal relationships, as well as perception, cognition, and motion. To measure brain activity, we utilize functional brain imaging instruments including functional MRI (fMRI) scanner and near-infrared spectroscopy (NIRS) scanner for detecting local circulation and energetic metabolic changes in the brain, and magnetoencephalography (MEG) for detecting higher temporal resolution of brain electrical activity, with the goal of attaining a dynamic and comprehensive understanding of the higher functions of the human brain.



Activity of the striatum subjected to monetary reward (green) and social reward (red)
When being praised by other people, the brain's reward system (striatum) reacts as when making money.

Investigating neural circuit activities in the brain

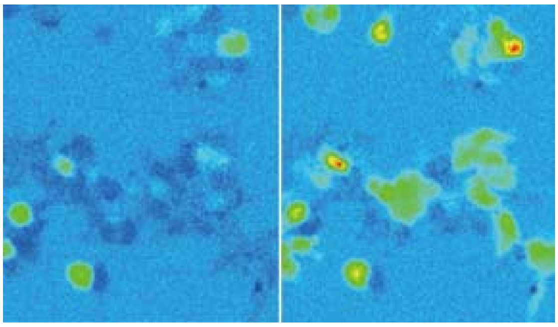
The direct recording (imaging) of neuronal activity *in vivo* is a powerful technique to understand how neuronal circuitry functions in brain. Recently, we applied various genetically modified techniques for manipulating specific neural circuit activities of mice and macaque monkeys to elucidate their functions. In addition, we are working to determine the pathological condition of the neurological disorder by means of disease-model animals with Parkinson disease or epilepsy.



Bioimaging of the brain cortex of a mouse expressing DsRed (red fluorescence protein) on nerve cells and GFP (green) on microglia

Clarifying the mechanisms underlying body homeostasis and its development

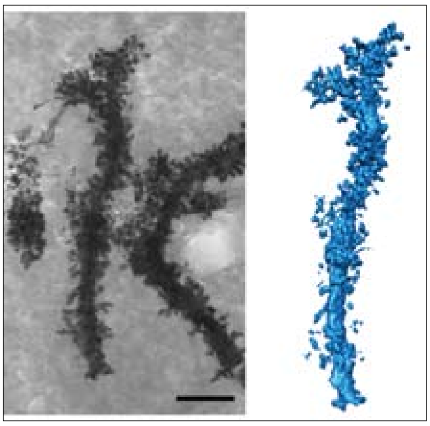
We aim to clarify the mechanisms underlying body homeostasis and its development. Various molecules, complicated cellular and organ functions, and interaction with neural activities are key factors of the homeostasis such as maintenance of cell size, body temperature, and body balance. The basic research serves as the scientific basis of health guidelines as well as evidences for better understanding of the disease.



Painless expressing cultured cells respond to higher temperature (40 degree Celsius, in right panel) to increase intracellular calcium concentration (light color)

Developing and applying novel research techniques for medicine, physiology, and neuroscience

To study medicine, physiology, and neuroscience in a systematic manner from molecules to individuals, we are developing novel research techniques for collaborative researches. For example, we developed dual fMRI system for simultaneous recordings of the brains of two individuals when the individuals are communicating with each other. We provide advanced electromicroscopy and laser microscopy for collaborative researches. We also provide valuable research resources such as virus vector, transgenic mouse, rat, and macaque monkeys to domestic researchers in Japan.



We successfully created a 3D reconstructed image of neural dendrites by using medical/biological high-voltage electromicroscopy.

Institute for Molecular Science

Director General

Iwao OHMINE

Almost all substances—including water, air, and living bodies—are made up of molecules, and their natures are closely related to the structures and functions of molecules constituting the materials. Molecular science is a fundamental discipline that gains, via experimental and theoretical investigations, deeper insights into the interactions between molecules and into chemical reactions that cause transformation of molecules. By finding novel characteristics of molecules and molecular assemblies, and by synthesizing new materials with desired properties and functionalities, molecular science provides invaluable clues to resolving future energy and environmental crises. By doing so, the research field will contribute to building new scientific and technological tools which are indispensable for realizing a sustainable society.

IMS' main research areas are theoretical and computational molecular science, photo-molecular science, materials molecular science, and life and coordination-complex molecular science. In addition to these fundamental areas, IMS has started to commit itself to an understanding of molecular systems that can transform energy, materials, and information with spatiotemporal-hierarchical architectures, those examples of which can be widely seen in bio-molecular systems. For this purpose, CIMoS was established on April 1, 2013, opening as a research center to promote the integration of life science and material science disciplines into a thriving interdisciplinary area of fundamental research. In each area, the frontiers of science are being explored by independent research groups led by professors or associate professors who take full initiative in original research activities. IMS has also been continuing efforts to further promote molecular science all over the world by supporting various collaborative research programs.

Designing intelligent molecular systems on the basis of lessons learnt from bio-molecular systems

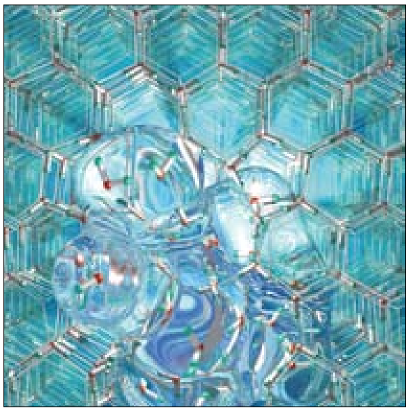
Motivated researchers at the Research Center of Integrative Molecular Systems (CIMoS) have come together to tackle the theme: "How do the characteristics of individual molecules lead to the expression of remarkable function and/or reactivity upon their assembly into molecular systems?" One course of action is to learn about the bio-molecular systems functioning over multiple layers of hierarchies. We aim to clarify the mechanism by which the sharing and control of information between the different spatiotemporal-hierarchies occurs, and to create novel molecular systems on the basis of the findings. The creation of such a flexible-but-robust molecular system with excellent functionality has the potential for improving efficiencies of material transformations and energy conversions to an ideal stage, thus, becoming a source of innovative technologies.

CIMoS
Research Center of Integrative Molecular Systems

Bio-molecular systems functioning over multiple layers of hierarchies, and an official logo of CIMoS.

Drawing vivid figures of molecules by theory and computation

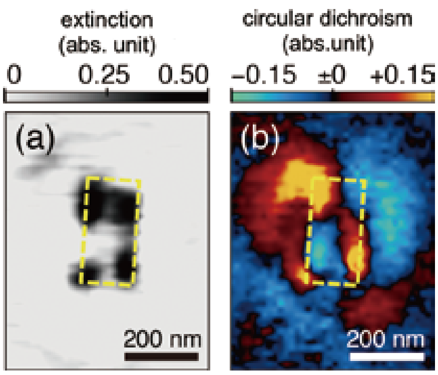
Behaviors of molecules and molecular assemblies are governed by the fundamental laws of physics, i.e., quantum mechanics and statistical mechanics. In the area of theoretical and computational molecular science, new theories and concepts are constructed on the basis of these fundamentals in physics. Large-scale calculations are carried out utilizing high-performance computers to achieve truly microscopic descriptions of various phenomena appearing in the real world and to predict the novel properties and functionalities of materials. In addition, IMS has been contributing to national projects on development and application of next-generation supercomputers, as a core center to elucidate the microscopic mechanisms of self-organization and functionalities in bio-molecules and nano-scale assemblies.



Molecular-level mechanism of ice melting unveiled by supercomputer simulation

Using light to capture lively figures of molecules

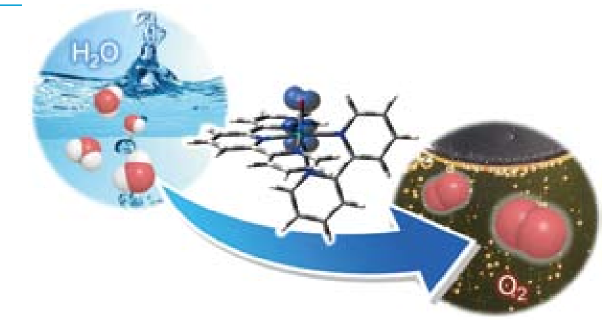
Light is one of the most valuable tools for detailed experimental examination of the characters of molecules and molecular assemblies. No field—from material science to bioscience—can proceed without utilizing light. In the area of photo-molecular science, highly active investigations are performed to develop light sources with unsurpassed performance such as the synchrotron radiation facility, which generates intense light in a wide frequency region from X-ray to terahertz, and microchip lasers, which are quite compact but still have surprisingly high output. These light sources are utilized for studies on the properties, functionalities, and reactivities of materials. This research area establishes the foundation for a wide range of fields in science through cutting-edge research on photo-molecular science, including the real-time probing of ultrafast structural changes of molecules, direct optical microscopic imaging of nanometer-scale assemblies, and precise quantum control of molecular motion and reactions.



Nanoscale optical extinction and circular dichroism images of achiral gold nanorectangle

Designing molecules at nanometer scale

For synthesizing valuable compounds without undesirable by-products and creating new materials with novel functionalities, it is necessary to take precise control of molecules and molecular assemblies. In the area of material molecular science, active researches are in progress to develop synthetic technologies for various chemical compounds with atomic-scale precision and to construct methods for well-designed molecular assemblies. These researches are expected to lead to findings of heretofore undiscovered chemical and physical phenomena at the nanometer scale and contribute to other fields in science and technology such as information, communication, and energy-conversion processes.



Formation of oxygen bubbles (right panel) from water catalyzed by a ruthenium complex (center)

International Hubs for

International Strategy

In response to diversification of research and accelerated scientific progress in natural science, it is becoming more essential to promote research through a new type of cooperation that crosses both national borders and academic fields.

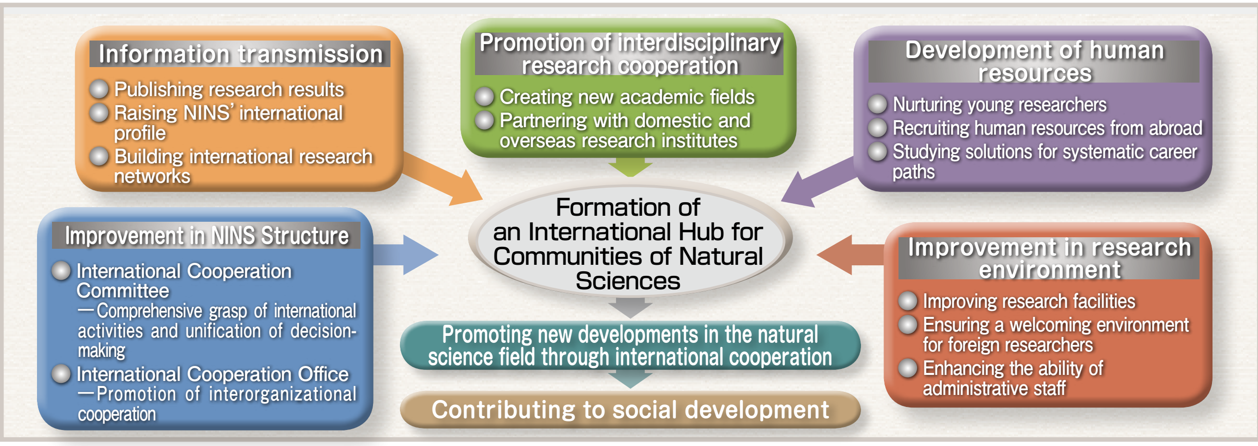
NINS consists of the five institutes: NAOJ, NIFS, NIBB, NIPS, and IMS. NINS has not only been supporting their international efforts to become hubs in their own fields, but also has been seeking to establish a cross-disciplinary hub that connects researchers in different fields in an international framework.

With an eye toward "the formation of an international hub for natural sciences researchers", and helped by researchers' communities, NINS is managing the members' international activities in a matrix manner — organizing them both horizontally and hierarchically to bring about scientific innovation. In 2012, the "NINS International Strategy Action Plan" was carried out and we have strengthened NINS' functions as an international hub for natural science research.

Visit by Prof. A.J. Stewart Smith, Dean for Research and Prof. Edwin L. Turner of Princeton University

Opening ceremony of the ALMA telescope built through international cooperation

NINS' International Strategies



Main contracting research institutions with NINS

Natural Sciences Research

Research Cooperation

NAOJ, NIFS, NIBB, NIPS, and IMS are Japan's Centers of Excellence in academic research in their respective fields. Since its inception, NINS has aimed to create new research fields through the coordination of the inter-disciplinary activities among these five institutes and building of new research communities in cooperation with universities.

In 2009, NINS established CNSI to undertake research in two fields: Imaging Science, created from interdisciplinary collaboration among the five institutes, and Brain Science, for promoting a nationwide inter-university network in the field of brain science. In 2013, CNSI added a third field, Astrobiology, in response to recent developments in astronomy, namely the discovery of numerous extrasolar planets that may satisfy the conditions for extra-terrestrial life. NINS then established the Astrobiology Center in 2015, to further develop research in this field. NINS has been expanding the community of creative researchers and continues to promote research that facilitates the further development of this academic field.

Furthermore, under the leadership of the president, NINS is deploying various efforts including the fostering of young researchers, the strengthening of international cooperation, the program for cross-disciplinary study by young researchers with an eye toward the promotion of interdisciplinary collaboration, and the program for international research collaborator exchange aimed at research promotion and interdisciplinary exchange through the implementation of flexible collaborative research with overseas research institutes, etc.

NINS Program for Promoting the Enhancement of Research Universities

We are conducting a research enhancement promotion project to achieve our two goals by the following four approaches.

1 Collaboration with overseas universities and research institutes
Promotion of joint utilization and joint research
Recruitment of brilliant researchers from other countries

2 Collaboration with universities and research institutes
Promotion of joint utilization and joint research

Support for the Promotion of International Advanced Research

Support for the Promotion of Joint Utilization and Joint Research in Japan

Universities
NINS
Companies
Research Institutes

Enhancement of Research Capabilities of NINS

Goal 1: Encourage cutting-edge academic research in the field of natural sciences through international joint research - strengthen joint research with the world's most advanced research institutes developing the world's most advanced research instruments -

Goal 2: Contribute to the enhancement of research capabilities of universities and institutes in Japan using the world's most advanced research environment for joint utilization and joint research

Dissemination of Information and Enhancement of Public Relations in Japan and Abroad

Support for Researchers (for young, female, or foreign researchers)

3 Encouragement of interaction with the public
Dissemination of information in English and international announcements

4 Improvement of the support system for a diversified research environment

Building of the Research University Network of Japan

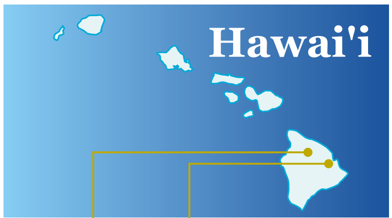
We are building the Research University Network of Japan (RU Network Japan) which will contribute to the enhancement of the research capabilities of individual universities, based on the idea of "collaborate where it is due", through facilitating mutual collaboration and making policy recommendations.

National Institutes of Natural Sciences SINCE APRIL 2004

Inter-University Research Institute Corporation

National Institutes of Natural Sciences Facilities

Subaru Telescope, NAOJ



NAOJ Chile Observatory

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