NINS

inter-university research institutes

National Institutes of Natural Sciences

Facilities

Japan

- National Astronomical Observatory of Japan
  Mizusawa VERA Observatory
- National Astronomical Observatory of Japan
  Solar Observatory
- National Astronomical Observatory of Japan
  Nobeyama Radio Observatory
- National Astronomical Observatory of Japan
  Nobeyama Solar Radio Observatory
- National Astronomical Observatory of Japan
- National Institutes of Natural Sciences
- National Institute for Fusion Science
- National Institute for Basic Biology
- National Institute for Physiological Sciences
- Institute for Molecular Science
  - Okazaki Research Facilities
- National Astronomical Observatory of Japan
  Okayama Astrophysical Observatory
- National Astronomical Observatory of Japan
  Subaru Telescope Base Facility (Hilo)

Hawaii

National Institutes of Natural Sciences
4-3-13-2F Toranomon, Minato-ku, Tokyo 105-0001, Japan
Phone +81-3-5425-1300 FAX +81-3-5425-2049
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National Astronomical Observatory of Japan
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Phone +81-422-34-3600 FAX +81-422-34-3690
URL http://www.nao.ac.jp/

National Institute for Fusion Science
322-6 Orosh-cho, Toki, Gifu 509-5292, Japan
Phone +81-572-58-2222 FAX +81-572-58-2601
URL http://www.nifs.ac.jp/

National Institute for Basic Biology
38 Nishigonaka, Myodaiji, Okazaki, Aichi 444-8585, Japan
Phone +81-564-55-7652 FAX +81-564-53-7400
URL http://www.nibb.ac.jp/

National Institute for Physiological Sciences
38 Nishigonaka, Myodaiji, Okazaki, Aichi 444-8585, Japan
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URL http://www.nips.ac.jp/

Institute for Molecular Science
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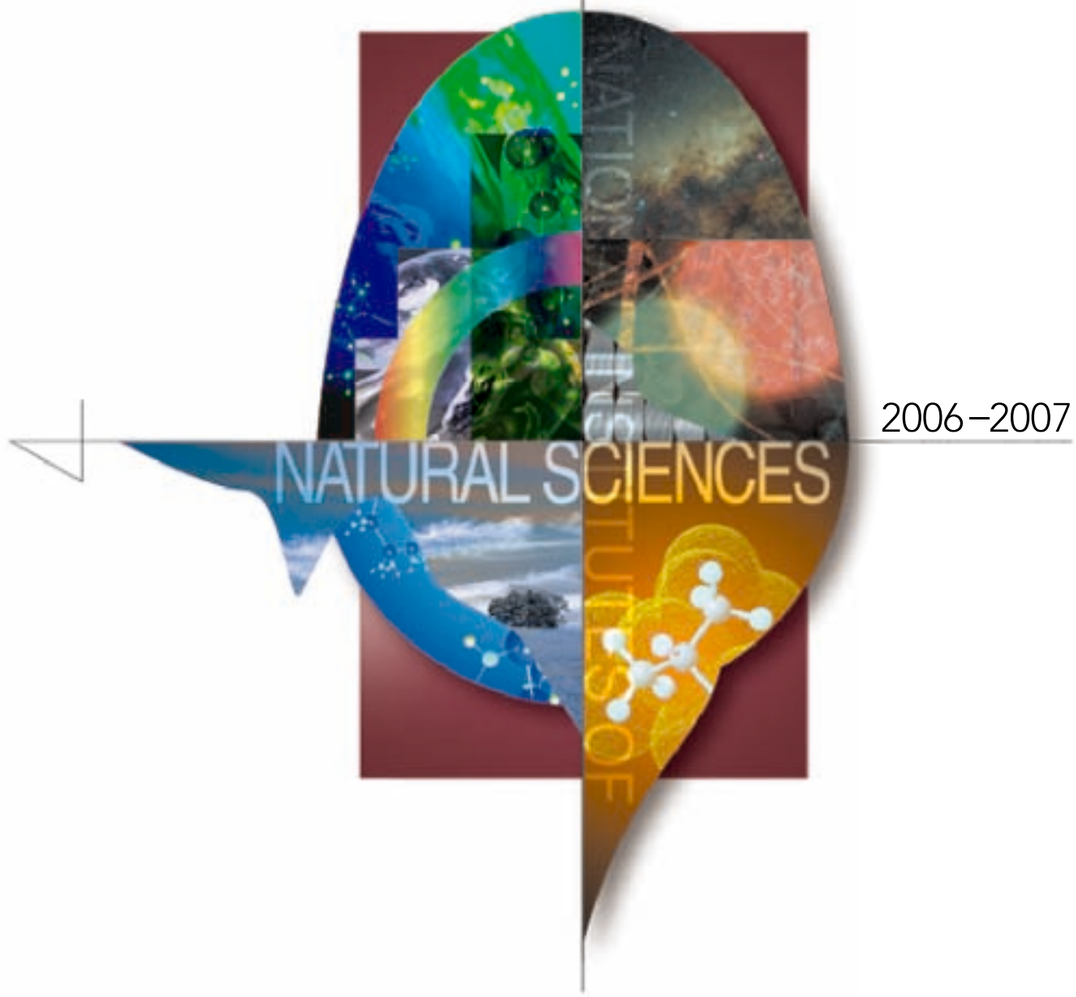
URL http://www.ims.ac.jp/indexj.html

NINS

National Institutes of Natural Sciences
SINCE APRIL 2004

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



2006–2007

inter-university research institutes

National Institutes of Natural Sciences

http://www.nins.jp/

CONTENTS

Message from the President

Aiming for Further Progress in the Natural Sciences

Inter-university Research Institutes
National Institutes of Natural Sciences
President
Yoshiro SHIMURA

Since its establishment in April 2004, the National Institutes of Natural Sciences (NINS), an inter-university research institute corporation (comprised of the National Astronomical Observatory of Japan, the National Institute for Fusion Science, the National Institute for Basic Biology, the National Institute for Physiological Sciences and the Institute for Molecular Science), has been aiming to bring about the further development of natural science. In order to achieve this, each inter-university research institute has been promoting cutting-edge and interdisciplinary research by further exploiting research fields of expertise. NINS has also been actively working on cooperation and collaboration with universities and research institutes attached to universities, thereby exploring and cultivating novel research fields and tasks in natural science, and also enhancing human resources in each field through measures such as the education of graduate students, as a research center of natural science in Japan.

In particular, with respect to research, NINS intends to improve its role and function by further promoting the research undertaken by each institute. At the same time, taking advantage of forming a single corporation, researchers of the five institutes will collaborate to find some novel field(s) and/or to excavate some new problems in natural science. As a start, “Imaging Science” has been extracted as a common theme for which to develop alliance activities for the researchers in the five institutes among the different fields of the institutes.

Also, as an interdisciplinary research center of natural science, NINS plans to further strengthen the collaboration between Japan and organizations in Europe, the U.S. and Eastern Asian countries, to implement approaches to form international research centers in which outstanding researchers are organized on a global scale. More specifically, NINS has established the International Strategy Headquarters to carry out its international affairs. In this context, NINS has already concluded agreements on international joint research with the European Molecular Biology Laboratory (EMBL), the European Southern Observatory (ESO) and the National Science Foundation (NSF) as the first step towards forming an international research center.

NINS will continue to carry out its responsibility as an inter-university research organization by looking at the development of natural science research in Japan for some decades to come. It will also aim to bring about further improvement as a base for transmitting the research results in the fields of natural science to the rest of the world.

We look forward to your continuous support for NINS.

Role of Inter-university Research Institute

Inter-university Research Institute Corporation and Inter-university Research Institute

World's Leading Research Institutes in Japan

National Institutes of Natural Sciences (NINS) consists of five inter-university research institutes: National Astronomical Observatory of Japan (NAOJ), National Institute for Fusion Science (NIFS), National Institute for Basic Biology (NIBB), National Institute for Physiological Sciences (NIPS), Institute for Molecular Science (IMS).

The inter-university research institute, is an organization unique to Japan, has a history of more than 30 years as a "research institute operated by the research community." It was organized as a "center of excellence for academic research" to provide a place for joint research and extramural use by researchers at universities and other institutes across Japan.

- Promotion of unique and cutting-edge academic research
- Contribution to the academic progress of the research community in its role as an institute for advanced studies
- Establishment and operation of large-scale facilities
- Promotion of cutting-edge research and providing facilities for use by researchers across Japan
- Studying, collecting and organizing academic materials and information
- Contribution to improving the intellectual foundation of Japan

Dynamic and comprehensive development of academic research
(such as the creation of new research fields through cooperation with the community of researchers at universities and other institutes)

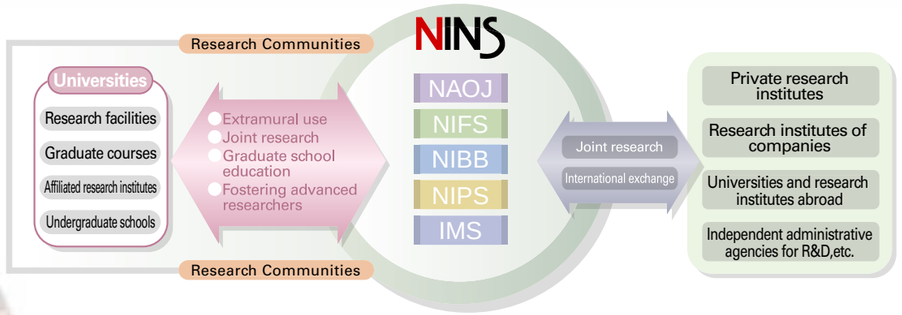
Promotion of an agile and strategic operation of study
(such as interdisciplinary research cooperation and international strategy)

Enhancement of comprehensive research support functions

International Center of Excellence for Academic Research

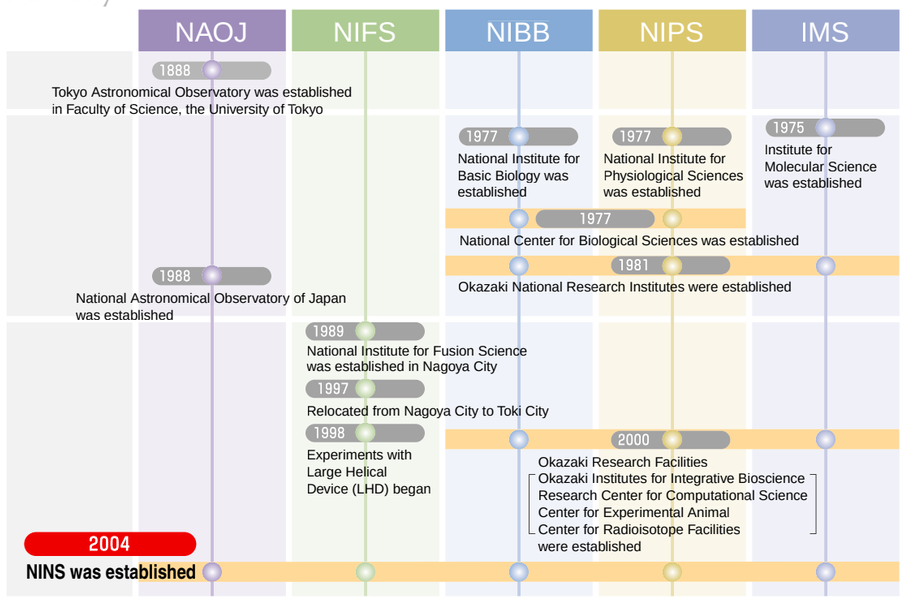
Restructured as independent administrative entities together with national universities according to the Law of National University Corporations

The inter-university research institute corporation was formed in April 2004 for the purpose of establishing and operating inter-university research institutes.

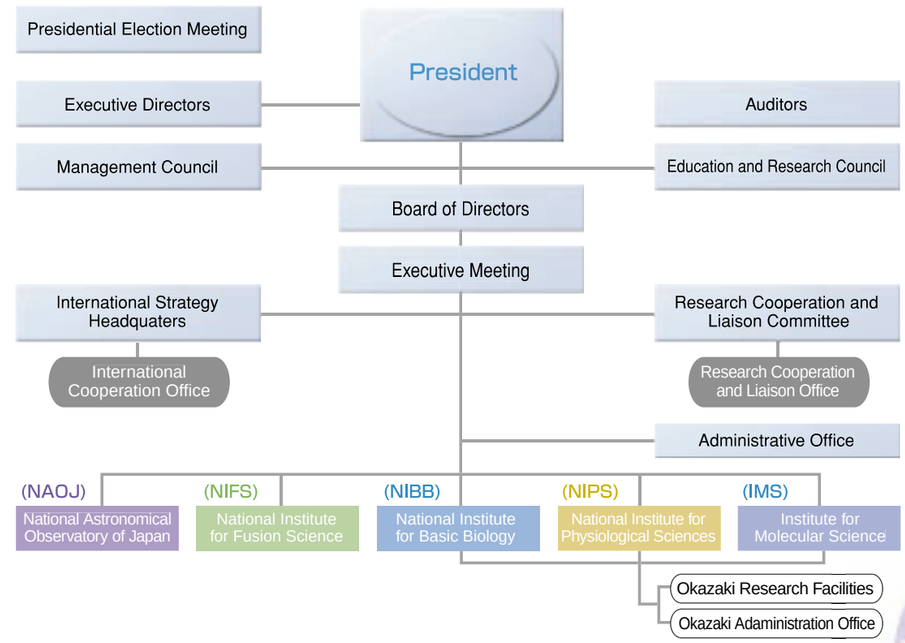


History & Organization

History



Organization



NINS

National Institutes of Natural Sciences
SINCE APRIL 2004

NAOJ

National Astronomical Observatory of Japan

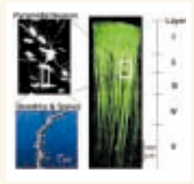
NAOJ is the national center of astronomical researches in Japan. Its aims are the development of astronomy and related sciences by promoting the open use of its state-of-art observing facilities such as the Subaru Telescope, organizing various joint-research programs, and encouraging versatile international cooperation.

The uniquely-shaped enclosure of Subaru Telescope located at the top of Mauna Kea (Altitude:4205m =13.760ft.) of Hawaii Island

NIPS

National Institute for Physiological Sciences

The objectives of NIPS are to elucidate the mechanisms by which the human body functions, which form the basis of medical science, and to clarify the pathophysiology of various diseases. Furthermore, as a center of physiological research, the institute provides its facilities and talent to domestic and foreign scientists for collaborative studies.



Multi-photon laser microscopic in vivo imaging of cortical neurons and fine structures

NIFS

National Institute for Fusion Science

NIFS implements collaborating research into the basic science of high-temperature plasmas and reactor engineering, with computer simulations and experiments on the Large Helical Device as leading projects, in order to realize a sun on the earth; controlled nuclear fusion, which is a new, safe and environmentally friendly energy source.

Large Helical Device (LHD) maintains high temperature plasmas in steady state

IMS

Institute for Molecular Science

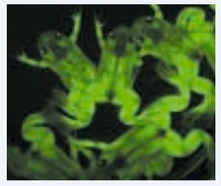
The aim of the IMS is to investigate fundamental properties of molecules and molecular assemblies through both experimental and theoretical methods. Since its inception, the IMS has made its facilities available to the worldwide scientific community, a policy which has fostered many joint programs involving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

Nonlinear spectroscopy by ultrafast lasers for molecular science

NIBB

National Institute for Basic Biology

The more we investigate living organisms the more variation they show in their forms and functions. We extract the basic and important processes underlying such diverse biological phenomena and investigate their basic principles through analyses of the structure and function of organisms, in the course of which we collaborate with a borderless community of researchers.



Transgenic frog expressing green fluorescent protein (GFP) throughout the entire body. This technique enables us to investigate the function of genes

Okazaki Research Facilities

Okazaki Research Facilities

The Okazaki Research Facilities, which are common-use facilities for NIBB, NIPS, IMS, consist 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.

NAOJ

NINS

National Astronomical Observatory of Japan

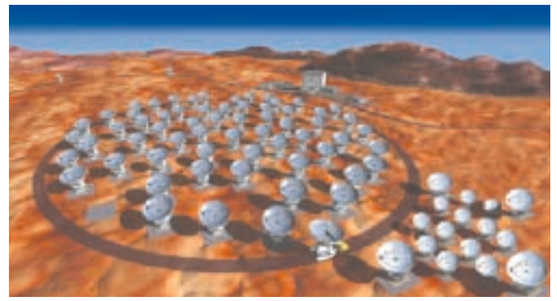
Director
Shoken MIYAMA

Astronomy is one of the oldest and yet most active sciences. The reason should be that human beings possess a fundamental desire to uncover our origin through understanding the structure of the universe. The famous Big Bang theory was established in the 20th century. Thanks to the theory, we have obtained a scientific basis that enables us to describe dynamism of evolution in a context of the history of life, life in the history of Earth, and Earth in the history of the universe. In the 21st century, we have been starting to explore extra-solar planetary systems and extraterrestrial life.

NAOJ keeps developing new observational means to study various objects and phenomena in the solar system, the sun, stars, galaxies, clusters of galaxies and the expanding universe. Theoretical studies are also important for us to more deeply understand the universe. Through these research activities, we hope to contribute profundity of human beings. NAOJ makes its best effort to establish a new paradigm which unifies life, Earth, and the universe.

ALMA

ALMA (Atacama Large Millimeter/submillimeter Array) is a partnership between Europe, North America, and Japan in cooperation with the Republic of Chile to build an international radio astronomy facility on the 5,000m Chilean plateau. NAOJ is leading the construction and operation of ALMA on behalf of Japanese and Taiwanese science communities. By pointing all the antennas in unison toward a single astronomical object and combining their signals, ALMA will unveil the formation of galaxies at a distance of 13 billion light years, the formation of stars and planets, and the synthesis of molecules including organic ones in the universe. Full operation of ALMA will start in 2012.



Expected view at completion

Subaru Telescope

The Subaru Telescope is our flagship observing facility. It is an 8.2 meter optical/infrared telescope located at the top of Mauna Kea of Hawaii Island in the U.S. Its open-use since 2000 has produced a number of excellent achievements from the discovery of the farthest galaxies, the observation of proto- and baby galaxies, up to the mechanism of proto-planetary systems.

Subaru Prime Focus Camera and the primary mirror

Nobeyama Radio Observatory (NRO)

Boasting the 45m antenna with the highest sensitivity in the millimeter wavelength and the Nobeyama Millimeter Array consisting of six 10m antennas, the NRO is pursuing the researches on a wide variety of astronomical phenomena from interstellar molecules and matters, proto-stellar disks, Milky Way and many other galaxies, up to the whole universe.

Nobeyama Millimeter Array (in front) and the 45-meter antenna (in rear)

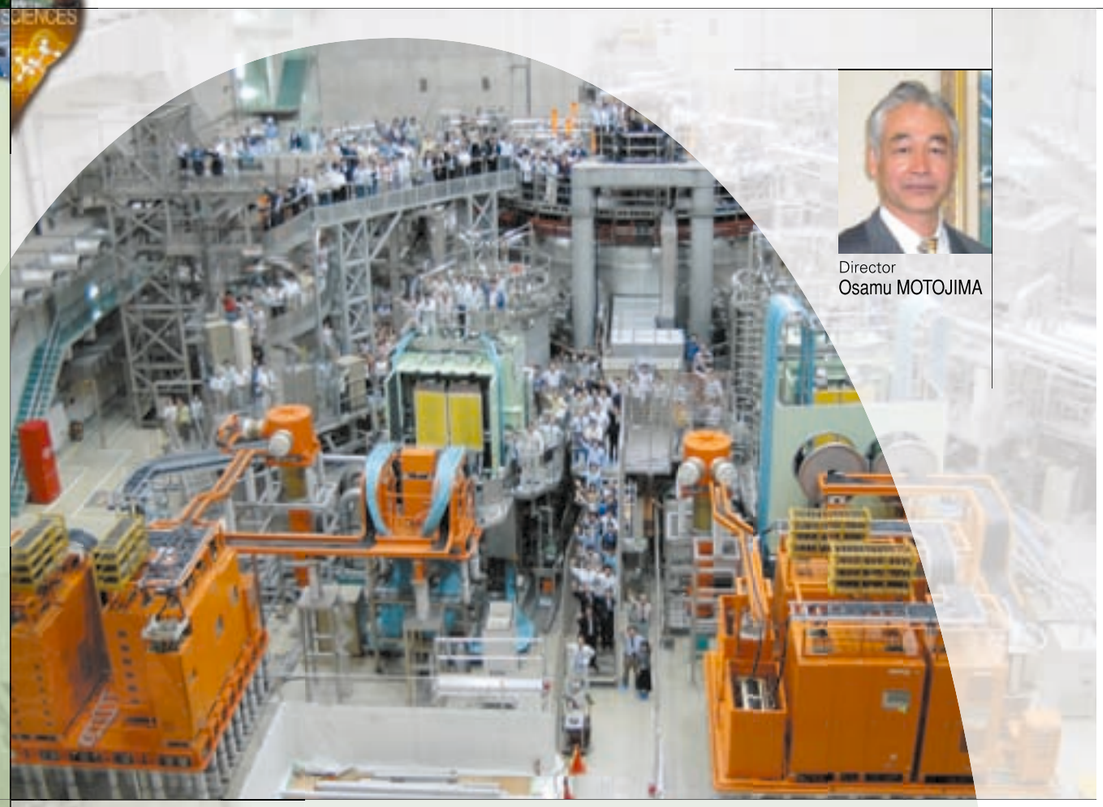
Four Dimensionally Digitalized Universe (4D2U) Project

The 4D2U is a brand-new attempt to provide the vivid images of the real universe to the public and professonal scientists. Employing advanced techniques on the virtual reality, it envisions the time evolution of 3D images based on the astronomical database and realistic simulations of astronomical events like the birth of the Moon, the explosion of a supernova, and the creation of the grand structure of the universe.

One scene of the formation process of a spiral galaxy predicted by a computer simulation, we can see smaller galaxies collide and merge to grow the bigger one.

NIFS

National Institute for Fusion Science



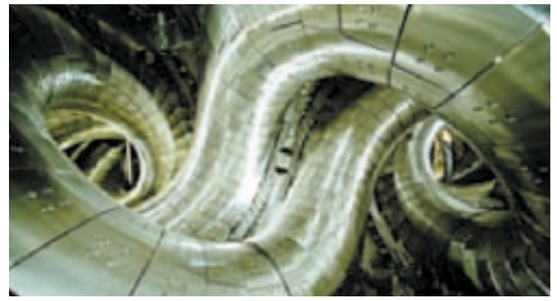
Director
Osamu MOTOJIMA

The industry-driven, high-tech world that humans have achieved in the recent era is largely built upon energy sources such as nuclear power and fossil fuels like coal, petroleum, or natural gas. Unfortunately, those fossil fuels generate a substantial amount of CO_2 and result in an aggravation of the global environment. Also, many problems still remain unsolved regarding nuclear power generation that utilizes the atomic fission processes. On the other hand, as the global population continues to grow, the amount of energy consumption increases proportionately. Under such circumstances, the necessity for developing a new source of energy is one of the most critical challenges that the world has to face and accomplish. Supposing that we could make this nuclear fusion reaction happen on earth, that means we will have secured in hand a perpetual source of energy. As a member of the National Institutes of Natural Sciences, the National Institute for Fusion Science (NIFS) actively promotes the following while it supports fundamental research in nuclear fusion plasmas. First of all, the institute will work in cooperation with society to nurture human resources with high capability for the next generation, and then, we shall make our best effort to actualize power generation by nuclear fusion that produces a safe, environmentally-friendly source of energy. To accelerate its scientific progress, NIFS will actively promote coordinated research with national and international universities and research institutions.

NINS

Large Helical Device Project

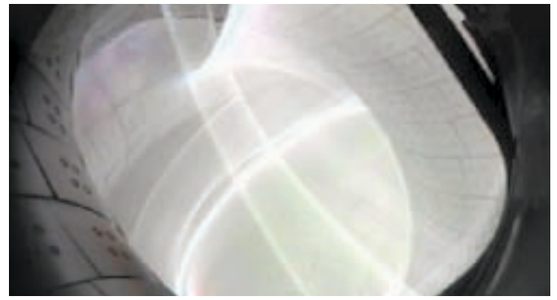
Large Helical Device (LHD) project employs the world's largest superconducting helical coils based on a heliotron magnetic field which was originally developed in Japan. The objectives are to conduct high-temperature plasma confinement research in a steady-state and to explore scientific issues leading to helical reactors.



LHD Vacuum Vessel

Physics of high-temperature steady-state plasmas

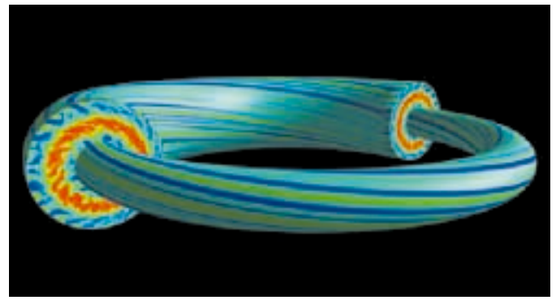
In order to clarify the physical mechanism governing high-temperature steady-state plasmas, experimental researches in LHD are proceeding in conjunction with bilateral collaboration in experimental devices in universities. Plasmas with the temperature of 100 million degrees are produced several-thousand times in a year in LHD, which provides a lot of opportunities for a variety of scientific researches.



LHD Plasma

Large Scale Simulation Research Project

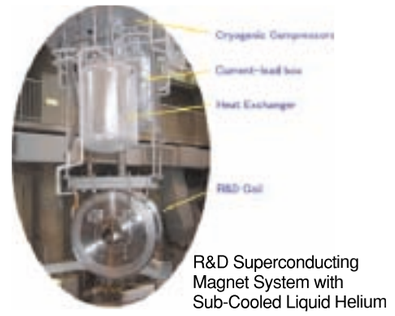
Research by the computer simulation is indispensable to study plasmas which have strong nonlinearities causing a variety of complexities. By large scale computer simulation, this project aims at systemizing the plasma physics, making clear the physical mechanism of various phenomena in fusion and related plasmas. Complexity science is also explored to support such systemization.



Simulation of Ion Temperature Gradient Turbulence

Engineering Research for Realizing Fusion Reactors

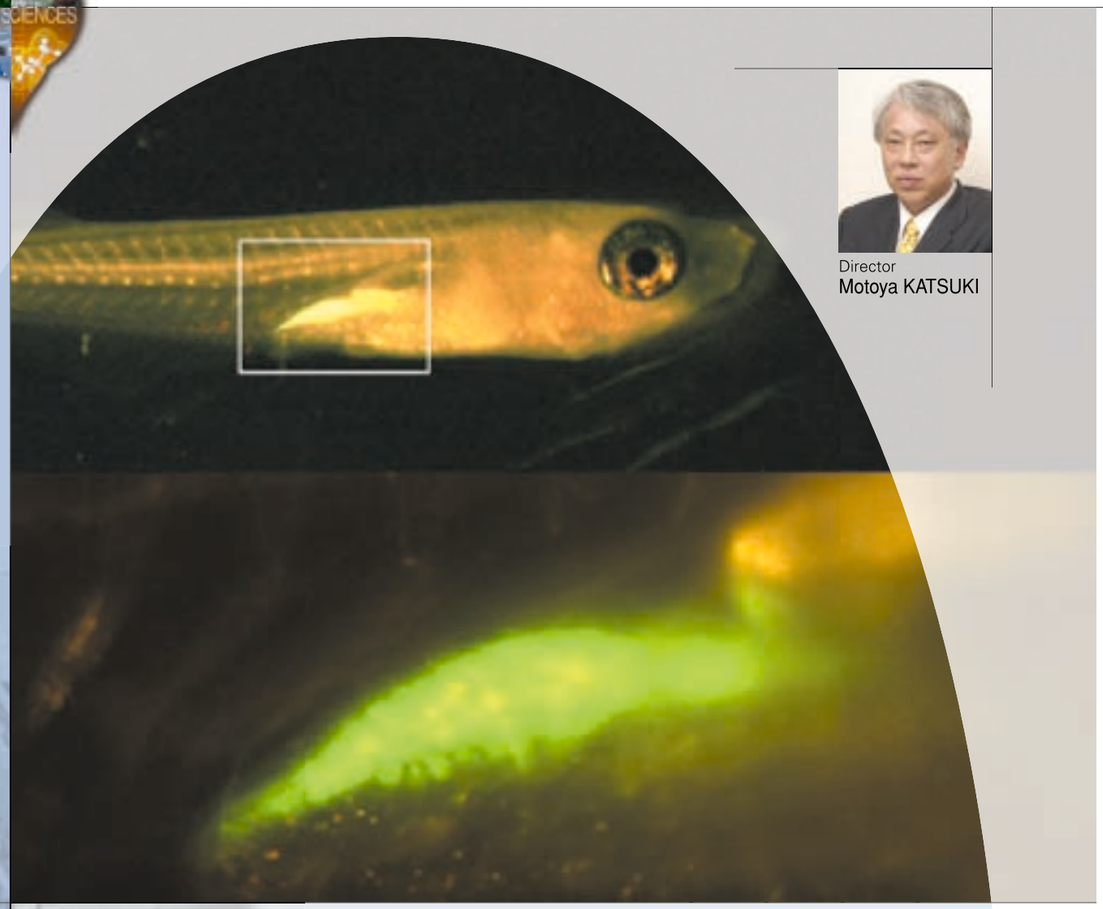
A broad range of engineering studies, such as improvement of superconducting coils, development of low-activating materials and advanced blankets, design studies on the future fusion reactor and investigation of safety features of a fusion system, is conducted as the inter-university research organization in the field of reactor engineering.The returns of the achievements to industries are being promoted through collaborative research activities with them.



R&D Superconducting Magnet System with Sub-Cooled Liquid Helium

NIBB

National Institute for Basic Biology



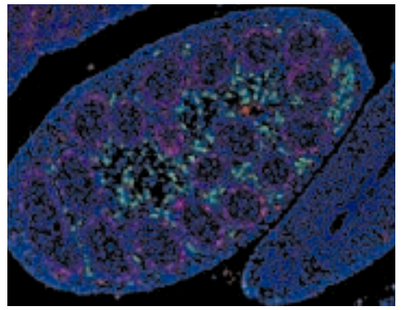
Director
Motoya KATSUKI

A surprising variety of living organisms. Shapes tailored to fit the environment. How, where, and under what conditions were they born? How and where did they metamorphose and stabilize? Is it just a coincidence or a necessity that so many species exist together in an intricate symbiotic relationship? An enigmatic world of living organisms extends in front of us. Despite the apparently overwhelming diversity, however, every organism is made up of a common unit: the cell, the proliferation and differentiation of which has been found to be controlled by common mechanisms.
At the National Institute for Basic Biology we are trying to find, through investigations of the fundamental mechanisms of life, how living organisms originated and how will they evolve in future. Since the human being is also a living organism, the study of the mechanisms of the circulation of life and environmental adaptation found in wild life are essential if we are to devise scientific solutions to the problems resulting from the destruction we continue to inflict on environment.
At our institute we study the molecules, cells, tissues, individual organisms and communities in order to understand the living mechanisms behind their existence.

NINS

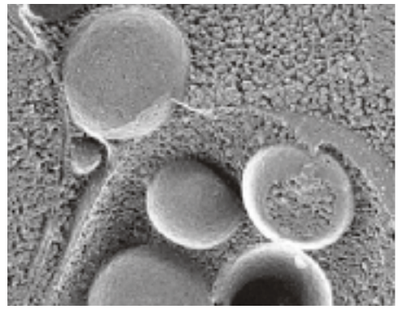
Mechanism of Sex Determination

Gonads (testes and ovaries) are the most important organs in determining the sex of an animal. In most male mammals, the testes develop during the fetal period and start production of male hormones; subsequently, the construction of sex differences in other parts of the body begins. The photograph shows the testis of a mouse fetus; the green cells are the Leydig cells producing male hormones. The rings in pink are seminiferous tubules within which are located primordial germ cells which will differentiate into sperms later. In the ovary of a female at the same stage, there are no such developed structures nor any specialized cells.



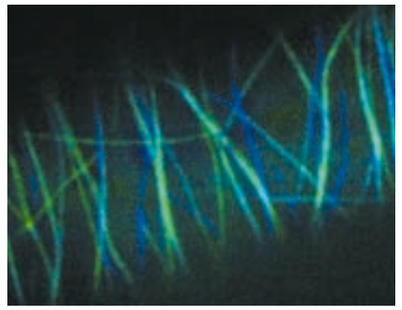
Molecular Dissection of Autophagy

Autophagy is a mechanism of protein degradation within a cell commonly found throughout eukaryotic cells. Since every cellular event is maintained by the balance between the synthesis and degradation of the related proteins, protein turnover is as important as protein synthesis. Genetic analyses using yeasts resulted in finding that autophagy requires 17 Atg proteins including two ubiquitination-like conjugation systems. The photograph shows membrane structures in the process of autophagy. Elucidation of the dynamics of autophagy will provide a novel aspect of cell physiology.



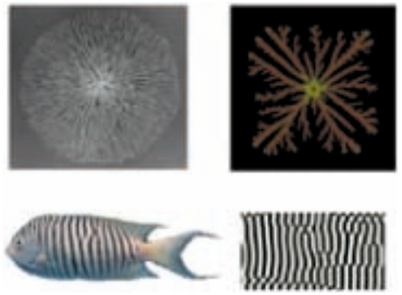
Microtubules' Role in Determining Cell Shape

Microtubules are tubes 25 nm (one forty thousandth of one mm) in diameter that form a dynamic network within a cell in order to transport proteins and organelles and which in turn works in the formation and maintenance of cell shape. The photograph shows a change in microtubules on the surface of a tobacco plant cell; microtubules that formed and disappeared over the course of 5 minutes are shown in different colors. The study of dynamic changes in microtubule distribution is expected to bring an understanding into the mechanisms behind the shaping of cells.



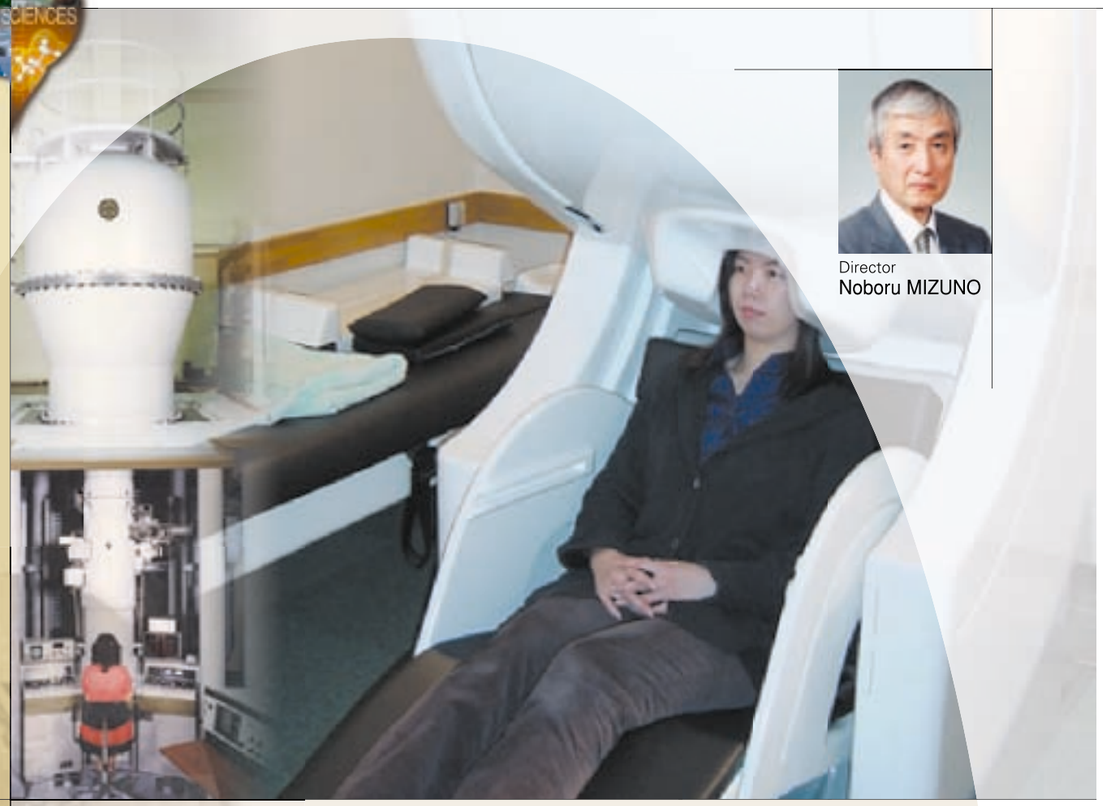
Mathematical Biology

How does the information inscribed in the genome evolve into the highly regulated behavior of organisms found in morphogenesis during development or flexible adaptation to the environment? We investigate this question through the integration of essential elements of biological information using computer calculations and mathematical models. The figures on the left show regular shapes found in the bacterial colonies and on the body surface of a fish. Using mathematical models, such ordered shapes can be reproduced as shown on the right and can be analyzed to reveal the underlying conditions.



NIPS

National Institute for Physiological Sciences

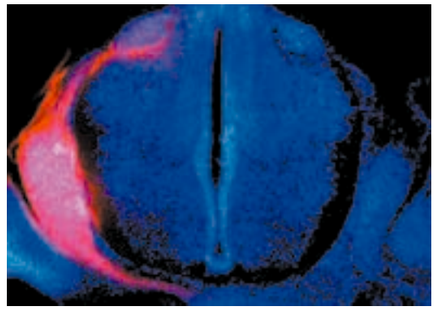


Director
Noboru MIZUNO

The mission of NIPS is to conduct research in the forefront of the physiological sciences by examining the living body at various levels of organization and thus understand the functioning of the human body. The recent progress in life sciences has been truly remarkable; there has been tremendous progress especially in molecular biology and genetic engineering. Non-invasive recording techniques have also become very useful for elucidating the physiological functions of the human body. Recently NIPS has focused on brain science, and it is now considered one of the best brain institutes not only in Japan but also in the world. One big news item is that a new research center, the Center for Integrative Bioscience, was founded in 2000 in cooperation with the Institute for Molecular Science and National Institute for Basic Biology as a center for interdisciplinary work. In addition, NIPS has started a joint research project on biosensor molecules. With the key phrase “Elucidation of Functioning of the Human Body” in mind, NIPS is performing cutting edge research in various fields involving not only physiology but also biochemistry, biology, cognitive science and medical engineering, and provides its facilities and talent to domestic and foreign scientists for collaborative studies.

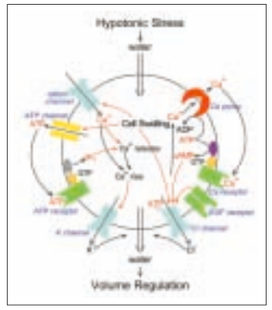
To clarify the mechanisms underlying neural development

We are studying the development of neural system and body homeostasis. For example, developing mammalian spinal cord is composed of several regions formed along the dorso-ventral axis and each region generates site-specific neurons and glial cells. Subsequently, neural network is formed by directed axogenesis. These developmental phenomena are crucial for functional brain formation. We are focusing on molecular mechanisms underlying cell differentiation and network formation. Figure shows projections of primary sensory fibers in the spinal cord by labeling DRG with red fluorescent dye.



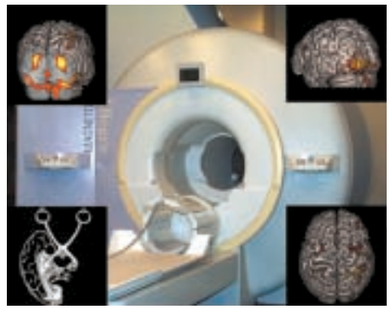
To clarify the molecular mechanisms of cell functions

The human body is composed of over 10^{13} cells, and its survival or death is supported or determined by the functioning of these cells. We are investigating the mechanisms by which cells function at the level of molecules such as channels, transporters, receptors, etc., and the mechanisms of operation of these functional molecules.



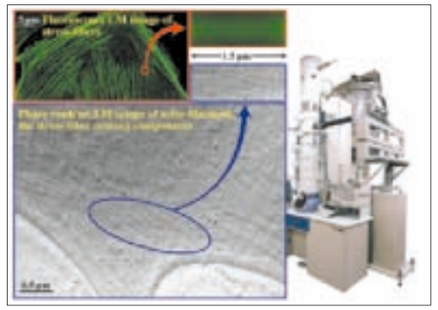
To explore higher brain function

One of the research goals in NIPS is to understand the higher brain functions such as perception, cognition and motor control in primates including humans using electrophysiological techniques such as single neuron recordings as well as noninvasive functional neuroimaging techniques, mainly functional MRI (fMRI) and magnetoencephalography (MEG), in combination with multimodality approaches including electroencephalography (EEG), transcranial magnetic stimulation (TMS) and near-infrared spectroscopy (NIRS).

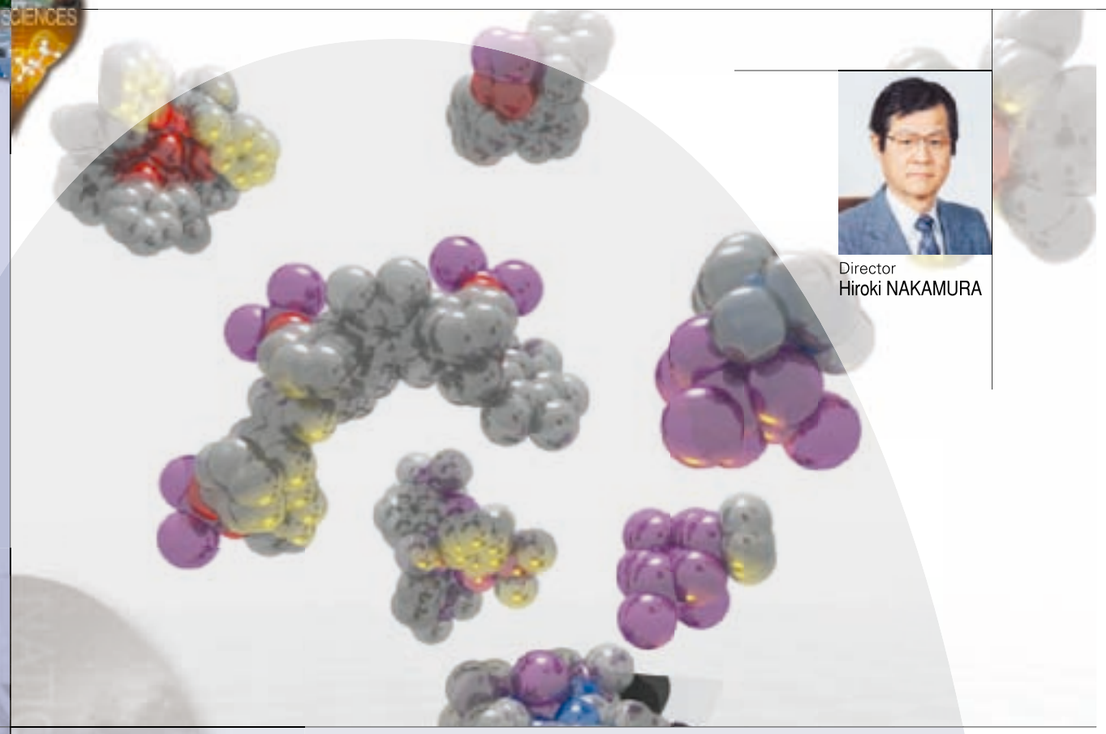


To visualize biological functions at a nanometer scale

Combination of electron and light microscopy provides a way to directly visualize in vivo functions of proteins and organelles in the cell. In particular, high voltage (300kV) phase contrast electron microscopy, in conjunction with quick freezing or high pressure freezing techniques, is opening a novel kind of physiology, “functional-structional biology” by its nano-meter resolution visibility for unstained intact cells.



Institute for Molecular Science



Director
Hiroki NAKAMURA

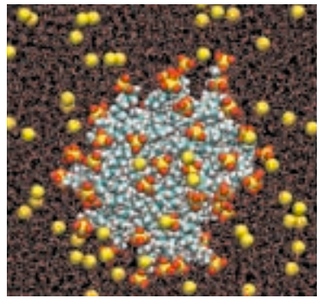
Molecular Science is a fundamental discipline for studying the structures, functions, and reactivity of molecules and molecular assemblies both theoretically and experimentally at the microscopic level. Through the discovery of novel molecular functions and the synthesis of new molecular materials with desirable properties and functionalities, molecular science provides invaluable clues to solve energy and environmental problems and develops a new science and technology based on the principle of circulation of materials.

The Institute for Molecular Science (IMS), as a Center of Excellence to conduct basic researches in molecular science covering a wide range of sciences from material to life science, provides concepts and methodologies to be used commonly in other fields. The main research areas of IMS are theoretical and computational molecular science, photo-molecular science, materials molecular science, and biological molecular science. Front running researches are carried out in each area by the independent research groups led by professors or associate professors based on their initiatives and originalities.

Employing the unique personnel policy, IMS has been producing a large number of outstanding scientists to universities and institutions in Japan since its foundation. IMS plays an important role in providing various collaborative research programs internationally as well as domestically, and also promotes multidisciplinary researches as exemplified by the establishment of The Okazaki Institute for Integrative Bioscience in cooperation with NIBB (National Institute for Basic Biology) and NIPS (National Institute for Physiological Science).

Theoretical and Computational Molecular Science

Self-organization of molecules and molecular assemblies and their structures and dynamics are studied theoretically and by large-scale calculations with various simulation methods including molecular dynamics and Monte Carlo algorithms. In particular, the national project on Development & Application of Advanced High-Performance Supercomputer Project by MEXT is underway to develop methodologies to create new theories or computational methods in nano science.



A Snapshot of micelle in water simulated by molecular dynamics method

Applications of Synchrotron Radiation

Various studies in molecular science regarding molecular structures, photo-induced chemical reactions, and materials functions are performed with the vacuum ultraviolet synchrotron radiation facility (UVSOR), which generates intense light in ultraviolet that molecular scientists have been dreaming of. The facility was in operation since 1983 and upgraded in 2003 for improving its performance.

UVSOR facility and radiation from the ring

Molecular Materials Science and Molecular-Scale Nanoscience

This project focuses on methods for realizing new functions of molecular assemblies, for synthesizing materials with atomic-scale precision, and for exploring novel phenomena unique to the nano-scale world. In addition, the Nanotechnology Support Project is underway to provide sophisticated facilities for structural analysis and function evaluation on nano-structured materials for researchers working on nanotechnology.

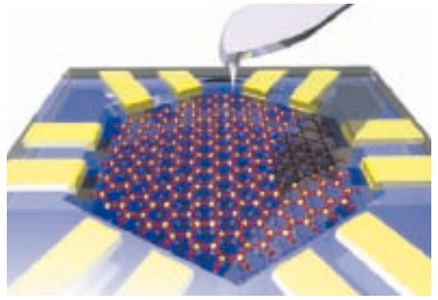
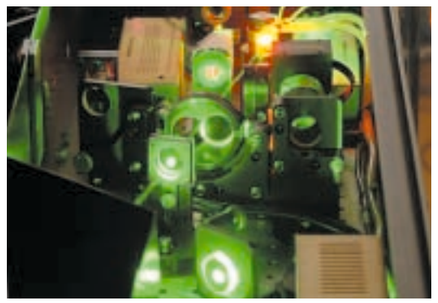


Image of self-assembled organic molecules in a nanometer scale

Photo-Molecular Science

Photo-Molecular Science plays a fundamental role in many disciplines including nano- and life science through the interactions of photons with molecules and materials. This project is aimed, with collaboration with RIKEN institute, at developing new coherent light sources, novel imaging techniques, methods for controlling quantum processes and chemical reactions to begin a new era of photoscience.



Laser facility for ultrafast sum frequency generation spectroscopy

Research Cooperation

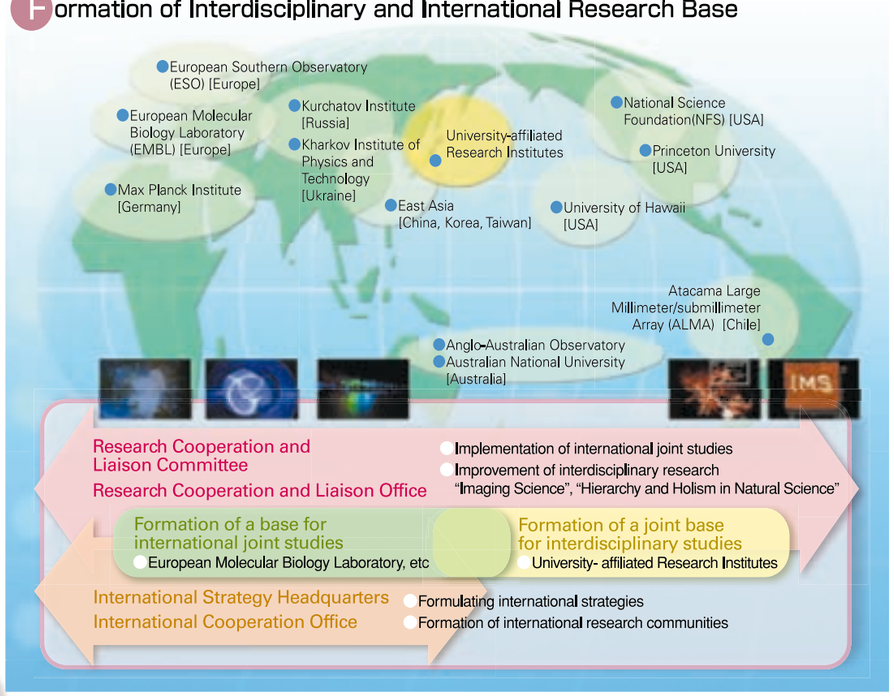
Efforts for Forming Bases for Interdisciplinary and International Research through Cooperation Across Fields of Study

The five institutes established under NINS—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) — are Japan's center of excellence of academic research in the respective fields. These institutes, associating with each other beyond the borders of academic fields, cooperate actively as a base for interdisciplinary research in the field of natural science with universities, university-affiliated research institutes and inter-university research institutes to promote the formation of new research communities. NINS also collaborates with institutes in the U.S., Europe and Eastern Asia, for the purpose of forming a base for international research coordinating reputable researchers on a worldwide basis.

In order to promote the formation of such interdisciplinary and international bases across fields of study, NINS established the "Research Cooperation and Liaison Committee" under the authority of the President, to discuss and plan matters of research cooperation. It has also established the Research Cooperation and Liaison Office, which is in charge of setting specific plans made by the "Research Cooperation and Liaison Committee", and is implementing liaison activities including symposiums.

From FY2005, the Research Cooperation and Liaison Office has set "Imaging Science" and "Hierarchy and Holism in Natural Science" as themes for cooperation across fields, and is promoting symposiums and other projects under these themes.

Formation of Interdisciplinary and International Research Base



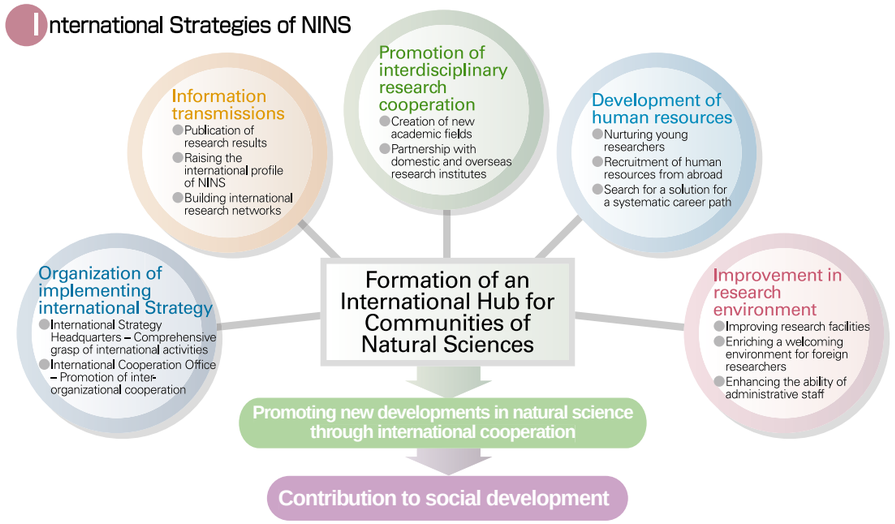
International Cooperation

The creation of new research fields in natural science will become possible with competent researchers in various fields cooperating with each other beyond the borders of their academic fields and forming completely new research communities. In order to achieve this, it is necessary to strengthen cooperation with international research communities and overseas research institutes as well as deepen mutual understanding and implement active joint research.

Working toward formation of an international research base, NINS establishes the "International Strategy Headquarters" to unify decision-making for its international activities. It also sets up "International Cooperation Office" for inter-organizational management of international activities and supporting those activities in each institute.

The International Strategy Headquarters establishes international strategies aiming at the "Formation of an International Hub for the Natural Science Research Community". With support and cooperation from the research community, it also promotes new approaches for the development of natural science.

International Strategies of NINS



Management Structure of International Affairs