NINS

National Institutes of Natural Sciences

SINCE APRIL 2004

2016

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
Akio KOMORI

The National Institutes of Natural Sciences consists of the five research institutes 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 and by consensus of the research community as an inter-university research institute, strives to enhance the roles and functions of each research institute and energetically presses ahead with cutting edge research in one's respective specialized fields. Additionally, in order to strengthen collaboration of different fields and to develop a new research horizon with an eye toward the further clarification of natural sciences, the five research institutes established the Center for Novel Science Initiatives at NINS as one of the merits of being a corporation. As a result of this, the Astrobiology Center was installed last year to create a new field of research directed toward the origin and evolution of life in the universe.

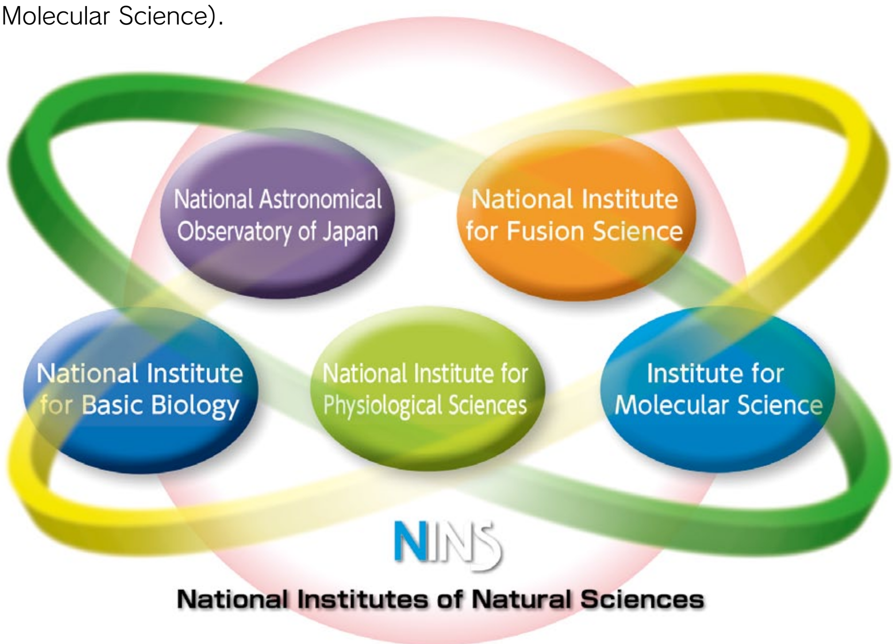
Various goals including those that set numerical targets are raised in the third mid-term plan of NINS that begins with this year. Within these goals, we have the promotion of collaborative research between different fields in greater detail and the development of new fields as major goals. These concur with what universities across-the-country aspire for, to carry out organizational reforms beyond departments as a part of university reform and to develop new research that is not restricted by existing specialized fields. Because lifting the barriers from the five research institutes is difficult at the current moment in the case of NINS, alternatively, we would like to build up a new joint research system implemented as NINS instead of each research institute independently carrying out joint use and joint research which are the most important functions of NINS as has often been the case in the past. At the introduction of this system, the barriers of the research institutes will practically be out of the way and regardless of advocating collaborative research between different fields, domestic and international researchers and graduate students can participate irrespective of the field. As well as achieving a major breakthrough on collaborative research in each specialized field, from the fact that we expect to develop and create new research and fields, in addition to the Center for Novel Science Initiatives, it may be said that this is a potent way to improve functional enhancements.

Additionally, numerical targets associated with the employment of international and female researchers, etc. in the third mid-term plan are set, however, these are unrealizable unless each research institute is flexible and clear as NINS in totality. As just described, to make certain practices a reality in NINS, we take it as a given that it is vital to implement following adequate consultation and agreement across NINS more than ever and more specifically operate by breaking down the boundaries of the research institutes from here on.

NINS is aimed at conducting world-class academic research in each field, creating learning befitting the 21st century, and contributing to society. We look forward to your continued support and cooperation to NINS.

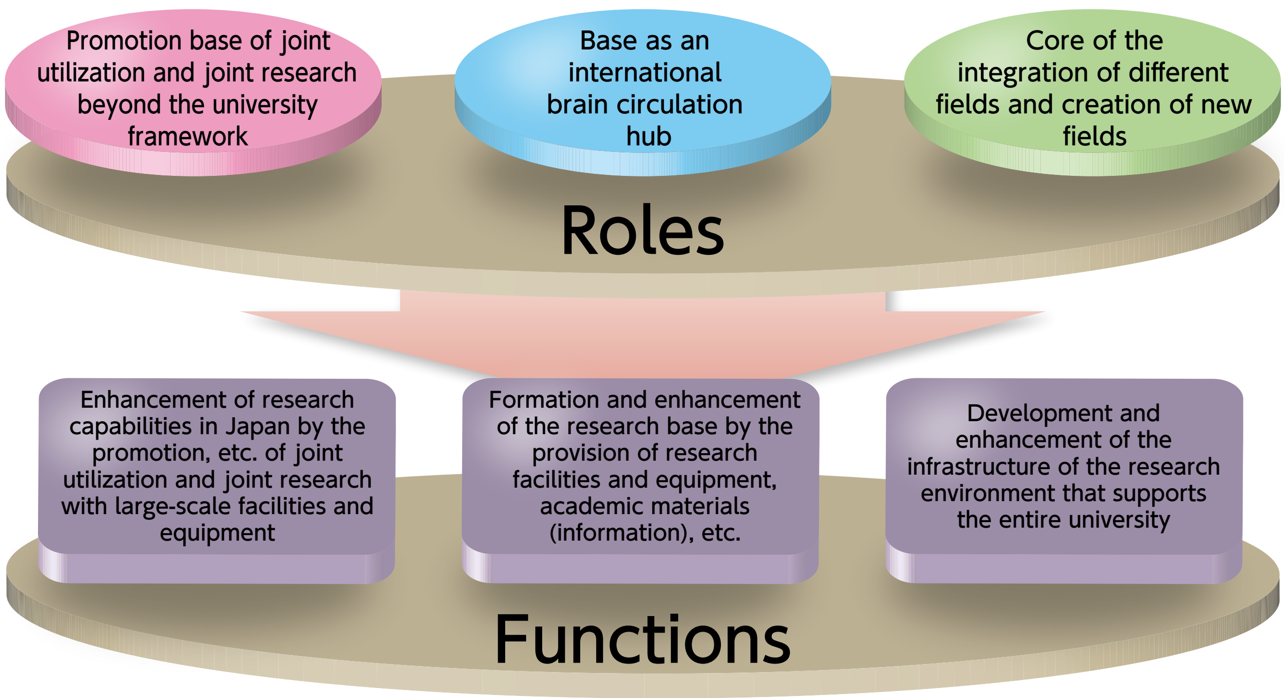
What is the National Institutes of Natural Sciences?

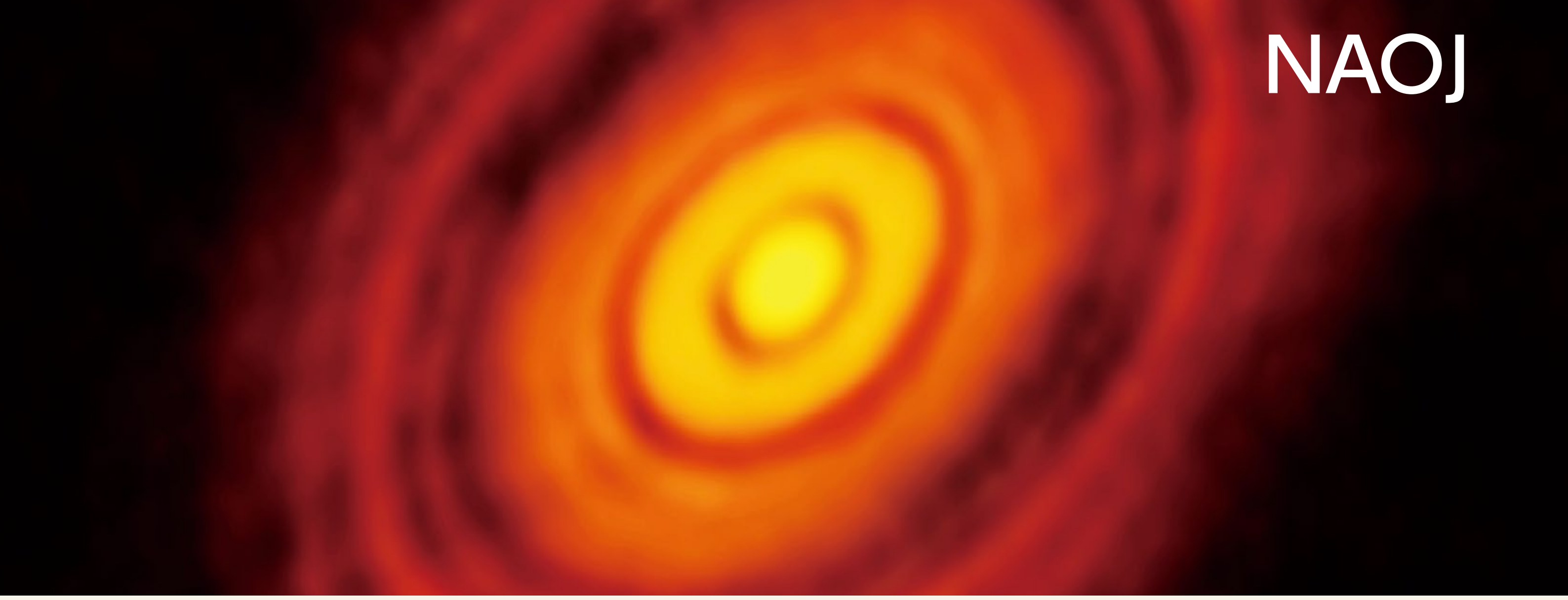
The National Institutes of Natural Sciences provides a ground for joint utilization and joint research to researchers of universities, etc. across Japan as an inter-university research institute corporation with promoting international and leading research by establishing and operating base research institutes in the fields of natural sciences involved in space, energy, materials, life, etc. (National Astronomical Observatory of Japan, National Institute for Fusion Science, National Institute for Basic Biology, National Institute for Physiological Sciences, and Institute for Molecular Science).



Roles and Functions of the Inter-University Research Institute

The inter-university research institute is a "research institute operated by the research community", a type of world-class organization unique to Japan and seeks to strengthen functions based on the characteristics of each institute with fulfilling roles as a core base to provide a place for joint utilization and joint research to researchers of universities, etc. across Japan beyond the framework of each university, an international brain circulation hub, and a core of the integration of different fields and creation of new fields.





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

National Astronomical Observatory of Japan

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. 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

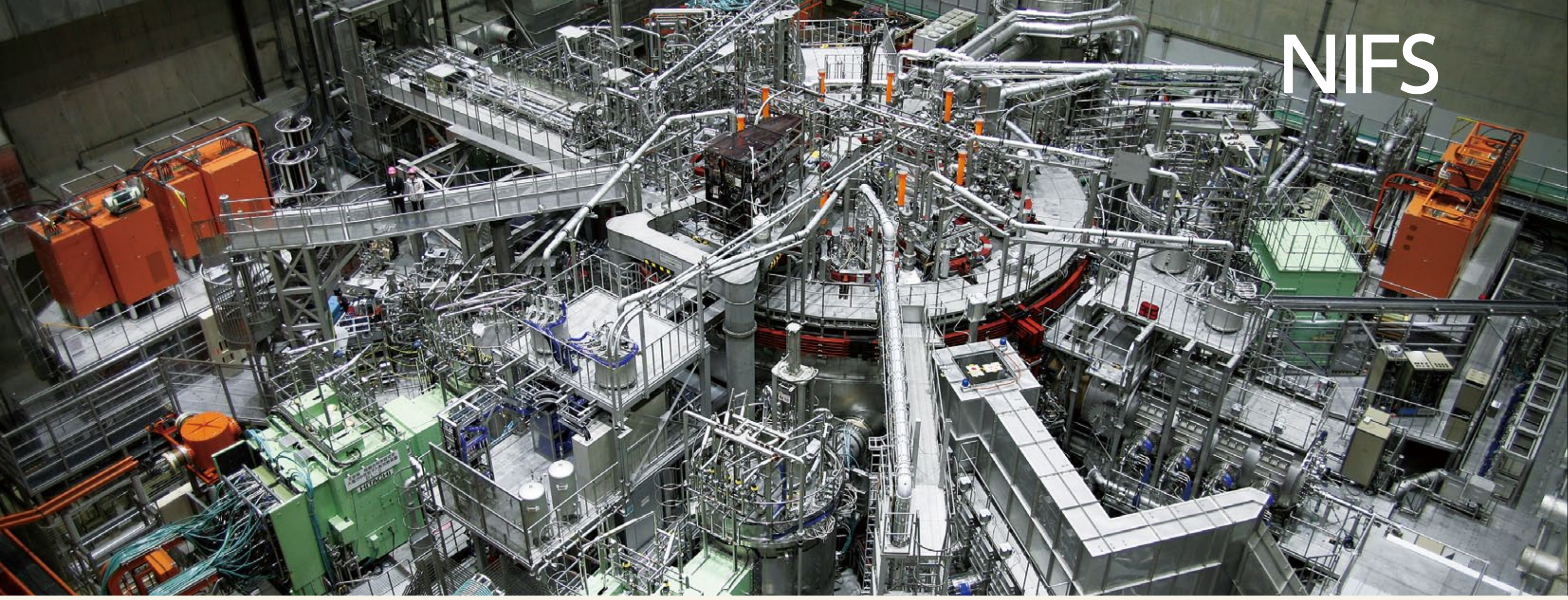
ALMA (Atacama Large Millimeter/submillimeter Array) is a partnership between Europe, North America, and East Asia (Japan, Taiwan, and South Korea) in cooperation with the Republic of Chile to operate an international radio astronomy facility on the 5,000 m Chilean plateau. By combining signals obtained with 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 and resolution have provided us 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

TMT (Thirty Meter Telescope) Project

The TMT Project is constructing an extremely large telescope with a 30 m aperture on Maunakea 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 between 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 Maunakea in Hawai'i



Large Helical Device (LHD)

National Institute for Fusion Science

Looking toward the future, developing new sources of energy that are safe and environmentally friendly is the most important issue shared in our world. At the dawn of achieving on earth the fusion reaction which also is the source of the energy in the sun and in stars, the human race can grasp an energy that will last forever because deuterium and lithium, which will become fuels, are abundant in seawater.

The National Institute for Fusion Science is advancing with active collaboration research with universities and research institutes in Japan and abroad. In order to achieve fusion energy as early as possible, the Institute is fostering the next generation of excellent researchers and establishing links with society. And the Institute is advancing strongly with academic research that includes fusion plasma.

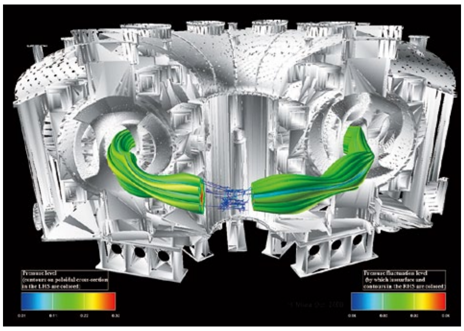
Research on high-temperature steady-state plasma utilizing the Large Helical Device

Large Helical Device (LHD) project employs the world's largest class of 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 that exceed several tens of millions 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.



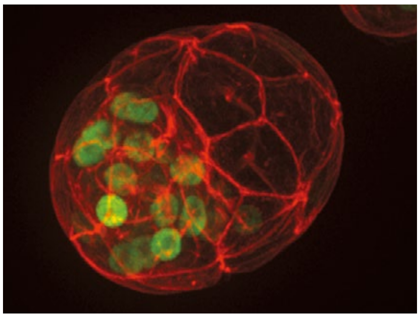
MHD simulation of LHD plasma

National Institute for Basic Biology

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. The aim of NIBB is understanding the fundamental aspects of life and the variety of survival strategies of organisms. In order to achieve this goal, NIBB promotes the development of research techniques and methods for multi-hierarchy analyses clarifying interactions of genes, cells, tissues, individuals and different species. NIBB conducts collaborative research projects with researchers around Japan and the world to elucidate the mechanisms underlying common fundamental aspects of all organisms, acquisition of their wide variety, and adaptations to divergent environments.

Exploring the diverse phenomenon of life

Living organisms have a variety of forms, characters, and abilities to adapt to their environments. How are the complicated forms of these organisms made? How did they acquire their characters and abilities through evolution? What is occurring in evolution? The research at NIBB encompasses a diverse range of organisms including plants, insects, fish, mice and microorganisms. In NIBB, many studies are conducted to elucidate the mechanisms of biological phenomena through analyses focused on gene functions, the movements and the roles played by cells, cell-to-cell communication, interaction between organisms, etc.


Cell differentiation in a mouse blastocyst

For the further advancement of biology

NIBB provides and uses cutting-edge technology such as next-generation DNA sequencers, mass spectrometers and light-sheet microscopes. NIBB conducts many collaborative research projects with researchers throughout Japan. As the core institution for the National Bioresource Project Medaka, as well as a subcenter for morning glory and Zebrafish, NIBB collects, preserves, and provides important biological resources to researchers in 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.


NIBB International Practical Courses

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

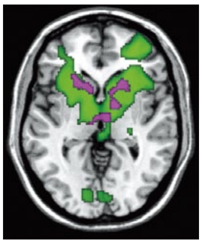
National Institute for Physiological Sciences

NIPS' mission is to conduct research at the forefront of physiological science by examining the living body at various levels of organization, 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 notably marked developments 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 focusing on higher brain functions as one of the most important research targets, 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 offers its facilities and expert staff to domestic and foreign scientists for collaborative studies.

Exploring the higher functions of the human brain

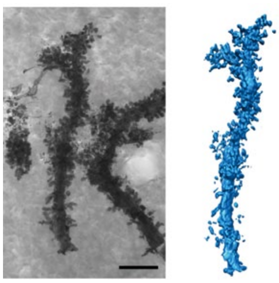
NIPS is promoting research on the higher functions of the human brain including language functions and value judgments, and interpersonal relationships, as well as perception, cognition, and motion. To measure brain activity, we utilize functional brain imaging instruments including functional MRI (fMRI) and near-infrared spectroscopy (NIRS) 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 in the presence of monetary reward (green) and social reward (red). When being praised by other people, the brain's reward system (striatum) reacts as when making money.

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 research. For example, we developed a dual fMRI system for simultaneous recordings of the brains of two individuals when they are communicating with each other. We provide advanced electromicroscopy and laser microscopy for collaborative research. We also provide valuable research resources such as virus vectors, transgenic mice, rats, and macaque monkeys for domestic researchers in Japan.



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

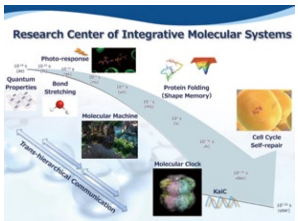
Institute for Molecular Science

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. 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, 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. 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 biomolecular 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.

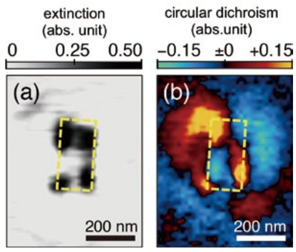


CIMoS
Research Center of Integrative Molecular Systems

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

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 photomolecular 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

Promotion of Joint Utilization and Joint Research beyond the Framework of Universities

To build advanced facilities and equipment for joint utilization and joint research in each field and contribute to developments in the fields of natural sciences of universities, etc. across Japan, we are promoting joint research through the provision, etc. of our resources in addition to making them available for use for researchers in universities, etc. Furthermore, to contribute to the enhancement of research capabilities of universities, we are consolidating initiatives on university collaborations which are serving as driving forces in each field and aimed at the further enhancement of interinstitutional collaborations with universities.

Introduction of Major Joint Utilization Facilities

National Astronomical Observatory of Japan

Subaru Telescope: The Subaru Telescope is our flagship observation facility. It is an 8.2 m optical/infrared telescope located near the top of Maunakea on Hawai'i Island in the U.S.A. since 2000.

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

National Institute for Fusion Science

The collaboration research programs at NIFS are performed together with three main facilities. These facilities are the LHD, the Plasma Simulator, and the Innovative Energy Circulation Technology for the three research projects of the LHD Project, the Numerical Simulation Reactor Research Project, and the Fusion Engineering Research Project, respectively.

Oroshhi-2 (Operational Recovery Of Separated Hydrogen and Heat Inquiry-2)

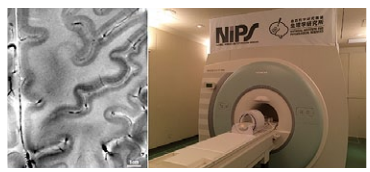
National Institute for Basic Biology

The Okazaki large spectrograph runs on a 30 kW Xenon arc lamp and projects a wavelength spectrum from 250 nm (ultraviolet) to 1,000 nm (infrared) onto its 10 m focal curve with an intensity of monochromatic light at each wavelength more than twice as much as that of the corresponding monochromatic component of tropical sunlight at noon. The spectrograph is dedicated to action spectroscopical studies of various light-controlled biological processes.

The Okazaki large spectrograph

National Institute for Physiological Sciences

Ultra-high-magnetic-field 7-tesla MRI facilitates analysis of the cerebral microstructure in the order of 100 microns, visualization of microvessels, and three-dimensional reconstruction of complex neuronal networks. This equipment will accelerate analysis of the higher cerebral function through integrated analysis of biological activity and anatomy, and it also helps to understand the human body as a biological system.



Ultra-high-magnetic-field 7-tesla MRI

Institute for Molecular Science

Light is called with various names such as infrared, visible, ultraviolet, vacuum-ultraviolet and X-ray, depending on its wavelength. A synchrotron light source is capable of producing light in the ultra-wide wavelength range from infrared to X-rays. Synchrotron light radiated by high energy electrons traveling in a strong magnetic field is intense and highly collimated. It is widely used in various research fields including molecular science. In IMS, a synchrotron light source has been operational since 1983. After several upgrades, it is still brightest in the world among low energy synchrotron light sources. By utilizing its excellent performance, the electronic structure that is the origin of the functionalities of solids is directly observed. This facility is called UVSOR and is used by many researchers not only from our country but also from foreign countries.

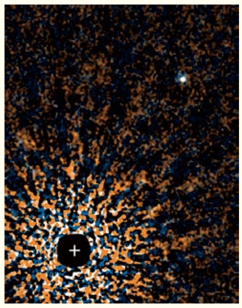
UVSOR

Integration of Different Fields and Creation of New Fields

While taking advantage of the predominant features of each institute, we are mounting efforts that create new academic disciplines and ensure their advancement, towards initiatives on the extended structures of nature and understanding of functions, beyond each field, and new developments in the natural sciences. Through various initiatives on collaboration among fields and exploration of research activities that can become new future fields, the newly created academic disciplines are aimed at the formation of genuine international joint research bases by the further development of the integration of different fields along with the constant promotion of groundbreaking new fields.

Astrobiology Center

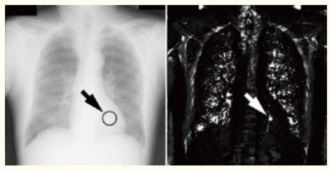
As a result of developments in extrasolar planet observations of recent years, astrobiology research to scientifically explore “life in the Universe” and uncover its mysteries has become a pressing subject. Astrobiology is a new learning set in space to probe places where there is life and its existence and discuss the origin and evolution of life instead of relying only from the Earth. The Astrobiology Center of NINS is advancing this field by integrating different fields covering a broad range of topics including astronomy, biology, and life science, promoting research into extrasolar planets and life both within and outside of the Solar System, and developing observational instruments for these purposes.



A "second Jupiter" around the Sun-like star GJ504. SEEDS project has discovered and captured an image of the least massive planet ever imaged.

Center for Novel Science Initiatives

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. Additionally, as a system to promote the constant creation of new fields, we established the Office of Novel Science Exploration in July 2015 and began the exploration of research activities that can become new future fields.



Software that can be used to detect a 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).

International Cooperation

Along with deepening collaboration with Europe, the US, etc. and promoting initiatives towards the creation of international research bases organizing excellent researchers in a global scale, we are promoting diverse international research exchange as an international brain environment hub including the conclusion of framework agreements among overseas research institutes, etc. and promotion of the implementation international joint research and researcher exchange.

International Collaboration with the European Molecular Biology Laboratory (EMBL)

EMBL is headquartered in Heidelberg, Germany. It is an international research institute run with financial support from 19 countries centering on the European Union nations. Based on an agreement on academic exchange executed in July 2005, and revised and extended in 2014, NINS and EMBL have engaged in academic exchange, personnel exchange and technological exchange. NIBB, which has common research fields with EMBL, is playing a central role in promoting joint research.

International Collaboration with Princeton University

NINS and Princeton University (US) concluded an agreement on academic exchange in March 2010. Based on this agreement, we are engaging in exchanges through mutual participation in symposiums and meetings, and support for joint research activities and educational activities. Additionally, for the enhancement of the framework to promote international joint projects, we established the North American base of the Research Enhancement Promotion Headquarters in 2015 and stationed a resident URA.

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

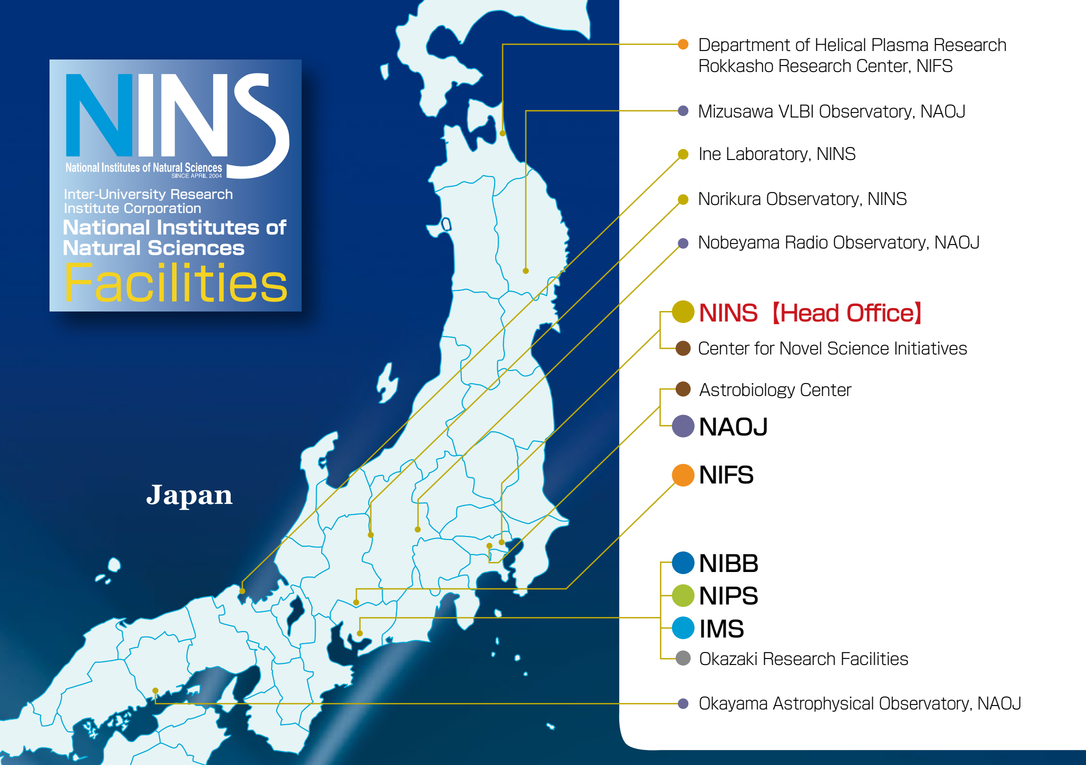
International Collaboration on the Construction and Operation of the Atacama Large Millimeter/Submillimeter Array (ALMA)

ALMA, which began full-scale operation in Chile in 2013, was completed through trilateral collaboration among Europe, Japan, and the US. The operation of ALMA is an international joint research project and NINS represents the participating countries along with the European Southern Observatory (ESO) and the National Science Foundation (NSF). The agreement on ALMA operation among the three parties was concluded in December 2015 and agreed on the building of operation and a governance system for the next twenty (20) years.

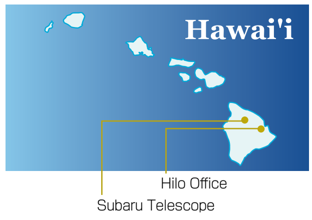
NINS, NAOJ, ESO, and NSF participated in the signing ceremony of the tripartite agreement on ALMA operation.

Inter-University Research Institute Corporation
National Institutes of Natural Sciences

Facilities



Subaru Telescope, NAOJ



NAOJ Chile Observatory

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Organization