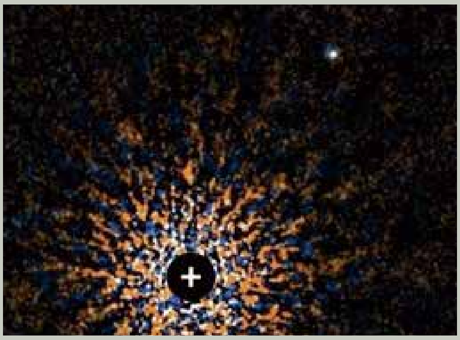
Inter-University Research Institute Corporation
National Institutes of Natural Sciences

National Astronomical Observatory of Japan



http://www.nao.ac.jp/en/

NAOJ

2015

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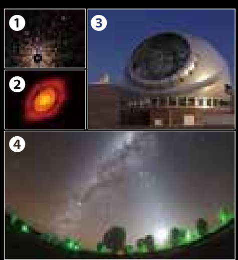
●Images from the NAOJ various observations and facilities.



Front Cover

1/Exoplanet GJ 504 b (point of light in the upper right) discovered by the Subaru Telescope. **2/**The disk of dust surrounding HL Tauri imaged by ALMA [ALMA(ESO/NAOJ/NRAO)]. **3/**Conceptual illustration of what TMT, which has started construction, will look like when completed. **4/**ALMA with the Moon, stars and Galaxy (photographer: Akira Kawamura).

Back Cover

5/Near infrared image of the star-forming region S 106 which is at a distance of approximately 2000 light-years from the Earth. A massive star called Infrared Source 4 (IRS 4) exists at the center of S 106. The hourglass appearance of S 106 is thought to be the result of the way material flows outwards from the central star. A huge disk of gas and dust surrounding IRS 4 produces the constriction at the center (Subaru Telescope).

Photo of NAOJ landscape : Yutaka Iishima
Illustration : Kouji Kanba • Four-Dimensional Digital Universe Viewer "Mitaka"
Design : Tamayo Arai

I wandered into the leafy, green grounds of the observatory ...

What is that star?

What is that Star?

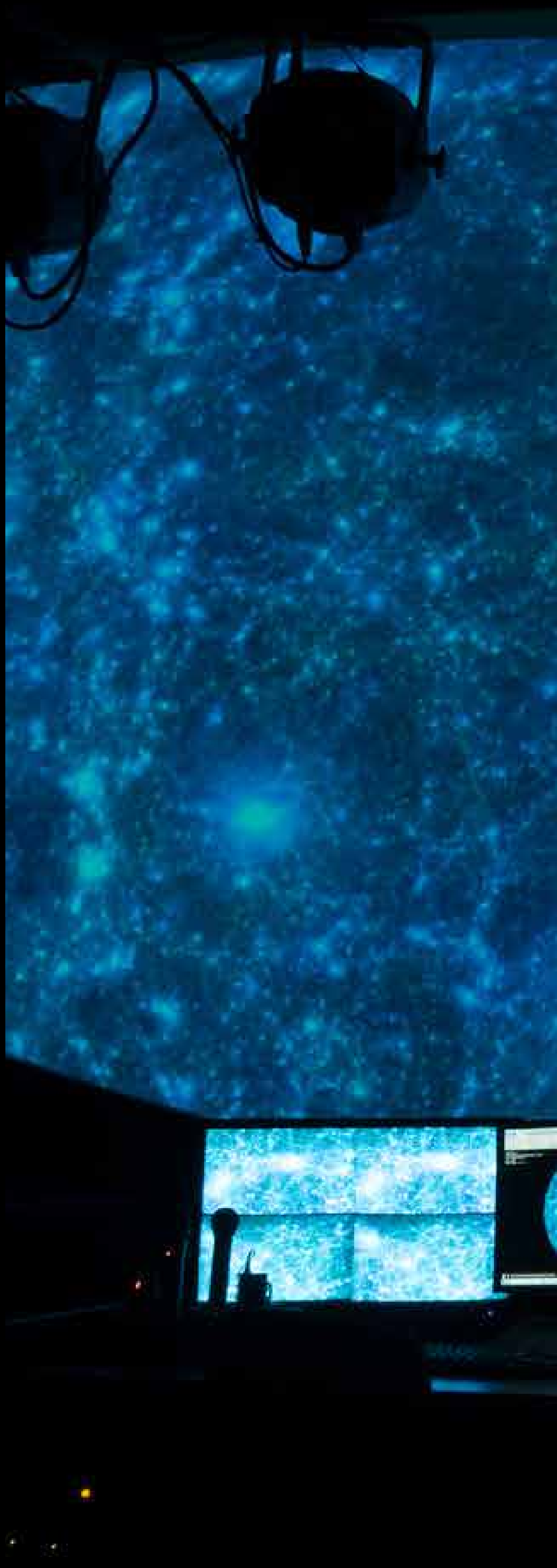
Humans have been asking the same question since time immemorial. Now, we can see into the farthest reaches of the vast Universe.

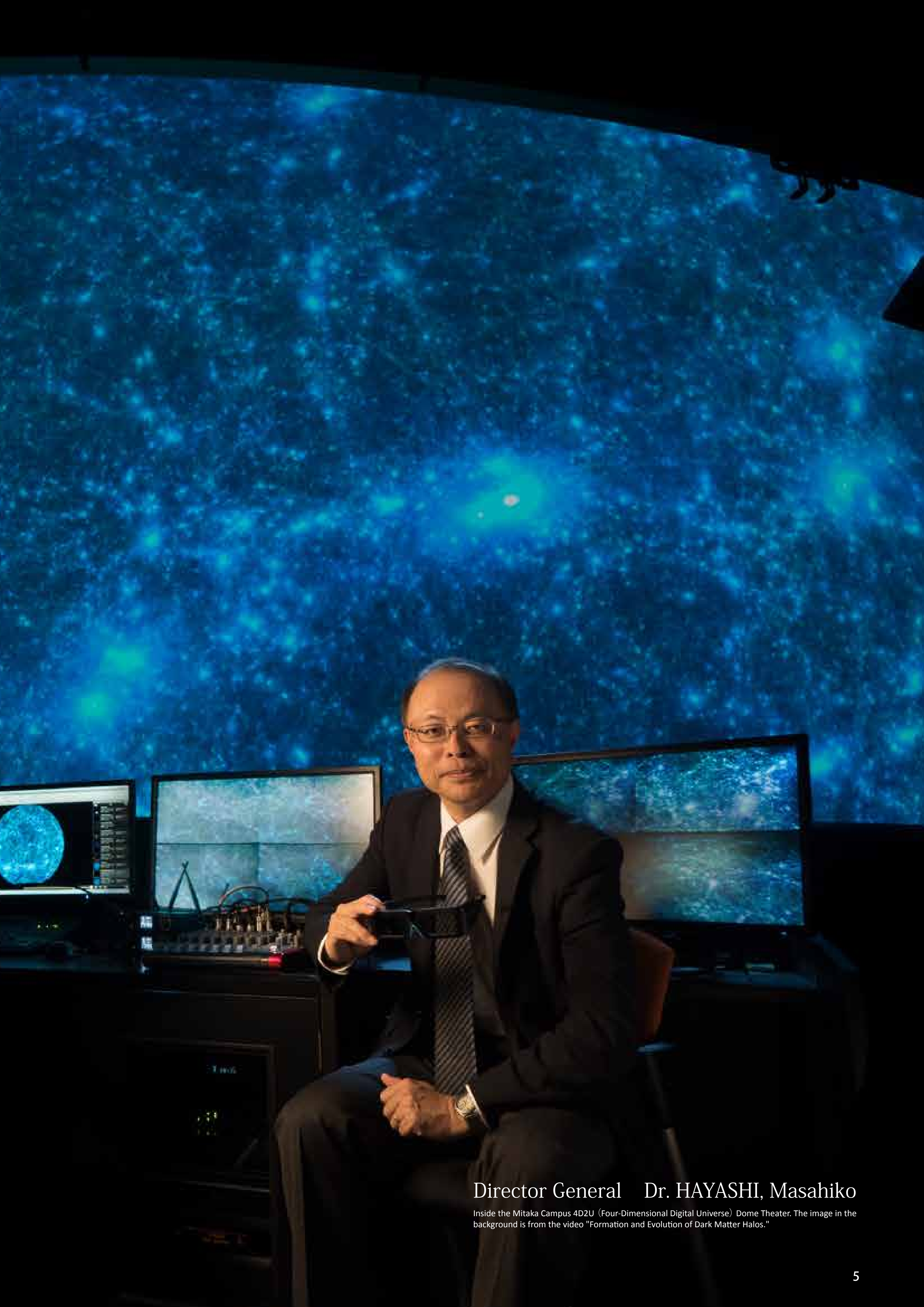
ALMA (the Atacama Large Millimeter/submillimeter Array) has been completed and has started to deliver exceptional results. ALMA is a dream come true for Japanese Radio Astronomers. When I was a graduate student, I had a chance to experience observations using Nobeyama's Millimeter Array. I still remember how impressed I was with its capabilities. It was apparent, even to a graduate student, that if we could increase the number of antennas, we would be able to capture pictures of the Universe in a level of detail that no other telescope in the world was capable of taking. But unless the arrays are built in a high location, they can't achieve that level of performance. At that time, there was a growing impetus to construct the Subaru Telescope in Hawai`i. It followed naturally that the next generation large radio interferometer should be built at the best site available internationally. It fills me with deep emotion to know that it has been more than 30 years since the Nobeyama Radio Observatory was founded and that ALMA has become a reality. I believe that many Japanese researchers, particularly young post-docs and graduate students, will produce leading edge results with observations using ALMA. I hope they will share their passion for research with the wider Japanese population.

Sixteen years have passed since the Subaru Telescope saw first light on January 28, 1999. Scientific papers based on the observational results of the Subaru Telescope are being published at a rate of roughly 1 paper every 3 days! The Subaru Telescope's ability to capture a wide field of view in a single exposure outclasses all other similarly sized telescopes. Thanks to this ability, the Subaru Telescope has delivered breakthroughs like the discovery of the most distant objects in the Universe and the large scale structure of the early Universe. Last year, observations using a "super" wide-field camera (Hyper Suprime-Cam) started. I believe this camera will display overwhelming power in the research fields of dark matter/dark energy and the history of galaxy formation.

The Subaru Telescope has a reputation for its superior optics capabilities. Thanks to these capabilities, progress is being made in the direct imaging of extrasolar planets. It successfully captured an image of a planet with a mass 4 times that of Jupiter. The Subaru Telescope can see already formed planets. In contrast, ALMA can observe the details of circumstellar disks in which planets form. The unique capabilities of these two telescopes make it possible to continue complementary research which will lead to a better understanding of the planetary system formation process. Without a doubt, this will advance studies about the possibility of life in the Universe.

When Earth-like planets are found, the search will start for signs of life on them. For that reason, we started construction of the next generation extremely large optical infrared telescope (TMT) on the summit of Mauna Kea where the Subaru Telescope is located. I think that with the TMT becoming a reality, the search for signs of life in the Universe is at hand.





Director General　Dr. HAYASHI, Masahiko

Inside the Mitaka Campus 4D2U（Four-Dimensional Digital Universe）Dome Theater. The image in the background is from the video "Formation and Evolution of Dark Matter Halos."

Activities and Objectives of NAOJ

The National Astronomical Observatory of Japan (NAOJ), the national center of astronomical research in Japan, promotes the open use of its facilities among researchers throughout Japan. NAOJ encourages collaborative research, observations and technological innovation, including inter-university research cooperation.
In addition, as one of the main international research bases in the world, NAOJ actively enhances flexible international research projects with personnel contributions and the most advanced observing facilities.
Modern astronomy has become highly advanced and large-scale. It is said that anymore constructing cutting-edge facilities and conducting observations to explore new horizons in astronomy is impossible without international cooperation.
NAOJ has taken part in many epoch-making international research projects throughout its 120 year history, gaining experience in research and technological innovation.
NAOJ aims to promote the development of astronomy, astro-physics, and the related fields of science.

Astronomy is one of the oldest and yet most active sciences. This means that human beings possess the fundamental desire to seek our origin and the reason for our existence through an understanding of the Universe. Since the establishment of the Big Bang theory of Universe creation in the 20th century, astronomers have been striving to describe the dynamics of the evolution of the Universe from its material production, the generation of stars and planets, the creation of life forms, up to the birth of human beings.

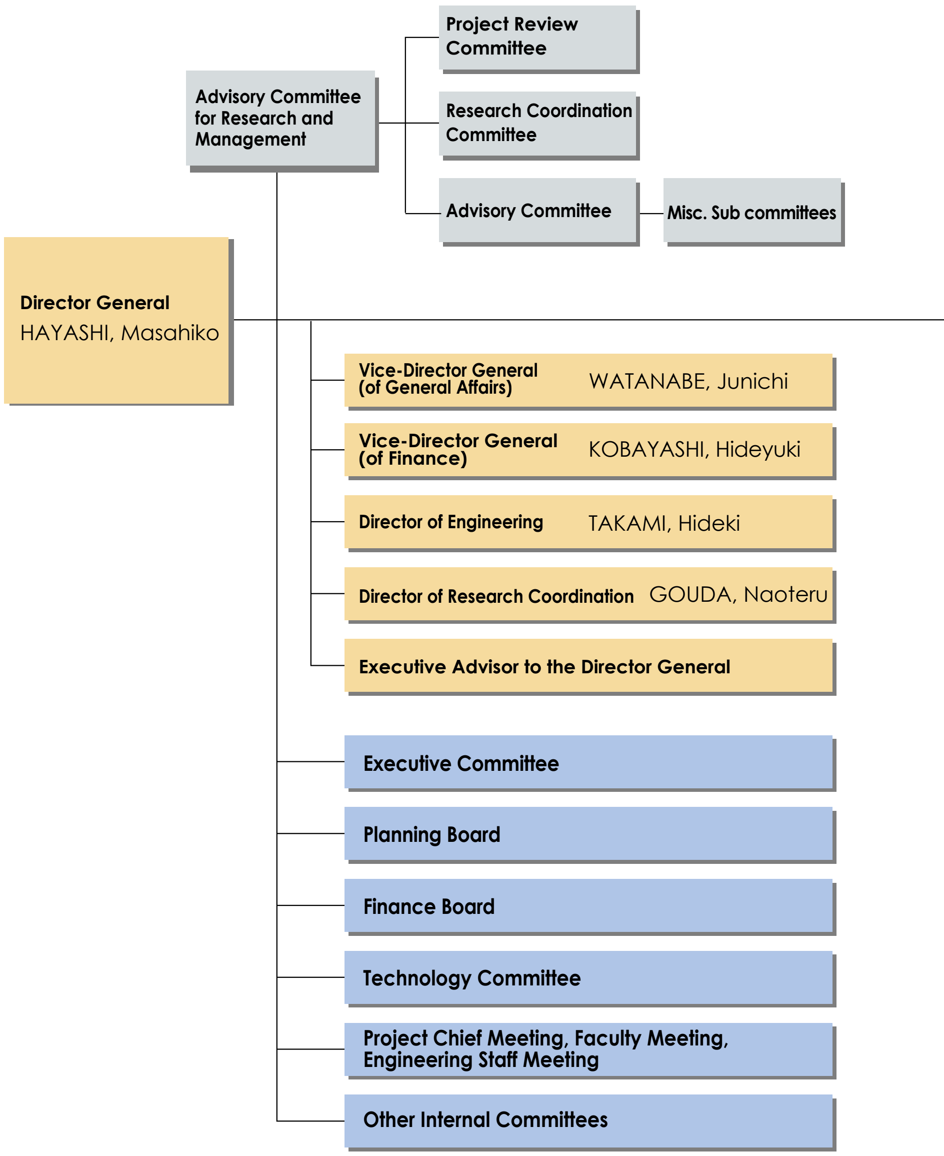
The 21st century will be the era in which we search for planets and life forms outside the Solar System.

The NAOJ is putting our best effort toward playing a key role in establishing a new paradigm for understanding the Universe, the Earth, and life as a whole.

For this purpose, we conduct observations of various objects, from the Earth to the Universe itself, and we consider the fundamental theoretically laws behind the observed phenomena. We also develop new technology to support these activities.

Organization

The Project System clarified the activities and plans of NAOJ in terms of projects, center and divisions, each with specific goals and deadlines. The goal is to raise awareness of our research activities and achieve further invigoration. The Project System advances the sharing of resources throughout the entire observatory; defines the responsibilities and capabilities of project leaders and staff; and improves the clarity and independence of research.

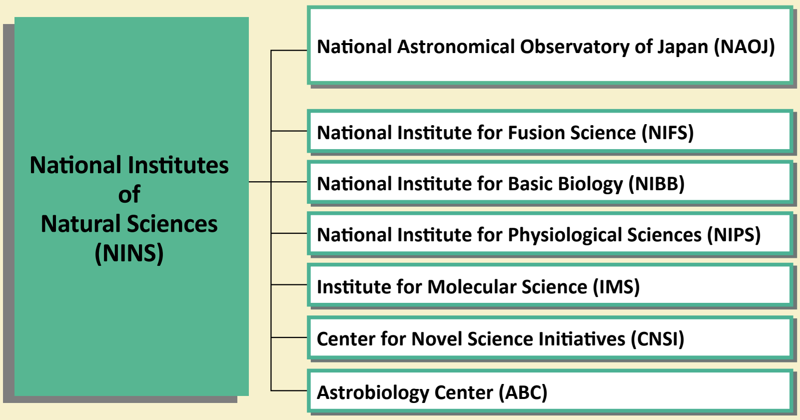


Research Objectives of NINS

The National Institutes of Natural Sciences (NINS), established on April 1, 2004, consisted of five inter-university research institutes specializing in natural science research: 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.

The integration of these research institutes, specialized in a wide range of scientific fields such as space, energy, materials, and life, is intended to promote the development of novel concepts and/or fields of natural science. Another aim of the NINS is to grow into a worldwide center of excellence in the natural sciences.

Astrobiology Center was established as of April 1, 2015 to promote the combined study of astronomy and life sciences.



Projects →p.14

C Projects Eight Observatories as Main Driving Force of NAOJ →p.14

- **Mizusawa VLBI (Very Long Baseline Interferometry) Observatory** →p.14
  Director : HONMA, Mareki
- **Nobeyama Radio Observatory** →p.15
  Director : SAITO, Masao
- **Solar Observatory** →p.15
  Director : HANAOKA, Yoichiro
- **Okayama Astrophysical Observatory** →p.16
  Director : IZUMIURA, Hideyuki
- **Subaru Telescope (in Hawai'i)** →p.16
  Director : ARIMOTO, Nobuo
- **Center for Computational Astrophysics** →p.17
  Director : KOKUBO, Eiichiro
- **Hinode Science Center** →p.17
  Director : WATANABE, Tetsuya
- **NAOJ Chile Observatory** →p.18
  Director : HASEGAWA, Tetsuo

B Projects Two Developing Projects for NAOJ's Future →p.19

- **Gravitational Wave Project Office** →p.19
  Director : FLAMINIO, Raffaele
- **TMT (Thirty Meter Telescope) Project Office** →p.20
  Director : USUDA, Tomonori

A Projects Four Projects for Next-Generation Astronomy →p.20

- **JASMINE** (Japan Astrometry Satellite Mission for INfrared Exploration) **Project Office** →p.21
  Director : GOUDA, Naoteru
- **Extrasolar Planet Detection Project Office** →p.21
  Director : TAMURA, Motohide
- **RISE**(Research of Interior Structure and Evolution of Solar System Bodies) **Project** →p.22
  Director : NAMIKI, Noriyuki
- **SOLAR-C Project Office** →p.22
  Director : HARA, Hirohisa

Centers Three Centers Developing NAOJ's Strengths →p.23

- **Astronomy Data Center** →p.23
  Director : OHISHI, Masatoshi
- **Advanced Technology Center** →p.24
  Director : NOGUCHI, Takashi
- **Public Relations Center** →p.24
  Director : FUKUSHIMA, Toshio

Divisions Four Research Divisions Supporting NAOJ →p.25

- **Division of Optical and Infrared Astronomy** →p.25
  Director : MIZUMOTO, Yoshihiko
- **Division of Radio Astronomy** →p.25
  Director : IGUCHI, Satoru
- **Division of Solar and Plasma Astrophysics** →p.26
  Director : SAKURAI, Takashi
- **Division of Theoretical Astronomy** →p.26
  Director : TOMISAKA, Kohji

Administration Department Four divisions that keep NAOJ running smoothly

- **General Affairs Division**
- **Accounting Division**
- **Financial Affairs Division**
- **Facilities Division**

Research Enhancement Strategy Office

- **Research Evaluation Support Office**

Office of International Relations →p.27

Human Resources Planning Office

Safety and Health Management Office

Engineering Promotion Office

NAOJ's "Philosophy"

"NAOJ's Philosophy" was codified in fiscal year 2014.

●Our Vision

・To be innovators striving to solve the mysteries of the Universe.

●Our Mission

・To develop and construct large-scale cutting-edge astronomical research facilities and promote their open access aiming to expand our intellectual horizons.
・To contribute to the development of astronomy as a world leading research institute by making the best use of a wide variety of large-scale facilities.
・To bring benefits to society through astronomy public outreach.

●Our Products / Deliverables

・To explore the unknown Universe and provide new insight into astronomy.
・To make our research outcomes widely known to society and pass on our dreams to future generations.
・To mentor next-generation researchers for their role on the world-stage.

NAOJ Facilities

Our research facilities have been set up around the world for better observational environments to explore the Universe.

Our research and observational facilities are scattered throughout various regions of Japan as well as in foreign countries. To better understand the Sun, stars, interstellar matter, galaxies and other celestial objects, the best quality data in a wide range of wavelengths, from visible to radio waves, are indispensable. For this purpose, our observational facilities are located in the optimum natural environments.

Open this fold out. This way, you can see an outline of the structure of the known Universe. Each of NAOJ's research and observational facilities is cooperating with the others to enhance efforts to unveil the mystery of the entire Universe.

NAOJ Chile

NAOJ Chile Observatory (C Project) → p.18

The Atacama Large Millimeter/submillimeter Array(ALMA) project is a partnership including Japan, Taiwan, Korea, Europe and North America in cooperation with the Republic of Chile to build and operate an international radio astronomy facility on the 5000 m Atacama Desert in Chile.Now NAOJ is working full scale on this huge project, leading the construction and operation of ALMA on behalf of the Japanese and East Asian science communities. ALMA was inaugurated as a completed observatory in March, 2013.

ASTE(Atacama Submillimeter Telescope Experiment)

The ASTE telescope observes radio waves with wavelengths in the range from 0.1 mm to 1 mm. In the superb atmospheric conditions of the Atacama Desert, ASTE has made new scientific discoveries in the center of our own Galaxy, in nearby star-forming regions, and in distant galaxies.

NAOJ Nobeyama Nagano Prefecture

Nobeyama Radio Observatory (C Project) → p.15

Nobeyama Radio Observatory raised Japanese radio astronomy to the top tier, internationally. The 45-m Radio Telescope is the largest millimeter radio telescope in the world. It has achieved epoch-making results, such as discovery of new interstellar molecules and accretion gas disks around proto-planetary systems. The Nobeyama Campus is open daily to the public.

NAOJ Okayama Okayama Prefecture

Okayama Astrophysical Observatory (C Project) → p.16

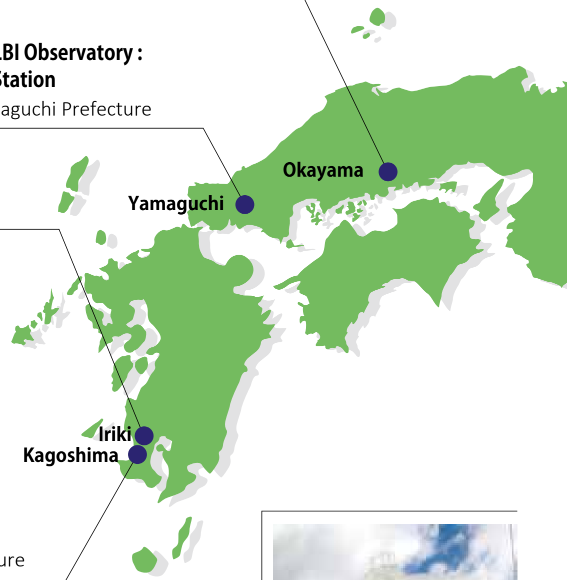
The main facility of the Okayama Astrophysical Observatory is a 188-cm reflector, one of the largest optical-infrared telescopes in Japan. The observatory is the center of optical and infrared observations in Japan aimed at galaxies, stars, and objects in the Solar System. New “eyes” with which to explore the Universe are being developed, such as an infrared spectrometer and an infrared wide field camera.

Mizusawa VLBI Observatory : Yamaguchi Station

Yamaguchi, Yamaguchi Prefecture

Seven VLBI Stations

(including Four VERA Stations)



Mizusawa VLBI Observatory : Iriki Station (VERA) (C Project) → p.14

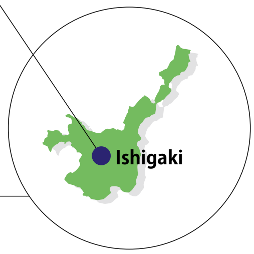
Satsumasendai, Kagoshima Prefecture

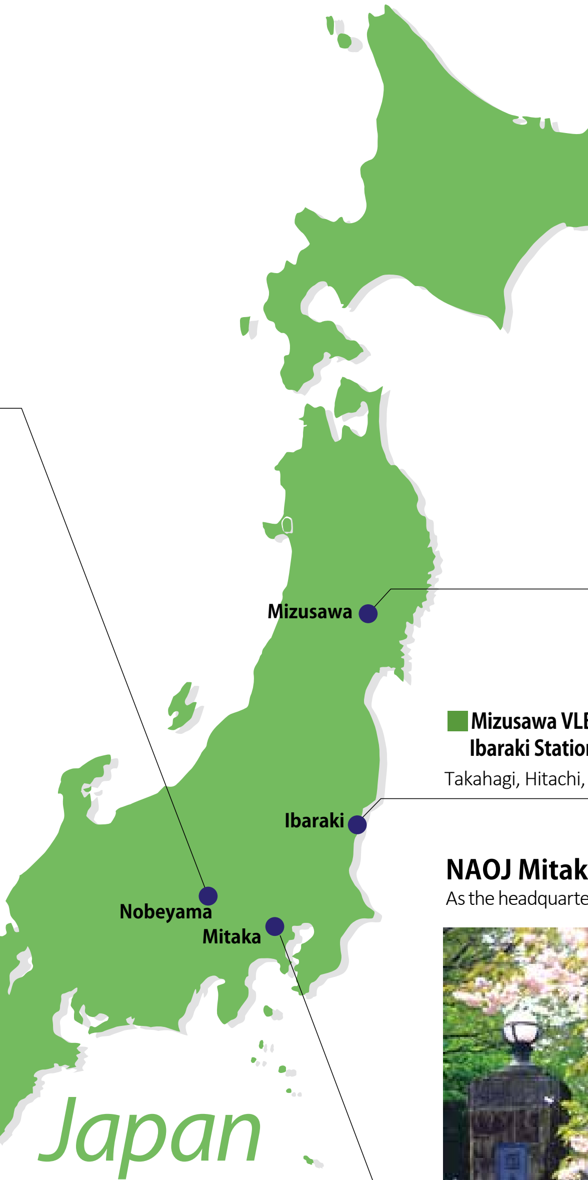
Mizusawa VLBI Observatory : Kagoshima Station

Mizusawa VLBI Observatory : Ishigaki-jima Station (VERA) (C Project) → p.14

Ishigaki, Okinawa Prefecture

MURIKABUSHI is a 105-cm telescope in Ishigaki-jima Astronomical Observatory.





NAOJ Mizusawa Iwate Prefecture

Mizusawa VLBI Observatory (VERA) (C Project) → p.14

Astrometry and geodesy are actively being researched, and the Time Keeping Office here contributes to the determination of Japan Central Standard Time. Our VERA telescope is creating a three-dimensional map of our Galaxy.

Esashi Earth Tides Station

This facility has been monitoring the details of the tidal deformation of the Earth. Shown here are laser tiltmeters to measure the extension of the Earth's surface using laser beams.

RISE(Research of Interior Structure and Evolution of Solar System Bodies) Project

(A Project) → p.22

The first accurate gravity and topography maps of the Moon were obtained using the KAGUYA mission's laser altimeter, relay satellite, and VLBI satellite. We intend to develop our research further by promoting exploration of not only the Moon but also asteroids and Jovian system.

Asteroid explorer "Hayabusa-2" (JAXA/Ikeshita).

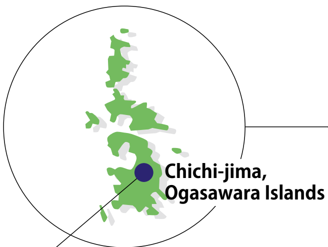
Mizusawa VLBI Observatory : Ibaraki Station

Takahagi, Hitachi, Ibaraki Prefecture

NAOJ Mitaka Tokyo Metropolis

As the headquarters of NAOJ, the Mitaka Campus houses offices of various projects and divisions, as well as administrative offices.

- **Solar Observatory** (C Project) → p.15
- **Center for Computational Astrophysics** (C Project) → p.17
- **Hinode Science Center** (C Project) → p.17
- **Gravitational Wave Project Office** (B Project) → p.19
- **TMT (Thirty Meter Telescope) Project Office** (B Project) → p.20
- **JASMINE (Japan Astrometry Satellite Mission for INfrared Exploration) Project Office** (A Project) → p.21
- **Extrasolar Planet Detection Project Office** (A Project) → p.21
- **SOLAR-C Project Office** (A Project) → p.22
- **Astronomy Data Center** → p.23
- **Advanced Technology Center** → p.24
- **Public Relations Center** → p.24
- **Division of Optical and Infrared Astronomy** → p.25
- **Division of Radio Astronomy** → p.25
- **Division of Solar and Plasma Astrophysics** → p.26
- **Division of Theoretical Astronomy** → p.26
- **Office of International Relations** → p.27



Mizusawa VLBI Observatory : Ogasawara Station (VERA) (C Project) → p.14

Chichi-jima, Ogasawara Islands Tokyo Metropolis

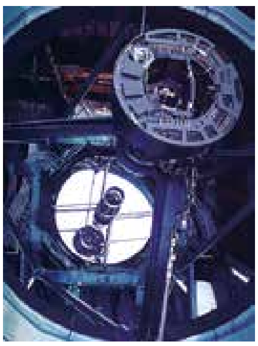
NAOJ Hawai'i

Subaru Telescope (in Hawai'i) (C Project) → p.16

On the Island of Hawai'i, State of Hawai'i, U.S.A.

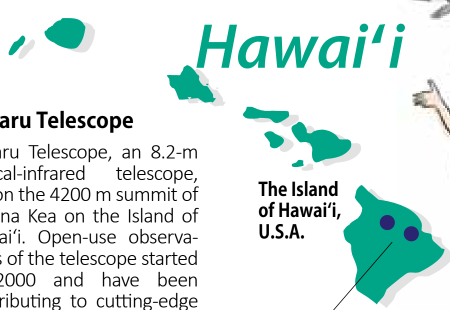
Hilo Office

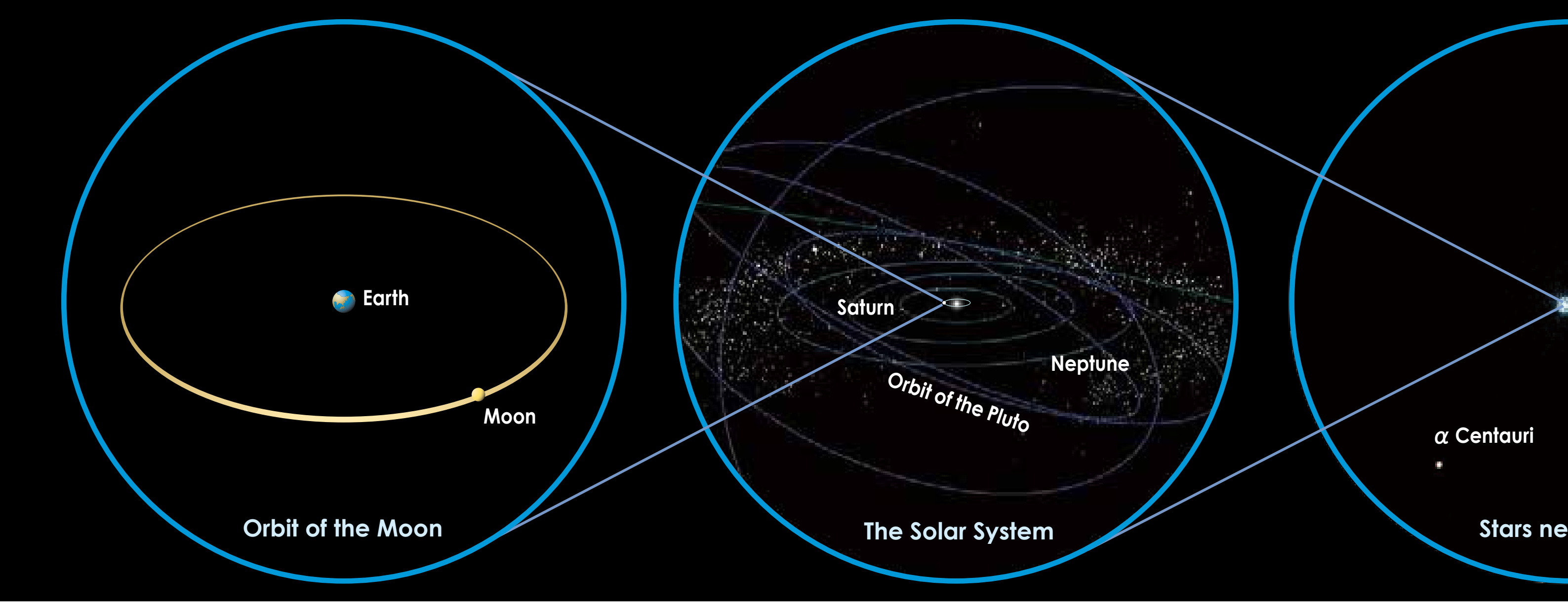
The Hilo Office is the base facility for the Subaru Telescope, located in Hilo, Hawai'i. It houses laboratories, a machine shop, a computer facility, and a remote observation room to support nightly observation programs.



Subaru Telescope

Subaru Telescope, an 8.2-m optical-infrared telescope, sits on the 4200 m summit of Mauna Kea on the Island of Hawai'i. Open-use observations of the telescope started in 2000 and have been contributing to cutting-edge astronomy ever since.





➡Increasing distance from the Earth　10^6 (1 million) km　10^{10} (100 billion) km　10^{14} km (10

Hierarchy of the Solar System

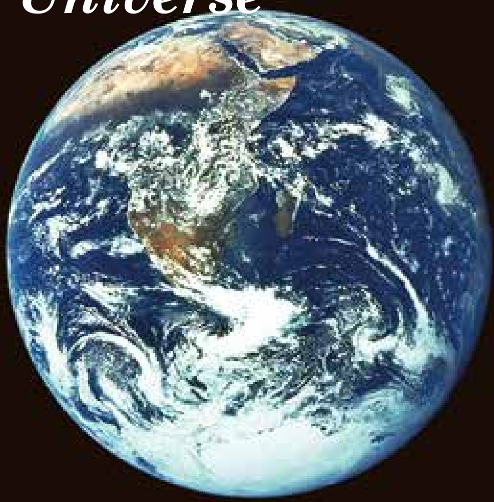
◆Projects researching all the four categories, "the Expanding Universe", "Galaxies", "the Milky Way", and "the Solar System" ●Mizusawa VLBI Ob

◆Projects researching "the Milky Way" and "the Solar System" categories ●Solar Observatory (p.15) ●Division of Solar and Plasma Astrophysics (p.2

◆Projects researching "the Solar System" category ●Hinode Science Center (p.17) ●RISE (Research of Interior Structure and Evolution of Solar System bodies) Project (p.22 ●SOLAR-C Project Office (p.22)

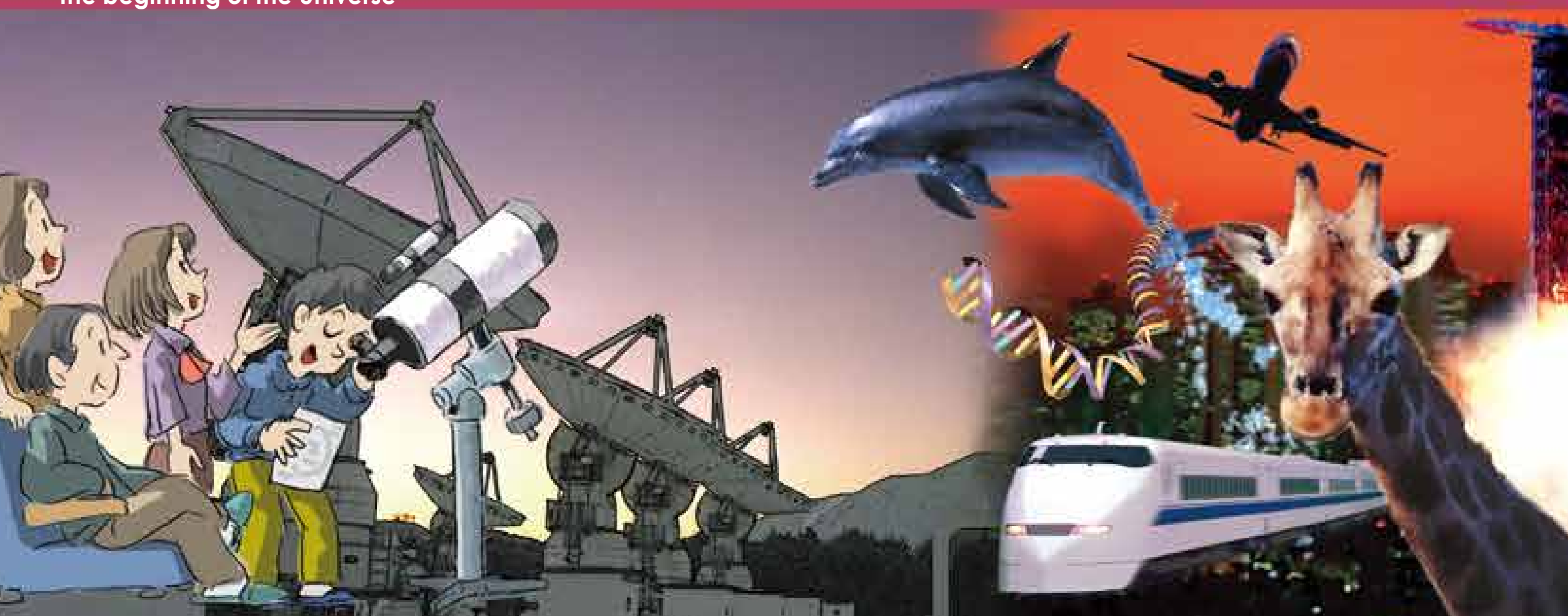
Extent and History of the Universe

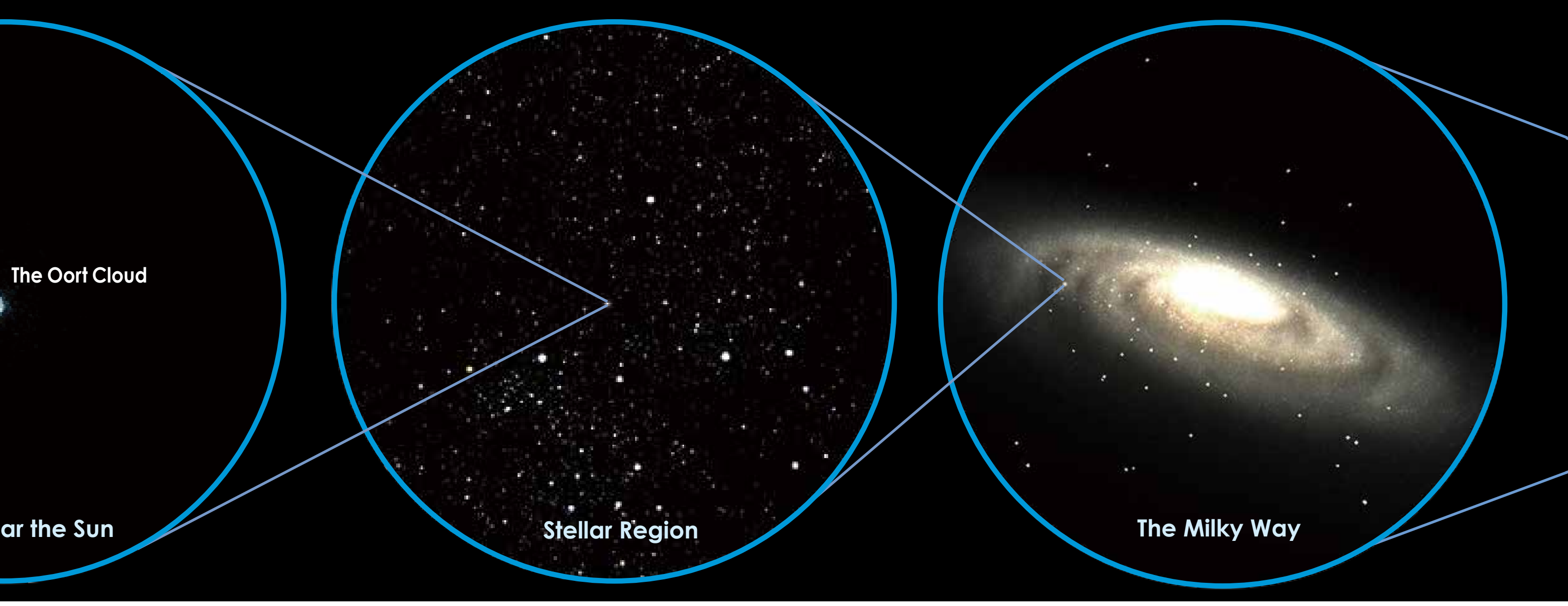
Let's have a look at the scale and the history of the Universe. The upper row displays the "extent of the Universe" in terms of distance, while the lower row illustrates the "history of the Universe and the Earth" as a scroll painting.



Since the speed of light is limited, we see the past Universe when we observe distant space. In other words, when we look at distant objects, we see back to study the begin-

➡toward the beginning of the Universe　3 seconds ago　10 hours ago　10 ye





) light-years) | 10^{16} km (1000 light-years) | 10^{18} km (0.1 million light-years)

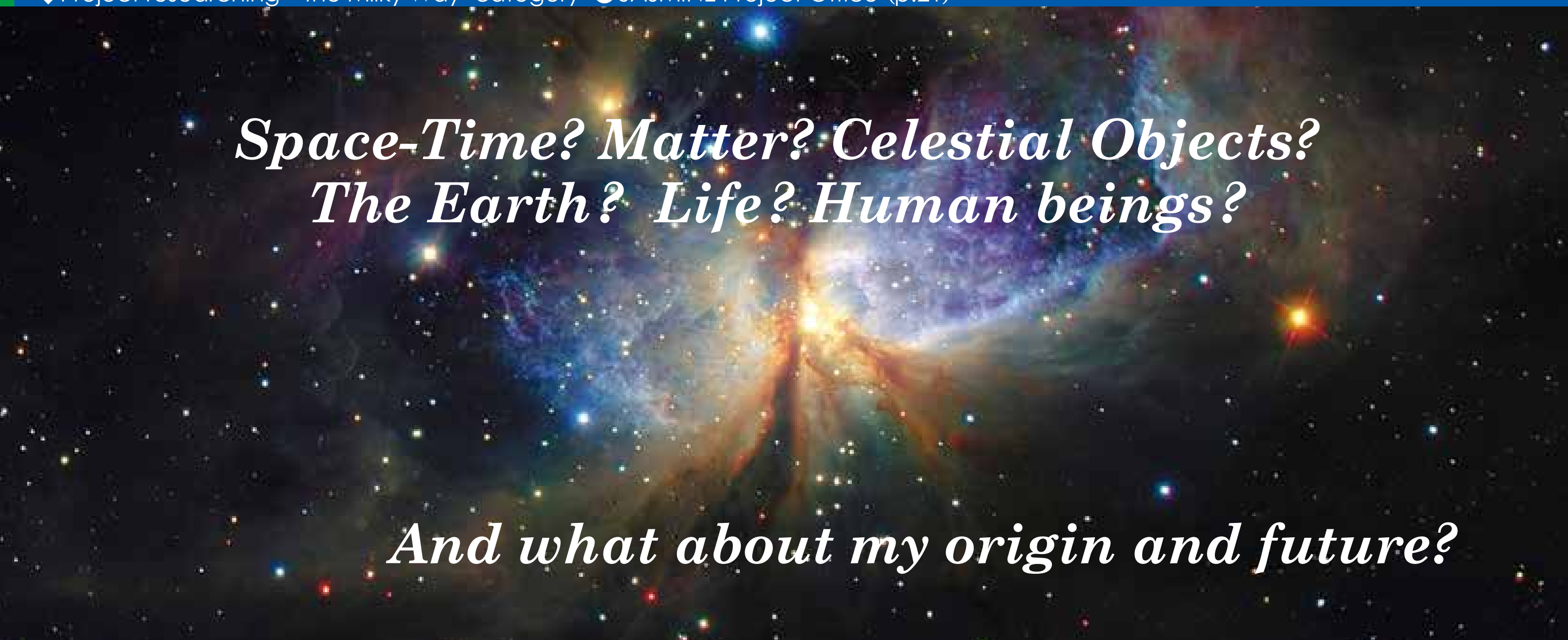
Hierarchy of the Milky Way

servatory (p.14) ●Nobeyama Radio Observatory (p.15) ●Okayama Astrophysical Observatory (p.16) ●Subaru Telescope (p.16)

26)

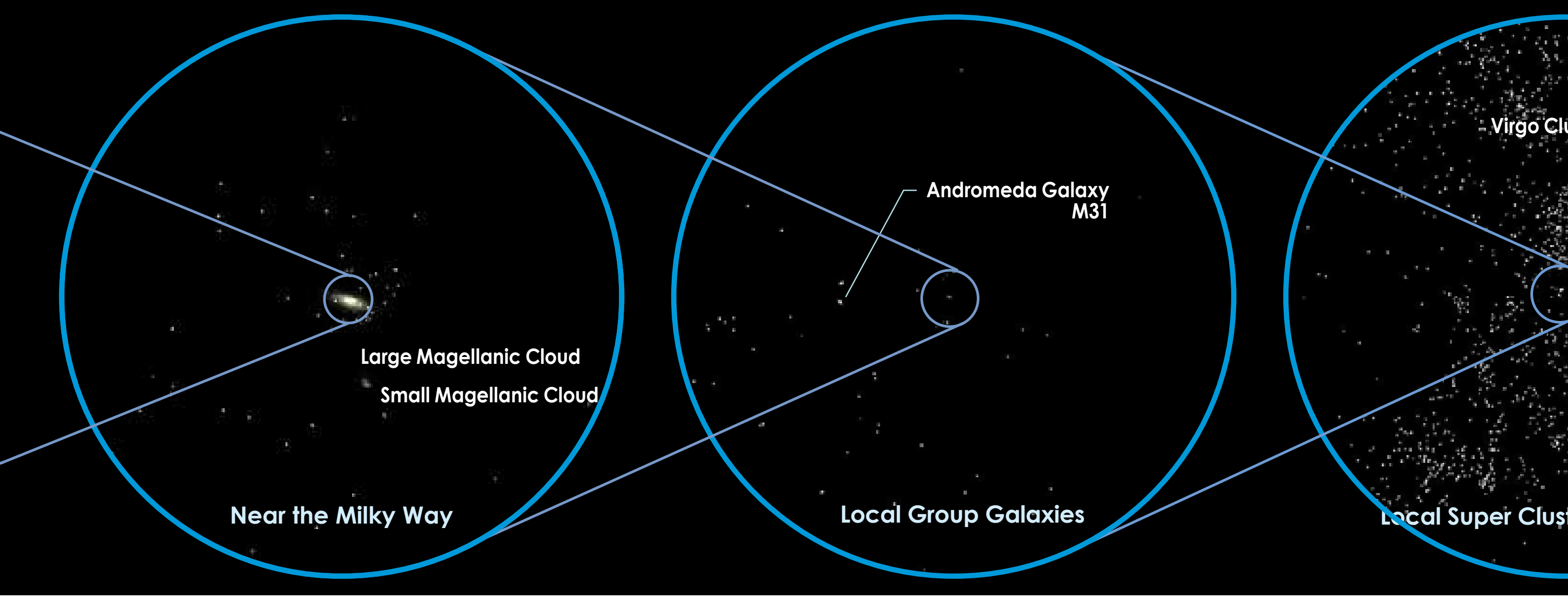
) ◆Project researching the three categories, "the Expanding Universe", "Galaxies", "the Milky Way" ●Gravitational Wave Project Office(p.19)

◆Project researching "the Milky Way" category ●JASMINE Project Office (p.21)



The star-forming region S106 IRS4 at a distance of about 2000 light-years from the Earth.

ars ago | 1000 years ago | 100 thousand years ago



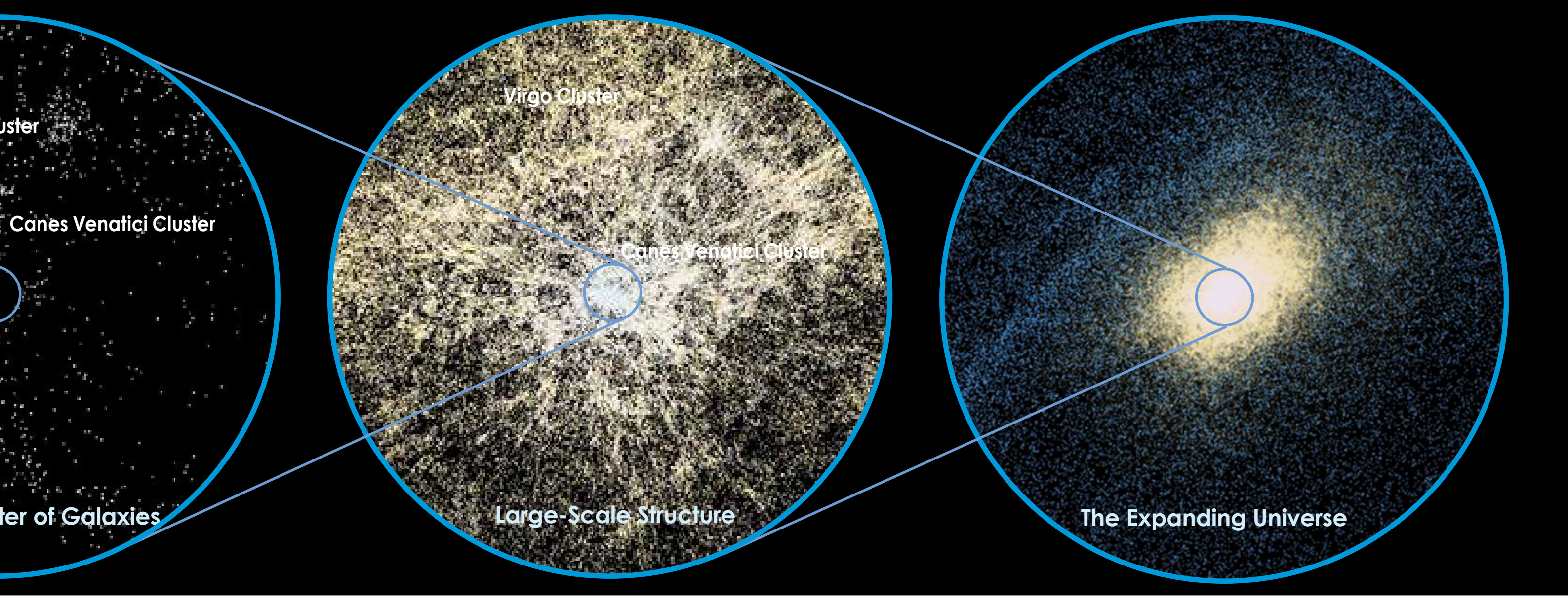
10^{19}km (1 million light-years) | 10^{20}km (10 million light-years) | 10^{21}km (100 milli

Hierarchy of Galaxies

● NAOJ Chile Observatory (p.18) ● TMT Project Office (p.20) ● Extrasolar Planet Detection Project Office (p.21) ● Division of Optical and Infrared Astr

Hickson Compact group of galaxies 40 (HCG40), which is 300 million light-years from us in the constellation Hydra (Subaru Telescope).

1 million years ago | 10 million years ago | 100 million y



ion light-years) | 10^{22}km (1 billion light-years) | 10^{23}km (10 billion light-years)

Hierarchy of the Expanding Universe

onomy (p.25) ● Division of Radio Astronomy (p.25) ● Division of Theoretical Astronomy (p.26)

A quasar located some 9.8 billion light-years away. The gravitational lens created by a huge cluster of galaxies makes 4 images of the distant quasar (SDSS J1004)

●What can we learn from this map?

This illustration is a macroscopic view of space and time.
Our expanding Universe was born about 13.7 billion years ago during the Big Bang. Today, the observationally reachable edge of the Universe is 13.7 billion light-years from us. In this figure, "today" is located in the left corner. The upper axis shows the distance scale of the Universe and increases by factors of ten from left to right. The time shown in the lower axis goes deeper into the past with increasing distance, where the scale indicates the diameter of a corresponding sphere of subspace. The middle panel classifies the Universe into four categories (the Expanding Universe, galaxies, the Milky Way, and the Solar System) according to the distance scale and shows the research fields of each of NAOJ's project teams.

ears ago | 1 billion years ago | 10 billion years ago

▲Mitaka Campus in spring. A row of cherry blossoms tints the entire campus pink.

Eight Observatories as Main Driving Force of NAOJ

The C projects group consists of the five observatories and three projects, such as Subaru Telescope, ALMA（NAOJ Chile Observatory）, "HINODE" and Nobeyama Radio Observatory, which have been completed as NAOJ facilities and are operating. This project group is the main driving force of NAOJ actively supporting leading edge observations and research.

Each observatory or research division explores a variety of mysteries of the Universe by analyzing electromagnetic waves of various wavelengths. The icons below express the main wavelength coverage of the observational techniques of each project and division.

- cm Centimeter wave (radio)
- mm Millimeter wave (radio)
- smm Submillimeter wave (radio)
- IR Infrared radiation
- V Visible light
- UV Ultraviolet ray
- EUV Extreme ultraviolet radiation
- X X-ray
- GW Gravitational Wave (Different from electromagnetic wave)

cm mm

Mizusawa VLBI Observatory

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Phone +81-197-22-7111
http://www.miz.nao.ac.jp/en

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- Mizusawa Station : 2-12, Hoshigaoka, Mizusawa, Oshu, Iwate 023-0861 / Phone +81-197-22-7111
- Iriki Station : 4018-3, Uranomyo, Iriki, Satsumasendai, Kagoshima 895-1402 / Phone +81-996-21-4175
- Ogasawara Station : Asahiyama, Chichi-jima, Ogasawara, Tokyo 100-2101 / Phone +81-4998-2-7333
- Ishigaki-jima Station : 2389-1, Tonoshirotakeda, Ishigaki, Okinawa 907-0004 / Phone +81-980-88-0011
- Ishigaki-jima Astronomical Observatory : 1024-1, Arakawa, Ishigaki, Okinawa 907-0024 / Phone +81-980-88-0013
- Ibaraki Station : 608-1, ishitaki, Takahagi, Ibaraki 318-0022
- Yamaguchi Station : 123, Nihonakagou, Yamaguchi, Yamaguchi 753-0302
- Kagoshima Station : Inside the Kinkouwan Park, Hirakawa, Kagoshima, Kagoshima 891-0133

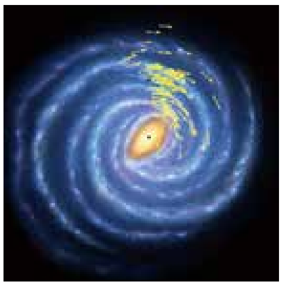
Creating a Map of the Milky Way Galaxy Using the Triangulation Technique with a Baseline the Size of Earth's Orbit

We formed a giant VLBI (Very Long Baseline Interferometry) observational network across Japan by combining observational data from 20 m radio telescopes erected in 4 locations around the country (Oshu City, Iwate Prefecture; Satsumasendai City, Kagoshima Prefecture; Ogasawara, Tokyo; and Ishigaki City, Okinawa Prefecture.) Through this network, we conduct observations to measure the positions of celestial objects in the Milky Way Galaxy with high precision. The positions of stars appear to shift due to the orbital motion of the Earth around the Sun (annual parallax.) Using this parallax we can accurately determine the distance to a star, while at the same time researching the motion of the Milky Way Galaxy. Remote observations using the 4 radio telescopes are controlled from Mizusawa Campus, and the observational data is combined and correlated in the Mizusawa Campus correlation center. Additionally, we are advancing the study of active galactic nuclei located in the centers of other galaxies through high precision measurements. Utilizing various radio telescopes, we conduct collaborative research with universities: Kagoshima University (6 m), Yamaguchi University (32 m), and Ibaraki University (Takahagi 32 m and Hitachi 32 m).

We are also advancing VLBI observations throughout Japan via cooperation with various observation faculties: The Geographical Survey Institute's Tsukuba 64 m, NICT (Kashima 34 m), JAXA (Usuda 64 m), and radio telescopes belonging to local universities (for example: Hokkaido University's 11 m and Gifu University's 11 m).

We are promoting international collaboration with countries in East Asia. Observations combining VERA and three KVN (Korean VLBI Network) radio telescopes located in South Korea are ongoing. Additionally, we are working to complete the East Asia VLBI Network through cooperation with organizations in multiple Chinese telescopes in Shanghai, Urumqi and Kunming. To this end, we are investing in the Japan-Korea Joint VLBI Correlator at the Korea Astronomy and Space Science Institute. It will play an important role as the main correlation center for VLBI observations in the East Asia region.

▲VERA Ogasawara station and the Milky Way Galaxy.



◀The position of 114 sources in the Galaxy measured by VERA, VLBA and EVN.

Director : Prof. HONMA, Mareki

memo

cm Centimeter wave

Electromagnetic waves with wavelengths between 1 cm and 10 cm. Using this wavelength range, we observe basic atoms such as atomic hydrogen, which is the most abundant element in the Universe. Synchrotron radiation from explosions can also be observed.

cm mm

Nobeyama Radio Observatory

462-2, Nobeyama, Minamimaki, Minamisaku, Nagano 384-1305
Phone +81-267-98-4300
http://www.nro.nao.ac.jp/en/index.html

The Nobeyama 45-m Telescope is the Largest Radio Telescope at Millimeter Wave, Exploring Millimeter Wave Astronomy

The Nobeyama Radio Observatory (NRO) operates the 45-m Radio Telescope that is one of the largest telescopes for millimeter wave observations in the world. Radio telescopes can reveal the structures of the Universe that we cannot see with our own eyes. For example, radio observations of the interstellar medium which is invisible with optical telescopes, can investigate how various stars are formed in galaxies. Until today, the 45-m telescope has obtained significant results such as discovering the supermassive black hole in the spiral galaxy NGC4258 and exploring the formation process of bio-molecules. The 45-m telescope continues to produce intriguing results to unveil the Universe.

Director :
Dr. SAITO, Masao

▲Radio image of the Milky Way obtained with the new receiver mounted on the 45-m radio telescope (the upper left). High angular resolution enables us to image fine structures of molecular clouds. Red, green, and blue represent the radio intensities of the carbon monoxide isotope.

IR V

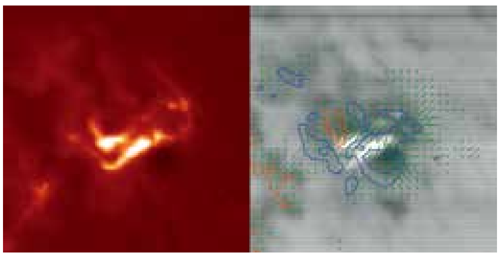
Solar Observatory

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://solarwww.mtk.nao.ac.jp/en/solarobs.html

We Investigate the Enigma of the Sun, the Nearest Star, Studying its Magnetic Field

The Sun seems to bless us with sunlight constantly, but actually it does not shine unchangingly. It sometimes shows sudden explosions on its surface. It shows long-term variations with the well-known 11-year cycle and longer periods. Studying the Sun not only helps us to understand the stars twinkling in the night sky but also reveals the effect of the Sun on our environment.
The variability of the Sun is caused by the magnetic field, and therefore, we are investigating the Sun through its magnetic information. We are observing the Sun with the Solar Flare Telescope, which has instruments with cutting-edge technology, and we are also operating long-term monitoring observations. Research and development for next generation telescopes are also ongoing.

▼The Solar Flare Telescope at the MITAKA headquarters, observing the magnetic field and flares on the Sun.



▲A solar flare seen in a hydrogen absorption line (left) and in a Helium absorption line (right). In the right panel, red and blue contours show the polarity of the surface magnetic fields, and short green lines show the direction of the magnetic field lines. These images, both of which were taken by the Solar Flare Telescope, show us the process of the accumulation of the magnetic energy and its release during the flare.

Director :
Dr. HANAOKA, Yoichiro

memo

mm Millimeter wave
Electromagnetic waves with wavelengths between 1 mm and 1 cm. Many molecules radiate emission lines in this wavelength range. With this range, we can study interstellar molecular clouds and learn about the process of star formation in these clouds.

IR V

Okayama Astrophysical Observatory

3037-5 Honjou, Kamogata, Asakuchi, Okayama 719-0232
Phone +81-865-44-2155
http://www.oao.nao.ac.jp/en/

Six exoplanets by the 188-cm telescope selected for NameExoWolrds campaign by IAU!!!

Okayama Astrophysical Observatory (OAO) is one of the most important domestic bases for optical-infrared observational astronomy in Japan. OAO operates the 188-cm reflector and promotes its open use. The main research fields being pursued by the 188-cm telescope are stars, interstellar matter, other galaxies, and extrasolar planets. OAO also operates two other telescopes, 91-cm and 50-cm reflectors, with which some original research projects are pursued about the Milky Way structure and variable and active objects. Astronomical instrumentation is another important activity at OAO. An infrared spectrometer and a fiber-link system for the high-resolution optical spectrograph are near completion, and a very wide-field infrared camera is underway. Moreover, OAO promotes domestic inter-university cooperation as well as East Asian astronomical collaborations.

◀The 188-cm reflector. It has been active at the forefront of astronomical observation since its construction in 1960. Recent major upgrades of its drive- and control-systems in FY2012 improved significantly its observing efficiency. An orange box at the rear of the telescope tube is the input part of the fiber-link to the high dispersion echelle spectrograph, HIDES, placed in a separate room. The fiber-link doubles or more the sensitivity of HIDES, which has boosted Doppler exoplanet searches at OAO.

◀Artist's impression of an ExoWorld. The first discovery of an exoplanet from Japan was made through a Doppler search with the 188-cm telescope and HIDES in 2003. Since then intensive searches have been made to detect 28 exoplanets at OAO. Six of them are chosen for the first 20 systems for the naming contest "NameExoWorlds" by public election organized by the International Astronomical Union in 2015.

Director :
Dr. IZUMIURA, Hideyuki

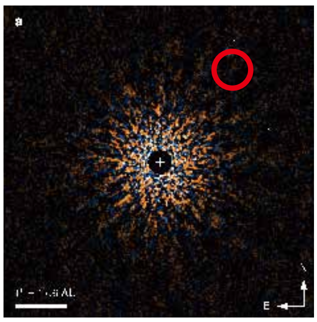
IR V

Subaru Telescope (in Hawai'i)

650 North A'ohoku Place, Hilo, Hawai'i, 96720, U.S.A.
Phone +1-808-934-7788
http://subarutelescope.org/index.html

Subaru Telescope' s Suite of Optical and Infrared Instruments Continually Enriches Our Knowledge of the Universe

The Subaru Telescope, completed in 1999 atop the summit of 4200 m Mauna Kea on the Island of Hawai'i, operates as a branch of NAOJ. This 8.2-m optical-infrared telescope serves astronomers from Japan and around the world as they explore the cosmos in an unending quest to gain a deeper and more accurate understanding of everything around us. Research with the telescope ranges from mapping satellites around the planets in our Solar System to searching for planets around nearby stars to observing the most distant objects at the edge of the known Universe. To facilitate such a wide range of research interests, Subaru Telescope not only maintains a variety of nine high-performance imagers and spectrographs but also develops new instruments. The Hawai'i- based staff shares responsibilities for keeping the telescope operating at peak performance; for upgrading and maintaining its highly technical and state-of-the art systems; and for reaching out to the worldwide scientific community to inspire sustainable and long-term support for the Subaru Telescope.



◀Astronomers have identified a "Second Jupiter" from the direct imaging toward a Sun-like star GJ 504 (○) . This planet, GJ 504 b, is very faint compared with the central star, even with the mask covering the star's bright light. The Strategic Explorations of Exoplanets and Disks with Subaru Telescope (SEEDS) Project addressed technical difficulties in finding such challenging objects.

Director :
Prof. ARIMOTO, Nobuo

◀Astronomers can use the Subaru Telescope to observe in a wide range of wavelengths, from the short-visible to the mid-infrared(0.3 〜 30 micrometers). A suite of imagers and spectrographs is available for their research.

memo

Submillimeter wave

Electromagnetic waves with wavelengths between 0.1 mm and 1 mm. This wavelength is between the millimeter wave and the far-infrared light. We can explore objects surrounded by dense interstellar dust such as protoplanetary disks and protogalaxies.

Center for Computational Astrophysics (CfCA)

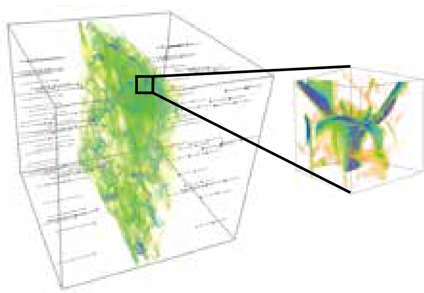
2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://www.cfca.nao.ac.jp/~cfca/index.html.en

Universe in a Computer

Numerical simulation in astronomy is regarded as the third methodology of astronomy alongside observational and theoretical astronomy. We need computer simulation because it is practically impossible for us to perform laboratory experiments of astronomical phenomena due to their huge time and spatial scales. We create universes in computers (often very large ones, referred to as supercomputers) reproduce astronomical phenomena there, and observe their behavior. In other words, computers are experimental tools to create virtual universes, and at the same time telescopes to observe them. In these virtual universes, we can watch the very early stage of the cosmos and its evolution, we can reproduce the formation of galaxies, and we can witness the origin, evolution, and final fate of planetary systems including our own. Our project, CfCA, possesses various types of high-performance computers such as a massive parallel computer Cray XC30 “ATERUI”, a bunch of special-purpose computers for gravitational many-body problems “GRAPE” and other facilities, all of which operate twenty-four hours a day, throughout the year. Astronomers all over the world use these resources. In addition, CfCA works on research and development for new software algorithms for the next-generation of simulation astronomy that will enable us to perform the largest numerical experiments ever attempted. By numerical simulations with supercomputers, we will, probably in the very near future, solve the longstanding questions such as the formation of galaxies, the origin of the Solar System, and the real picture of black holes.

▲Supercomputer, Cray XC30 "ATERUI".

Director :
Prof. KOKUBO, Eiichiro



▲To study how massive stars are formed, a simulation of a molecular cloud collision with Mach number larger than 100 was performed by ATERUI. It was found that a huge amount of gas is accumulated behind a shock wave, indicating that such a formation mechanism of massive stars is plausible.

▲Special-purpose computers for gravitational many-body problems, GRAPE.

V EUV X

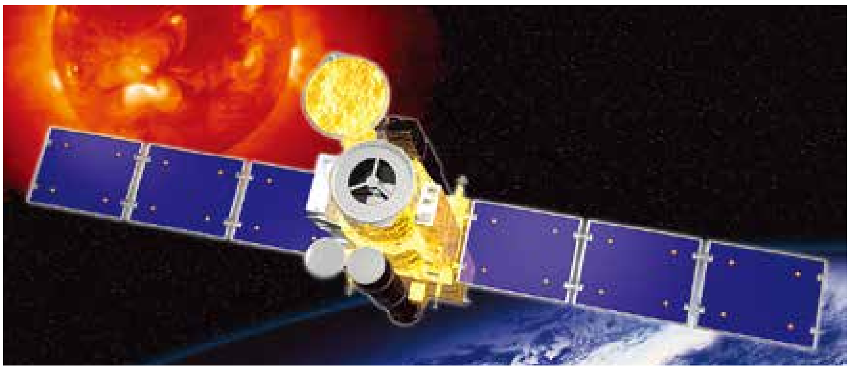
Hinode Science Center

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://hinode.nao.ac.jp/index_e.shtml

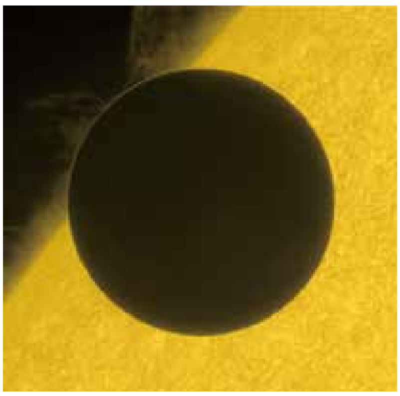
Staring at the Sun: New Solar Observatory HINODE

Since its launch in September 2006, Japan’ s solar physics satellite, the HINODE, has continued its observation of the Sun, sending back solar images of unprecedented clarity every day. HINODE carries three advanced telescopes, and the acquired data are immediately released to the world science community.

The Hinode Science Center has been playing a leading role in instrument design and development, mission operation and data analysis with the Japan Aerospace Exploration Agency (JAXA) and has been promoting international collaboration with NASA, UK and ESA. The center also provides a data analysis platform computer facility where information on data analysis and the latest science results can be exchanged. The platform is actively used by researchers and educational personnel inside and outside Japan. The center is also active in public outreach through web releases about new science results from HINODE.



▲An artist’s rendering of HINODE in orbit.



◀Transit of Venus, 2012 June 6

Director :
Prof. WATANABE, Tetsuya

memo

IR Infrared radiation

Electromagnetic waves with wavelengths between 1 μm (0.001 mm) and 0.1 mm. These wavelengths are suitable for studies of thermal radiation from protostars and interstellar dust. We must avoid wavelengths absorbed by the Earth's atmosphere.

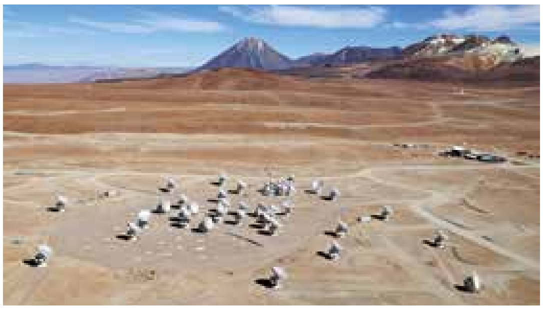
NAOJ Chile Observatory

Calle Joaquín Montero 3000, Oficina 702, Vitacura, Santiago, Chile / Phone +56-2-656-9253
2-21-1, Osawa, Mitaka, Tokyo 181-8588 / Phone +81-422-34-3600
http://alma.mtk.nao.ac.jp/e/index.html

ALMA: the new eye on the cool universe

ALMA was built and is operated in Chile, on the Andean plateau 5000 m above the sea level, by a global partnership among Japan/Taiwan /Korea, North America, Europe, and Chile. ALMA "sees" astronomical objects in millimeter and submillimeter waves using 66 antennas with diameters of 7 or 12 meters. ALMA is delivering breakthroughs in solving the great mysteries of the Universe, such as the formation of galaxies right after the Big Bang, the ongoing births of planetary systems, and the evolution of matter in the Universe leading to the origin of life. The NAOJ Chile Observatory, established in April 2012, is committed to the completion, operations and maintenance of ALMA, as well as the operations of the 10-m ASTE Submillimeter Telescope in Chile. The East-Asian ALMA Support Center (EA ASC) in Mitaka, Tokyo, promotes research activities using ALMA in East Asia.

▼Dust disk around a young star HL Tauri captured by ALMA with unprecedented resolution. The image exceeds all expectations and reveals a series of concentric and bright rings, separated by gaps. This is an enormous step forward in the observation of how planets form.
Credit: ALMA(ESO/NAOJ/NRAO)



▲ALMA antennas at the Array Operations Site (AOS)
Credit：Clem & Adri Bacri-Normier（wingsforscience.com）/ESO

Director :
Prof. HASEGAWA, Tetsuo

ALMA photo by KAWAMURA,Akira

memo

Ⓥ Visible light

The visible light is the portion of the electromagnetic spectrum from 380 nm（0.38 μm）to 770 nm（0.77 μm）in wavelength, which is visible to the human eye. Visible observation is the oldest type of astronomy. Visible light can target a wide variety of objects including stars, star clusters and galaxies.

Departments of NAOJ B Projects

▲The 20cm Telescope Dome(Mitaka Campus). This was constructed when the Tokyo Astronomical Observatory was moved to Mitaka. It became as a registered tangible cultural property in 2002.

Two Development Projects for NAOJ's Future

The B projects group includes two project offices that are under construction or being developed. These are expected to undertake NAOJ observations and research in the near future. In particular, the TMT (Thirty Meter Telescope) project is planning to construct the next-generation large telescope following Subaru Telescope. With its 30 m primary mirror consisting of 492 segments, the ability to gather light would be ten times greater than existing telescopes. Moreover, we will achieve a resolution ten times higher than that of the Hubble Space Telescope by using an Adaptive Optics (AO) system. We aim to construct TMT through international cooperation following ALMA.

Each observatory or research division explores a variety of mysteries of the Universe by analyzing electromagnetic waves of various wavelengths. The icons below express the main wavelength coverage of the observational techniques of each project and division.

- cm Centimeter wave (radio)
- mm Millimeter wave (radio)
- smm Submillimeter wave (radio)
- IR Infrared radiation
- V Visible light
- UV Ultraviolet ray
- EUV Extreme ultraviolet radiation
- X X-ray
- GW Gravitational Wave (Different from electromagnetic wave)

GW

Gravitational Wave Project Office

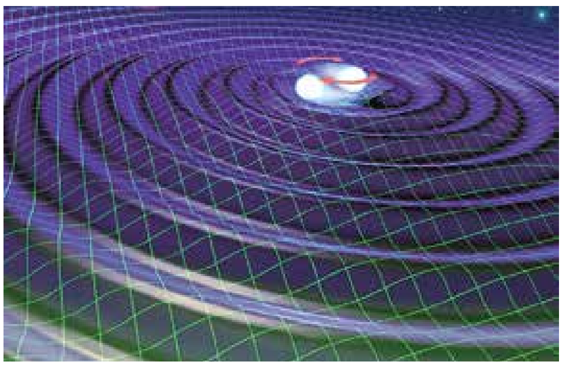
2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://tamago.mtk.nao.ac.jp/spacetime/index.html

Gravitational Wave Telescope will Reveal New Aspects of the Universe

The detection of gravitational waves will reveal new aspects of the Universe that cannot be observed by other means, such as the details of the primordial cosmos, the core dynamics of the supernovae, and the surface behavior of black holes. For the purpose of opening a new window, we are promoting the KAGRA project together with ICRR, KEK, and other universities. KAGRA is a large cryogenic gravitational wave antenna using a 3 km laser interferometer placed in the Kamioka underground site. TAMA300, the 300-m laser interferometer situated on Mitaka campus, is a prototype of KAGRA and acts as a test facility to evaluate key elements and techniques before installation on KAGRA. The project office is also promoting the DECi-hertz Interferometer Gravitational wave Observatory (DECIGO) in space in anticipation of the future development.

▲Central parts of TAMA300. Main optical components of the laser interferometer are installed in vacuum tanks connected by vacuum tubes.

Director :
Prof. FLAMINIO, Raffaele



▶Illustration of the gravitational waves emitted by a coalescing neutron star binary (illustrated by KAGAYA). KAGRA will detect the waves if such an event were to occur within 700 million light years of Earth.

memo

UV Ultraviolet ray

Electromagnetic waves with wavelengths between 10 nm and 100 nm. We can investigate high-energy and super high temperature phenomena in the Universe. Since the Earth's atmosphere absorbs most of the ultraviolet rays, observations in this wavelength are made from outside the atmosphere.

IR V

TMT (Thirty Meter Telescope) Project Office

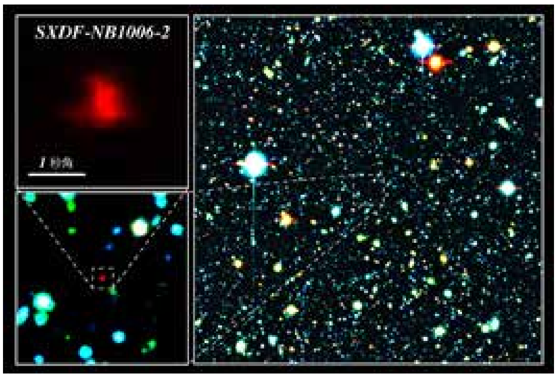
2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://tmt.nao.ac.jp/

Constructing a 30m-Class Optical-Infrared Telescope for the 2020s

Based on the scientific and engineering success of 8.2-meter Subaru Telescope and other 8m-class telescopes, astronomers are preparing to begin construction of the Thirty Meter Telescope (TMT) as an international science project. Such a telescope, together with other next-generation facilities based on ground and in space, will play an essential role in the 2020s to deepen the human perception of the structure and evolution of the Universe, and the origins of stars, planets and life. National Astronomical Observatory of Japan (NAOJ) is responsible for the project in Japan. Japan's important roles in the project includes the construction of the telescope structure and segment mirrors for the primary mirror.

▲TMT as completed on Mauna Kea. The expected construction site is close to the Subaru Telescope site on Mauna Kea.

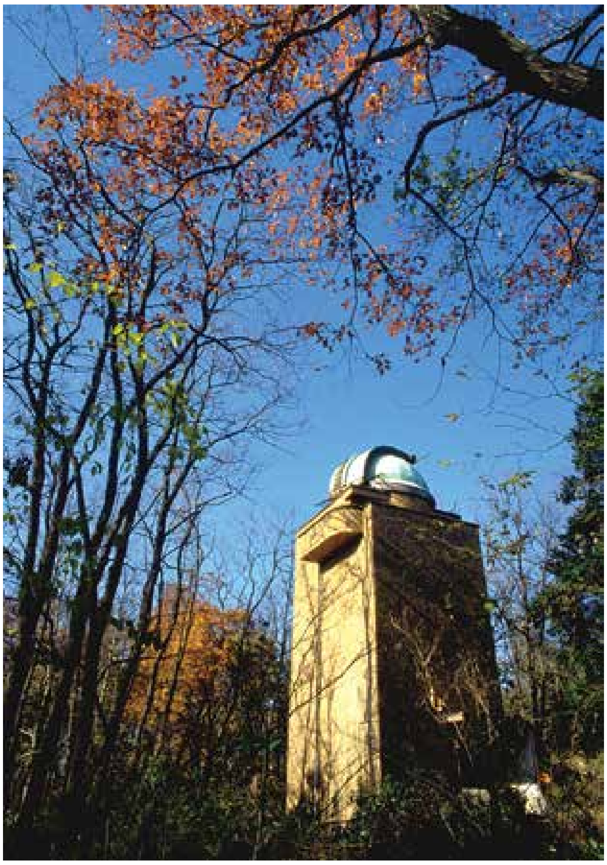
Director :
Prof. USUDA, Tomonori



▶One of the most distant galaxies with a measured distance of 12.9 billion light years, was discovered by the Subaru Telescope. The TMT with its advanced adaptive optics camera will show the fine details of this reddish spot and elucidate the formation and evolutionary history of galaxies.

Departments of NAOJ

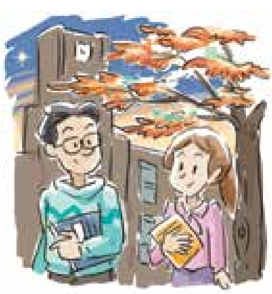
A Projects



▲Solar Tower Telescope (Einstein Tower) at Mitaka Campus. It became a registered tangible cultural property in 1998.

Four Projects for Next-Generation Astronomy

The A projects group is designed and established to foster pioneering research and development (R&D) activities. This aims to encourage the creativity of researchers and create a diverse and advanced R&D environment. Four project offices, that are JASMINE Project Office, the Extrasolar Planet Detection Project Office, the RISE Project, and the SOLAR-C Project Office; are classified into the A project group. Each project has selected an ambitious theme, and is performing the R&D that will open the way to a new era of Astronomy.



Each observatory or research division explores a variety of mysteries of the Universe by analyzing electromagnetic waves of various wavelengths. The icons below express the main wavelength coverage of the observational techniques of each project and division.

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- V Visible light
- UV Ultraviolet ray
- EUV Extreme ultraviolet radiation
- X X-ray
- GW Gravitational Wave (Different from electromagnetic wave)

memo

EUV Extreme ultraviolet radiation

Extreme ultraviolet radiation is electromagnetic waves with wavelengths between 10 nm and 124 nm. This wavelength is well suited for the observation of high-temperature astronomical phenomena, from 10,000 degrees C to 20,000,000 degrees C. These observations must be conducted outside the atmosphere.

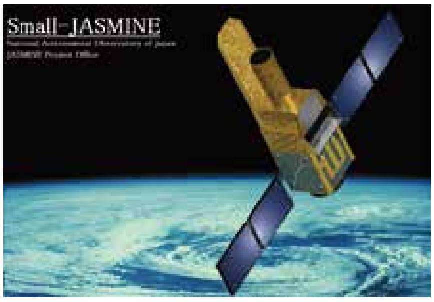
IR

JASMINE Project Office

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://www.jasmine-galaxy.org/index.html

Drawing a Detailed Map of the Milky Way at Infrared Wavelenths Using an Astrometry Satellite

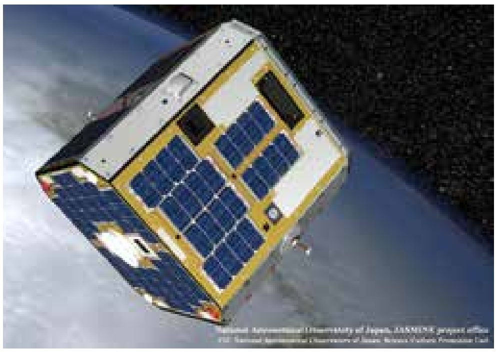
JASMINE is a satellite for measuring the distances and apparent motions of stars around the central bulge of the Milky Way with yet unprecedented precision. First we are planning the launch of a small science satellite in around FY2021. This Small-JASMINE with a 30 cm diameter primary mirror will focus on the survey of a restricted region limited to only a few square degrees of the bulge. Secondly we plan to launch a middle-sized satellite with an 80 cm diameter primary mirror in the late 2020s that will survey the entire region of the bulge. By observing infrared light that can penetrate the Milky Way, these JASMINE missions will be able to obtain reliable measurements of extremely small stellar motions with the accuracy of 0.01 milliarcseconds（1 / 360,000,000 of a degree）on the sky. These will provide the precise distances and velocities of many stars up to 30,000 light years away. With such a completely new map of the Milky Way, including the information about stellar movements, we expect that many new exciting scientific results will be obtained in various fields of astronomy.



▲Artist's impression of JASMINE（the Small- JASMINE satellite : the small science-satellite with 30 cm primary mirror diameter）observing the Milky Way.

Director :
Prof. GOUDA, Naoteru

▶Before the launch of Small-JASMINE, we are developing a very small astrometry mission satellite, Nano-JASMINE (5-cm diameter primary mirror, 35 kg satellite). It is determined that the Nano-JASMINE satellite will be launched in the near future. Nano-JASMINE will provide a star catalogue covering the whole sky with a positional accuracy of 3 milliarcseconds. Moreover high-accuracy proper motions (~0.1 milliarcseconds /year) can be obtained by combining the Nano-JASMINE catalogue with the Hipparcos catalogue.



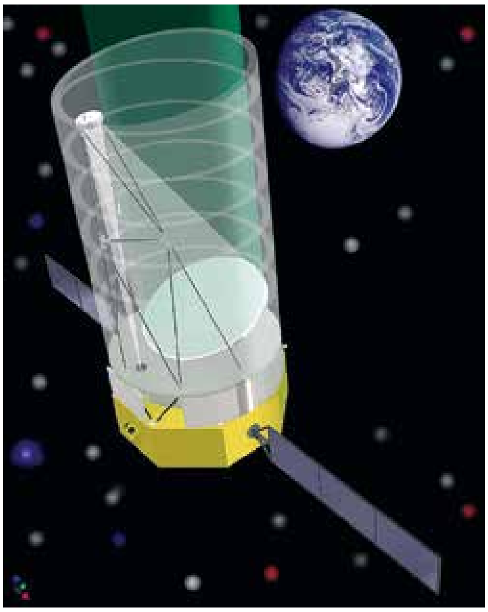
IR V UV

Extrasolar Planet Detection Project Office

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://esppro.mtk.nao.ac.jp/

Looking for Other Jupiters, Other Earths, and Other Life Out There

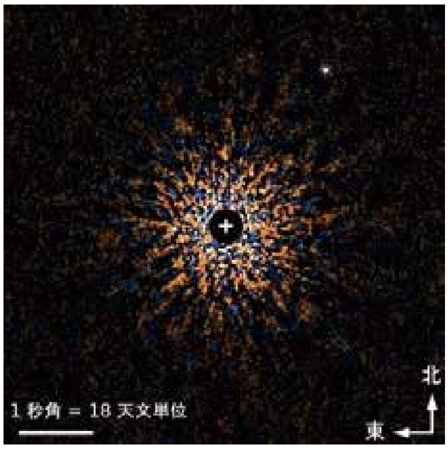
More than 1900 exoplanets, planets circling around stars other than the Sun, have been discovered since the first detection in 1995. Direct imaging is the ultimate way of studying such exoplanets. We need a special high-contrast imaging technique to image a faint planet close to a very bright star. The Extrasolar Planet Detection Project Office will develop the instruments for the study of exoplanets on the Subaru Telescope and future space missions, and promote their researches step-by-step from giant planets to Earth-like planets including planet formation sites. This is to answer questions such as "Are we alone in the Universe?" or "Are there other Earths that harbor life?"



▲An image of a high-contrast space telescope with a coronagraph. Currently, Strategic Explorations of Exoplanets and Disks with Subaru Telescope（SEEDS）and IR planet hunting instrument development(IRD), TMT coronagraph (SEIT) development, WFIRST coronagraph (WACO) R&D are also ongoing.

Director :
Prof. TAMURA, Motohide

▼Infrared image of planet（upper-right）around a solar like star GJ 504 obtained with HiCIAO camera and AO188 on the Subaru Telescope.



X X-ray | Electromagnetic waves with wavelengths between 0.01 nm and 10 nm. We can investigate high-energy and super high-temperature phenomenon in the Universe. Because the Earth's atmosphere completely absorbs X-rays, observations of this wavelength are made from outside the atmosphere.

cm IR V

RISE (Research of Interior Structure and Evolution of Solar System Bodies) Project

2-12, Hoshigaoka,Mizusawa,Oshu, Iwate 023-0861
Phone +81-197-22-7111
http://www.miz.nao.ac.jp/rise/en

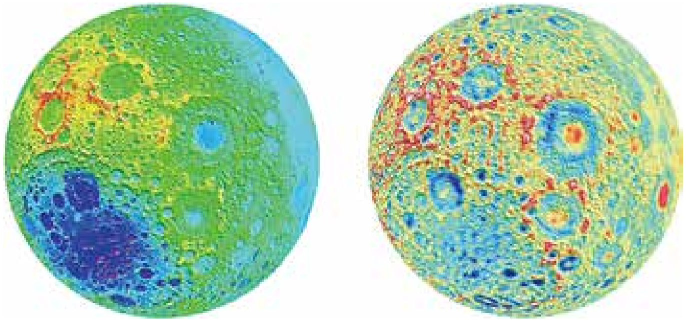
We Investigate the Evolution of Solar System Bodies by Spacecraft Exploration

We restarted a project with a new status, phase-A (future missions), in April, 2012. The term of "RISE" now stands for "Research of Interior Structure and Evolution of solar system bodies". We have obtained important results in SELENE (Kaguya) such as clarifying the lunar gravity field in the far side and creating the global topographic map including the polar region through development and operation of radio sources for VLBI and laser altimeter.

Our goal is to elucidate the origin and the evolution of the solar system bodies by studying their interior. We therefore intend to develop our research further by promoting exploration of not only the Moon but also the other solar system bodies such as Mercury, Mars, Jovian system, and asteroids. Now we are preparing for the study of an asteroid currently called 1999 JU_3 with collaborators in JAXA, universities and institutes by using a laser altimeter aboard Hayabusa-2 asteroid explorer. We also participate in the development of a laser altimeter called “GALA” (Ganymede Laser Altimeter) with Germany, Switzerland, and Spain for the JUICE mission, which will explore the Jovian system.

▲Imaginary figure of touch-down of Hayabusa-2 spacecraft on the asteroid 1999JU_3 (JAXA)

Director :
Prof. NAMIKI, Noriyuki



▲The first accurate lunar topography map (left) and gravity anomaly map (right).
(NAOJ/Chiba Inst. tech./JAXA)

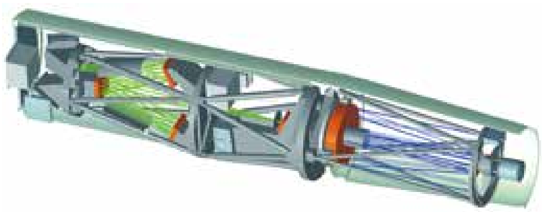
IR V UV EUV X

SOLAR-C Project Office

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3705
http://hinode.nao.ac.jp/SOLAR-C/index_e.html

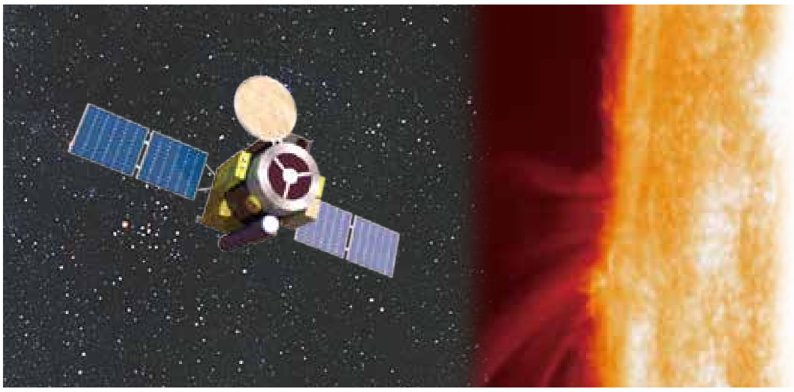
Planning of the SOLAR-C Mission for Visualizing the Origin of Solar Activity

We aim to carry out the SOLAR-C satellite mission that follows the 3rd Japanese space solar observatory HINODE for elucidating a link between solar magnetic fields and solar activity. It has been found from HINODE observations that there are unexpected ubiquitous activities of tiny jets and waves in the 10^4K temperature chromosphere, and a new small-scale heating event with dynamical motions at the base of the corona near the chromosphere. These are understood as phenomena that are strongly associated with the magnetic field on the Sun. Based on unprecedented high-resolution imaging and spectroscopic observations the SOLAR-C will resolve the fundamental scales of magnetic structures over the solar atmosphere from the photosphere to the corona that have been found from HINODE observations. It will reveal the origins of solar activity through the measurement of magnetic fields in the chromosphere.



▲The CLASP spectro-polarimeter in development for a rocket-borne experiment for the launch in summer 2015 (the aim is detecting magnetic fields in the chromosphere and the transition region by observing far ultraviolet range). A similar technique is to be used for the SOLAR-C spectro-polarimetry.

Director :
Dr. HARA, Hirohisa



▲SOLAR-C satellite in orbit (an artist's illustration)

memo

GW Gravitational wave

Unlike electromagnetic waves, a gravitational wave is a wave due to the distortion of space-time itself. Gravitational waves are so faint that they have not yet been detected directly. These waves are expected to help us resolve gravitational phenomena that cannot be fundamentally understood using electromagnetic waves.

Departments of NAOJ Centers & Divisions

Three Centers Developing NAOJ's Strengths, and Four Research Divisions Supporting NAOJ

The three Centers exceed the framework of individual projects and play key roles in equipment development/technological research, the numerical simulations, data analysis, data archiving, and public outreach activities. The Centers simultaneously have characteristics of both projects and basic infrastructures of NAOJ. The four Research Divisions have been newly set up to secure spontaneous ideas and individual research by each astronomer as well as to enhance the flexibility of our staff. Each researcher working for their project belongs to one of these infrastructures.

Each observatory or research division explores a variety of mysteries of the Universe by analyzing electromagnetic waves of various wavelengths. The icons below express the main wavelength coverage of the observational techniques of each project and division.

- cm Centimeter wave (radio)
- mm Millimeter wave (radio)
- smm Submillimeter wave (radio)
- IR Infrared radiation
- V Visible light
- UV Ultraviolet ray
- EUV Extreme ultraviolet radiation
- X X-ray
- GW Gravitational Wave (Different from electromagnetic wave)

▲Snowy morning (Mitaka Campus) . The winter sunlight shines on the snow-clad Musashino forest.

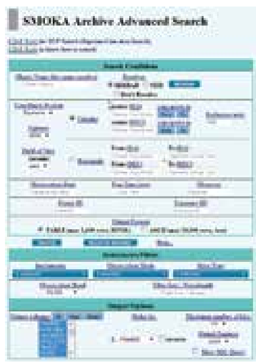
Astronomy Data Center

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://www.adc.nao.ac.jp/E/index-e.htm

Center of Data Intensive Astronomy

The Astronomy Data Center (ADC) is a “hub” of astronomical data, as one of the largest data centers in the world and will launch a new era, where Data-Intensive Astronomy is the fourth paradigm in astronomy. ADC delivers observational data from the NAOJ's Subaru Telescope, ALMA, Nobeyama Radio Telescopes, VERA, ASTE, HINODE, and RISE. Data from other observatories in the world are also delivered through the “Japanese Virtual Observatory (JVO)” operated by ADC. Since observational research is often conducted by data analyses, ADC also supports various data reduction software, covering a wide range of wavelengths. ADC operates an extremely high-speed and secure computer network with a maximum speed of 40 Gbps. In addition to supporting astronomical research activities, ADC research staff have their own research goals such as reducing the large amounts of data produced at astronomical observatories accurately and effectively, and enhancing network security under distributed and complicated network configurations.

▲The NAOJ Data Analysis, Archival and Publication system that has been in operation since March, 2013.



▲SMOKA . Raw observational data publication system for the Subaru Telescope and other observatories.

◀The JVO system enables the exchange and publication of observed data between astronomical observatories worldwide.

Director : Dr. OHISHI, Masatoshi

Advanced Technology Center

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://atc.mtk.nao.ac.jp/E/index_e.html

Center for Advanced Instrumentation and Technology Development for Astronomy

Advances in astronomy are realized through state-of-the-art instrumentation. Many advanced NAOJ projects require the development of the latest technologies that are not readily available elsewhere. Basic development of key technologies is also critically important for our future. The Advanced Technology Center (ATC) provides a platform to meet the current and future technology needs in astronomy. ATC owns world-class equipment such as high-quality clean rooms for the SIS mixer for ALMA and space-astronomy instruments, space chambers, optical methodology instruments, ion-beam sputtering machines for thin-film coating, and precision machinery. These facilities are widely used by scientists and engineers both inside and outside of NAOJ. Our products include the Hyper Suprime-Cam (HSC) aboard Subaru Telescope, and the ALMA band 4, 8 and 10 receivers. We are committed to the development of the gravitational waves detector KAGRA, and the focal plane instruments aboard the Thirty Meter Telescope (TMT) as well as various basic development programs vital for future ground-based and space astronomy.

▲Large clean room for the development of space-astronomy instruments.

Director :
Prof. NOGUCHI, Takashi

▶The machine shop for fabrication of astronomical instruments and for consultation on manufacturing solutions.

Public Relations Center

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://www.nao.ac.jp/en/

We Present the Latest Scientific Knowledge of the Universe in Understandable Ways.

The Public Relations Center (PRC) was created in 1998 to share the latest astronomy research results with the public. We communicate and promote research breakthroughs in a manner that is understandable, relevant, and exciting. For this purpose, we offer a range of services and deliver amazing scientific information through a variety of media including the Web and scientific publications. We have also built an effective partnership with dissemination experts working for public observatories, science museums, and planetariums. The PRC is organized into eight branches: the Public Relations Office, the Outreach and Education Office, the IAU/International Outreach Office, the Ephemeris Computation Office, the Publications Office, the Library, the Museum Project Office, and the General Affairs Office. We also collect information about newly discovered objects and provide astronomical reading materials for the public.

▲On Mitaka campus, a 50-cm (diameter) telescope is used for social education programs including stargazing and observation practice. We offer stargazing parties for the public twice per month, on the Friday before the second Saturday and on the fourth Saturday. PRC supports students who come for practice observation or extracurricular classes.

Director :
Prof. FUKUSHIMA, Toshio

▼We answer more than 10 thousand questions a year from the general public.

IR V

Division of Optical and Infrared Astronomy

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://optik2.mtk.nao.ac.jp/index-e.html

Authentic Astronomy. We Reveal the Universe as it Appears.

It is possible to see entirely different universes when we look at our Universe in different wavelengths. The Universe observed in optical and infrared wavelength looks just as it does when you see it with your own eyes. Instead of eyes, we use large ground-based telescopes such as the Okayama 188-cm Telescope and the 8-m Subaru Telescope, which have thousands to millions of times greater visual power than eyes, in order to investigate the Universe to answer many unsolved questions. What structure does our Universe have ? When was it born? How were planets and stars born? When and how did life appear in the Universe? We would like to answer these fundamental questions thorough our various scientific research. We are also working as liaison for different projects, the promotion of exploratory projects, public outreach, and education for graduate students.

▲M 20 observed at Okayama Observatory. A filamentary dark nebula can be seen in front of the diffuse nebula.

Director :
Prof. MIZUMOTO, Yoshihiko

▶NGC 6946 observed by the Subaru Telescope. Active star formation occurs in the many red clumps. This is an image taken by graduate students in their observing class.

cm mm smm

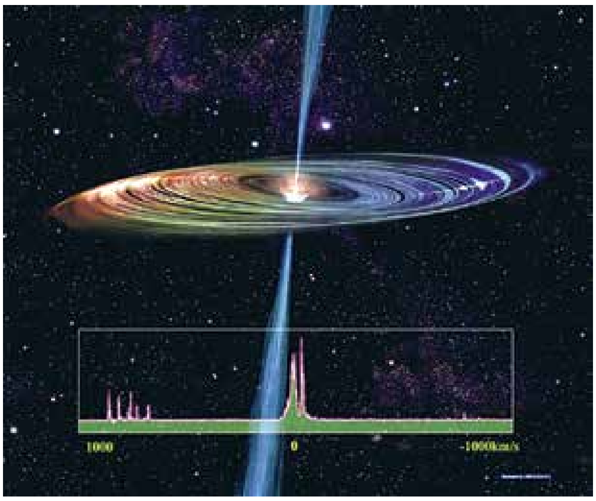
Division of Radio Astronomy

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600

Radio Astronomy to Explore the Universe Not Seen at Optical Wavelengths

Radio astronomy unravels mysteries and phenomena of the Universe by studying pictures taken at radio wavelengths invisible to human eyes. There are many questions about the Universe that have yet to be answered, including “How were galaxies formed after the Big Bang?” “How have galaxies evolved for 13.7 billion years and developed into the Milky Way Galaxy where we live?” “What is the detailed structure of the Milky Way Galaxy like?” “What is the formation process of the Solar System and other planetary systems?” “What did it take to give birth to the Earth abundant in fauna and flora, and also to the Moon close to the Earth?” and, “How and when did life arise during the evolution process of cosmic materials?” These questions and other mysteries of the Universe are studied in close cooperation by the members of the Division of Radio Astronomy of the National Astronomical Observatory of Japan : the Nobeyama Radio Observatory, the Mizusawa VLBI Observatory, the RISE Project, and the NAOJ Chile Observatory that has constructed the ultimate radio telescope in Chile.

▼Artist's impression of the rotating disk around the supermassive black hole in NGC 4258. From measurements of the disk's rotation speed of 1000 km/s, the mass of the black hole is estimated to be 36 million times the mass of the Sun. (Credit: J. Kagaya)



Director :
Prof. IGUCHI, Satoru

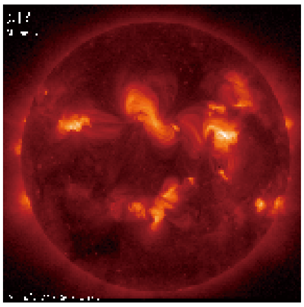
cm IR V UV EUV X

Division of Solar and Plasma Astrophysics

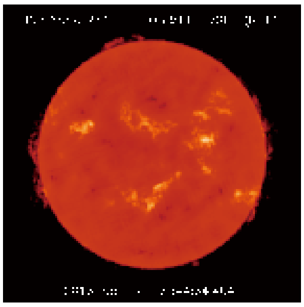
2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://solarwww.mtk.nao.ac.jp/en/index.html

The Sun is Our Star Just Right There

The Sun is a star only 150 million kilometer away from the earth. The earth is full of life, not freezing cold, owing to the energy supplied from the Sun. Occasionally the Sun shows "flare explosion", and the blast wave reaches the earth in about one day and shakes the magnetosphere and produces aurorae. In the Division of Solar and Plasma Astrophysics, we are studying the Sun from its interior to the surface and to the outer atmosphere (the corona), by using multi-wavelength data from the Hinode mission, Nobeyama Radioheliograph, and visible and infrared telescopes of Solar Observatory. Our challenge is to understand the mechanism of the Sun's magnetic activity and its influence on the earth and human activity.

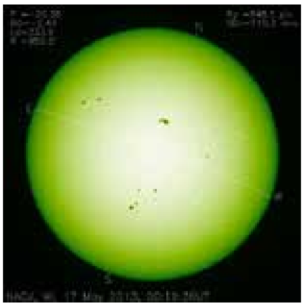


▲X-ray image (Hinode X-ray Telescope)

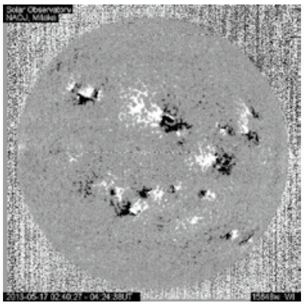


▲Radio image (Nobeyama Radioheliograph)

Director :
Prof. SAKURAI, Takashi



▲White-light image (Solar Observatory/ Full-disk Telescope)



▲Magnetic field map (Solar Observatory/ Infrared Polarimeter)

The Sun seen in various wavelengths

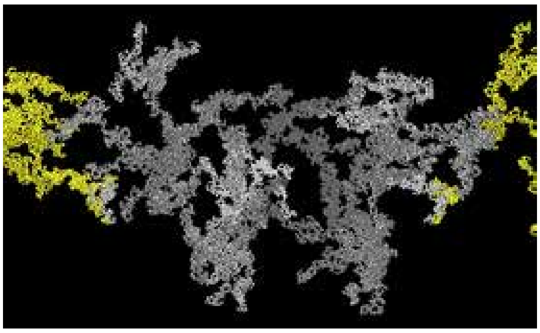
All the data were taken on 17 May 2013.
The solar north is up in the top-row images while celestial north is up in the bottom-row images, and their orientations differ by about 20 degrees.

Division of Theoretical Astronomy

2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://th.nao.ac.jp/index_en.html

Theoretical Astronomy : Intellectual Bases of Astronomy.

We are working on theoretical astronomy and astrophysics. It may often be imagined that an astronomer watches the dark sky every night through a telescope. Instead, we use papers, pencils and computers to carry out our research. Being motivated by the latest observational data, we are trying to extract the essence of various complicated astronomical phenomena. Occasionally we request telescope time to prove a theory. The development of astronomy is brought about by both theoretical and observational work. The objects we are investigating are diverse: moons, planets, stars, space plasma galaxies, clusters of galaxies, active galactic nuclei, large scale structures of the Universe, and the Universe itself. One of our major efforts is dedicated to numerical simulations. Unlike experiments in the laboratory, astronomical phenomena are usually impossible to examine from many viewpoints. Numerical simulations make it possible to investigate these phenomena in detail. We are using the CfCA supercomputer, which is among the best in the world, as a “Telescope for Theory” and producing the newest research results.



▲A dust aggregate under compression in planet formation.

Director :
Prof. TOMISAKA, Kohji

▼Member of Division.

Office of International Relations

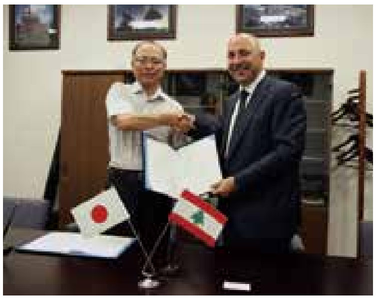
2-21-1, Osawa, Mitaka, Tokyo 181-8588
Phone +81-422-34-3600
http://naoj-global.mtk.nao.ac.jp/index.html

To Make the NAOJ a Truly International and Innovative Research Center in Astronomy.

The role of the Office of International Relations (OIR) is to promote and support international research projects conducted by NAOJ research staff.
In implementing this objective, we:

1) lend support to international research projects,
2) act as a contact point for international exchange with overseas astronomy research organizations,
3) distribute information about international astronomy projects,
4) assist organizing international conferences and seminars,
5) help to provide accommodation for overseas researchers and students coming to the NAOJ,
6) act as an international hub for the Japanese astronomy community.

▶Signing of a research collaboration agreement between Notre Dame University, Lebanon and the NAOJ.



Director:
YAMAGUCHI, Takahiro

◀Visit of the NAOJ delegates to Majmaah University, Saudi Arabia. Collaborations to build a new university's observatory are in progress.

Ishigakijima Astronomical Observatory

Observatory on a Tropical Island Where the Southern Cross and 21 Stars of the First Magnitude Twinkle

The observatory is located on Ishigakijima at 24 degrees north latitude, on the southwest edge of Japan. The "Southern Island Star Festival" that started with the foundation of the VERA Ishigakijima Station has developed into an event in which 10,000 people participate. Meanwhile, the observatory was constructed for astronomy outreach and observational study of Solar System bodies in 2006. In 2013, the astronomy lecture room where we can enjoy the 4D2U (Four-Dimensional Digital Universe) theater was established as an annex to the observatory. Including the participants for the star parties held on weekends and holidays, 13,000 people visit there annually. Observations of transient objects such as gamma-ray burst afterglows, supernovae, and comets are powerfully performed.

▲The Ishigaki-jima Astronomical Observatory and the Milky Way. The 105-cm reflecting telescope is the largest in the Kyushu and Okinawa areas and is known by the name "MURIKABUSHI (star cluster, Pleiades) ".

4D2U Dome Theater

The Theater Takes Us to the Four-Dimensional Universe

How big is our Universe? What kind of celestial bodies are in it? Mapping of the Universe reveals the Universe we live: Earth in the Solar System, stars nearby the Sun, Milky Way Galaxy with hundreds of billions of stars, nearby galaxies, and large-scale structure of the Universe. The 4D2U (Four-Dimensional Digital Universe) Dome Theater has the atlas of our observable Universe based on astronomical observations. Movie contents visualize numerical simulations of astronomical research and show us how the Universe evolved in its 13.8 billion-years history. At the theater, you will find a clue to answer fundamental questions such as: What are we? Where do we come from?

▲4D2U Dome Theater with audience

●When is the theater open?

The 4D2U Dome Theater is open every month on the Friday before the second Saturday and on the third and fourth Saturday (reservations required). Currently operated in Japanese only.
See https://prc.nao.ac.jp/4d2u/, for details in Japanese.

Time Keeping, Ephemeris Computation, and Open Houses of NAOJ

Japanese Central Standard Time and Atomic Clocks

The Astronomical Time Keeping Office determines and sets Japanese Central Standard Time. It has been annexed to the Mizusawa VLBI Observatory and runs a group of atomic clocks for keeping time. The clocks are compared with those of other time keeping centers around the world via the GPS satellite link and contribute to the determination of the International Atomic Time, the world's standard time. The Mizusawa VLBI Observatory contributes to the determination of the Universal Time based on the Earth's rotation by observing quasars with VLBI. Japanese Central Standard Time is determined through these observations and disseminated through the NTP service.

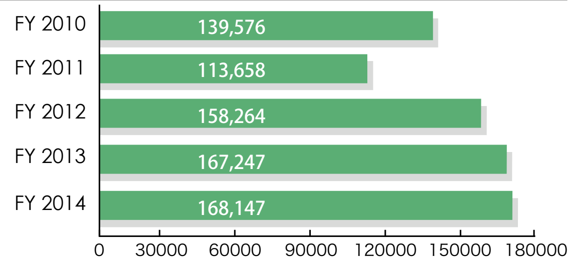
Atomic clocks at the Time Keeping Office. The office encourages the development and studies of high-precision time measurement and for the dissemination of time signals for astronomical observations, such as the observations of pulsars. It also provides official approval for clocks.

Open Houses of NAOJ

NAOJ Welcomes Visitors to Our Research and Observation Facilities.

We release the latest findings and research results to the public. Many outreach activities are also provided such as Visitors' Area, open house days, and regular stargazing parties at the headquarters and other observation facilities. Our activities are getting popular and the number of visitors to the NAOJ campuses has reached 100,000 every year. Our outreach programs covers various themes and purposes to meet a broad range of public interest in astronomy and outer space.

■Number of Visitors to NAOJ form Fiscal Year 2010 to 2014

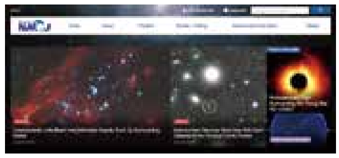


Total number of visitors to
Mitaka, Mizusawa, Nobeyama, Okayama and Hawai'i campuses

Mitaka, Mizusawa, Nobeyama, and Okayama Campuses are open daily to the public. Many visitors participate in an annual open house day at each campus. The Subaru Telescope in Hawai'i provides guided tours at the summit facility. You may sign up for a tour on the Subaru Telescope website. Our staff members on other campuses also offer public outreach programs such as open house days, special stargazing parties, and guided tours of the facilities. Each campus has set up its own website to communicate a variety of information. Everybody can enjoy virtual-tours of our research and observation facilities, and learn about cutting-edge astronomy.

●NAOJ Mitaka (the headquarters)
http://www.nao.ac.jp/en/
2-21-1 Osawa, Mitaka, Tokyo, *181-8588 Japan*
Phone +81-422-34-3600
- **Visitors' Area** (No reservations required. Open hours; 10:00~17:00 except Year-end and New Year Holidays)
- **Annual Open House Day**
- **Regular Stargazing Parties** (Reservations required, see page 24)
- **4D2U Theater** (Reservations required)
- **Cultural Property Tours** (Reservations required)

Guidebook of the Visitors' Area on Mitaka Campus. Japanese, English, Chinese, Korean and Spanish versions are available.



●Mizusawa VLBI Observatory
http://www.miz.nao.ac.jp/en
2-12 Hoshigaoka, Mizusawa, Oshu, Iwate, 023-0861
Phone +81-197-22-7111
- **Visitors' Area** (Open hours; 9:00 ~ 17:00 except Year-end and New Year Holidays)
- **Annual Open House Day**

Kimura Memorial House is one of the main pageantries of Mizusawa sightseeing. Visitors can learn about the history of the first Director of the Latitude Observatory, Dr.Hisashi Kimura, who discovered the z-term of the latitude variation.

●VERA Iriki Station
●VERA Ogasawara Station
●VERA Ishigaki-jima Station
- **Visitors' Area** (Open hours; 9:00 ~ 17:00 except Year-end and New Year Holidays)
- **Annual Open House Day**

●Ishigaki-jima Astronomical Observatory
- **Visitors' Area** (Open hours; 10:00 ~ 17:00 except Mon. and Tue., Year-end and New Year Holidays)
- **Regular Stargazing Party** (19:00 ~ 22:00 on Sat. Sun. and holidays)

Oshu Uchu Yugakukan

●Nobeyama Radio Observatory
http://www.nro.nao.ac.jp/en/
462-2 Nobeyama, Minamimaki, Minamisaku, Nagano, 384-1305
Phone +81-267-98-4300
- **Visitors' Area** (Open hours; 8:30~17:00 except Year-end and New Year Holidays)
- **Annual Open House Day**

Photo of the annual open house day on Nobeyama Campus. The Visitors' Area has become a pillar of Nobeyama sightseeing.

●Okayama Astrophysical Observatory
http://www.oao.nao.ac.jp/en/
3037-5 Honjo, Kamogata, Asakuchi, Okayama, 719-0232
Phone +81-865-44-2155
- **Visitors' Area** (Open hours; 9:00〜16:30 except Year-end and New Year Holidays, and maintenance period)
- **Annual Open House Day**

Photo of the open house day at Okayama Astrophysical Observatory. Visitors can have a close look at the 188-cm Telescope.

●Subaru Telescope (in Hawai'i)
http://subarutelescope.org/index.html
650 North A'ohoku Place, Hilo, Hawai'i, 96720, U.S.A.
TEL +1 (808) 934-7788
- **Public Tour inside the enclosure**
(Reservation is required through the Subaru Telescope's website for pre-scheduled time slots.)

The Subaru Telescope enclosure. Visitors can tour this facility and see the giant telescope up close.

Almanacs and "*Rika Nenpyo* (Chronological Scientific Tables)"

Almanacs The Ephemeris Computation Office computes the 24 Sekki, the traditional Japanese seasons markers, such as vernal and autumnal equinoxes. It also calculate the rising and setting of the Sun and the Moon, solar and lunar eclipses, planetary phenomena, etc., and produces a "Calendar and Ephemeris" each year. On February 1st, we announce its summary as "Reki Yoko" in the official gazette. Since the information on the koyomi（citizen's calendar）is closely related to human life, we also publish "Rika Nenpyo" and provide useful tools on our website to make them available for many people to use.

Rika Nenpyo

In cooperation with many research organizations, we have been publishing "Rika Nenpyo" , which has a history of over 90 years as the most reliable data source for natural sciences in Japan.

"Rika Nenpyo" has been quoted in many examinations and textbooks.

Visitors' Area at Mitaka Campus

Visitors' Area is open daily to the public except Year-end and New Year Holidays.

Open Hours : From 10:00 AM to 5:00 PM

Observatory History Museum

The dome built in 1926 was renovated as a museum. The 65-cm telescope is the largest refractor in Japan. Panels, old instruments, and documents illustrating the history of NAOJ are displayed inside of the dome.

65-cm Equatorial Refractor Telescope

We preserved the big 65-cm equatorial refractor at the center on the deck of the second floor. The telescope was used for astronomical research observations until 1998.

Exhibits

Exhibits on the first and second floors display various photos, documents, instruments, and so on to explain the past and present of NAOJ.

65-cm Telescope Dome

This is a big structure with a height of 19.5 meters and a dome diameter of 15 meters. In the late 1920' s, Japanese builders had no techniques to build a semi-spherical dome. So the construction of the dome was conducted by shipbuilders, who had techniques for building ship hulls. It became a national registered tangible cultural property.

Exhibition Room

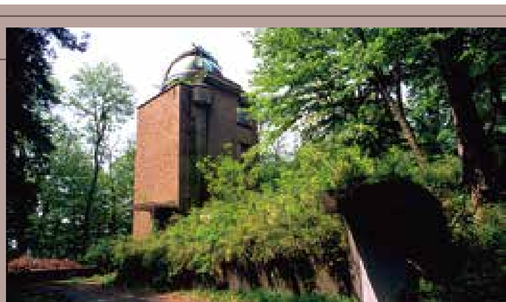
The Exhibition Room in the Visitors' Area of the Mitaka Campus contains models of the state-of-the-art, major telescopes of NAOJ such as the Subaru Telescope, the Nobeyama 45-m Radio Telescope, ALMA, TAMA300, and TMT. There are also many displays explaining the recent results of our research.

Repsold Transit Instrument

This building was erected in 1925. In 2011 the Repsold Transit Instrument was registered as an important cultural property, because of its value in the historical development of Japanese astronomy.

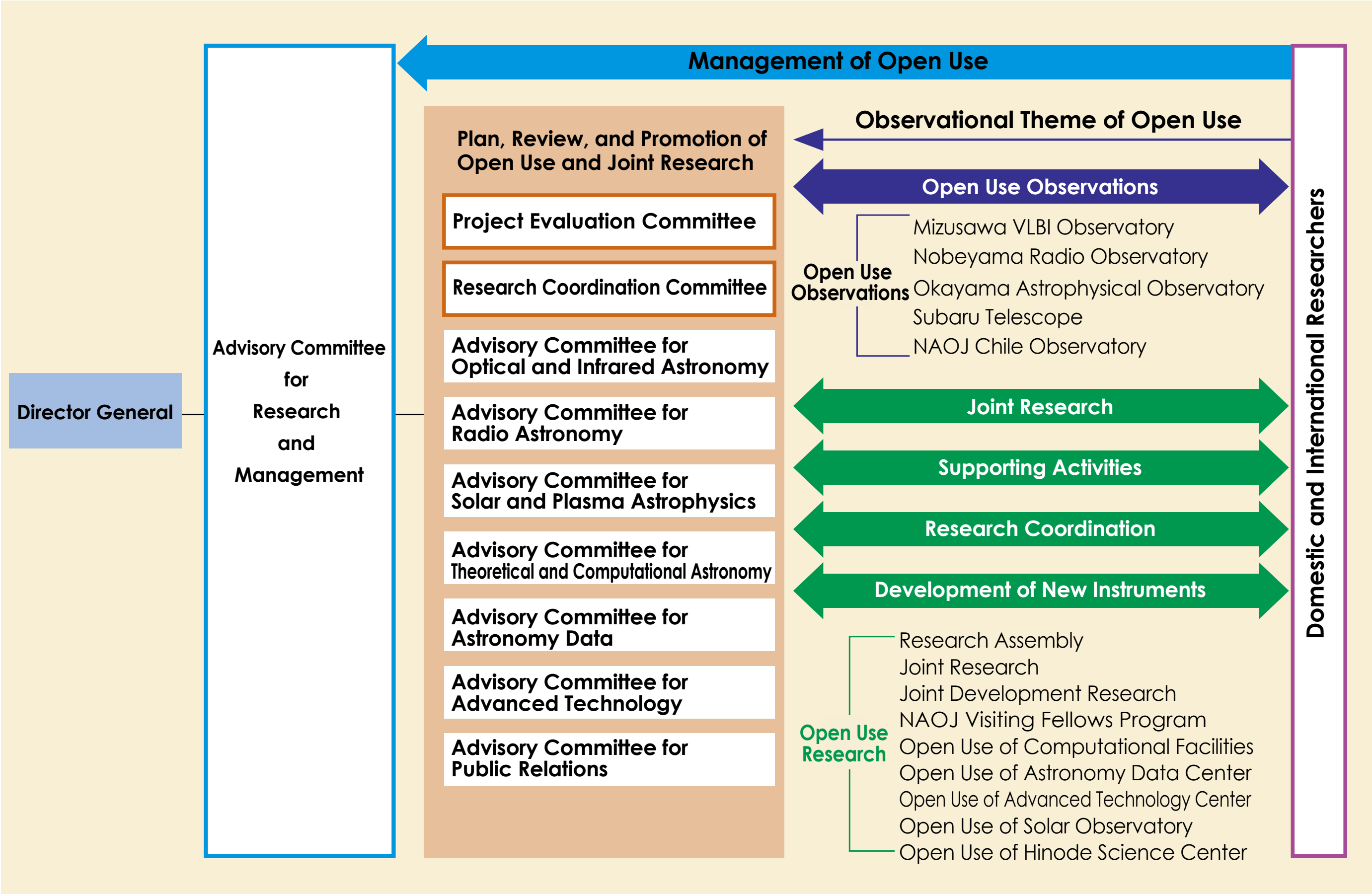
Solar Tower Telescope

The Solar Tower Telescope (The Einstein Tower) is located in the Visitors' Area of the Mitaka Campus. It was completed in 1930 and its classic architecture represents the so-called Taisho-Era style. It is preserved as a national registered tangible cultural property. The inside of the tower is closed, to the Public.



NAOJ as an Inter-University Research Institute

As an open-use institute for universities, the National Astronomical Observatory of Japan (NAOJ) actively promotes joint observation and joint research programs, as well as international cooperative projects. The success of these activities is based on the foundation of research and education provided by universities and other institutes throughout the country. To promote the open use of our facilities based on active relationships with researchers nationwide, NAOJ provides the following arrangement:



Administration for Open Use

As an open-use institute for universities, the National Astronomical Observatory of Japan (NAOJ) is administrated by astronomical researchers from universities and related institutes as well as by NAOJ staff. The Advisory Committee for Research and Management, an interface between the astronomical community and NAOJ, is the highest committee to determine key issues for management, such as overseeing personnel administration, restructuring, and so on.

NAOJ Advisory Committee for Research and Management (the sixth term)
(period; April 1, 2014–March 31, 2016)

From universities and related institutes

UMEMURA, Masayuki：Professor, Faculty of Pure and Applied Sciences, University of Tsukuba

OTA, Kouji：Professor, Graduate School of Science, Kyoto University

OKUMURA, Sachiko：Professor, Graduate School of Science, Japan Women's University

KAJITA, Takaaki：Professor, Institute for Cosmic Ray Research, University of Tokyo

○ **KUSANO, Kanya**：Professor, Solar-Terrestrial Environment Laboratory, Nagoya University

SUGITA, Seiji：Professor, Graduate School of Frontier Sciences, The University of Tokyo

NAKAGAWA, Takao：Professor, Institute of Space and Astronautical Science

MURAKAMI, Izumi：Professor, National Institute for Fusion Science

MOMOSE, Munetake：Professor, College of Science, Ibaraki University

YAMADA, Toru：Professor, Graduate School of Science, Tohoku University

From NAOJ

ARIMOTO, Nobuo：Professor, Subaru Telescope

USUDA, Tomonori：Professor, TMT Project Office

GOUDA, Naoteru：Professor, JASMINE Project Office

KOBAYASHI, Hideyuki：Professor, Mizusawa VLBI Observatory

SAKURAI, Takashi：Professor, Solar Observatory

TAKAMI, Hideki：Professor, Advanced Technology Center

TOMISAKA, Kohji：Professor, Division of Theoretical Astronomy

NOGUCHI, Takashi：Professor, Advanced Technology Center

HASEGAWA, Tetsuo：Professor, NAOJ Chile Observatory

◎**WATANABE, Junichi**：Professor, Public Relations Center

◎Chair ○Vice-Chair (listed in the order of Japanese phonetics)

Graduate Course Education

NAOJ constitutes the Department of Astronomical Science of the Graduate University for Advanced Studies (SOKENDAI). NAOJ also cooperates with the Graduate School of Science of the University of Tokyo to educate graduate students. In addition, graduate students from other universities study at NAOJ. Through the educational activities above, NAOJ contributes to fostering the education of graduate students in a variety of leading research fields.

Number of Graduate Students (FY 2015)

SOKENDAI (five-year doctoral course) ··················32
Other Universities (master and doctoral course) ······38

■Department of Astronomical Science, School of Physical Sciences, the Graduate University for Advanced Studies (SOKENDAI)

●We accept both 3- and 5-year doctoral candidates, the latter is a unified 2-year masters and 3-year doctoral course. The entrance examinations for 3-year doctoral course are held every August and January.

●Five-year doctoral course. The entrance examination is held in every August.

●Course Organization

- Optical and Near Infrared Astronomy Course
- Radio Astronomy Course
- General Astronomy and Astrophysics Course (Theoretical Astrophysics, Numerical Astrophysics, Gravitational Systems, General Relativity and Cosmology, Public Outreach)

■Visiting Graduate Students Program

Graduate students from Kagoshima University, and so on (FY 2015)

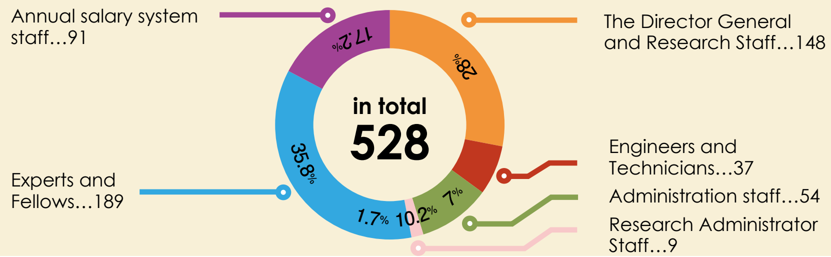
Cooperation in Graduate Course Education

Graduate School of Science, the University of Tokyo
Graduate School of Science, Kyoto University
Graduate School of Science and Engineering, Kagoshima University
Graduate School of Science, Toho University
Graduate School of Science, Tohoku University
Graduate School of Science, Hiroshima University
Graduate School of Science, Kobe University
Graduate School of Humanities and Science, Ochanomizu University
Graduate School of Science and Engineering, Hosei University

▲An observation training course at the Subaru Telescope

Profile of NAOJ (FY2015)

■Number of Employee



■Campus Area

1,005,999m²
(tenancy 544,464m²)

■Budget (including personal salaries)

15,858,975,000 yen

History of NAOJ (1888-2013)

Tradition and the Leading Edge. NAOJ Continues to play a Key Role in Japanese Natural Sciences.

NAOJ was established in 1988 as an Inter-University Research Institute by reorganizing the Tokyo Astronomical Observatory of the University of Tokyo, the Latitude Observatory, and a part of the Nagoya University Atmospheric Research Center. The antecedent institutes had long histories and made many research contributions.

1888	The Tokyo Astronomical Observatory was established by the Faculty of Science, the University of Tokyo.
1899	The Latitude Observatory was established in Mizusawa.
1908	Astronomical Society of Japan was established.
1925	Publications of “Rika Nenpyo” began.
1946	Publication of Almanacs and “Calendar and Ephemeris” began.
1949	The Nagoya University Atmospheric Research Center was established. Norikura Solar Observatory began observations.
1960	Okayama Astrophysical Observatory began observations.
1969	Nobeyama Solar Observatory began observations.
1970	Nobeyema 6-m Radio Telescope began observations.
1972	A Leap second began to be included calendar calculations.
1981	Astronomical Satellite “HINOTORI” began solar observations.
1982	Nobeyama Radio Observatory began observations.
1988	The National Astronomical Observatory of Japan was established.
1992	Nobeyama Radioheliograph began observations.
1996	Introduction and open use of supercomputers.
1997	Space VLBI satellite “HALCA” began observations.
1999	Subaru Telescope began observations. Laser Interferometer Gravitational Wave Antenna “TAMA300” began observations.
2000	Visitors’ Area opened at Mitaka Campus.
2001	Agreement of ALMA project among Europe, the United States, and Japan. VERA Stations began observations.
2004	NAOJ was incorporated as the National Astronomical Observatory of Japan, National Institutes of Natural Sciences. Construction of ALMA began.
2006	HINODE began solar observations.
2007	As a part of the Four-Dimensional Digital Universe (4D2U) project, the tridimensional dome theater was completed. The Lunar Explore “KAGUYA” was launched and began observations.
2008	One of 12-m antennas of NAOJ was certified as the first ALMA antenna.
2010	Norikura Solar Observatory was closed after 60 years of service.
2012	Regular ALMA observations started.
2014	Construction of TMT began.

Now, we understand that star ......

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