Inter-University Research Institute Corporation
National Institutes of Natural Sciences

National Astronomical Observatory of Japan

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

NAOJ

2023

NAOJ Facilities

Our research facilities have been set up throughout Japan and around the world in the best observational environments to explore the Universe.

Japanese Branches

NAOJ Mizusawa

Mizusawa VLBI Observatory (VERA)

NAOJ Mizusawa has a long history since its founding as a part of the International Latitude Observatories. It operates VERA to observe the Milky Way, black holes, etc.

Center for Computational Astrophysics

NAOJ Mizusawa hosts ATERUI II, the world's fastest supercomputer dedicated to astronomy.

RISE Project

The RISE Project has contributed to instrument development, observation operations, and spacecraft orbit estimation for KAGUYA and Hayabusa2, and has been carrying out research and development for exploration of the satellites of Mars and Jupiter.


VERA Mizusawa Station


ATERUI II

NAOJ Nobeyama

Nobeyama Radio Observatory

Nobeyama Radio Observatory raised Japanese radio astronomy to the top tier internationally. The 45-m Radio Telescope is one of the largest millimeter radio telescopes in the world. It has achieved epoch-making results, such as discovery of new interstellar molecules and detection of the signature of a supermassive black hole in a galaxy. Nobeyama Campus is open daily to the public.

GWSP Kamioka Branch, KAGRA

KAGRA, a gravitational wave telescope constructed in the Kamioka Mine, aims to expand the field of gravitational wave astronomy. The Kamioka Branch of the Gravitational Wave Science Project supports the installation and commissioning of KAGRA.

Subaru Telescope Okayama Branch

Open-use observations are conducted by NAOJ at the 3.8-m telescope of the Okayama Observatory, the Astronomical Observatory of the Graduate School of Science, Kyoto University. Open-use observing opportunities with the largest optical and near-infrared astronomy facility in Japan are provided.


Mizusawa VLBI Observatory : Ibaraki Station


Mizusawa VLBI Observatory : Yamaguchi Station

NAOJ Mitaka

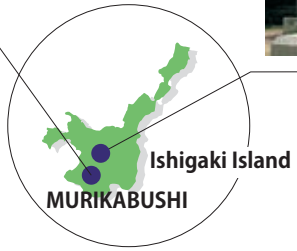
As the headquarters of NAOJ, Mitaka Campus houses offices of various projects and divisions, as well as administrative offices.


Chichijima, Ogasawara Islands

Mizusawa VLBI Observatory : Ishigaki-jima Station (VERA)


Ishigakijima Astronomical Observatory

MURIKABUSHI is a 105-cm telescope in Ishigakijima Astronomical Observatory.




Mizusawa VLBI Observatory : Iriki Station (VERA)

Mizusawa VLBI Observatory : Ogasawara Station (VERA)

Overseas Branches

NAOJ Hawai'i

Subaru Telescope, NAOJ TMT Project

With many clear nights and stable airflow, the summit region of Maunakea (4200 meter altitude) is well suited for astronomy observations. Here, NAOJ constructed and operates the Subaru Telescope, and the 30 meter optical-infrared telescope TMT is being constructed through international collaboration.

Hilo Base Facility

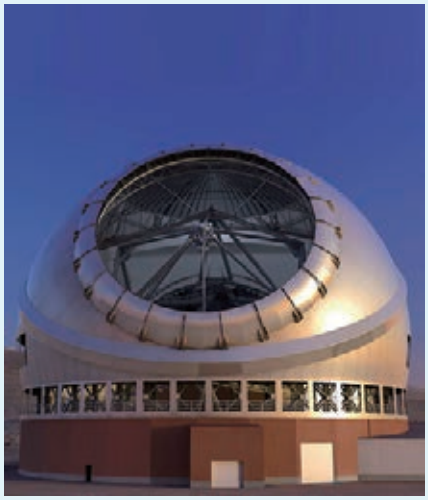
The base facility of Subaru Telescope is located in Hilo on the Island of Hawai'i. As the base for the unified operation of the Subaru Telescope and TMT, this facility has laboratories, a machine shop, computer room, a remote observation room, etc.

The Subaru Telescope (left)

An optical-infrared telescope with a world-class 8.2 meter aperture. Full-scale observations started from FY 2000. In FY 2022, a new project called "Subaru Telescope 2.0" started to investigate the evolution of the Universe and the origin of elements with new core instruments.

TMT (right)

An extremely large optical-infrared telescope being constructed through international collaboration between Japan, the United States, Canada, China, and India. With more than 10 times the light collecting power of the Subaru Telescope, it aims to discover signs of life in the atmospheres of exo-planets and capture the light from the earliest stars in the Universe.



NAOJ Chile

NAOJ Chile, NAOJ ALMA Project

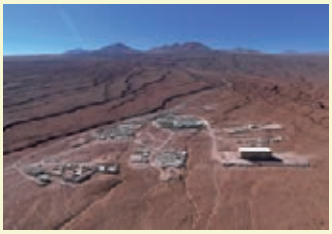
The Atacama Desert in northern Chile, one of the driest places on Earth, is an ideal location for short wavelength radio wave (millimeter and submillimeter wave) observation. ALMA and ASTE have been established here. The NAOJ Chile office and the Joint ALMA Observatory Santiago Central Offices are located in Santiago, the capital of Chile.

ALMA

ALMA, led by NAOJ, the National Radio Astronomy Observatory (US), and the European Southern Observatory, is a giant radio telescope array with 66 antennas operated on a 5000 meter elevation plateau in Chile. NAOJ collaborates in East Asia with the Academia Sinica Institute of Astronomy and Astrophysics in Taiwan and the Korea Astronomy and Space Science Institute. Credit: ESO

ASTE

ASTE observes submillimeter radio waves with wavelengths shorter than 1 millimeter. Established in the Atacama Desert with optimal conditions for submillimeter astronomy, it applies its strength to observations of the southern sky including the Galactic center region, nearby star-forming regions, and distant galaxies.



ALMA Operations Support Facility

The Operations Support Facility is located 30 kilometers away from the ALMA Array Operations Site. It serves as the "base camp" for ALMA with lodgings and a cafeteria for ALMA staff in addition to the control room for remote operation of ALMA and laboratories where instrument maintenance is performed. Credit: ESO

Public Access to NAOJ facilities

To widely disseminate our research results to the public, the major facilities of NAOJ offer visitors' areas, annual open house days, or regular stargazing parties.

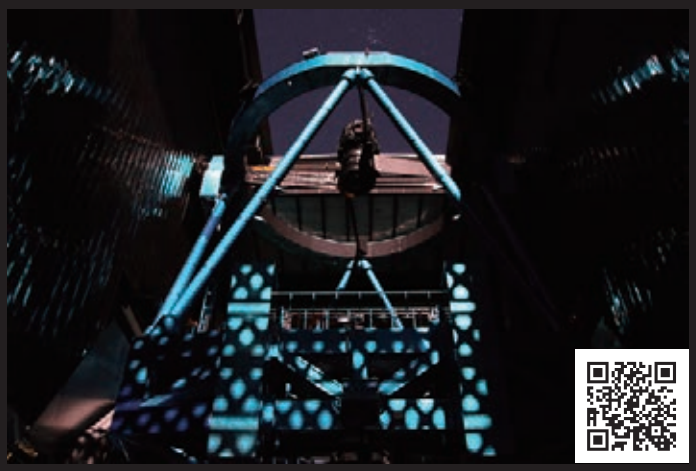
NAOJ's Leading Edge Facilities

NAOJ is involved in many world-class observatories and research facilities, either as the leader or as a partner with other research organizations. Major projects include Subaru Telescope, ALMA, KAGRA, ATERUI II, and Mizusawa VLBI Observatory. Moreover NAOJ promotes future-development projects like TMT. Here we introduce our major telescopes and instruments.

Subaru Telescope

The Subaru Telescope is an optical-infrared telescope with an 8.2-m monolithic primary mirror. It is installed near the summit of Maunakea, Hawai'i. The Subaru Telescope is accessible to the world astronomical community through open-use observations. The new project "Subaru Telescope 2.0" started in FY 2022, centering on large-scale survey observations by strengthening its wide field of view and high-resolution observation capabilities. Subaru Telescope 2.0 has the scientific goals of investigating dark matter and dark energy; the evolution of galaxies and the large-scale structure of the Universe and galaxies; multi-messenger astronomy; and extrasolar planets.

The Subaru Telescope illuminated by moonlight and the Pleiades star cluster (Subaru).



ALMA

The ALMA Compact Array, also known as the Morita Array. (C) ALMA (ESO/NAOJ/NRAO)

The Atacama Large Millimeter/submillimeter Array (ALMA), located at an altitude of 5000 meters at the Chajnantor plateau in northern Chile, is a cutting-edge telescope array operated by a global partnership led by Japan, the United States, and Europe. ALMA observes astronomical objects in millimeter and submillimeter waves in ultra-high resolution using 66 antennas. Japan has contributed 16 of the antennas, called the Atacama Compact Array (ACA), receiver cartridges for three frequency bands, and a high-performance supercomputer called the ACA Correlator. In addition, Japan has led East Asian collaboration for receiver cartridges for an additional band and a high-performance spectrometer for the ACA. ALMA is delivering breakthroughs in understanding the formation of early galaxies, the origins of planetary systems, and the evolution of matter in the Universe.

Mizusawa VLBI Observatory

The 20-m radio telescope at Mizusawa VLBI.

As the center of VLBI astronomy in Japan, Mizusawa VLBI Observatory operates the VERA array consisting of four 20-m radio telescopes located at Mizusawa, Iriki, Ogasawara, and Ishigaki Island, which forms a huge virtual radio telescope with a diameter of 2300 km. Having explored the 3D structure of our Milky Way galaxy by measuring the distances to Galactic objects with high accuracy for more than 15 years, now we promote international collaborations to expand the East Asian VLBI Network together with China, the Republic of Korea, Thailand, and so forth, which enables astronomers to obtain images of celestial objects with extremely high angular resolution.

We promote the use of computer systems for simulation including ATERUI II; the world's fastest supercomputer for astrophysics (theoretical peak performance of 3 Pflops), research and development for simulation technology; and astronomy research using simulations. Our objective is to reveal aspects of the Universe that cannot be observed by any telescope through calculations based on the laws of physics. The project office has made many contributions to our understanding of the large-scale structure of the Universe, and the formation and evolution of celestial objects. We strive to provide more realistic simulations and address the unsolved mysteries of the Universe.

The supercomputer for astronomy "ATERUI II".

ATERUI II

The first detection of gravitational waves by LIGO marked the beginning of gravitational-wave astronomy. In collaboration with ICRR, KEK, and other institutes, we promote the KAGRA project; a large interferometer with 3-km L-shaped arms in an underground tunnel at Kamioka Mine. KAGRA was designed based on TAMA300, a 300-m laser interferometer situated underground in NAOJ Mitaka Campus. TAMA300 is now used to develop new technologies for upgrading KAGRA and conduct pre-installation testing of the instruments for KAGRA. The project office also conducts research on improving the sensitivity of gravitational-wave detectors and the possibility of a space-based gravitational-wave observatory.

The KAGRA vacuum duct.

KAGRA

TMT

An artist's rendition of the night sky and TMT.

The Thirty Meter Telescope (TMT) is an extremely large optical-infrared telescope with an aperture of 30 m, slated for construction on Maunakea in Hawai'i. Thanks to its unprecedented assembly of 492 mirror segments, TMT will have 13 times the light-gathering power and 3.6 times the resolving power of the 8.2 m Subaru Telescope. TMT will explore the mysteries of the Universe far beyond the reach of existing telescopes, such as research in astrobiology. Its observations will range from objects within our Solar System to distant stellar explosions, the farthest galaxies, and other traces of the beginning of the Universe. The TMT Project is advancing through international collaboration including Japan, USA, Canada, China, and India.

Various Projects and Centers Pursuing NAOJ's Extensive Astronomical Research

NAOJ Chile
Nobeyama Radio Observatory
Solar Science Observatory
Center for Computational Astrophysics
JASMINE Project
RISE Project
SOLAR-C Project
PFS Project
GLAO Project
ASTE Project
Astronomy Data Center
Advanced Technology Center
Public Relations Center
Division of Science

For further information on our Projects and Centers, visit our website at:

https://www.nao.ac.jp/en/research/project/

NAOJ's "Philosophy"

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

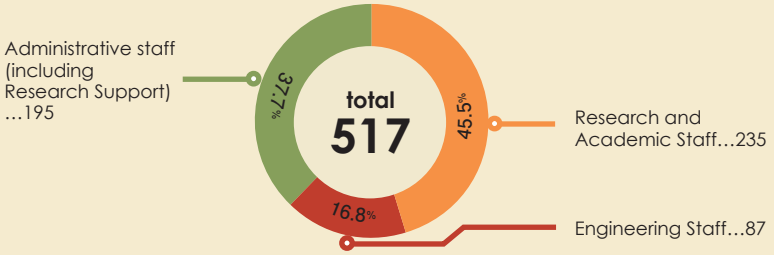
●To explore the unknown Universe and provide new insight into astronomy.

●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.

Profile of NAOJ (as of April 1, 2023)

■Number of Employees



■Campus Area

1,013,425m^2
(tenancy 556,309m^2)

■Budget (FY 2022, including salaries)

12,338,166,000 yen

Graduate Course Education

NAOJ constitutes the Astronomical Science Program of the Graduate University for Advanced Studies (SOKENDAI). NAOJ also accepts graduate students from other universities through the Cooperative Graduate School Program and the Visiting Graduate Students Program. 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 (as of April 1, 2023)

Students from SOKENDAI	31
Students from Cooperative Universities	29
Visiting Graduate Students	11

Astronomical Science Program, the Graduate University for Advanced Studies (SOKENDAI)

●**Department of Astronomical Science, School of Physical Science, SOKENDAI is graduate school based at NAOJ.**

●**The graduate school offers two programs: a five-year doctoral program for graduate students and a three-year doctral program for graduates with a Master's degree.**

●**Course Organization**

- **Optical and Infrared Astronomy Course**
- **Radio Astronomy Course**
- **General Astronomy and Astrophysics Course**

NAOJ accepted students from the following graduate schools in the last five years.

The University of Tokyo, University of Tsukuba, University of Electro-Communications, Tokyo Institute of Technology, Tokyo University of Agriculture and Technology, Ibaraki University, Nagoya University, Osaka Metropolitan University, Niigata University, Yamaguchi University, Kyushu University, Kagoshi-ma University, Hosei University, Nihon University, Tokyo City University, Kyoto Sangyo University, Konan University, (in no particular order)

An observation training course at the Subaru Telescope.

History of NAOJ (1888-2023)

The origin of NAOJ dates back to the latter Edo era (more than 300 years ago) when continuous observations of stars began at Asakusa Observatory of the shogunal tenmon-kata (the shogunal astronomical office).

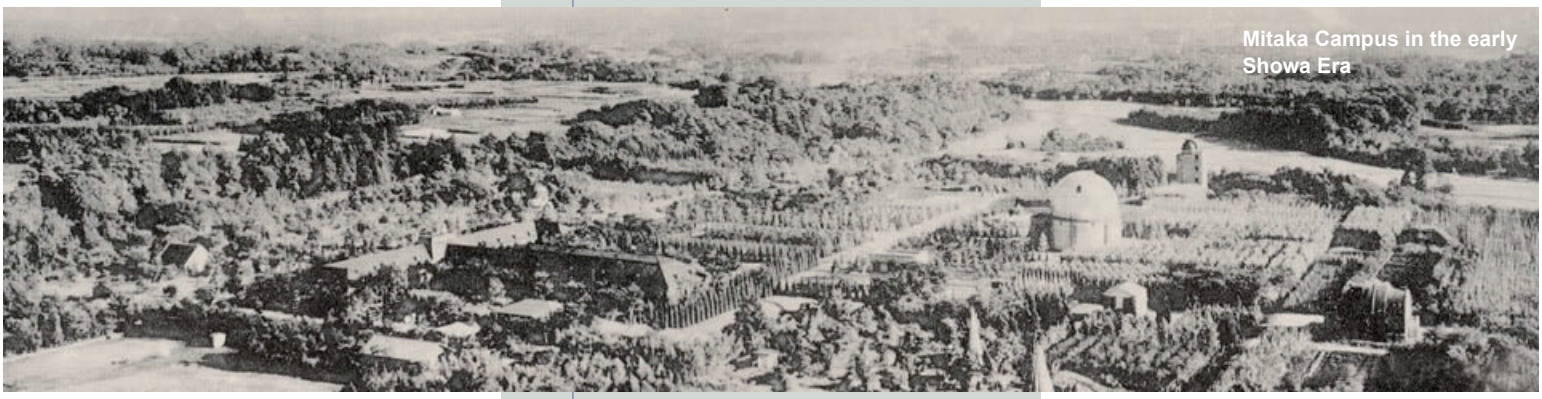
The first main tasks of the astronomical observatory were determining longitude and latitude by observing stars, calculating the calendar, and determining the time. These were started as national projects in the Meiji era, and have been continued as part of the work of NAOJ.


Latitude Observatory

1888	The Tokyo Astronomical Observatory was established. (Iikura, Azabu)
1899	The Latitude Observatory was established in Mizusawa.
1924	The Mitaka campus was started to establish.
1925	Publication of "Chronological Scientific Tables (Rika Nenpyo)" began.

Rika Nenpyo

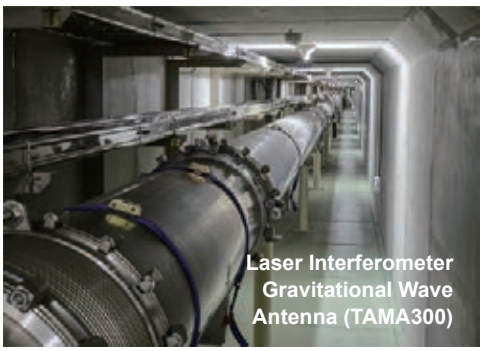
Since its first publication in 1925, we have been publishing Rika Nenpyo for almost 100 years in cooperation with many other research organizations.
Also available in English.
https://official.rikanenpyo.jp/posts/5905


Mitaka Campus in the early Showa Era


65-cm Refractor Telescope

1926	65-cm Telescope Dome completed.
1929	65-cm equatorial telescope was equipped.
1930	Solar Tower Telescope (The Einstein Tower) was built.
1946	Publication of Almanacs and "Calendar and Ephemeris" began.
1949	Norikura Solar Observatory began observations.
1960	Okayama Astrophysical Observatory began observations.
1962	Dodaira Observatory began observations.
1969	Nobeyama Solar Observatory began observations.
1982	Nobeyama 45-m radio telescope began observations.
1988	The National Astronomical Observatory of Japan was established.
1992	Nobeyama Radioheliograph began observations.
1999	Subaru Telescope first light.
1999	Laser Interferometer Gravitational Wave Antenna "TAMA300" began observations.
2000	Dodaira Observatory was closed.
2000	Visitors' Area opened at Mitaka Campus.
2001	Agreement of ALMA project among Europe, the United States, and Japan.
2001	VERA Stations began observations.
2004	NAOJ was incorporated as the National Astronomical Observatory of Japan, National Institutes of Natural Sciences, Inter-University Research Institute Corporation.
2006	Ishigakijima Astronomical Observatory began observations.
2006	HINODE began solar observations.
2007	As a part of the Four-Dimensional Digital Universe (4D2U) project, the 3-dimensional dome theater was completed.
2007	The Lunar Explore "KAGUYA" was launched and began observations.
2010	Norikura Solar Observatory was closed after 60 years of service.
2011	ALMA Early Science operation started.
2013	Regular ALMA observations started.
2014	TMT International Observatory was established. NAOJ participated as an initial member.
2015	Nobeyama Solar Observatory was closed.
2018	Okayama Astrophysical Observatory was closed.
2018	Super Computer ATERUI II started operation.
2020	KAGRA began observations.


Solar Tower Telescope


Laser Interferometer Gravitational Wave Antenna (TAMA300)


Nobeyama 45-m Radio Telescope


Mizusawa 20-m Radio Telescope


Subaru Telescope


ALMA

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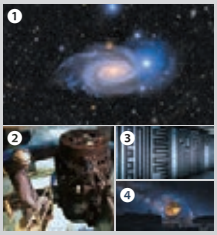

Front Cover

1/ Spiral galaxy NGC 3338 is about 76 million light-years away with a similar mass to the Milky Way. (Credit: NAOJ)
2/ Hyper Suprime-Cam (HSC) on the Subaru Telescope. (Credit: NAOJ/HSC Project)
3/ Massively parallel supercomputer Cray XC50 “ATERUI II.” (Credit: NAOJ)
4/ Conceptual image of TMT when completed. (Credit: NAOJ)

Back Cover

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).