Introduction of the NAOJ Museum Plan

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We developed a Basic Concept for the NAOJ Museum (tentative name) in the fiscal year 2014 with the keywords "to be a gateway that links the past, present, and future astronomy driven by NAOJ". To preserve past items and to present NAOJ's present and future science and projects, four missions are set: (1) Bring the latest NAOJ-driven astronomy at the on-site museum, (2) Be a pioneer of science communication in astronomy, (3) Catalog and preserve the historically important instruments and documents owned by NAOJ, and (4) Increase the international presence and visibility of NAOJ by sharing resources and activities.

1. Background of NAOJ

The National Astronomical Observatory of Japan (NAOJ) is the center of Japanese astronomy possessing world leading research facilities [1]. The former Tokyo Astronomical Observatory was established in 1888 and moved to Mitaka, its current location, in 1924. Today at Mitaka headquarters there are historical telescopes and observational instruments. Ten buildings are Registered Tangible Cultural Properties of Japan, and the Repsold Transit Instrument is designated as an important cultural property of Japan.

NAOJ has multiple observational facilities located both inside and outside Japan. Mizusawa VLBI Observatory in Iwate Prefecture was established in 1899 as the Latitude Observatory. Okayama Astrophysical Observatory began observations with the 188-cm Reflector Telescope in 1960. Nobeyama Radio Observatory in Nagano Prefecture with the 45-m Radio Telescope began observations in 1982.

The latest telescopes were built in foreign countries. Subaru Telescope on Maunakea, Hawai'i achieved first light in 1999. Atacama Large Millimeter/ submillimeter Array (ALMA) in Chile started initial operations in 2011 in collaboration with other countries. The Thirty Meter Telescope (TMT) is now being constructed on Maunakea.

2. Opening of the Facilities

All NAOJ observational facilities except Chile observatory are now open to the public. In Mitaka headquarters, the Visitors' Area is open daily except during the New Year's season. Stargazing parties with the 50-cm Telescope for Public Outreach, 4D2U regular screening, group tours and cultural property tours are provided to the public.

4D2U (Four-Dimensional Digital Universe) [2] is a project aimed at developing scientifically accurate contents based on astronomical observations and numerical simulations. It presents celestial bodies and astronomical phenomena in four

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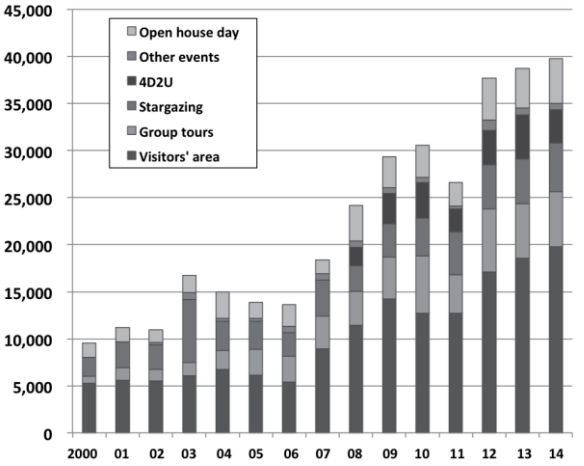

Fig. 1 Number of visitors in Mitaka headquarters from 2000 to 2014.

dimensions (3D spatial dimensions + time). The 4D2U Dome Theater was completed in 2007 and reopened in April 2015 with the new projection system.

At Mitaka headquarters, regular opening of the facilities started in 2000 and the number of visitors is increasing as shown in Fig. 1. Today more than 35,000 people visit Mitaka headquarters per year. NAOJ Nobeyama receives more visitors. More than 50,000 people visit there every year. About 17,000 people visit NAOJ Mizusawa and about 13,000 people visit NAOJ Okayama every year.

3. Basic Concept for the NAOJ Museum (Tentative Name)

3.1. Overview and Missions

The latest NAOJ observational facilities are located in Hawai'i and Chile, locations that are difficult for people in Japan to access. Therefore, a museum is necessary as a place where people can become familiar with the research and discoveries. In addition, a place where historical items and documents can be preserved is also essential. The current basic concept for the NAOJ Museum (tentative name) was developed in the fiscal year of 2014 among Mitaka, Mizusawa, and Nobeyama staff members.

The NAOJ Museum's objective is that everyone can be familiar with the Universe. With the keywords "to be a gateway that links the past, present, and future astronomy driven by NAOJ", we set four missions:

(1) Bring the latest NAOJ-driven astronomy at the on-site museum.
(2) Be a pioneer of science communication in astronomy.
(3) Catalog and preserve the historically-important instruments and documents owned by NAOJ.
(4) Increase the international visibility of NAOJ by sharing resources and activities.

The achievement that everyone can depict a general image of the Universe by following the path of astronomical research can be expected with implementation of the missions.

3.2. The NAOJ Museum "Group"

As all observational facilities of NAOJ are open to the public and each facility makes its own collaborations with local communities. For example, Mitaka headquarters makes an agreement with Mitaka City and collaborates with Mitaka Picture Book House in the Astronomical Observatory Forest, and Mitaka Network University operated by Mitaka City. NAOJ Mizusawa collaborates with Oshu Space and Astronomy Museum operated by Oshu City. NAOJ Nobeyama collaborates with Minamimaki Village Rural Exchange Center "Vegetaball With" operated by Minamimaki Village.

The NAOJ Museum is the tentative name of the group of Mitaka Core Museum and other branches. Mitaka Core Museum will lead museum activities such as development of teaching materials and contents. The branches are located in Mizusawa, Nobeyama, Okayama, and Ishigakijima. Ishigakijima is related to Mizusawa branch and one of the VLBI stations. NAOJ Okayama joined our museum activities in 2015 mainly to create a common archival database of astronomical items and documents owned by NAOJ. In future, the Hawai'i and Chile branches may join.

Each branch keeps its own local collaborations and at the same time the NAOJ Museum Group has inter-regional cooperation with other research institutes, museums, schools and universities, and so on.

3.3. Implementation of the Four Missions

The first and second missions are related to the present and future astronomy. One of the most important resources is NAOJ researchers and technical staff members. They allow people to touch the latest science and technologies with direct communications. We propose the following four new activities to engage people in the latest astronomy.

A) Direct communication between NAOJ staff and the public

Astronomer talks will provide "on-site" talks by project groups such as the Solar Flare Telescope group or the TAMA300 (Gravitational Wave Laboratory Building) group about once a week on weekdays. We will also set up a restaurant of café at the museum and provide opportunities whereby NAOJ staff and visitors can freely talk or NAOJ staff can answer questions from visitors on weekdays, perhaps in daytime or the evening.

Guided tours of the latest astronomy facilities at NAOJ are also proposed. Guided tours related to the hottest and latest topics in astronomy will be provided by NAOJ staff members who actually work at the tour sites.

To reduce the workload of project staff members, the NAOJ museum staff members will set up the talks. In addition, in the initial stages of operation, the tours will be done only by the project groups who are willing to collaborate. (see Fig. 2)

B) New programs for 4D2U

In collaboration with the Center for Computational Astrophysics (CfCA) of NAOJ, we will create and add new contents of 4D2U in multiple languages. The contents created at the Mitaka Core Museum will be available at all branches. (see Fig. 3)

C) Simulation experiences at ALMA and Subaru/TMT sites

To connect Japan and observational facilities in overseas, we will install cameras at the ALMA site in Chile and Subaru/TMT site in Hawai'i. The information

Fig. 2 (top) A scientist explains about the Solar Flare Telescope and solar activities to the visitors. (bottom) Guided tours at TAMA300. Both photos were taken at the annual Mitaka Open House Day.

will be available in real time, and visitors of the NAOJ museum will be able to obtain up-to-date observational results, understand the on-site situation, and communicate with NAOJ staff in Chile and Hawai'i (see Fig. 4).

D) Semi-permanent exhibits/activities

On the annual Mitaka Open House Day each project group provides hands-on activities and displays that everyone can enjoy. To be a good role model of science communication, exhibits and activities currently provided at the open house day will be provided on a weekly or monthly basis. These semi-permanent exhibits and activities will provide opportunities for NAOJ staff members to communicate the latest topics in astronomy with the public. (see Fig. 5)

In the initial stages of operation, the exhibits and activities will be provided only by the project groups who are willing to collaborate.

The third mission is related to past astronomy. To conserve astronomical items,

Fig. 3 New movie "Dark Matter Halo Formation and Evolution" screened at the 4D2U Dome Theater. This movie was released in April 2015 at the grand reopening of the Dome Theater.

Fig. 4 A Subaru scientist at the Base Facility in Hawai'i has a live show for a science museum in Japan using a teleconference system.

we propose the following two new activities:

E) Preserving a 10-m antenna in working condition

At Nobeyama Branch, a 10-m antenna of Nobeyama Millimeter Array is preserved in working condition.

F) Creation and release of an archival database

We will create a database of astronomical items such as glass photographic plates, photographic prints, observational instruments, and facilities owned by NAOJ, and open it to the public. Guidelines will be set before creating the

Fig. 5 A scientist explains a diorama of the ALMA observing site on the Mitaka Open House Day.

database, and a useful system will be designed to share the database with other institutions. This project already started in 2015 among Mitaka, Mizusawa, Nobeyama, and Okayama staff members.

We set the fourth mission to target foreign researchers and tourists. In 2020 the Tokyo Olympics will be held and the demands for the Olympics match our fourth mission.

4. Challenges and Current Efforts

4.1. Briefing Session for NAOJ Staff

On June 26, 2015, we held a briefing session for the NAOJ Museum plan at Mitaka headquarters. Mizusawa, Nobeyama, Okayama, and Hawai'i staff members joined through network. A total of 61 staff members participated and about 62% of the participants agreed on a basic plan (strongly agree 26%, agree 36%, not sure 26%, disagree 8%, strongly disagree 2%, no response 8%). We also received various opinions.

- Researchers at universities study astronomical history. NAOJ should only provides historical items.
- 4D2U screening must be provided more frequently.
- NAOJ should develop more items to sell at the museum shop. Sell books written by NAOJ astronomers with authors' autographs.
- NAOJ should conserve old instruments, documents, and oral history. Please set guidelines.
- What is the difference between current activities and the NAOJ Museum plan?

The feedback from the briefing session was basically positive. However, we concluded that we had to reconsider our plan without a new building, new staff, or new organization of the NAOJ Museum due to the severe budgetary situation. On the other hand, we still have NAOJ staff members, new system of the 4D2U Dome Theater and original contents, and historical items. We also started collaborations

Fig. 6 The Observatory History Museum and the slope in front of the entrance. A person in a wheelchair can enter the first floor.

among Mitaka, Mizusawa, Nobeyama, and Okayama. Using the existing resources we will develop the facility opening activities.

Here we present our current efforts that can grow as our signature programs in near future.

4.2. New System of the 4D2U Dome Theater

4D2U public screening is one of the most popular programs. The renovation of the Dome Theater was completed in April 2015. The new system introduces projectors capable of showing brighter, higher resolution, higher contrast images. The stereoscopic image projection method has been changed from the spectral comb filtering method to an active shutter system (a time-separated method). In this method, signals for the left eye images and right eye images are emitted by one projector at 120 frames per second and received by synchronized 3D glasses. Using this system eliminates light loss, which was a drawback of the spectral comb filtering method, making it possible to offer brighter, clearer images. Additionally, with the former system, 3D projection was not available on the rear portion of the dome but now with the new system full-dome 3D is possible.

The seating capacity in the Dome Theater has been increased from 20 to 40, allowing many guests to watch at once. Starting from April 2015, the regular screenings will be increased from two days per month to three days per month. The registration capacity has been changed from 100 to 160 guests.

CfCA, the developer of the 4D2U contents, frequently updates Mitaka software with which users can seamlessly navigate across the Universe from Earth to the edge of the observable Universe. The Mitaka software and some movie contents are downloadable on the 4D2U website both in Japanese and in English and they must be a good teaching resources for our museum-like activities.

4.3. Visitors with Special Needs

We developed a braille guidebook for Mitaka Visitors' Area with a tactile map. This guidebook was developed working with sight-impaired people and a tactile map expert. We also created versions of the guidebook in multiple languages: Japanese, English, Chinese, Korean, and Spanish.

The Observatory History Museum is one of the most popular locations. We eliminated the uneven level of the road and made a slope in front of the Observatory History Museum (see Fig. 6). In addition we installed cameras on the first floor so that a visitor in a wheelchair can enter the first floor and watch the 65-cm refractor on the second floor with the cameras.

5. Summary

We developed the basic concept for the NAOJ Museum (tentative name). Using NAOJ's unique resources such as researchers and technical staff members, 4D2U contents, and the latest observational facilities, we made plans for new activities to implement the missions. Also we established close connections among Mitaka, Mizusawa, Nobeyama, and Okayama staff members to create a database of astronomical items. Based on our vision and mission in the basic concept, we are now rearranging the plan within a realistic budget.

References

[1] http://www.nao.ac.jp/en/
[2] http://4d2u.nao.ac.jp