

## DISSEMINATION OF THE “TOUCH THE UNIVERSE” TACTILE EXHIBITION

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### ABSTRACT

We created a whole set of the “Touch the Universe” tactile exhibition, including 3D models of celestial bodies and telescopes that both blind and visually impaired (BVI) people and sighted people can understand and enjoy. Through the JAPAN Science Museum Association network, science museums in Japan can easily borrow it and hold their own tactile exhibition without using a 3D printer. The exhibition set consists of existing 3D models, additional tactile images, scale models of the Solar System. Each model has a concise description panel with both printed and braille letters. This easy-to-use set can be a breakthrough for science museum staff members to hold their own tactile exhibition and communicate with BVI people.

### RESUMEN

Creamos un conjunto completo de exposiciones táctiles que se llama “Touch the Universe (Tocar el Universo)” con modelos 3D de objetos astronómicos y telescopios. Los modelos están diseñados y creados para que las personas ciegas y con discapacidad visual, y también personas con visión completa, puedan entender y disfrutar. A través de la red de la Asociación de Museos Científicos de JAPÓN, los museos científicos en Japón pueden alquilar el conjunto de modelos 3D y dar una exhibición sin usar una impresora 3D. El conjunto de exposiciones está compuesto de modelos 3D existentes, imágenes táctiles, y modelos a escala del Sistema Solar. Cada modelo tiene un panel de descripción conciso con letras impresas y en braille. Este conjunto es fácil de usar y puede ser un gran avance para que los comunicadores astronómicos de museos científicos puedan comunicar a las personas ciegas y con discapacidad visual usando los modelos táctiles.

*Key Words:* astronomy education — inclusive astronomy — tactile models

### 1. DEVELOPING 3D MODELS

The three-dimensional (3D) modeling and printing technology seemed to have been more familiar since the 2010s, which enabled astronomers and astronomy communicators to create a tactile model with a 3D printer. Tactile models are one of the practical tools for communicating astronomy with BVI people and have been developed by astronomy groups in various countries of the world using observational data. For example, in Spain and other countries, “A Touch of the Universe” international project<sup>6</sup> (e.g., Pérez-Montero 2019) developed a tactile sphere of the Moon, Mars, and other planets. The “Tactile

Universe” project<sup>7</sup> (Bonne et al. 2018) in the United Kingdom created 3D-printed tactile images of galaxies like the Whirlpool Galaxy (M51). NASA’s Chandra X-ray Center in the United States of America developed the 3D models of supernova remnants such as Cassiopeia A and other objects<sup>8</sup> (Arcand et al. 2019). Printable 3D files (mainly STL files) can be downloaded from the three websites. NASA also has a repository website<sup>9</sup> of a collection of a wide variety of printable 3D models of celestial bodies, spacecrafts, and telescopes.

In Japan, a NAOJ team created a 1/110th scale model of the Subaru Telescope, NAOJ’s large optical-infrared telescope on Maunakea, Hawai‘i (Usuda-Sato et al. 2019a). The two types of models were developed based on feedback from BVI people and a science teacher of special needs. One is a detailed model for sighted people and BVI people with excellent haptic observing skills. Another is a simplified model for BVI students learning how to touch samples and models in science classes at spe-

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<sup>6</sup><https://astrokit.uv.es/>

<sup>7</sup><https://tactileuniverse.org>

<sup>8</sup><https://chandra.cfa.harvard.edu/tactile/>

<sup>9</sup><https://nasa3d.arc.nasa.gov>

cial needs schools. On the official 3D-models website of NAOJ<sup>10</sup>, the complete STL file packages with manuals are available.

As listed above, many tactile resources are available online, and anyone can download STL files and reproduce tactile models with a 3D printer. However, using a 3D printer looks like a barrier for many astronomy communicators because enough skills and experience are required to use a 3D printer successfully. Breaking the barrier is necessary for dissemination of tactile models.

In 2018, from August 17 to December 22, we held the “Touch the Universe” special exhibition at Tactus Museo<sup>11</sup> (Fig. 1), a tactile museum of the Japan Braille Library (JBL), by combining the Subaru Telescope models with other existing tactile models and images (Usuda-Sato et al. 2019b). Once the exhibition set became visible, science museums looking for tactile resources contacted NAOJ and JBL. Akashi Municipal Planetarium in Hyogo prefecture held a similar special exhibition in cooperation with NAOJ and JBL from October 19 to December 8, 2019<sup>12</sup>. Sendai Astronomical Observatory in Miyagi prefecture plans to have one in spring 2022.

## 2. THE “TOUCH THE UNIVERSE” PROJECT

To break the barrier for science museum staff members to hold a tactile exhibition, the four institutions - NAOJ, JBL, Akashi Municipal Planetarium, and Sendai Astronomical Observatory - started collaborating as the “Touch the Universe” project team. We won a grant from the JAPAN Science Museum Association in 2020 (Primary Investigator: Y. Suzuki) for creating a whole set of the tactile exhibition similar to the ones held at Tactus Museo of JBL and Akashi Municipal Planetarium. Using the Association’s existing lending-borrowing system, science museums affiliated with the Association can have their own special exhibition with the tactile exhibition set. The project’s goal is to create the exhibition set and develop and expand a national network of inclusive astronomy in Japan.

The four institutions have different strengths. NAOJ is a research institute that can provide 3D model of telescopes and celestial bodies. For example, the exhibition set includes the 3D models of the asteroids Itokawa and Ryugu. Using a 3D printer, a NAOJ researcher created them at the same scale with the latest surface topography data (Fig. 2).



Fig. 1. Poster of the “Touch the Universe” special exhibition at Tactus Museo of the Japan Braille Library in 2018. The poster showed 3D models of the Subaru Telescope, the Hayabusa2 spacecraft, the Space Shuttle, and the Moon, which could be touched at the exhibition.

JBL is an expert on the visually impaired. They share helpful information and tips with the team members to develop a tactile exhibition and communicate with BVI people. They also have experience at Tactus Museo holding a tactile exhibition during the COVID-19 pandemic. Akashi Municipal Planetarium and Sendai Astronomical Observatory are science museums outside of Tokyo. They are experts in communicating astronomy and have communication experiences with people with disabilities. They also work with local governments, local braille translation groups, and local sign language interpreters.

Our project consists of three phases. Phase I is the creation or reproduction of the whole set of the tactile exhibition. We have completed Phase I in March 2021 and delivered it to the JAPAN Science Museum Association office. Phase II is developing an official project website for uploading audio guides and movie files with QR codes, two-dimensional ver-

<sup>10</sup>[http://prc.nao.ac.jp/3d/index\\_e.html](http://prc.nao.ac.jp/3d/index_e.html)

<sup>11</sup>[https://www.nittento.or.jp/about/fureru/exhibition\\_02.html](https://www.nittento.or.jp/about/fureru/exhibition_02.html)

<sup>12</sup>[https://www.am12.jp/event/tokubetsuten/tokubetsu\\_r1/tokuten.universal.html](https://www.am12.jp/event/tokubetsuten/tokubetsu_r1/tokuten.universal.html)

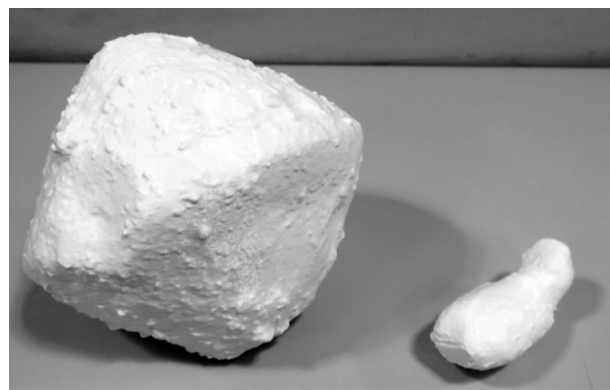


Fig. 2. The tactile models of the asteroids Ryugu (left) and Itokawa (right). They were created at the same scale with the latest surface topography data.

sions of the barcodes, so that museum staff members can use the files at their exhibition. We will also upload tips for the exhibition and communication with BVI people. The website should make museum staff members feel comfortable and confident holding their own tactile exhibition. Phase III is to have online inclusive astronomy workshops with museum staff members planning an exhibition with the tactile model set. The purpose of the workshops is not only to help them hold their exhibition but also to expand the national network of inclusive astronomy. We will share our experiences and tips for the exhibition and brainstorm for future work through the network.

### 3. PHASE I: TACTILE EXHIBITION SET

As many excellent resources are available inside and outside Japan, we did not have to invent a new one ourselves. Our tactile exhibition set was created in collaboration with other projects. For example, we downloaded STL files of the Moon and Mars spherical models from the “A Touch of the Universe” website and reproduced them with NAOJ’s 3D printer. The Universe Awareness (UNAWA) International Office Team created “Universe in a Box” educational kit<sup>13</sup> for children and teachers. The scale model of the Sun and eight planets is included in a box. Under the supervision of JBL, we put each small planet ball in a transparent bag and added a printed and braille label on it (Fig. 3).

In Japan, the Multi-Modal Textbook on Astronomy project team created various tactile images of celestial bodies in collaboration with the Braille Translation Network for Mathematics & Information Science, Tsukuba University (Mineshige et al. 2009).

<sup>13</sup><https://www.unawe.org/resources/universebox/>



Fig. 3. *Top:* The Mars (left) and the Moon (right) spherical tactile models developed by A Touch of the Universe and re-created by NAOJ using its downloadable STL files. *Bottom:* The tactile scale model of the planets created initially as Universe in a Box educational kit and modified by the authors. A transparent bag enables BVI people to touch a small planet ball with a braille label without losing it.

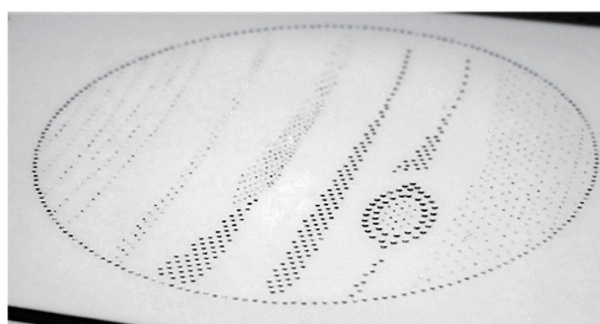


Fig. 4. The tactile image of Jupiter, developed by the Multi-Modal Texbook on Astronomy project team, which was published in astronomy textbooks braille versions targeting three different tiers of education: undergraduate students in science courses, secondary school students, and young children.

We included the Moon, Jupiter, and Saturn images developed with three different dot sizes in the exhibition set (Fig. 4).



Fig. 5. The handmade scale model of the Solar System representing the relative distances. From left to right, each knot represents the Sun, Mercury, Venus, Earth, Mars, Jupiter, and Saturn. (Uranus and Neptune knots are not in the photo.) This scale model can be re-produced easily by astronomy communicators and educators with low-cost materials.

Each model or image has a concise description panel with both printed and Braille letters. In each panel, we added tips about how to touch the models and images, which should be helpful for museum staff members to explain the model for BVI people. We use large gothic or sans-serif letters for all panels considering low-vision people, who are hard to see letters. In addition to the scale model of the planet balls shown in Fig. 3, we added another scale model of the Solar System representing the relative distances of the planets made by Akashi Municipal Planetarium (Fig. 5). The rope knots represent the locations of the Sun and planets. Each knot has a printed and Braille label.

#### 4. PHASE II AND III: OFFICIAL WEBSITE AND BUILDING NATIONAL NETWORK

The JAPAN Science Museum Association already started lending the “Touch the Universe” exhibition set to affiliated museums. As of January 2022, nine science museums from northern to southwestern Japan reserved the set. The first exhibition started on January 12, 2022, at Miyazaki Science Center<sup>14</sup> in Miyazaki prefecture until February 20, followed by Sendai Astronomical Observatory. The exhibition set is fully booked until March 20, 2023, and rotates from one museum to another at about five-day intervals.

At the same time, we are developing an official website of this project as Phase II. We will upload audio guides which can be accessed with QR codes soon so that museums staff members can use them easily at their exhibition. We are also creating videos such as greeting by the Director of JBL, who had developed math and science teaching resources for BVI

students and was one of the leaders of the Multi-Modal Textbook on Astronomy project. These resources will be uploaded to the official website.

As Phase III, we have just started reaching museum contact persons who reserved the exhibition set. Our tactile exhibition seems very popular among science museums in Japan, and it is a chance for us to expand our national network. The network is expected to make more astronomy communicators feel comfortable and confident in communicating with BVI people and increase awareness of inclusive astronomy.

#### 5. ACKNOWLEDGMENTS

The Earth spherical model was created by Nippon Charity Kyokai Foundation and donated by JBL. The Moon and Mars spherical model were created by A Touch of the Universe project and their additional information was provided by Amelia Ortiz-Gil (Observatorio Astronómico - Universidad de Valencia, Spain). The two models were re-created by Tomomi Kanzawa (NAOJ). The 3D models of the asteroids Ryugu and Itokawa were created and donated by Hiroshi Araki (NAOJ). The Subaru Telescope 3D models were designed by Hirotaka Nakayama (NAOJ). The scale model of the Solar System was originally created by Pedro Russo (Leiden University, Netherland) and the EU-Universe in a Box team, and donated by Lina Canas (international Astronomical Union Office for Astronomy Outreach). The tactile images were created by the Braille Translation Network for Mathematics & Information Science, Tsukuba University of Technology, and donated by Shin Mineshige (Kyoto University).

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<sup>14</sup><https://cosmoland.miyabunkyo.com/event-info/>