

Japan Public Observatory Society (JAPOS)
11th National Training Workshop

Text / Course Reader

"Toward the 100th Anniversary of Public Observatories"

*Exploring the Possibilities for Public Observatories and Science Communication
Techniques*

Based on Our Journey So Far and the Latest Research

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Japan Public Observatory Society (JAPOS)

Public Program Working Group

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Introduction

Since its establishment in 2013, JAPOS's "Public Program Working Group" has continued training activities for interpreters at public observatories and related public facilities for more than ten years.

Previous National Training Workshops

1. A summary of activities to date can be divided into three broad phases.

Phase 1 (FY2012–FY2017)

Activities related to public observatory operations were divided into A) operational management, B) exhibit display, and C) science communication techniques for public star-gazing sessions. Special focus was placed on C), and research into actual star-gazing sessions was carried out. This work identified three elements of science communication technique: ① astronomical knowledge, ② equipment operation skills, and ③ communication skills. These were further broken down into sub-elements to clarify the overall structure. By implementing these in actual sessions, it became possible to freely reconstruct and conduct a wide variety of star-gazing sessions, improving the qualitative experience for participants while also making the framework applicable to training new interpreters.

Phase 2 (FY2018–FY2019, interrupted by COVID)

Adopting Toshiaki Ito's theory of museum generations, this phase described the historical development of public observatories and their science communication techniques through the third generation, while looking ahead to the fourth. Beginning with the birth of the modern museum and reviewing the historical context including colonialism, the phase covered three communication approaches used as the basis of science communication in public observatories (analogous to exhibition in museums): ① science communication, ② facilitation, and ③ interpretation. It also addressed the need to go beyond A) quantitative, positivist approaches to include B) qualitative approaches such as narrative and ethnography.

Phase 3 (FY2023–)

Began with the 9th Training Workshop. Japan's first public observatory will celebrate its 100th anniversary in 2026. With that as a goal, the 9th workshop launched as the first installment of a new series, progressively exploring and developing the following content over three years:

- What is required of "public observatories as museums"
- Establishing the "Japanese-style public observatory" and its future development
- The role of public observatories (astronomical facilities) and astronomical science communication in the coming digital society

2. Three-Year Plan for Phase 3

9th Training Workshop — Year 1 of Phase 3: Mapping stage to gain an overall overview

10th Training Workshop — Year 2 of Phase 3: Accumulating more data, improving quality, systematizing

11th Training Workshop — Year 3 of Phase 3: Completion of comprehensive text, English version, online dissemination (planned for 2026)

9th National Training Workshop (2024)

As the first year of the three-year plan, we took the following steps in a mapping stage to gain an overall overview:

- As one of the new roles of "public observatories as museums," to deepen "astronomical science communication techniques that contribute to people's well-being through astronomical experiences" in particular.
- As clarified by a survey and comparison with U.S. observatories, a characteristic of the "Japanese-style public observatory" has been the provision of lifelong learning opportunities contributing to the enriched lives of users from the very beginning. This phase also re-examines the existence of Japan's ancient astronomical culture.
- Exploring "the role of astronomical facilities and science communication in the coming digital society," including electronic observing, live streaming, VR technology, and the emergence of generative AI.

Through these efforts, the 9th Training Workshop aimed to practically understand and experience — through lectures and workshops — why "looking up at the starry sky and living beneath it" connects people to well-being.

As a result, the following well-being elements were newly suggested as underlying the development of public observatories in Japan:

- Public observatories provide users with opportunities for astronomical experiences that enrich their lives, as well as intellectual learning, as lifelong learning facilities.
- Japan's astronomical culture historically contains, at its core, a rich cosmological worldview in harmony with nature.
- There are many elements within astronomical experiences that connect to solving challenges of modern society.

10th National Training Workshop (2025)

As the second year of the three-year plan, the following implementation goals were established:

1) Basic understanding

- A public observatory's general public programs are themselves a form of "observatory bathing" (天文台浴) — a type of "museum bathing"
- To enhance the benefits of observatory bathing from a well-being perspective, examine it from multiple angles and consider specific implementation methods

2) Star-gazing sessions

- Directly experience how observatory bathing is implemented and functions within stargazing sessions

3) The diverse character and public programs of public observatories

- Create specific proposals for the future, such as the Minami Aso Luna Observatory example, and explore future prospects

Outlook for the Following Year

Building on these results, the following prospects emerged:

1) Survey of the current state of domestic and international public astronomical facilities

- Broaden knowledge on diverse forms of astronomical learning, cosmological worldviews, and self-understanding formation in various countries and cultures
- Clarify similarities and differences to deepen understanding

2) Reflect on astronomical activities across various civilizations from the origins of humanity to the present

- Understand how humanity has conceptualized itself and the cosmos
- Provide new insights into the structural understanding of how these have influenced society's dominant narratives and individual identity formation

3) Provide opportunities and develop activities

- Provide diverse opportunities for many people to enjoy the pleasure of knowing and learning about stars and space
- Expand activities that contribute to people's well-being through such astronomical experiences

Subsequent Concrete Development Activities

1) → "JAPOS International Collaboration Promotion Committee" established in 2025

- Collaboration with KASI (Korea Astronomy and Space Science Institute) in South Korea
- Planning a JAPOS-exclusive session at IPS 2026 Fukuoka Congress
- Establishing contact with the Hong Kong Space Museum

2) → Investigation of prior research on "Awe" and its introduction and social implementation in Japan

- Lectures and workshops at the 11th Kyushu & National Training Workshop

3) → Providing opportunities and developing activities

- Developing live-streaming programs connecting public observatories and planetariums
- Development and deployment of web app "Connected Through Space" (implementing features such as "Starry Sky Life Log")

11th National Training Workshop (2026)

As the final year of the three-year plan, and to mark the 100th anniversary of public observatories in Japan while drawing a vision for the next 100 years, attention is focused on the description in Japan's Ministry of Education, Culture, Sports, Science and Technology Course of Study: "deepening a sense of awe (畏敬の念) toward that which transcends human power." Additionally, we reference the findings on "Awe (畏敬)" from empirical research led by Dr. Dacher Keltner and others, and work toward its implementation in public observatories.

1)

Design and practice training programs that offer multifaceted learning opportunities for "observatory bathing" implementation methods and possibilities, based on the latest findings and results of empirical experiments.

2)

Have participants experience a simulated nocturnal star-gazing session, and conduct multifaceted evaluation and practical examination from the perspective of Awe:

- Does Awe arise in participants?
- In what situations does it arise?
- With what internal factors in participants is it associated?
- What interpreter behaviors support the experience of Awe?

3)

Toward the social challenge of restoring modern people — whose well-being has been compromised — to a rightful state of health and happiness, explore various practical methods unique to public observatories for solving today's social challenges through "living happily beneath the starry sky." This is pursued through collecting, accumulating, and analyzing data from the practice and improvement of observatory bathing programs, as well as evidence of physical and mental effects, using the perspective of "Awe" in human history as a guiding lens.

Chapter 1: Social Role of Astronomical Observatories (Public Astronomical Facilities)

This chapter provides an overview of the current situation of public observatories, said to number approximately 400 across Japan. First, by examining the needs of visitors, we explore why public observatories are considered necessary. Next, we trace the history of public observatories in Japan, examine how they are evaluated by users, the facilities themselves, external parties, and their governing bodies, then consider the shifts in positioning and challenges brought about by major societal changes, and finally look at future tasks.

1. User Needs and Evaluation Criteria at Public Observatories

People's interest in astronomy is inherently wide-ranging. From the everyday experience of dawn and dusk skies, the rising and setting of the sun and moon, and the seasonal movement of bright stars and constellations, a desire to gain knowledge and understanding of meteorological and astronomical phenomena exists broadly across East and West, regardless of age. Public observatories serve this universal curiosity. Japan — sometimes called "the kingdom of public observatories" — has approximately 400 such facilities, a number without parallel anywhere in the world. What needs do visitors bring to these observatories, and by what criteria do they evaluate their astronomical experiences? Let us examine this in detail.

1) A Gaze Toward the Universe: How Has Humanity Understood Itself and the Cosmos?

"Where do we come from? What are we? Where are we going?" and "What is the nature of the world we inhabit?" — these questions have been common to humanity across every era.

Human understanding of the cosmos and of the self has developed in diverse forms across the world's cultures. While the ancient Egyptians associated the stars with their gods, ancient Greek philosophers sought a rational order in the cosmos. In ancient China, the harmony between Heaven and Earth was regarded as the model for cosmic order and human society, and the movements of the cosmos and human destiny were interpreted through the theories of Yin-Yang and the Five Elements. Mesoamerican civilizations such as the Maya and Aztec developed precise astronomy and incorporated their cosmological worldviews into religious ritual and the creation of calendars.

These diverse cultural cosmologies have profoundly influenced the human self-understanding and sense of place in the world. However, since the modern era — particularly with advances in scientific inquiry — humanity's view of the cosmos has changed dramatically. Darwin's theory of evolution, Einstein's theory of relativity, and quantum mechanics fundamentally transformed our understanding of the nature of the cosmos and the human position within it, and these scientific discoveries not only changed humanity's view of the universe but also profoundly affected the self-understanding of "what it means to be human."

In the modern era, astronomical science has advanced our understanding of the cosmos exponentially. The expansion of the universe¹, and the existence of dark matter and dark energy², have greatly extended our understanding of the birth, evolution, and structure of the cosmos. These discoveries have generated new debates not only in astrophysics but also in philosophy and religion regarding the relationship between the self and the cosmos.

Yet cultural biases are embedded in cosmological worldviews. In particular, our awareness of how different cultures and societies interpret the cosmos — and how those interpretations influence individual identity and collective values — remains insufficient.

For example, in traditional African cosmological worldviews, the cosmos is the source of life and is deeply connected to everyday human life through bonds with ancestors and spirits. Among the indigenous peoples of Oceania, celestial bodies play an important role not only as navigational guides but also as part of the stories and histories passed down across generations.

These cultural cosmological worldviews — including Japan's astronomical culture — hold low recognition in the contemporary Western-centric world, yet most of them place importance on harmony and coexistence with nature, offering a perspective different from empirical scientific approaches and opening diverse windows for understanding the relationship between the cosmos and the self. Re-evaluating the relationship between the cosmos and humanity from these perspectives will, going forward, offer important insights to those of us confronting the crises of modern society and the global environment.

2) Astronomy and Scientific Learning

In Japan, since the first modern astronomical observatories and observation facilities were established in the Meiji era, researching and providing higher education in astronomy as a discipline has been the primary role of observatories as institutions³. Building on this, astronomy has been taught to the public as part of the national education system from elementary through compulsory schooling — a pattern seen in many modern nation-states.

Nevertheless, according to the "Public Awareness of Astronomy Survey Project (2024)"⁴, many members of the public believe they have not studied astronomy at any stage of education, and today a large proportion obtain information about astronomy and space from websites.

Meanwhile, approximately 30% of the general public have some interest in astronomy, though they are more interested in climate change and Japanese culture, and equally interested in arts and space exploration. Mythology, astrology, philosophy, religion, and physics attract relatively less interest. About one-third of people have visited a science museum or planetarium, while only about one in ten has visited an astronomical observatory. That said, the proportion of respondents who would like to visit such facilities is generally about half of the total, similar to the popularity of frequently visited facilities such as libraries, cinemas, aquariums, and zoos. Many of these people have experienced viewing the moon, stars, solar eclipses, and lunar eclipses, and while fewer have seen comets or auroras or observed stars through a telescope, the desire to have such experiences is very high³.

3) Escape from Daily Life and Refreshment

Modern society is filled with stress — bound by an overflow of information, the pursuit of efficiency, and financial values. The need to escape from such daily pressures, experience and enjoy the extraordinary, and find healing and refreshment is growing larger.

The starry sky and outer space represent one such destination. There are parallels with the boom in scenic landscapes and outdoor activities; viewing a sky full of stars, meteor showers, solar eclipses, lunar eclipses, and auroras are all popular pursuits.

These experiences and journeys involving the starry sky and space are known as "astro-tourism" or "sora (sky) tourism." According to the "Sky Tourism Marketing Survey 2018"⁵ conducted domestically, approximately 8.5 million people participate in sky tourism — by no means a small number — and the estimated potential participant pool is 40 million, meaning approximately one in three Japanese citizens could be expected to participate.

Breaking down the actual participants: 53% observed lunar or solar eclipses, 32.4% observed meteor showers, 20.6% had astronomical experiences at public observatories, and 9%

participated in starry sky-themed events and experiential programs. It is clear that many people enjoy such experiences in all their forms.

2. Public Observatories in Japan

1) The 100th Anniversary of Public Observatories

In 2026, Japan's public observatory tradition — which began with the Kurashiki Observatory — reaches its 100th anniversary. To understand the distinctive character of Japan's public observatories, let us look back at their history.

"The Beginning of Telescopic Astronomical Observation in Japan"

Only a few years after Galileo first turned a telescope toward the heavens in 1609, Japan received its first telescope in 1613, presented to Tokugawa Ieyasu by the Dutch East India Company. In the late 18th century, the first domestically produced telescope by Iwahashi Zenbei was used for astronomical observation at the Asakusa Shitennodai (the forerunner of the Tokyo Astronomical Observatory). Records also remain of telescopic astronomical observations being made available to the public during the Edo period. One early example is Tachibana Nankei's gatherings at his private residence — though these were, in a sense, limited to a circle of associates⁶.

A record of observation sessions "opened broadly to the public" survives in a travel account. Published in Paris in 1870 following serialization in a magazine, and translated into Japanese in 1969 as Humbert's Japan and the Japanese (「アンペール 幕末日本図絵」), the account describes the area around Ueno in a chapter titled "The Markets of Edo." In the area Humbert compared to the Champs-Élysées — Yamashita, near Ueno Park — various small shops lined the streets, and a townspeople "astronomer" is described calling out to passers-by, offering to "show you the sun, moon, and stars through a long telescope" for a fee, with a crowd gathering around. The star-gazing event Humbert witnessed took place in 1863 (Bunkyo 3), meaning that public star-gazing events were being held at least 160-plus years ago⁷.

"Individual Observation and Public Star-gazing Events"

What is the difference between observation conducted by an observatory for research purposes or by an individual within their private sphere, and a star-gazing event open to the public — both using the same astronomical telescope? The Japan Public Observatory Society (JAPOS) defines the significance of public observatories in its regulations, drafted by Takehiko Kuroda: "Public observatories engaged in lifelong learning support to cultivate a view of nature through real celestial objects and to contribute to the formation of a rich character: Article 2"⁸. The JAPOS White Paper^{9,10} also defines the survey targets of "public observatories" as: facilities that have been established for the purpose of public access and possess fixed or mobile telescope equipment (including mobile observatory vehicles and cart-mounted telescopes).

"The Beginning of Star-gazing Events in Japan"

Following the Meiji Restoration, an observatory for student training was built at Tokyo Imperial University, and in 1888 the Imperial University Affiliated Tokyo Astronomical Observatory was established in Azabu for research purposes. Among the earliest examples of organized public star-gazing events is the one held at the Tokyo Astronomical Observatory in 1913, following a public lecture by the Astronomical Society. In January 1920, through the efforts of Professor Kazuyoshi Yamamoto of Kyoto Imperial University — who devoted himself to the popularization

of astronomy and the cultivation of amateurs — the Astronomical Enthusiast Society (天文同好会, now the East Asian Astronomical Society) was founded as the first national amateur organization. Behind this lay the heartfelt desire of amateur astronomers to observe stars more freely and conduct their own observations.

At that time, however, owning a telescope personally was prohibitively expensive. According to the 1925 product catalog of Nippon Kōgaku (now Nikon), which manufactured Japan's first domestically produced astronomical telescope in 1920, a 3-inch (7.6 cm) refractor telescope with a metal tripod cost 600 yen — equivalent to approximately 3.2 million yen in 2024 terms (based on an elementary school teacher's starting salary). Nojiri Hōei, known as the "literary man of the stars," purchased a 4-inch telescope in 1928 and frequently held star-gazing events in his home garden for people's enjoyment, but such cases were rare.

"The Beginning of Japan's Public Observatories"

Haruji Hara, managing director of Kurashiki Spinning, who supported the vision of Yamamoto — who sought to provide advanced observation capabilities suitable for serious amateur use with full-scale observation equipment — invested his own funds to establish the Kurashiki Observatory in 1926, Japan's first public observatory. It began activities as a private observatory with Yamamoto as director, arousing great public interest in the stars. Honda Minoru, a renowned comet discoverer who later became director of the Kurashiki Observatory, joined as a staff member in 1941.

A public observatory is an observatory open to citizens that possesses fixed telescopes and is engaged in lifelong learning support to cultivate a view of nature through real celestial objects and to contribute to the formation of a rich character. Following the establishment of the Kurashiki Observatory, telescopes with apertures of 20–60 cm were introduced to science museums and public star-gazing events began to be held. In the prewar era, a small number of facilities — including the National Museum of Nature and Science in Ueno, the Ikoma Astronomical Museum, the Osaka City Electric Science Museum, and the Yamaguchi Prefectural Education Museum (now the Yamaguchi Prefectural Museum) — served the role of public observatories.

"Growth and Development of Public Observatories in the Postwar Era"

After the end of World War II, expositions were held in various regions as highlights of regional revitalization, and observatories became prized pavilion attractions. Among the pioneers of municipally operated public observatories were the Asahikawa City Observatory (1950), the Toyama City Observatory (1956), and the Sapporo City Observatory (1958). The Higashiyama Observatory (1951) was established as a facility to give citizens a sense of dreams and was later taken over by the Nagoya City Science Museum.

Through the 1960s and 70s, social education facilities incorporating observatories were built across the country. By the late 1970s, the total number of active public observatories was approximately 50 — a figure that looked modest compared to the more than 200 planetarium facilities already in operation, indicating that public observatories were still in the process of spreading.

The 1980s brought a rapid increase. This period coincided with the high economic growth era, and the "Hometown Creation Projects" launched in 1988 provided strong tailwinds. Boosted by excitement surrounding the return of Halley's Comet in 1986, close to 100 facilities were established during the decade.

In the 1990s, development moved toward ever-larger-aperture telescopes. By the latter half of the decade, newly installed telescopes exceeding 1 meter in aperture were no longer unusual.

Entering the 21st century, as the number of public observatories and the aperture of their telescopes grew, an increasing number of facilities came to possess advanced observing equipment — including cooled CCD cameras for imaging, visible-light spectrographs, and near-infrared cameras — fully capable of supporting research purposes.

"The Crisis of Closures and Decommissioning"

In the 2010s, while some facilities continued vibrant activities following renovations and upgrades, the number of public observatories facing existential crises began to increase. The suspension or closure of serious astronomical facilities with full-scale telescopes — such as the Kawabe Astronomical Park (suspended in 2014) and the Toyama City Observatory (closed in 2021), which had long contributed actively to astronomy outreach in their regions — became a succession of difficult events, and the value and *raison d'être* of public observatories can be said to have been once again questioned within the industry¹⁰.

"Nationwide Organizing Movements and the Founding of JAPOS"

Since the 1990s, efforts to understand the actual state of public observatories continued. In contrast to the spectacular large-aperture telescope construction boom of the 1990s, issues such as insufficient staffing, poor working conditions, inadequate budgets, and lack of information came to light. In 1991, in response to the requests of many public observatories, "The Association of Astronomical Observation Facilities Nationwide" was established to share information and foster exchange (with annual national conventions also held).

Entering the 21st century, as national and local government finances deteriorated significantly, reductions in services and closures of astronomical social education facilities — including public observatories — became conspicuous. In 2003, the Astronomical Society of Japan issued a request titled "Strengthening Social Education Facilities Related to Astronomy," recognizing the importance of lifelong learning even within the academic society. Public observatories — then said to number more than 400 — deepened their sense of crisis, and a momentum grew to organize public observatories and their staff in order to promote the development of facilities and improvement of staff quality and exchange, and to enrich lifelong learning that helps cultivate a rich humanity through the celestial objects. Against this background, the Japan Public Observatory Society (JAPOS) was founded in July 2005⁹.

2) The History of Amateur Astronomy in Japan

The foundation of Japan's astronomical culture lies in the fact that ordinary citizens have historically led lives closely connected to astronomy. Let us overview the history of amateur astronomy in Japan¹¹.

Astronomy is a uniquely unusual academic field in which the activities of non-professional researchers — so-called amateurs — are remarkable and contribute meaningfully at the scholarly level³. Japanese amateur astronomers in particular are active in many areas and have been honored with the Astronomical Society of Japan's "Celestial Discovery Award," "Celestial Merit Award," and "Astronomy Education and Outreach Award," and the East Asian Astronomical Society's "Celestial Discovery Award," "Yamamoto Issei Memorial Academic Encouragement Award," and "Magellan Award," among others.

"Before the Meiji Era"

When amateur astronomers in the modern sense first emerged in Japan is unclear. By the late Edo period, there were already three public observatories: the Tsuchimikado family (descendants of Abe no Seimei) observatory in Kyoto's Umekoji (following the Chinese tradition), and the Asada school's Edo Observatory and Osaka Inuma-ya Observatory (both following Western learning). Many amateur astronomers likely appeared at that time as well,

though details are unclear. With the Meiji Restoration, the shogunate's Astronomical Bureau was dissolved and the instruments of the Asakusa Observatory were transferred to the new government's Kaisei School.

"Amateur Astronomers Who Became Active in the Meiji Era"

Several subsequent astronomical observatory reconstructions linked to the Tokyo Observatory established in 1888 were promoted by astronomical events visible from Japan: the Venus transit of 1874 and the total solar eclipse of 1887. For the former, no organized Japanese observations were possible, but Japanese individuals cooperated as interpreters, observation assistants, and photographers for foreign observing expeditions. For the latter — a total solar eclipse along a line from Niigata to Ibaraki on August 19 — three corona photographs by Sugiyama Masaji (of the group led by Chief Meteorological Agency Director Arai Ikumatsu) were published in the *Journal of the Royal Astronomical Society*, and a splendid corona sketch by Izawa Shuji (Director of the Ministry of Education's Editorial Bureau), who was observing separately, was published in the scientific journal *Nature*. These were achievements by amateurs rather than astronomy professionals.

In 1900, preceding the founding of the Astronomical Society of Japan, amateur astronomer Inoue Shiro (Yokohama) independently discovered a nova in Perseus. He also independently discovered a comet in Cygnus in 1903. These two discoveries are the first examples of Japanese amateur activity (the result of ongoing observation rather than sporadic events), and it is interesting to note that at the time of the comet discovery several fellow enthusiasts gathered to look through the telescope, suggesting that groups of enthusiasts may already have existed. The founding of the Astronomical Society of Japan was delayed by the Russo-Japanese War and other factors until April 1908; it is significant that among the 18 participants at its inaugural meeting was amateur Inoue Shiro.

"Kazuyoshi Yamamoto — Father of Amateur Astronomy — and the National Spread of Activities"

In 1920, Kazuyoshi Yamamoto (Professor at Kyoto Imperial University), who devoted himself to the popularization of astronomy and the cultivation of amateurs, founded the Astronomical Enthusiast Society (later the East Asian Astronomical Society) — Japan's first astronomy enthusiast club, with virtually all members being amateurs. Its journal, *Tenkai* ("The Celestial World"), published amateur observation data in every issue. Meanwhile, the Astronomical Society of Japan's journal *Tenmon Geppō* ("Astronomical Monthly Report") also established an observation column from 1924, and included guidance on observation methods by Kanda Shigeru (Tokyo Observatory), who from early on placed great importance on amateur astronomer cooperation in observation.

Yamamoto not only established the headquarters of the Astronomical Enthusiast Society in Kyoto but also created branches across the country, organized around prominent local amateurs. Some of these continue to the present day, while others became independent as local astronomy clubs. By the early Showa era their number exceeded 30, extending to Manchuria, Korea, Taiwan, Shanghai, and North America. Particularly noteworthy is the amateur activity in the Suwa region: inspired by an astronomy lecture by Yamamoto and Kanda in 1921, the Suwa Branch was established. Nagano Prefecture is known as a region enthusiastic about education, and astronomy was no exception — producing many amateur astronomers. The driving force was Sanzawa Katsuei (teacher at Suwa Middle School), first branch president, known as one of the first in Japan to observe sunspots. His sunspot observations from October 1921 through 1934 were noted at the end of 2023 as "improving the state of data for a period when the long-term organization of observation data worldwide was

insufficient, contributing to improvements in the fundamental data for understanding long-term solar activity variability"¹².

Beyond these, the contributions of amateur astronomers to astronomy span many fields. To illustrate, the table of contents of History of Amateur Astronomy in Japan and its sequel includes the following diverse fields^{11,13}: sunspots (the Sun), planets, solar and lunar eclipses and transits of Mercury and Venus, occultations, meteors, meteoritic dust, meteorites, comets, minor planets, zodiacal light, variable stars and novae, photoelectric observation, artificial satellites (artificial celestial bodies), astronomical calculation (computers), astrophotography, telescopes (primarily mirror grinding), astronomy enthusiast clubs (school astronomy clubs), publications, history of astronomy, astronomical folklore.

3. The Current State and Evaluation of Public Observatories in Japan

The following provides a general overview of the current situation¹⁰.

1) Current State of Public Observatories

Public observatories include some established as standalone observatory facilities, and others installed within multi-purpose facilities. Specifically, these include: astronomical observatories, accommodation facilities, museums and science museums, social education facilities, school education-related facilities, outdoor activity facilities, child welfare facilities, and others. Their organizational and management structures also vary: national, prefectural, municipal, locally incorporated entities and groups, private businesses, and others.

The varying scale, establishment purposes, management structures, and operational forms result in a wide range of circumstances and challenges for each facility.

2) Needs and Evaluation of Public Observatories

Regarding needs and evaluation, the 2018 nationwide survey by JAPOS, "Public Observatory White Paper 2018"¹⁰, reveals the following:

User Evaluation of Public Observatories (White Paper 3-7)

Particularly for nocturnal star-gazing events, participant numbers are increasing at some facilities. Over the most recent five years, families with children showed the greatest growth at 36%, followed by facilities reporting no change in participant composition at 33%.

Self-Evaluation by Public Observatories (White Paper 3-12)

Issues noted include "budget cuts and staff reductions," "difficulty in long-term planning due to fixed contract periods," and "unstable employee status," reflecting the difficult operational environment of public observatories.

- Staff structure: 82% of overall facility supervisors are full-time employees; the ratio of dedicated to concurrent staff is 7:3
- Number of staff: "2–5 people" is the most common at 31%, followed by "0–1 person" at 16%
- Employment type of observatory staff: "civil servant" is highest at 25%, followed by "commissioned staff" at 23% and "regular private-sector employees" at 15%

External Evaluation of Public Observatories (White Paper 3-12)

- "Museums and science museums" and "social education facilities" and "school education facilities" emphasize "lifelong education and school education"

- "Observatories," "child welfare facilities," and "accommodation facilities" emphasize "number of visitors"
- For "observatory" facilities, "user evaluation" and "information dissemination and public access" are important criteria

Governing Body Evaluation of Public Observatories (White Paper 3-12)

Whether facilities prioritize "lifelong education and school education" or "number of visitors" varies by facility and is closely related to the goals of each governing body.

4. Public Observatories as Museums: New and Diverse Social Roles

1) How the Museum Act Revision Changes the Role of Museums

In April 2022 (Reiwa 4), "The Act for Partial Amendment of the Museum Act" was passed, realizing the first standalone revision of the Museum Act in approximately 70 years. From April 1, 2023 (Reiwa 5), a transition to the new framework has been underway. Article 1 defines the purpose of the Museum Act as being based not only on the "Social Education Act" as before, but also on the spirit of the "Basic Act on the Promotion of Culture and the Arts."

In this regard, the Agency for Cultural Affairs' notification dated April 15, 2022, "On the Promulgation of the Act for Partial Amendment of the Museum Act," explains in its preamble and notes as follows:

"As the environment surrounding museums changes significantly, the roles and functions required of museums are becoming more diverse and sophisticated. As expressed, for example, in the Basic Act on the Promotion of Culture and the Arts (amended in 2017) and in the concept of 'Museums Connecting Cultures' presented at the 2019 International Council of Museums (ICOM) Kyoto General Assembly, museums have come to be required to serve as cultural facilities in collaboration with related organizations in the areas of urban development, international exchange, tourism, industry, welfare, and education."

"The intent of defining the purpose of the act in Article 1 as being based on the spirit of the Basic Act on the Promotion of Culture and the Arts is to clarify that museums are facilities that contribute to the enrichment of the cultural lives of the people and the realization of a vibrant society through their activities, and that museums are required to function as facilities that simultaneously serve the dual roles of social education facilities and cultural facilities."

"Among the provisions of Article 3, Paragraph 3 — 'shall endeavor to contribute to the revitalization of the region by promoting education, academic research, and culture in the region, cultural tourism, and other activities' — ① 'other activities' includes diverse activities such as urban development, efforts in the welfare sector, promotion of local industries, and international exchange; and ② 'revitalization of the region' includes not only revitalization of local urban development and industries, but also the resolution of various regional challenges including social inclusion issues such as community decline and isolation, population decline, depopulation, aging, and environmental problems."

In this way, new roles were added to museums, including "efforts in the welfare sector, social inclusion issues such as community decline and isolation, population decline, depopulation, aging, and the resolution of environmental problems."

2) Museums and Well-being

In response, the Japanese Museum Association and the ICOM Japan Committee held the "International Museum Day Symposium" at the National Museum of Nature and Science on May 21, 2023. The theme was "Museums and Sustainability, Well-being."

Among the presentations, the report by Professor Izumi Ogata of Kyushu Sangyo University attracted particular attention. According to *Bijutsu Techō (Art Handbook)*: "From a well-being perspective in particular, we should pay attention to the 'museum bathing' introduced by Ogata. This refers to the practice of quantifying the healing and refreshing effects of museums through blood pressure and psychological measurements, and utilizing these for health promotion and disease prevention. The scientific evidence that museum visits contribute to stress reduction has been established, and Ogata suggested the possibility that museums could be positioned as a 'new well-being resource.'"¹⁴

5. Characteristics of the Japanese-style Public Observatory

In 2022, during the height of the COVID pandemic, Minami Aso Luna Observatory conducted a survey of outreach activities at astronomical observatories in the United States¹⁵. This survey suggested that the activities of public observatories in Japan strongly possess museum-like characteristics that contribute to the well-being of local communities, such as providing lifelong learning opportunities.

1) Survey Objectives, Targets, and Methods

The survey targeted prominent observatories or science-related museums in the United States, with three primary objectives:

- Investigate the thinking, current state, and future plans regarding online services.
- Survey thinking, implementation status, and future plans regarding public outreach activities.
- Survey thinking regarding activities as museum-type facilities.

In addition to these three axes, inquiries were also made, to the extent possible, into the history and background of each facility, the advantages and disadvantages of their respective management structures, and the difficulties caused by unprecedented external factors such as natural disasters and pandemics, as well as political factors, and how these were resolved. Another objective was to obtain reference cases and data for comparative study with Japan's public observatories.

The target observatories were Mount Wilson Observatory, Chabot Space and Science Center, Lick Observatory, Griffith Observatory, and Palomar Observatory. Their selection was based on the following criteria:

- Having a public access or outreach program
- Located on or near the U.S. West Coast, taking scheduling into account
- Having a relatively long history

From among facilities meeting these criteria, a list was created that represented diverse management structures (public and private) and operational purposes (observatories and

science museums), and survey requests were sent via various means to facilities accessible even during the pandemic.

Prior surveys were conducted via questionnaire wherever possible; Deputy Director Takano of Minami Aso Luna Observatory also traveled to the United States to conduct on-site inspections and detailed interviews with staff. Detailed individual survey results appear in the report of the National Association of Science Museums¹, and this survey revealed that the origins and problem-solving approaches of American observatories are fundamentally different from those of Japanese public observatories.

2) Differences in How Outreach Activities Are Understood

While the sample size of surveyed facilities is limited, it is evident that in the United States, the targets of outreach activities and astronomy education are clearly distinguished. Outreach activities are efforts by academic research and educational institutions to return the fruits of their activities and research broadly to society; but they also appear to be weighted heavily as activities aimed at acquiring and promoting stakeholder understanding and support.

Educational activities in the U.S. also clearly define the attributes of the target group and in many cases provide programs designed accordingly. This makes it possible to evaluate each facility multidimensionally — by the effectiveness and enrollment of educational programs, the number of participating organizations, and the amount of external funding secured as an indirect measure of outreach.

In contrast, Japanese public observatories have little outreach in this sense; their educational activities presuppose a broadly defined group of general local residents, and they place high value on contributing to society through lifelong learning–type educational activities. As a result, evaluation standards appear to be limited to the single metric of "number of visitors."

This difference is understood as stemming from the different origins, histories, and national character, as well as political and administrative factors, of the astronomical facilities on each side.

3) Differences in Fundraising and Support Culture

Significant differences were also observed in fundraising and support culture. In the United States, a culture of donation is well-established, and it is standard practice for each facility to move strategically in securing donations and external funding for operating costs. Ties with support organizations (such as local amateur astronomy groups) are also strong, and volunteers are recruited from these support organizations as one solution to maintaining stable public operations. Observatories in the California mountains in particular are frequently exposed to wildfires and sometimes suffer severe direct and indirect damage; even in such cases, there are examples of facilities seeing through the situation with support from their organizations and donations. This also reflects the accumulated know-how in securing external funding and the good relationships cultivated with support organizations in normal times.

4) Differences in Online Services and Electronic Observing

Regarding the development of online services and electronic star-gazing events, Japanese public observatories have gradually introduced such services and technologies, and in recent years they have become somewhat commonplace. In contrast, at the U.S. facilities visited, only Palomar Observatory offered a virtual tour of its interior (simply browsing prepared 3D data) on its website, along with a few irregular remote lectures via Zoom and similar platforms — nothing particularly remarkable was observed.

5) Differences in Establishment Purposes and Approach to Collaboration

Astronomical observatories in the United States were largely built with clear individual scientific objectives for academic research purposes, and many followed a development path of beginning public access activities after making major contributions to astronomy, with the balance gradually shifting in that direction.

In Japan, by contrast, the majority of public observatories are facilities that began with public access as their primary purpose. This historical background represents a major difference that this survey reconfirmed.

6) Differences in Facility Collaboration

This influence manifests in various aspects. For example, in Japan, public observatories form an association (JAPOS) and collaborate horizontally to share various challenges. In other words, since the challenges faced by each of Japan's public observatories share many common elements, horizontal collaboration that leverages economies of scale in obtaining hints for service development and effective operational maintenance strategies seems highly effective.

In the United States, by contrast, each facility maintains strong individuality and faces different challenges; the idea of forming an industry association for cooperation seems difficult to generate, and no prominent collaborative activities among facilities have been observed.

The Distinctive Character of the Japanese-style Public Observatory — Future Development Potential

As seen above, Japan's public observatories do not take the form of academic research and educational institutions conducting outreach; rather, as social education and lifelong learning facilities, they presuppose a broad group of general local residents as their users, and place high value on contributing to society through lifelong learning activities. Moreover, the majority of independent observatories are facilities that began with public access as their purpose. And across the COVID period, the widespread adoption of electronic observing and live broadcasting is also a major characteristic of Japanese public observatories.

In this way, based on the following factors, Japan has developed to the point where it is fair to call it a "kingdom of public observatories":

- The number of public observatories established for the purpose of public access is incomparably greater than anywhere else in the world
- They are oriented toward lifelong learning for citizens
- A nationwide organization has been formed, creating an industry with mutual cooperation

Behind this lies Japan's unique astronomical culture and history, national character, and political and administrative factors, strongly suggesting the establishment of a uniquely Japanese "Japanese-style public observatory."

If the "Japanese-style public observatory" — which opens its doors widely to welcome visitors, provides places for learning through enjoyable astronomical experiences using astronomical telescopes and electronic observing — comes to be widely recognized domestically and internationally as a lifelong learning facility, and its existence becomes established, then just as Japanese culture today captivates the world and attracts travelers, Japan's public observatories seem to have the potential for major global development in the years to come¹⁶.

6. New Positioning of Japan's Public Observatories and Future Tasks

1) Three Dimensions of the Public Observatory

Recent social trends have brought new demands on public observatories as museums. They are now required to be not only ① a "social education facility" for science and astronomy as before, but also ② a "cultural facility" contributing to the enrichment of the cultural lives of citizens and the realization of a vibrant society. And the character as ③ a "lifelong learning facility" for citizens to "refine their character and lead rich lives" — the ideal defined in Article 3 of the Fundamental Law of Education — seems to be becoming ever more clearly defined.

2) The Basic Stance and Distinctive Character of Japan's Public Observatories

Specifically, it is important to return to the basic principle of the JAPOS constitution (Article 2): "public observatories engaged in lifelong learning support to cultivate a view of nature through real celestial objects and to contribute to the formation of a rich character." Visitors to stargazing events often say things like "Looking at the stars calms my heart" and "My worries seem so small compared to all this." These are not mere byproducts of intellectual learning but rather the essential role of public observatories that many visitors are seeking.

Japan's public observatories, from their cultural and historical background, appear to have actively fulfilled this role from the very beginning.

3) What Is a Public Observatory in Japan?

Synthesizing what has been discussed above, the emergence of public observatories in Japan can be understood through the following elements and historical context:

- Japan's cosmological and worldview traditions transmitted since antiquity, including the calendar system and mythology
- Tangible and intangible astronomical culture rooted in daily life across Japan's regions
- Modern, scientifically rigorous Western astronomy since the early modern era
- The diverse activities of amateur astronomers
- The cultivation of soil for establishing public observatories throughout the country as a result of the above

As a result of these elements and their historical context, facilities have been established across Japan that serve simultaneously as ① places for learning astronomy and space science as social education and lifelong learning facilities, and as ② facilities with dimensions now understood as museum functions such as tourism, urban development, and welfare.

4) Looking Ahead

Going forward, it will be necessary to deepen the definition and social understanding of public observatories from these perspectives, and to work toward enhancing their social significance.

The society of the future will see various realities (VR, MR, etc.) implemented as living spaces through digitization and advances in communication infrastructure, and will also see decisive changes in human activity accompanying the evolution of AI. What is the social role of public observatories in such a world? And how can public observatories fulfill their essential mission

amid the emergence of various devices for experiencing space beyond optical telescopes? This is an unavoidable challenge for the future.

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Chapter 2: The Starry Sky Principle — Why People Look Up at the Night Sky

A Dialogue between a Human and Generative AI

There exists in human beings — for reasons not well understood — a common experiential rule comprising two elements: an impulse to look up at the starry sky, and a deep emotion experienced there. This has sometimes been called the "Starry Sky Principle."

In this chapter, we explore why people look up at the sky, why it is necessary to do so, what effects people would suffer if they stopped looking up, and what meaning "living beneath the starry sky" holds for human beings in the first place — and we do so through a dialogue with generative AI, a non-human interlocutor.

1. Data Collected in FY2024 Analyzed with Generative AI to Derive an Answer to the Question: "Why Do People Look Up at the Night Sky?"

1) Purpose and Background

It was proposed as a hypothesis that the results of the Starry Sky Principle workshop conducted at the FY2024 JAPOS National Training Workshop contain responses reflecting the biases of modern humanity — biases of the form "A society that looks/doesn't look at the starry sky must be like this" — and that these responses may not be appropriate for a comparative analysis addressing the proposition "Why do people look up at the night sky?"

Accordingly, an attempt was made to use generative AI (ChatGPT-4o, OpenAI) to first classify and exclude inappropriate items, and then perform a comparative analysis to obtain an answer to the proposition "Why do people look up at the night sky?" Multiple further reflections were then developed based on that answer.

2) Analysis Method

(1) The data from poster paper created during last year's Starry Sky Principle workshop was transcribed into text. Only the content written on sticky notes was extracted, classified by whether participants look up or do not look up at the starry sky, and converted to CSV format.

(2) A comparative analysis was conducted using ChatGPT-4o with the following prompt:

"This CSV contains elements associated from the keywords 'Society A: Everyone has the habit of looking up at the starry sky' and 'Society B: No one has the habit of looking up at the starry sky,' describing people's lifestyles, values, and elements such as science and technology and culture. We want to obtain an answer to the proposition 'Why do people look up at the night sky?' through comparative analysis. However, these elements contain biases stemming from the prejudices of modern humanity — 'A society that doesn't look at the starry sky must be like this' or 'A society that looks at the starry sky must be like this' — and elements that are inappropriate for the comparative analysis of the proposition are mixed in. Against this background, please perform the comparative analysis following the steps below: (a) From both A and B, exclude elements inappropriate for the comparative analysis of the proposition 'Why do people look up at the night sky?'; (b) After completing (a), compare the elements of 'A: Society where everyone has the habit of looking up at the starry sky' and 'B: Society where no one has the habit of looking up at the starry sky,' and discuss what influence looking up at the starry sky has on people's lives and values; (c) Based on the results of (b), propose an answer to the proposition 'Why do people look up at the night sky?'"

3) Results

Step (a): Excluding Elements Inappropriate for Comparative Analysis

First, to consider the proposition "Why do people look up at the night sky?", it is necessary to eliminate the influence of bias. Elements reflecting preconceptions and prejudices about "a society that looks/doesn't look at the starry sky" are identified and excluded.

Society A: A society that looks at the stars

- "Good eyesight," "large eyes" — physical characteristics unrelated to looking up at the starry sky
- "Hairy species," "people without hair" — elements related to biological evolution rather than culture or values

Society B: A society that doesn't look at the stars

- "Only tall buildings," "underground urban development" — based solely on urban structure (not directly linked to whether one looks at the starry sky)
- "Inorganic" — an abstract and subjective element (categorically defining the character of society)

Step (b): Comparison of Society A and Society B

The following characteristics are observed in the comparison results:

1. Differences in Values

Society A: A society that looks at the starry sky

- "Science and technology are advanced, but nature is also valued"
- "Wanting to know the world outside where one lives"
- High interest in natural scenery, such as "a blue sunset sky"

Society B: A society that doesn't look at the starry sky

- "Many convenient entertainments: video and VR" → digital content-centered
- "Authenticity is disliked" → virtual and artificial experiences preferred over real ones?
- "The city is noisy day and night" → an environment with constant artificial stimulation

2. Differences in Social Environment

Society A:

- "Smiling elderly people" → high happiness levels?
- "Quickly forgetting the past" → a future-oriented society?

Society B:

- "The city has only people (no pets)" → low biodiversity?

- "Not much color" → poor visual variation in the environment?

Step (c): Answer to "Why Do People Look Up at the Night Sky?"

From this comparison, organizing "what influence looking up at the starry sky has on people" leads to the following conclusions:

- Looking up at the starry sky is connected to "curiosity about the outside world." In Society A, there is a consciousness of "wanting to know the world outside where one lives." The starry sky makes one feel the expanse of one's location, stimulating intellectual inquiry — a desire to "know more" and "look further."
- Looking up at the starry sky provides an opportunity to feel "connection with nature and the universe." In Society A, there is a value of "cherishing nature" alongside advanced science and technology. Looking up at the starry sky enables one to feel "being part of the universe" and to step outside of an anthropocentric worldview.
- Looking up at the starry sky may lead to a "sense of happiness." Society A is characterized by "smiling elderly people," while Society B has "many convenient entertainments" but gives an impression of being somewhat inorganic. Gazing at the starry sky creates quiet, calm time and may bring spaciousness to the human heart.

Conclusion: "Why Do People Look Up at the Night Sky?"

"People look up at the starry sky because, in doing so, they position their existence within a broader world, feel intellectual curiosity and a connection to nature, and through that process attain richness of heart."

2. Multiple Reflections Using Generative AI Based on the Answer to the Proposition

1) Relationship with Japan's Traditional Culture and Social Norms

[Prompt]

Based on the answer to the proposition "Why do people look up at the night sky?", discuss the relationship with Japan's traditional culture and social norms.

Several common elements are seen between the conclusion derived from the analysis — "Why do people look up at the night sky?" — and Japan's traditional culture and social norms.

1. The Starry Sky and Impermanence (Mujō)

Japanese culture contains the concept of mujō — the idea that all things are constantly changing. Hōjōki (Record of Ten Square Feet) by Kamo no Chōmei, for example, states "The world is always in flux." Stars in the night sky also move with the passage of time, and some — like shooting stars — disappear in an instant. Gazing at the starry sky becomes an opportunity to experience this impermanence directly and to sense that human activity is part of the great flow of the cosmos.

2. The Starry Sky and Nature Worship

Japan's traditional culture is deeply rooted in "nature worship" — treating nature as sacred from ancient times. In Shinto, not only mountains, rivers, and forests but also celestial bodies are considered the domain of the divine, and stars and the moon often hold special significance.

Collections such as the Manyōshū and the Kokinshū contain many expressions related to the beauty of the night sky and the stars. Traditional observances such as tsukimi (moon-viewing) and Tanabata (Star Festival) are also closely connected to the starry sky. Thus, in Japanese culture, "looking up at the starry sky" is rooted as an act with spiritual meaning, not mere entertainment.

3. The Starry Sky and Zen Thought

Zen teachings place importance on "selflessness (muga)" and "entrusting oneself to something greater." Looking up at the starry sky becomes an opportunity to feel one's smallness and to see one's existence from a broad perspective. In Japan, quietly gazing at the stars has long been valued as a way to attain spiritual calm.

From this perspective, the elements of "richness of heart" and "connection with nature" possessed by Society A (the star-gazing society) are strongly connected to Japan's traditional culture and social norms.

Comparison with Contemporary Japan

On the other hand, features seen in Society B (the non-star-gazing society) — "convenient entertainments," "noisy day and night," "authenticity is disliked" — share common ground with life in contemporary Japanese urban areas. In contemporary Japan, smartphones, video content, VR, and similar technologies have advanced, reducing opportunities to look up at the night sky. Urban nights are also brightly lit with artificial lighting, increasing the environments in which the natural starry sky is difficult to see. These environmental changes may be gradually causing the loss of the "habit of looking at the stars" that was rooted in Japan's traditional culture.

Summary

In Japan's traditional culture, looking up at the starry sky was deeply connected to concepts of impermanence (mujō), nature worship, and Zen thought. However, contemporary urbanization and digitization are creating an increasing number of environments — like Society B — where one "doesn't look at the stars." By once again valuing the habit of looking up at the starry sky, it may be possible to rediscover part of Japan's spiritual culture and recover richness of heart. From this perspective, the question "Why do people look up at the night sky?" might also be expressed as: "Because human beings are inherently beings who attain spiritual stability by positioning themselves within the cosmos."

2) Modern Social Challenges That the Habit of Looking Up at the Starry Sky May Help Resolve

[Prompt]

Attempt a different reflection. Based on the answer to the proposition "Why do people look up at the night sky?", what modern social challenges might be resolvable by having the habit of looking up at the starry sky? And why can they be resolved?

This analysis yielded the conclusion that "people look up at the starry sky because, in doing so, they position their existence within a broader world, feel intellectual curiosity and a connection to nature, and through that process attain richness of heart." Based on this perspective, we consider the possibility that the habit of looking up at the starry sky could resolve challenges facing modern society.

1. Mental Stress and Mental Health Issues

Challenge:

Many people in modern society experience stress and anxiety under pressure from work and school, the comparative culture of social media, and urban noise. In particular, the proliferation of smartphones and digital devices means people are constantly in a state of receiving information, with little mental space.

Why looking up at the starry sky may help:

- Mindfulness effect: Looking up at the starry sky means having time to quietly gaze at the vast cosmos. This resembles the practice of mindfulness — focusing consciousness on "this moment" — and brings stress reduction and relaxation effects.
- Relativization of the self: By gazing at the vast cosmos, one can gain the feeling that "my worries are small on a cosmic scale," creating spaciousness in the heart.
- Opportunity for digital detox: Stargazing creates a good opportunity to step away from the screens of smartphones and PCs.

2. Declining Environmental Awareness

Challenge:

In modern society, interest in nature has waned with urbanization and industrial development, and awareness of environmental issues has declined. Light pollution — the problem of too much artificial light making it impossible to see stars — is advancing in particular, and urban residents have few opportunities to know what the night sky originally looked like.

Why looking up at the starry sky may help:

- Heightening environmental awareness: When looking up at the starry sky becomes a habit, the question "Why can't we see the stars?" arises, becoming a trigger to think about light pollution and environmental degradation.
- Promoting a lifestyle of coexistence with nature: Through stargazing, it becomes easier to feel the value of "cherishing nature," potentially raising awareness toward a sustainable society.

3. Decline in Scientific and Technological Interest and Curiosity

Challenge:

As a trend in contemporary education and society, "passive learning" and "efficiency-first thinking" have strengthened, and the capacity to think and explore independently has declined. In particular, interest in fundamental sciences such as physics and astronomy is decreasing.

Why looking up at the starry sky may help:

- Stimulating intellectual curiosity: Looking up at the starry sky naturally generates questions such as "What is that star?" and "What is the cosmos like?" This can become a trigger to heighten interest in science.
- Promoting inquiry-based learning: Stargazing involves elements such as memorizing constellations and predicting the movements of celestial bodies, producing educational effects that nurture thinking skills and inquiry.

4. Increasing Social Division and Loneliness

Challenge:

With the development of social media and progress of urbanization, people's communication has become centered online, and opportunities for real-world dialogue have decreased. In particular, with the advance of individualism, more people feel that "social bonds have become fragile."

Why looking up at the starry sky may help:

- Connection through shared experience: The starry sky is something many people can share across national and cultural boundaries. "Looking at the stars together" becomes an opportunity to connect people of different generations and backgrounds.
- Alleviating loneliness: By thinking about one's existence in the vast cosmos, one can hold the feeling of "not being alone." This evokes a sense of "connection" in the philosophical sense.

5. Lack of Future Orientation and Creativity

Challenge:

In modern society, there is a tendency for short-term results and practical utility to be demanded, while long-term vision and creative thinking are undervalued. Historically, looking up at the starry sky has generated mythology, literature, and art, but such opportunities for inspiration are decreasing today.

Why looking up at the starry sky may help:

- Creating opportunities to think about the future: Feeling the expanse of the cosmos becomes a trigger to think about "the future of humanity" and "the future of the Earth."
- Cultivating imagination and creativity: The starry sky can be a source of creative inspiration for literature, music, and art.

Conclusion

The habit of looking up at the starry sky has the potential to contribute to resolving the following modern social challenges:

- Mental stress and mental health issues → mindfulness effect, relativization of the self
- Declining environmental awareness → heightened interest in light pollution and nature protection
- Decline in scientific interest and curiosity → stimulating intellectual curiosity, strengthening science education
- Increasing social division and loneliness → connection through shared experience, alleviation of loneliness
- Lack of future orientation and creativity → inspiration and ideas from a cosmic perspective

Therefore, the answer to the question "Why do people look up at the night sky?" is not merely romance or interest, but can be considered to be "one of the keys to resolving various challenges facing society and individuals."

3) Benefits of Public Observatory Astronomical Experiences in Restoring the Habit of Looking Up at the Starry Sky

[Prompt]

Attempt yet another reflection. Premising the answer to the proposition "Why do people look up at the night sky?", if modern people could recover the habit of looking up at the starry sky by visiting a public observatory — a type of museum — and participating in an astronomical experience program, what benefits would this bring? One role of museums in Japan is the purpose of "contributing to the enriched lives of users"; please discuss from this standpoint.

One role of museums in Japan is "contributing to the enriched lives of users." If modern people could recover the habit of looking up at the starry sky by visiting a public observatory and participating in astronomical experience programs, the following benefits can be expected.

1. Stimulating Intellectual Curiosity and Promoting Lifelong Learning

Benefit: Deepening interest in the universe and starry sky, stimulating intellectual curiosity

- Stargazing is connected to many diverse fields beyond astronomy, including physics, mathematics, history, philosophy, and mythology.
- As modern people tend to forget "the joy of knowing" in work and daily life, learning science and history behind the stars through star observation cultivates spontaneous inquiry.

Functioning as a place for lifelong learning:

- Having a place to gain new knowledge even after formal schooling ends raises the degree of fulfillment in life.
- Experiential learning, such as "memorizing constellation names and positions" and "learning how to use a telescope," also contributes to the intellectual growth of adults.

Why it enriches life:

Deepening knowledge leads to a sense of fulfillment in life. In particular, the act of "looking up at the starry sky" is not merely information gathering; it is a trigger for thinking that broadens one's perspective, with the potential to change how one views life.

2. Spiritual Fulfillment and Enhancement of Well-being

Benefit: Relaxation effect from looking up at the starry sky

- Gazing at the vast cosmos raises expectations of psychological effects such as "my worries seem small" and "being freed from the stress of daily life."
- Observatory observation is a precious natural experience, especially for those in urban environments where stars are hard to see.

Relativization of the self and change in life view:

- Looking up at the starry sky is also an opportunity to feel the smallness of one's existence — a way of thinking that connects with Buddhist concepts of impermanence and Zen thought, and becomes a trigger to see life's worries objectively.

Why it enriches life:

The habit of looking up at the starry sky reduces the stress and sense of stagnation of daily life, providing time to calm the heart. It also has philosophical aspects — "re-examining one's way of life and values by sensing the expanse of the cosmos" — leading to long-term happiness.

3. Community Formation and Recovery of Social Bonds

Benefit: Generating shared experiences for family and friends

- While stargazing can be enjoyed alone, "looking up at the stars together with someone" allows sharing of common topics and emotions.
- For example, a parent and child visiting a public observatory together and "searching for stars together" and "peering through a telescope" becomes an opportunity to deepen parent-child communication.

Formation of an astronomy community:

- Public observatories often gather astronomy fans and specialists, becoming "a place for people interested in space to interact."
- Sharing the common interest of "looking at the starry sky" makes it easy to generate cross-generational connections.

Why it enriches life:

"Watching the stars" generates connections between people. In modern society, "personal time" has increased through social media and digital media, but opportunities for real communication are decreasing. The experience at public observatories has the potential to improve the quality of human relationships through the simple act of "gazing at something together."

4. Heightening Environmental Awareness and Contributing to Sustainability

Benefit: Becoming a trigger to become interested in light pollution

- In urban areas, places where stars are invisible due to excessive artificial light are increasing.
- People who have seen "the original starry sky" at a public observatory may wonder "Why can't we see stars in the city where I live?" — becoming a trigger to become interested in light pollution and energy consumption issues.

Consciousness reform toward a sustainable society:

- Astronomy teaches us "that the Earth is a small existence in the cosmos" and "that we live within limited resources."

- Understanding this can heighten awareness of environmental issues and climate change, leading to a sustainable lifestyle.

Why it enriches life:

Having a consciousness of "protecting our Earth" allows one to hold a sense of responsibility and mission toward society. The feeling of "wanting to leave a beautiful starry sky for the next generation" also becomes a trigger to actively engage in environmental protection activities.

5. Enhancement of Imagination and Creativity

Benefit: The mysteries of the cosmos stimulate creative thinking

- Astronomy is a field with many unsolved aspects, and is rich with themes that stimulate the imagination — such as "What is out there in the cosmos?" and "What will become of future humanity?"
- Experiences related to space provide inspiration not only for science and technology but also for many creative fields such as literature, art, and music.

Promoting future-oriented thinking:

- It is no exaggeration to say that the history of humanity began with "looking up at the stars." Great scientists and philosophers of the past also gazed at the night sky while contemplating the future.
- Modern people can also cultivate the capacity to envision the future by "having interest in space."

Why it enriches life:

As imagination and creativity increase, the way of enjoying daily life, ways of working, and problem-solving abilities improve, and choices in life expand.

Conclusion

Recovering the "habit of looking up at the starry sky" through astronomical experiences at public observatories contributes to a "rich life" in the following ways:

- Stimulates intellectual curiosity and becomes a place for lifelong learning
- Attains spiritual fulfillment, enhancing well-being
- Leads to community formation, recovering social bonds
- Heightens environmental awareness, contributing to a sustainable society
- Cultivates creativity, gaining the ability to think about the future

In other words, "looking up at the starry sky" is not merely a romantic act but an important habit for resolving part of the challenges of modern society and leading a more fulfilling life.

3. Reflection

Up to this point, we have pursued dialogue and reflection in line with the basic problem awareness of "Why do people look up at the night sky?" Let us now summarize and re-present the answers to that problem awareness.

A) The Proposition "Why Do People Look Up at the Night Sky?" and Its Answer

Organizing "what influence looking up at the starry sky has on people" from this comparison leads to the following conclusions:

- Looking up at the starry sky is connected to "curiosity about the outside world."
- Looking up at the starry sky provides an opportunity to feel "connection with nature and the universe."
- Looking up at the starry sky may lead to a "sense of happiness."

Conclusion: "People look up at the starry sky because, in doing so, they position their existence within a broader world, feel intellectual curiosity and a connection to nature, and through that process attain richness of heart."

B) Multiple Reflections Using Generative AI Based on the Answer to the Proposition

1) Relationship with Japan's Traditional Culture and Social Norms — Summary:

- In Japan's traditional culture, looking up at the starry sky was deeply connected to impermanence (mujō), nature worship, and Zen thought.
- However, contemporary urbanization and digitization are creating more environments like Society B, where one "doesn't look at the stars."
- By once again valuing the habit of looking up at the starry sky, it may be possible to rediscover part of Japan's spiritual culture and recover richness of heart.

2) Modern Social Challenges Potentially Resolvable by the Habit of Looking Up at the Starry Sky — Conclusion:

- Mental stress and mental health issues → mindfulness effect, relativization of the self
- Declining environmental awareness → heightened interest in light pollution and nature protection
- Decline in scientific interest and curiosity → stimulating intellectual curiosity, strengthening science education
- Increasing social division and loneliness → connection through shared experience, alleviation of loneliness
- Lack of future orientation and creativity → inspiration and ideas from a cosmic perspective

3) Benefits of Public Observatory Astronomical Experiences in Restoring the Habit — Conclusion:

- Stimulates intellectual curiosity and becomes a place for lifelong learning
- Attains spiritual fulfillment, enhancing well-being
- Leads to community formation, recovering social bonds
- Heightens environmental awareness, contributing to a sustainable society
- Cultivates creativity, gaining the ability to think about the future

C) From the Reflection on the "Starry Sky Principle" — The Next Problem Awareness: "Why Does This Happen?"

There is a common experiential rule shared by human beings — called the "Starry Sky Principle" by some — comprising two elements that defy easy explanation: ① an impulse to look up at the starry sky, and ② a deep emotion felt there.

The conclusions derived from the proposition surrounding this are:

- People look up at the starry sky because, in doing so, they position their existence within a broader world, feel intellectual curiosity and a connection to nature, and through that process attain richness of heart.
- Human beings are inherently beings who attain spiritual stability by positioning themselves within the cosmos.
- It is one of the keys to resolving various challenges facing society and individuals.
- "Looking up at the starry sky" is not merely a romantic act but an important habit for resolving part of the challenges of modern society and leading a more fulfilling life.

However, why this phenomenon occurs remains still unknown. The next process will therefore be to elucidate its mechanism.

Chapter 3: Modern Stress and Cosmological Worldview

People living in contemporary artificial society carry a great deal of stress, and as a result their "well-being" — the state of being physically and mentally balanced, healthy, and happy — is being compromised. Prior to the formation of civilization, people are thought to have carried enormous stress from life-threatening environments, but with the development of society this was gradually replaced by economic stress, stress from human relationships, and other modern pressures. One might say, in a sense, that humanity formed a complex society and began generating stress of its own creation. Furthermore, the cosmological and natural worldview grounded in personal experiences with nature — which everyone once possessed — is being gradually lost, and today people live within a cosmological and natural worldview delivered through the dominant cultural influence of media and other forces, in a society disconnected from nature.

This chapter examines the nature of stress in contemporary society and explores how a "cosmological worldview" — an awareness of the universe as a whole — can serve as a counterweight to that stress. The chapter also reviews studies on the effects of nature and star-gazing on human psychology.

1. Psychological Stress in Contemporary Society

Contemporary society is characterised by information overload, an emphasis on efficiency and competitive performance, and the erosion of natural time rhythms through artificial lighting and digitalisation. These conditions generate chronic psychological pressure that accumulates silently in the bodies and minds of people of all ages and backgrounds.

One physical manifestation of this pressure is autonomic nervous system dysregulation, which can present as fatigue, dizziness, headaches, palpitations, insomnia, and many other symptoms. As discussed in Chapter 5, this state of disrupted well-being is closely linked to disconnection from natural environments — including the night sky.

2. The Cosmological Worldview as a Resource

Across human history, awareness of the cosmos has served as a stabilising framework for self-understanding. The regular movements of celestial bodies provided a basis for calendars, agriculture, navigation, and ritual. More fundamentally, looking up at a vast, ordered universe gave people a sense of their own place within a larger whole — a sense that their individual concerns, while real, existed within an incomparably grander context.

This experiential awareness — of being a small part of something immeasurably large — is precisely what modern research identifies as a key trigger of Awe (discussed in depth in Chapter 7). It reframes problems, softens ego-centrism, and opens the individual to connection with others and with the natural world.

3. Astronomy, Health, and the Case for Public Observatories

The connection between astronomy and human well-being is not merely metaphorical. Studies reviewed in Chapter 5 demonstrate measurable physiological and psychological benefits from star-gazing experiences: reductions in blood pressure, decreases in negative affect (anger, confusion, depression), and increases in reported sense of meaning and connectedness.

Public observatories are uniquely positioned to provide these benefits at scale. Unlike private star-gazing, which requires travel and equipment, public observatories offer accessible, guided encounters with the night sky — encounters enriched by expert narration and social sharing. Chapter 5 presents empirical evidence from the Minami-Aso Luna Observatory's "Observatory

Bathing" programme, which builds on the methodology of "museum bathing" to document these effects.

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Chapter 4 The Spread of AI and the Role of Humanity

Public Program WG Text Editing Committee

Generative AI (Artificial Intelligence) has rapidly entered everyday life, reshaping how we work, learn, and communicate. This chapter surveys the current state of AI development, its social applications, and the governance challenges it poses — before asking what, in this context, remains distinctively human.

1. The Rise of Generative AI

The decisive characteristic of generative AI is that it is accessible to everyone. Earlier AI applications required specialised knowledge or were restricted to narrow domains. Generative AI reverses this: anyone can use it for work, creative projects, or daily tasks. According to Boston Consulting Group estimates, the global generative AI market could reach \$121 billion (approximately ¥17 trillion) by 2027.

As of early 2026, the leading large language models available to the public include OpenAI's ChatGPT and Google's Gemini, both offering free tiers alongside paid enterprise plans. Anthropic's Claude and other major systems are also widely used. These platforms are increasingly multimodal — capable of generating and analysing text, images, audio, and video simultaneously.

2. What Generative AI Can Do (as of February 2026)

Generative AI services are now differentiated across multiple modalities:

1. Text generation — conversational and search-integrated, exemplified by ChatGPT, Gemini, and DeepSeek.
2. Image generation — from text prompts, via Stable Diffusion, DALL-E, Adobe Firefly, and others.
3. Audio synthesis — high-quality text-to-speech and voice cloning, with associated concerns about deepfake audio and fraud.
4. Video generation — OpenAI's "Sora" and ByteDance's "Seedance 2.0" generate high-definition footage from written descriptions.
5. Multimodal integration — these capabilities are converging into unified systems that handle text, images, audio, and video together, evolving from single-function tools into comprehensive intelligent assistants.

Beyond creative support, generative AI is being embedded into corporate operations, government services, healthcare, and scientific research. Communities of practice sharing optimised "prompts" (instructions for AI systems) have proliferated online, lowering the barrier to effective use.

3. AI Applications Across Sectors (January 2025 onwards)

The following case studies, drawn from recent reporting, illustrate the breadth of generative AI adoption:

- Large enterprises are making AI training mandatory for all employees, with information-security and output-verification protocols in place.
- Local governments are deploying closed-network (air-gapped) AI systems to handle routine administrative tasks without risk of data leakage.

- Japan's national government revised its AI developer guidelines in 2025, clarifying safety obligations and risk-management requirements.
- The G7, building on the Hiroshima AI Process, is working toward enforceable international standards for AI safety and transparency.
- Medical institutions are using AI for clinical documentation, diagnostic image analysis, and patient communication, accelerating healthcare digitalisation.
- ESA's "AnomalyMatch" AI tool analysed 35 years of Hubble Space Telescope archive images and identified more than 1,300 previously uncatalogued cosmic anomalies — including "jellyfish galaxies" with gaseous tendrils — in days rather than years.

4. Risks and Governance

The rapid spread of generative AI has surfaced a set of urgent governance challenges:

- Misinformation and deepfakes — high-fidelity synthetic images, audio, and video increase the risk of impersonation and disinformation, particularly in electoral contexts. Platforms are being pressed to label AI-generated content and remove malicious deepfakes swiftly.
- Liability clarification — governments are moving to hold AI developers explicitly accountable for safety failures, while balancing these requirements against the need to preserve space for innovation.
- International frameworks — the EU's AI Act (in full operation from 2025) takes a "hard law" approach, categorising AI by risk level and imposing pre-deployment obligations. The United States continues with a fragmented, state-level approach. Japan has adopted a "soft law" model centred on guidelines rather than mandatory penalties, aiming to combine innovation promotion with social trust.

5. The Approaching Horizon of Artificial General Intelligence (AGI)

AGI — Artificial General Intelligence — refers to a system capable of performing any intellectual task that a human can, across all domains. Current AI systems, however impressive in specific applications, remain classified as narrow AI.

Recent statements from leading laboratories suggest AGI may arrive sooner than previously anticipated:

- Google DeepMind CEO Demis Hassabis has indicated AGI could emerge around 2030, contingent on advances in "world models" — AI systems that understand physical reality.
- OpenAI's roadmap reportedly targets research-intern-level AI capability by 2026 and an autonomous AI researcher by 2028.
- Anthropic's chief scientist Jared Kaplan has suggested that a critical decision about allowing AI to train itself autonomously may arrive between 2027 and 2030.

- Anthropic President Daniela Amodei has argued that the concept of AGI itself may be becoming obsolete, as AI already surpasses humans in certain domains while lagging in others.

The benefits of AGI, if realised, could include acceleration of scientific discovery, medical breakthroughs, and solutions to global problems. The risks include loss of meaningful human control, rapid labour market disruption, and the danger that safety is deprioritised in competitive development races.

These projections remain speculative and should be understood as informed forecasts rather than established predictions. The future development of AI will depend not only on technological progress but also on governance, social acceptance, and international cooperation.

6. The Difference Between AI and Humanity — The Awe Perspective

As generative AI and the prospect of AGI reshape the intellectual landscape, the question "what is distinctively human?" becomes more pressing. One illuminating lens is the emotion of Awe (discussed fully in Chapter 7).

Awe, as defined by Keltner and Haidt, is a self-transcendent emotion triggered by encounters with vastness and requiring cognitive reappraisal — a reorganisation of the self's framework for understanding the world. From this vantage point, the AI–human distinction is not primarily one of processing power but of capacity for experience:

- AI can compute vastness — it can describe the scale of the universe, analyse astronomical data, and generate accurate explanations — but it cannot experience vastness. There is no "self" in AI that is relativised by an encounter with the infinite.
- The subject of cognitive reappraisal — the entity that must revise its world-model in response to something that exceeds comprehension — is always human. AI updates its parameters through optimisation, but this is not the same as the lived disorientation and expansion of horizon that characterises Awe.
- Awe generates ethical orientation — research shows that Awe experience reduces self-centredness and promotes prosocial behaviour. AI's ethical behaviour, by contrast, depends entirely on external design and regulation. The ethical impulse in humans arises from within; in AI it must be imposed from without.
- Even if AGI is achieved, it will not be a being capable of Awe — of standing before the universe in silence, of having its self-narrative shaken and rewritten.

The difference between AI and humanity is not quantitative (a matter of how much intelligence) but qualitative: humans are beings capable of Awe.

7. How Public Observatories Should Relate to AI

Public observatories are not simply being asked whether to adopt AI. The deeper question is: in an era of AI, how should human beings maintain their relationship with the universe?

- AI as a supplementary intelligence, not a substitute for experience — AI can assist with explanations, observation planning, and visitor queries, but it cannot replicate the embodied encounter with the cosmos that generates Awe.
- The observatory as a site for engaging with the unknowable — as generative AI provides instant answers to almost any question, the observatory becomes more important as a place where people can confront what cannot be answered — where they can stand before a universe that exceeds understanding.
- Connecting well-being and planetary health — AI increases energy demand and transforms the information environment, creating new pressures. The observatory offers an alternative: star bathing and observatory bathing as cultural practices that restore well-being through Awe, not through technological optimisation.
- Redefinition of the observatory in the AI era — as AI commoditises information provision, the observatory's distinctive value lies in three roles: (1) a place to restore the capacity to engage with the unknown; (2) a forum-type experiential space for generating and sharing meaning; (3) a social infrastructure sustaining ongoing well-being.

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Chapter 5 Observatory Bathing and Its Relationship to Well-being

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In the course of running nightly star-observation events, staff at Minami-Aso Luna Observatory began to notice consistent psychological and behavioural changes in visitors after they had looked up at the stars. Comments such as "my worries felt trivial" and "I want to cherish my family more" — unrelated to astronomical knowledge per se — prompted the question: does star-gazing restore well-being? Since 2019 the observatory has been pursuing research to test this hypothesis.

1. Humanity Has Always Lived Beneath the Stars

1) Human Evolution

Homo sapiens appeared in Africa approximately 300,000 years ago. Throughout the vast majority of human evolutionary history, people lived outdoors without artificial lighting: waking with the sun, spending nights beneath the stars around a fire. The night sky was not a special attraction but a normal part of human existence. Our evolutionary heritage is inseparable from the rhythms of the cosmos.

From the earliest tool-using "ape-men" (australopithecines) through Homo erectus, Neanderthals, and modern Homo sapiens, every iteration of humanity has shared the night sky. Neanderthals — who lived until roughly 40,000 years ago — made ornaments from animal teeth and shells, and left cave paintings. Modern humans carry approximately 1–4% Neanderthal DNA, a reminder of our deep shared ancestry.

2) Contemporary Society: Living Without Stars

Contemporary society has largely severed the connection between humans and the night sky. Key factors include:

- Information overload and time pressure — modern life involves continuous exposure to stimulation, rapid decision-making, and the constant management of competing demands.
- High-rise urban environments — city dwellers increasingly look up to see not sky but the faces of neighbouring buildings.
- Light pollution — more than one-third of the world's population, and roughly 80% of North Americans, can no longer see the Milky Way. The Ministry of the Environment notes that light pollution disrupts sleep, wildlife, plant growth, and astronomical research alike.

This disconnection from the night sky is not merely an aesthetic inconvenience. It represents a break from an environment that shaped human psychology over millions of years — a break whose psychological and physiological costs are only beginning to be understood.

2. The Meaning and Significance of Looking Up at the Stars

1) Healing Effects of Star-gazing

Social psychologist Professor Shinji Usui identifies multiple mechanisms through which looking at the night sky promotes psychological recovery:

- Nocturnal calm — the parasympathetic nervous system becomes more active at night; darkness and quiet reduce physical and mental noise.
- Stepping away from everyday routine — the act of going outside, away from screens and fluorescent lights, is a small but real liberation from daily pressures.
- Upward gaze — looking up is associated with raised energy and a lighter mood; looking into the distance relaxes the eye muscles, relieving headaches and tension.
- Starlight and twinkling — steady, irregular flickering (known as 1/f fluctuation) is soothing to the nervous system, in the same way as candlelight, birdsong, or the sound of a brook.
- Projection and self-reflection — the darkness of the sky provides a blank canvas onto which inner states are projected. Star-gazers find themselves confronting their own thoughts, fears, and hopes with a clarity that ordinary busy-ness obscures.
- Awe and scale — "In the great cosmos I am very small." This awareness softens ego-centrism, places personal problems in perspective, and fosters gratitude.

2) Examples of Nature and Stars Affecting Mind and Body

Several initiatives illustrate the growing movement to harness astronomical experience for healing:

- Hoshi-tsumugi no Mura (Village of Woven Stars) — a non-profit founded in 2017 that brings planetarium experiences to children in long-term hospital care and to people with rare diseases, their families, and the medical staff who care for them. By 2021 more than 300 hospitals had been visited. The documented benefits extend beyond patients to family members and healthcare workers.
- Awe research — studies by Dr Shiota (Arizona State University) and others show that Awe experiences — the kind triggered by confronting the vastness and timelessness of the universe — increase humility, gratitude, and prosocial motivation. Awe also suppresses excessive production of inflammatory cytokines and promotes secretion of oxytocin (the "bonding hormone"), with tangible physiological benefits.
- Astrotherapy — the International Astronomical Union's Office of Astronomy for Development has a dedicated Flagship Project on "Astronomy for Mental Health." The concept of "Skychology" — improving well-being by looking at the sky — encompasses four key effects: increased calm, induction of meditative states, reduction of stress and anxiety, and the simple benefit of going outdoors.

3. Museum Bathing — The Public Observatory as a Museum

"Museum bathing" is the practice of visiting museums and galleries to promote psychological recovery and physical health — analogous to "forest bathing" (shinrin-yoku) in nature. Research led by Professor Izumi Ogata (Kyushu Sangyo University) has collected data from more than 90 institutions and 1,334 participants, demonstrating that museum visits reduce negative

psychological states (anger, confusion, depression) and normalise blood pressure through autonomic nervous system regulation.

Public observatories qualify as museums under Japan's Museum Act (revised 2022), which added "social inclusion, community welfare, and the resolution of local challenges" to the list of official museum objectives. Observatory bathing can therefore be understood as a form of museum bathing — with the additional dimension that the primary exhibit is the living cosmos itself.

1) The Observatory Bathing Pilot Study

In September 2025, Minami-Aso Luna Observatory conducted a pilot "Observatory Bathing" experiment using the methodology of museum bathing. Nine participants (seven Japanese, two Myanmar; all female) visited the observatory from a nearby care facility. Physiological measurements (blood pressure, pulse) and psychological assessments (POMS — Profile of Mood States) were taken at three time-points: before departure, on arrival at the observatory, and after the experience.

Full results are to be shared via lecture slides at the 2026 training workshop, in accordance with a research agreement with Kyushu Sangyo University. Preliminary findings show outcomes consistent with those of previous museum bathing studies: measurable relaxation effects and improved psychological state following observatory contact. This marks the first scientific pilot of "Observatory Bathing" as such, coinciding with the 100th anniversary of public observatories in Japan.

4. The Star Experience Tour and Research Outcomes at Minami-Aso Luna Observatory

1) Generational Model of Public Observatory Interpretation

Drawing on Ito's museum typology, the observatory defines four generations of interpretation:

- Generation 1 (Object-display type) — the guide shows individual celestial objects of interest, one by one.
- Generation 2 (Themed-exhibition type) — objects are selected around an educational theme; the programme is pre-planned.
- Generation 2.5 (Discovery-learning type) — themed programme plus facilitator support for real-time moments of insight ("Eureka!" moments).
- Generation 3 (Creative-forum type) — guide and participants co-create the experience as equal partners in a shared forum of wonder.

The Star Experience Tour at Minami-Aso Luna Observatory is designed as a Generation 3 experience.

2) Structure of the Generation 3 Star Experience Tour

The tour runs approximately 100 minutes each evening, with one "Star Concierge®" accompanying groups of around 15 visitors through four venues:

6. PlanetaCafé (currently paused due to COVID-19 protocols) — pre-tour one-to-one interviews to personalise the experience.
7. 4K Planetarium — astronomical knowledge, current sky objects, mythology, and cultural stories about the stars.
8. Observatory (telescope) — direct observation through the 82 cm primary mirror telescope, with interpretive support.
9. Hoshimi-ga-Hara (Star-viewing field) — participants lie on summer beds in the open air beneath the full sky; since January 2023, a campfire and drinks service has been added.

5) Observatory Bathing: Questionnaire Survey — Japanese vs Foreign Visitors (Text Mining Analysis)

Between June 29 and August 22, 2024, questionnaires were distributed to 219 participants in the morning following their Star Experience Tour. Four open-ended questions mirrored the four generational model levels; a fifth supplementary question was also included. Text Mining (TM) analysis was applied to ensure objective extraction of emotional states.

Key findings:

- Generation 1–2 responses were dominated by cognitive nouns — names of stars, constellations, and celestial events — reflecting knowledge acquisition.
- Generation 2.5 responses shifted to words describing sensory experience.
- Generation 3 responses centred on: behavioural change ("looking up at the night sky again"); psychological insight ("my worries felt trivial," "my self felt small"); and expressions of gratitude and Awe toward nature and significant others.
- AI-assisted summaries of the responses confirmed these patterns and showed consistent themes across Japanese and foreign participants, including: the healing power of the experience, a renewed sense of the beauty and vastness of the universe, connection with family and friends, and a desire to protect the earth from light pollution.

The research, still ongoing, demonstrates that star-gazing experiences foster curiosity and healing and offer promise as a contribution to well-being enhancement.

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Chapter 6 What It Means to Be Human — Toward Solutions to Social Challenges

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1. Future Challenges and Directions

Proposing a "Living Happily Beneath the Stars" Movement

Modern society has lost the ancient, natural human way of living. The psychological and physical costs of this disconnection have been examined in earlier chapters. Observatory bathing, star-gazing experiences, and the empirical evidence presented in Chapter 5 provide a basis for a social movement aimed at restoring well-being by returning people to the experience of "living happily beneath the stars."

This movement must be built collaboratively — by citizens, public astronomical facilities, and allied organisations who share awareness of the problem.

The Luna Observatory Bathing Programme (L-OBP)

As a concrete example of what such a programme might look like, Minami-Aso Luna Observatory has developed the "Luna Observatory Bathing Programme" — a residential, overnight experiential programme structured around four sequential processes:

10. Encounter — meeting new knowledge, narratives, and stories: the eternal story of the night sky and cosmos; the natural environment of Aso; the history and culture of the local region; the story of Minami-Aso Luna Observatory; the stories of the staff; and the participants' own personal stories.
11. Awareness — insights are spontaneously kindled within participants through three interlocking facilitation techniques: Science Communication (universal, scientific — bringing knowledge and understanding of the grand narratives of the cosmos, earth, and humanity); Interpretation (subjective, artistic, cultural, and historical — honouring each participant's unique context without exception); and Facilitation (integrating each person's story into the larger universal narrative, generating a sense of self-affirmation and security rarely available in daily life).
12. Liberation — participants recover their authentic selves. Time alone for quiet reflection, or gentle interaction with a close companion or small group, allows them to rediscover the sources of their own happiness. The night ends with participants fully at ease in mind and body, drifting into sleep.
13. Return — enriched by a new foundational experience (of time and space), participants re-engage with their daily lives with a positive forward orientation.

2. The Harmony of Truth, Goodness, and Beauty

"What should a public observatory — as a museum — be asked to provide?"

Modern people are constrained by information overload, the relentless pursuit of efficiency, and the dominance of monetary value. They have lost the ancient natural human way of living — waking with the sun, sleeping beneath the stars — and have consequently damaged their well-being.

As a new role for the "public observatory as museum," the challenge is to return people to a healthy, happy state — and specifically to develop "astronomical interpretation techniques that contribute to people's well-being through astronomical experience."

The concept of "observatory bathing" has been proposed to meet this challenge, with early results showing meaningful outcomes. The Luna Observatory Bathing Programme is one practical realisation of this concept.

Stepping back further: since ancient Greece, the three ideals of Truth, Goodness, and Beauty have been invoked as the mark of a fully realised human life. The invitation of the night sky is to spread all three wings — intellect, ethics, and sensibility — and receive the boundless gifts that the cosmos offers. Public observatories are among the places where this integrated human flourishing remains possible.

3. Creating a Future Where People Live Happily Beneath the Stars

Establishing and Advancing the Japanese Model of Public Observatories

Japan's public observatory tradition is globally distinctive. The cultural background that produced it — rooted in a Shinto sense of kinship with nature (the "eight million gods"), a rich tradition of folk astronomy, the vitality of amateur astronomy across the country, and an exceptionally high public literacy in natural science — has given rise to a type of institution found nowhere else in the world.

Star-viewing and astronomical experience resonate deeply with Japanese aesthetic sensibility — from ancient myth and poetry to Kenji Miyazawa's "Night on the Galactic Railroad." This cultural affinity makes Japan's public observatories uniquely well-placed to pioneer a new, global model of the observatory as a site of Awe-mediated well-being.

4. Toward Solutions to Social Challenges

Public Observatories in the Digital Society

The universe is no longer accessible only through the telescope eyepiece. It extends into smartphones, VR headsets, and the metaverse. Public observatories must navigate this expanded reality, using every available digital tool to guide visitors toward richer understanding — while anchoring the experience in the irreplaceable reality of the actual night sky.

The role of the astronomical interpreter will evolve accordingly: curating across multiple realities, personalising the experience for each visitor, facilitating "Eureka!" moments of self-directed discovery, and working alongside AI as an assistant rather than a substitute.

A "Generation 4" interpretation model — building on the Generation 3 creative-forum approach and incorporating digital tools — is an urgent development priority for the field.

Chapter 7 Awe

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Terminology note: This chapter uses the original English terms from Dacher Keltner's AWE: The New Science of Everyday Wonder (2023) and the foundational paper Keltner & Haidt (2003). Key terms include: Awe, vastness, need for accommodation, moral beauty, collective effervescence, small self, self-transcendent emotions, Default Mode Network (DMN), well-being, and everyday Awe.

1. Why "Human-ness" and the Night Sky Matter Now

Contemporary society puts relentless pressure on individuals to manage, optimise, and perform. Information overload, time scarcity, and an emphasis on personal responsibility for outcomes have made the world feel like a system to be controlled rather than a reality to be inhabited.

In this context the question "what does it mean to be human?" is no longer merely philosophical — it is a practical social challenge. And a useful way to approach it is through the long arc of human history.

For the overwhelming majority of our evolutionary past, human beings lived without artificial lighting, spending their nights beneath the stars. The night sky was not a special destination; it was the normal environment. The sun's arc marked the day; the stars' movements marked seasons and years; the rhythms of the cosmos were the rhythms of human life.

Since industrialisation — and especially since the spread of electric lighting — most people have lost routine access to this environment. The stars are now "somewhere you have to go," not "part of where you already are." This is an unprecedented rupture with the sensory and emotional environment in which human psychology evolved.

Reports from star experience events — "my mind calmed," "my perspective widened," "my daily worries felt relative" — are consistent across age groups and backgrounds. These changes are too systematic to be dismissed as mere entertainment. Something real is happening. Understanding what requires the concept of Awe.

2. What Is Awe?

Awe (often translated into Japanese as *ikei*, 畏敬) is a complex, self-transcendent emotion that arises when a person confronts something that exceeds their existing frameworks of understanding. It is now recognised in psychology, neuroscience, and social science as a distinct emotional category — not simply a strong form of surprise or admiration.

In the foundational framework of Keltner and Haidt (2003), Awe is defined by two core features [5]:

- Vastness — not only physical scale (the size of the universe, a mountain range, a celestial body) but also temporal, conceptual, and social magnitude. Vastness is whatever exceeds the ordinary bounds of experience in some dimension.
- Need for accommodation — when an encounter cannot be adequately explained by existing knowledge, the mind is prompted to modify or expand its frameworks. Awe arises when both conditions — vastness and need for accommodation — are simultaneously present.

A defining feature of Awe is the transformation of self-awareness. During Awe, people perceive themselves as relatively small (the "small self"), and self-centred concerns temporarily recede.

This is not self-negation but re-positioning: the person places themselves within a larger whole — nature, the cosmos, humanity, social order [6].

Awe is also a mixed emotion — it resists simple classification as pleasant or unpleasant [3, 5]. An experience of a vast natural phenomenon or celestial event may be simultaneously beautiful and frightening, comprehensible and overwhelming. This ambivalence is what distinguishes Awe from everyday pleasure or achievement.

Recent research has shown that Awe is not confined to rare, life-changing moments. "Everyday Awe" can be kindled by nature observation, art, the deepening of scientific understanding, or witnessing another person's exceptional generosity or skill [10]. This means Awe is not a one-off event but a psychological resource that can be cultivated.

3. The Eight Mechanisms That Generate Awe

Keltner (2023) identifies eight principal pathways through which Awe is reliably elicited. All eight share the two core conditions of vastness and need for accommodation, but each operates through a different domain of experience [5, 16]:

1) Moral Beauty

Awe arising from witnessing exceptional altruism, courage, compassion, or self-sacrifice. The "vastness" here is ethical and value-based rather than physical. Moral beauty reduces self-centredness and promotes prosocial behaviour and moral motivation [6].

2) Collective Effervescence

Awe arising when many people synchronise their emotions and attention — in rituals, festivals, concerts, religious ceremonies, or sporting events. Drawing on Durkheim's sociological concept, this pathway temporarily dissolves the boundary between self and group, strengthening belonging, social cohesion, and cooperative behaviour.

3) Nature

One of the most frequently cited Awe triggers. Mountains, oceans, the night sky, celestial phenomena, and ecological diversity combine physical vastness with incomprehensibility in ways that reliably generate strong Awe. Nature-based Awe is associated with stress reduction, attentional restoration, improved subjective well-being, and heightened environmental awareness [4, 6].

4) Music

Music induces Awe through temporal structure and emotional elevation — especially grand harmonies, sudden dynamic changes, and unexpected structural turns that prompt cognitive reappraisal. Music creates a form of shared meaning that transcends verbal expression.

5) Visual Design and Art

Architecture, fine art, film, and design can generate Awe through scale, intricacy, or the simultaneous presence of order and complexity. This form of Awe includes wonder at what human creativity can achieve — a confrontation with "the limits of what humans can make."

6) Spirituality and Religion

Awe arising from religious experience, meditation, prayer, or ritual — characterised by a felt connection to something beyond the individual self. This pathway does not require formal

religious belief; what is essential is sensitivity to the transcendent and the mysterious. Research suggests this form of Awe influences how people understand the meaning of life and death.

7) Life and Death

Birth, ageing, death, evolution, and the cycle of life simultaneously evoke the finitude and continuity of existence, generating powerful Awe. This pathway involves fear and sorrow alongside recognition of the value of time and the importance of values — prompting deep re-evaluation.

8) Epiphany

The moment of sudden comprehension of a fundamental truth — a philosophical insight, a scientific discovery, a metaphysical idea, a personal realisation, a mathematical equation, a confession that changes everything in an instant. In every case, the epiphany reorganises facts, beliefs, values, intuitions, and images into a new system of understanding.

These eight mechanisms belong to different experiential domains, but they share the same core: vastness and need for accommodation. Awe is not limited to any single type of object or situation — it is a universal, plastic emotion that can arise across nature, society, culture, and intellectual life.

4. Bodily and Expressive Responses to Awe

1) Goosebumps, Tears, and Words

Awe is not merely a subjective shift in meaning — it is accompanied by clear physiological and expressive reactions. Three are particularly consistent across cultures: goosebumps, tears, and changes in language use (either silence or an impulse to narrate).

2) Goosebumps — Physiological Arousal and the Wavering of Self-Boundaries

The piloerection (goosebumps) that accompanies Awe is mediated by the sympathetic nervous system. In emotional research it is termed "aesthetic frisson" — it appears in response to music, art, vast nature, and cosmic imagery [2, 12]. It arises most strongly when expectation and deviation, order and surprise, occur simultaneously — a bodily reflection of Awe's mixed-emotion character.

Goosebumps tend to occur at precisely the moment when the boundary between self and world becomes temporarily unstable — when one touches "something beyond oneself."

3) Tears — Emotional Release and Re-ordering of Values

The tears of Awe differ from tears of grief or pain. Often reported as "tears of emotion" or "tears without clear reason," they are associated with the parasympathetic nervous system and represent an emotional integration process — the release and synthesis that follow intense arousal [14].

These tears are particularly likely when an Awe encounter connects the individual to a universal context beyond personal experience — a signal that one's self-narrative is being updated.

4) Words — Silence and the Impulse to Narrate

A characteristic feature of Awe is that the impulse to fall silent and the impulse to speak co-exist. During the experience, the scale and complexity of the encounter exceeds existing linguistic frameworks, producing verbal arrest — language simply cannot keep up [5, 13].

After the experience, a strong desire typically arises to share the encounter through metaphor, narrative, or poetry. This narration serves to integrate the experience into personal meaning and translate it into knowledge that can be socially shared.

5) Integrated Understanding of Bodily and Linguistic Responses

Goosebumps, tears, and altered language are all expressions of the same reality: Awe is a whole-person experience that crosses the boundaries of body, emotion, and meaning-making. Goosebumps signal immediate physiological arousal; tears signal emotional integration; language signals the reconstruction and sharing of meaning. Together they are "visible signs" of the transition — the moment when a self-centred worldview is shaken open and a new framework begins to form.

5. Awe as an Emotion

1) Classifying Awe Among the Emotions

Awe belongs to the family of self-transcendent emotions — emotions that cross self-boundaries and strengthen connection to others and to larger wholes. Self-transcendent emotions include gratitude, compassion, elevation, and Awe itself. As a group, they reduce self-centred concern and promote social and ethical orientation [10].

2) Awe as a Mixed Emotion

Awe cannot be reduced to a single valence. It typically combines positive emotions (joy, wonder, aesthetic pleasure) with negative ones (fear, anxiety, the discomfort of incomprehension). This ambivalence arises because Awe temporarily separates the individual from a manageable, predictable world and exposes the limits of existing cognitive frameworks — producing a productive tension at the very heart of the experience.

3) Awe and the Transformation of Self-Awareness

The small self — the subjective sense that "I am very small" — is one of the most consistently reported features of Awe. Self-appraisal, social comparison, and attention to personal desires all temporarily diminish. The result is not self-negation but re-positioning: the person perceives themselves as part of a larger system — nature, society, the cosmos [6].

4) Awe and the Sense of Time and Existence

During Awe, people often report that time seems to slow and that immersion in the present moment intensifies [8]. The usual consciousness of time pressure and efficiency fades. This temporal shift suggests that Awe releases people from immediate goal-orientation and promotes a longer-range, meaning-centred perspective.

5) The Functional Role of Awe

From an evolutionary perspective, Awe serves adaptive functions: it heightens cognitive flexibility, opens the mind to new frameworks, and loosens the grip of fixed beliefs. It promotes learning, cooperation, and exploration — and is associated with increased prosocial behaviour, altruistic judgment, and care for the social order.

6) Comparing Awe to Related Emotions

Awe is easily confused with surprise or inspiration, but is distinct from both. Surprise is a short-term response to prediction violation. Awe is more sustained and involves transformation of

world-understanding and self-perception. Inspiration focuses on motivational arousal; Awe precedes and underlies inspiration by reorganising cognition and values at a deeper level.

6. Awe and the Default Mode Network

Neuroscientific research has begun to investigate how Awe affects the Default Mode Network (DMN) — the brain network centred on the medial prefrontal cortex, posterior cingulate cortex, precuneus, and temporoparietal junction. The DMN is active during rest and introspection, and is deeply involved in self-referential thought, memory of the past and imagination of the future, understanding others' mental states, and the narrative comprehension of one's life [7].

In short, the DMN is the neural substrate of "who am I and what am I in the world?" The small self experience that accompanies Awe is likely related to changes in DMN activity. Multiple studies suggest that during or immediately after Awe, the self-evaluative, self-centric functions of the DMN are temporarily reduced [1, 13]. This reduction is not the dissolution of the self but rather the loosening of the self-narrative — the beginning of its reconstruction within a wider context.

Awe does not "switch off" the DMN; it weakens its dominance and shifts the balance among cognitive networks. The DMN normally prioritises the maintenance of the self-narrative and its consistency with past experience. Awe introduces instability into this stability — opening the possibility of new meanings and new world-understandings.

Since the DMN also underlies empathy and understanding of others, its modulation during Awe is consistent with the increased prosocial behaviour reported after Awe experiences. As self-centric narrative is relativised, others and nature come to be perceived not as separate from the self but as part of the same system.

Interestingly, meditation and religious or spiritual experience also produce changes in DMN activity and blurring of self-boundaries [1, 13]. Awe shares partial neural characteristics with these states, though it is distinct in being triggered externally — by nature, the cosmos, art — rather than being primarily an inward, contemplative practice.

7. How Awe Changes the Way We See the World

Awe is not only a transient emotional experience; it reshapes the frameworks through which a person understands and gives meaning to their existence. Through Awe, the perspective on self, others, nature, and the cosmos is reorganised, enabling a grasp of the world at a larger scale [6, 11].

1) Expansion of Cognitive Scale

Awe's central effect is the expansion of cognitive scale. The objects that generate Awe exceed the person's ordinary cognitive range in some physical, temporal, or conceptual dimension. Confronting such an object causes the person to relativise their everyday concerns and problems. The result is a shift from a self-centred view of the world to a view in which the self is one element within a far vaster context.

2) Reduction in Cognitive Certainty and Increase in Flexibility

Awe introduces uncertainty into the assumption that "the world is understandable and predictable." When confronted by a phenomenon or concept that exceeds comprehension, existing knowledge and beliefs are found to be insufficient. Cognitive certainty temporarily decreases.

But this uncertainty functions not as negative confusion but as a doorway to greater cognitive flexibility. After Awe, people become more open to new information and alternative viewpoints, and more willing to re-examine fixed beliefs and values.

3) Shift from Self-centrism to a Relational Orientation

As the small self arises, the world comes to be perceived not as "a set of objects to satisfy my desires" but as "a network of interconnected relationships." The links between self, nature, other people, and society are brought into prominence; the person becomes more aware of how their actions affect the whole.

4) Reorganisation of Values and the Sense of Meaning

Awe causes people to re-evaluate the values that organise their lives. Confronting vast nature, the cosmos, or the cycle of life makes the relativity of everyday standards — success, ownership, efficiency — visible. People come to place greater weight on meaning, connection, and contribution. Awe shifts the evaluative criterion from "what have I achieved?" to "of what world am I a part?"

5) Integration of Worldview and Its Narrative Form

Awe promotes the cognitive integration of fragmented experience into a coherent narrative understanding of the world. When confronted with the incomprehensible, the mind seeks order and meaning — and uses scientific, philosophical, or narrative frameworks to reconstruct the world. Through this process, the world comes to be perceived not merely as a sequence of events but as an ordered whole with deep meaning. Awe cultivates the capacity to approach the world both as something to be understood and as something to be held with reverence.

6) Ripple Effects on Behavioural Choice

Changes in worldview ultimately affect behaviour. The broader perspective and relational orientation promoted by Awe make it easier to choose altruistic actions, cooperation, environmental care, and long-term judgment. In this sense, Awe is not merely a cognitive experience — it is a foundational emotion that orients social behaviour.

Chapter 7 has examined in detail the many effects that Awe has on human beings, drawing on current research. This provides, in a sense, an answer to why the Stellar Principle (Chapter 2) exists — and a hint toward the answer to "what it means to live happily beneath the stars." Chapter 8 examines the activities of public observatories from the perspective of Awe.

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Chapter 8 The Significance and Future of Public Observatories

— A Reflection on the 100th Anniversary —

Public Program WG Text Editing Committee

Terminology note: Chapter 8 continues using Keltner's original English terms: Awe, vastness, need for accommodation, small self, collective effervescence, self-transcendent emotions, well-being, planetary health, observatory bathing, museum bathing, star bathing, forest bathing, and everyday Awe.

In the year that marks the 100th anniversary of Japan's first public observatory, engagement with recent Awe research has brought a major turning point in understanding what public observatories mean for society. What follows is one reflection on that turning point — a synthesis of what the preceding chapters have established.

1. Awe and Astronomical Experience in Human History

1) The Night Sky and the Formation of Human Worldviews

Awe has been defined as a psychological concept only recently, but the experience itself has been present throughout human history. The stars and the regular movements of celestial bodies have been the starting point of religion, myth, philosophy, the calendar, and science. Humanity has long engaged with the cosmos through celestial observation — sensing an order and vastness that transcends the self.

In the transition from hunter-gatherer to agricultural societies, celestial observation was at once a practical tool for understanding seasons and time and an experience of sensing the finitude of human existence within cosmic order. Reverence and wonder at celestial phenomena are the primordial form of Awe — deeply woven into how humanity has always formed its worldview.

In this human-historical context, the modern public observatory can be understood not merely as a science education facility but as a device that reopens — for people living in contemporary society — the Awe experiences that humanity has always had.

Across the long arc of human history, the night sky was not an exceptional experience but an ordinary part of the daily environment. Since birth, humans have lived without artificial lighting, waking with the sun and sleeping under the stars — a pattern repeated over millions of years. The night sky was "part of how it was normal to be human," not "a special landscape."

2) Disconnection from the Stars — and the Return

Since modernity — and especially from the late nineteenth century onward — urbanisation, industrialisation, and the spread of artificial lighting have rapidly separated humanity from the night sky. For many people today, looking up at the stars has become a non-everyday event. This environmental change represents not merely a change in visual landscape but a rupture from the sensory and emotional environment that was the evolutionary and cultural premise of human psychology.

Seen from this perspective, the strong Awe that contemporary people experience when they encounter the night sky is best understood not as "a special emotion" but as a reconnection with a familiar sense that is evolutionarily and culturally deeply rooted. The reverence, the small self, the re-recognition of time and existence — these are not newly acquired emotions but basic emotional responses, cultivated over the long span of human history, being called forth again in modernity.

2. The Distinctive Character of Awe Experience at Public Observatories

1) What Is Awe Experience at a Public Observatory?

The astronomical observation experience provided by a public observatory strongly satisfies the two core elements that constitute Awe: vastness and need for accommodation [5]. The spatial and temporal scale of the cosmos vastly exceeds ordinary human intuition. Visitors inevitably become aware of the limits of their commonsense worldview.

Moreover, the observatory experience is shared — with expert guides and with other participants. Standing before a celestial object that "belongs to no one," people simultaneously feel wonder, fall silent, and search for words. This shared quality naturally evokes the collective dimension of Awe — what Keltner calls collective effervescence.

Such experience relativises the self-centred concerns and immediate preoccupations that are easily swollen in daily life, and provides an occasion to relocate the self within a wider context.

Awe experience at a public observatory refers to the entire process — mediated by celestial observation — through which a person reconstructs their relationship to self, world, and cosmos. It is not merely knowledge acquisition or visual impact, but a comprehensive experience in which emotion, cognition, body, and social connection are simultaneously transformed.

2) Distinctive Features of Awe Experience at Public Observatories

Four distinctive features can be identified:

14. Direct bodily perception of cosmic scale — the stars and nebulae and galaxies visible through the 82 cm telescope are not images or information; they are actually present phenomena. This reality heightens the intensity and authenticity of the Awe experience. Vastness is directly perceived, not inferred.
15. Standing at the boundary of understanding and incomprehension — astronomical knowledge makes the cosmos comprehensible as an object of study, while the cosmic scale ultimately guides participants into a domain that exceeds intuitive understanding. This "intellectually understandable but experientially unfathomable" state shakes existing cognitive frameworks and promotes need for accommodation. The public observatory is a device that allows this instability to be experienced safely and affirmatively. (See the Generation 2.5 interpretation technique.)
16. Relativisation of self-centrism — facing the cosmic scale, the individual temporarily sets aside their worries, roles, and social evaluations and perceives "the self as one being within the cosmos" [6]. This small self experience is not self-negation but re-positioning — a lightening of psychological burden and a reorganisation of values.
17. Inherently shared experience — the sky belongs to no one; multiple people can look up at the same sky simultaneously. Sharing "wonder" and "silence" across differences of role (guide, participant, novice, expert) gives Awe a social meaning that transcends personal emotion. This shared quality transforms experience from a transient emotion into a memorable meaning-experience. (See the Generation 3 interpretation technique.)

3) A Concrete Example — Awe Experience at Minami-Aso Luna Observatory

The Star Experience Tour at Minami-Aso Luna Observatory is designed as a Generation 3 (creative-forum type) observation event. The guide and participants do not stand in a one-directional teaching relationship; the emphasis is on the "forum" — the place itself — where everyone wonders, questions, and makes meaning together in front of the stars.

The tour moves through a planetarium, a telescope, and open-air star-viewing — a journey that gradually separates participants from their everyday sensibility. This design progressively delivers the experience of vastness and naturally promotes need for accommodation.

Notably, in the Star Experience Tour, Awe is not "consumed" as a moment of emotion but deepens and persists through the arc of the experience. Questionnaire and free-response data consistently record the following: "I felt healed." "My mind calmed." "My daily worries felt small." "I felt gratitude." These responses represent the small self — the re-positioning of the self within the cosmos.

After the experience, the Awe does not remain locked inside each individual. Through dialogue and reflection, participants verbalise their wonder and emotion and layer it with others' perspectives. This process transforms the Awe from a temporary emotional reaction into an experience that shapes values and behaviour.

3. Awe as the Bridge to Well-being Recovery

1) Awe, Forest Bathing, Star Bathing, and Museum Bathing

Recent research demonstrates that Awe experience is associated with the recovery and improvement of subjective well-being [15]. Awe does not directly "dissolve" stress or anxiety, but it relativises these problems — making it possible to re-interpret them within a larger meaning-framework.

The small self that Awe generates temporarily weakens self-criticism and ruminative thinking. Feeling that "I am not the centre of the world" is a release from the relentless self-management and self-optimisation that contemporary society demands.

The connection between Awe experience and well-being recovery is illuminated by the parallel concepts of forest bathing, museum bathing, and star bathing. Forest bathing — immersion in natural environments — is known to balance the autonomic nervous system and reduce stress markers. Museum bathing uses cultural spaces to release psychological tension and improve psychological health markers (anger, confusion, depression) and normalise blood pressure [17].

What these practices share is the insight that well-being recovery does not come only from solving specific problems but arises more fundamentally through a reconstruction of the relationship between the self and the world. Awe is the emotion that mediates this reconstruction.

Star bathing can be understood as a restorative practice in the same family as forest bathing and museum bathing — placing oneself in the historically familiar human environment of the night sky and confronting cosmic scale, allowing the relationship between self and world to be readjusted. Through this process, the Awe-characteristic emotions of reverence, gratitude, and humility arise, forming the psychological basis for well-being recovery.

2) Awe and Observatory Bathing

"Observatory bathing" is the attempt to implement star bathing in an intentional and reproducible form within society. The observatory provides not only the stars themselves as aesthetic objects or educational subjects but also, as a museum-like space, constructs a safe environment in which visitors can face the cosmos with ease. When interpretation, dialogue, sharing, and reflection are woven together, Awe experience deepens from a transient emotion into a comprehensive experience accompanied by meaning-making and integration.

The Star Experience Tour at Minami-Aso Luna Observatory is a concrete realisation of observatory bathing. Participants physically relax under the night sky, psychologically relativise

themselves, and socially share their wonder with others. Through this multilayered process, well-being appears not as something "recovered and repaired" but as "something originally present that is remembered again."

Observatory bathing can therefore be understood as a practice that extends the frameworks of natural therapy and museum bathing into cosmic experience — capable of bearing Awe-mediated well-being recovery. It is not therapy or intervention but a cultural device that reopens, within contemporary society, the human relationship with the world that was always already there.

4. The Practical Significance and Contemporary Role of Public Observatories

The public observatory's practical significance and contemporary role can be re-defined well beyond knowledge transmission or recreational experience. The observatory serves as:

18. A place to restore the capacity to engage with the unknown and the unknowable — in contemporary society, where the world is increasingly perceived as a system to be managed and optimised, the cosmic experience offered by the observatory restores the stance of engaging with what cannot be fully understood or controlled.
19. A place for generating and sharing new meaning — through Awe, the observatory functions as a "site of meaning-generation," enabling people to reconstruct their relationships with themselves, others, and the world.
20. A social infrastructure supporting ongoing well-being — the recovery of this stance provides an occasion to re-understand well-being not as mere comfort or satisfaction but as "a continuous process of how one relates to the world." The public observatory is a social infrastructure that supports this process — quietly but surely.

5. The Future of Public Observatories — Toward the Next 100 Years

1) Planetary Health and Well-being

As this text has shown, the cosmos and we human beings are connected at a very deep level. The cosmos is not merely an object of observation or aesthetic appreciation. The Earth — which holds us in its embrace — is itself part of the cosmos; and we, like all other beings, are part of the cosmos.

Standing on this premise, it becomes clear that there is an essential relationship between "the beautiful night sky produced by a balanced Earth environment (planetary health)" and "the state of living in health and happiness as a human being (well-being)." This is not an accidental correlation but a necessary connection arising from the very fact that human beings exist as part of the cosmos.

2) Gifts from the Night Sky

The beautiful night sky, the natural ecosystem, the social bonds that allow human beings to live humanly — none of these can be won through individual effort alone. They are not "rights" that can be owned. They are gifts — irreplaceable gifts from nature and the ecosystem, given to humanity since birth: "gifts from the night sky and the cosmos."

Since antiquity, human beings received these gifts with "great reverence and deep gratitude" (Awe), and possessed the wisdom to build harmonious ways of living. But the arrogant modern ego misrecognised these gifts as self-evident entitlements and began to consume not only the

natural environment but human beings themselves as instruments of utility. As a result, we have lost what mattered most — and created a world that is convenient but impoverished in meaning.

3) Awe and a Planetary Movement

How can we shape a new culture and civilisation that integrates modern science and technology with the ancient human way of living in harmony with nature — rather than setting them in opposition? And how can we realise a world in which everyone naturally knows they live within a vast cosmos, and "lives happily beneath the stars" as a matter of course?

21. The first step is to humbly ask what the way of "living happily beneath the stars" — which we have lost — really was. We must revisit the millions of years of human history during which people lived in harmony with nature.
22. Next, it is necessary to assert that "living happily beneath the stars" is a gift from nature, an innate way of being human, and a proper part of human society — and to reclaim it.
23. Further, we must begin — through embodied realisation of where these gifts come from — to work with gratitude toward the restoration of a harmonious society and Earth environment.
24. At the same time, as Newton said — "I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me" — we must always remain humble before the unknowable cosmos.
25. Awe — the "reverence and gratitude directed toward all living things and indeed all things" that can only be born when one notices the "gifts from the night sky and nature" — is a universal human quality, confirmed by recent international research. Awe is the source from which "the fundamental life-force as humanity" and social bonds have always arisen.
26. In an age when opportunities to notice these things are being lost, the urgent and indispensable task is to reconstruct the social environments, sites, and mechanisms through which each person can rediscover Awe as an individual, lived experience. Public observatories are one such social device — to be re-defined precisely in this light.
27. In Japan in particular — where a culture of kinship with nature, represented since the Jōmon period by the "eight million gods" (yaoyorozu no kami), provides the backdrop for the distinctively Japanese public observatory — our institutions are especially well-suited to serve as sites where people can come to know, intuitively and through experience, a presence greater than themselves. Future comparative international research will help clarify this distinctive quality and connect it to the resolution of global social challenges.
28. "Cognitive reappraisal" — the reconstruction of cognitive structures — becomes more accessible through sites of experience and learning such as those represented by public observatories. The possibility arises of a renewed "awakening experience" — the realisation that human society is woven into the natural system and sustained by its gifts. If this awareness begins to be shared and exchanged with gratitude in social and economic life — if a "pay it forward" (on-okuri) ethos takes hold — a new culture and civilisation, different from modernity, may begin to take shape.
29. "Planetary health" and "well-being" are today a global movement questioning, at its roots, a society of excessive capitalism that threatens the Earth's environment and human survival. Within that great social movement, public observatories too must move forward as participants in a planetary-scale flow.

4) The Future

In a world where "living peacefully and contentedly and happily beneath the stars" has been newly realised, people will naturally look up at the night sky as evening falls and enjoy it — equipped as a matter of course with the astronomical knowledge, skills, and depth of sensibility to do so.

At that time, we will all share, along with scientific knowledge, the cosmological understanding (cosmology) that we are all part of the cosmos — as lived experience, as "great reverence and heartfelt gratitude."

5) The Public Observatory Completing Its Role

Originally, the observatory aimed to nurture worldviews by observing the stars and transmitting knowledge — to weave the meaning of human life into the cosmos. Since modernity, however, has there not been a tendency to emphasise the provision of a rational, scientific image of the cosmos at the expense of the human dimension — and to unconsciously reinforce a worldview that measures wealth only through possession?

But if a planet that allows people to "live happily beneath the stars" is reborn, then — just as hospitals, originally founded to treat disease, would transform their purpose as diseases disappear, becoming places for maintaining and promoting everyday health — the current "public observatory," whose primary purpose has been the popularisation of scientific knowledge, will also have completed its historical role.

By the time Japan's public observatories mark their 200th anniversary, they may have transformed into "new sites and new public astronomical facilities as commons (shared heritage)" — bringing people and the cosmos into ever-deeper relationship — and may be shouldering that new role in the long story of humanity.

6. References (Chapter 8)

(See references in Chapter 7, which are shared with Chapter 8.)

Conclusion

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As this text has shown, the fundamental direction of the Public Program Working Group is, building on the achievements of the first and second periods — the systematisation of interpretation techniques and the training outcomes from earlier workshops — to further deepen understanding in the third period and beyond by:

- Learning about public astronomical facilities both within Japan and internationally and the current state of related research across a broad range;
- Broadening awareness of cosmologies and self-understanding across diverse cultures, in order to clarify both the differences and the common ground among them.

Through this historically and culturally informed astronomical awareness, the aim is to understand how humanity has understood itself and the cosmos across many eras and civilisations, and to offer — through the perspective uniquely available to public observatories — new structural insights into how this has shaped individual identity formation.

Further, the goal is to discover, through this understanding, the role that public observatories can play in addressing contemporary social challenges and opening a vista toward the future. For it is here — in this direction — that the essential reason for the existence of public observatories, and the most important direction they should pursue, is to be found.

Japan Public Observatory Society

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Appendix 1 What Is an Observatory?

Public Program WG Text Editing Committee

Chapter 1 of the main text introduced the history of public observatories in Japan with a focus on the significance of their 100th anniversary. This appendix examines the broader astronomical culture from which that history grew, looking in more detail at the many dimensions of Japan's astronomical heritage and comparing Japan's trajectory with international developments. This comparison helps to clarify the distinctive character of the Japanese public observatory.

1. What Are Japan's Public Observatories?

Japan's public observatories can be understood as institutions that combine:

30. Cosmologies and worldviews transmitted since ancient times through the Japanese calendar and myth;
31. Tangible and intangible astronomical cultures rooted in the everyday life of communities across Japan;
32. The scientific Western astronomy that arrived from the early modern period onward;
33. A foundation built by the activities of many amateur astronomers;
34. The accumulated conditions that allowed observatories to be established throughout the country;

— and which have consequently become, in their local communities, sites of social education and lifelong learning in astronomy and space science, while also embodying what can now be recognised as the museum functions of tourism, community development, and social welfare.

(This is the view of the Public Program Working Group.)

2. Historical Roles

1) Creation Myths

Creation myths are found across the world. They represent how the people of a given place understood the birth of the cosmos. Surveying them broadly, two major types can be identified: (1) those that narrate the creation of the world from nothing by a supreme deity, with the birth of the first gods and the separation of heaven and earth; and (2) those in which the world exists from the beginning, heaven and earth are already separated from the primordial time, and the supreme deity lives in heaven or on earth and later ascends.

Japan's Kojiki belongs to the first type; the parallels between the story of Izanaki and Izanami and the Greek myth of Orpheus are frequently noted.

Japan harbours three distinct mythological traditions, corresponding to the three routes by which the Japanese people migrated to the islands: (1) the Kojiki tradition, via the Korean peninsula; (2) the Ainu Yukar, in which animals speak in the first person, via Siberia; (3) tsunami myths transmitted in Okinawa and the Ryūkyū archipelago, related to the widespread flood myths found globally, via a sea route. The sea route would naturally have involved "star navigation" — confirming that astronomy is at the very origin of humanity.

2) The Calendar and Time

A second great historical function of astronomy is the establishment of the calendar and the measurement of time. Since ancient times, the regular cycles of celestial bodies have been the basis of timekeeping: the day (the most basic rhythm of life), the month (the lunar cycle), and

the year (the solar cycle of the seasons). The solar calendar follows the sun; the lunar calendar, the moon.

Ancient Egyptian and Mayan civilisations produced sophisticated astronomical calendars that required precise, long-term observation of the sky. These are evidence of the early and careful measurement of celestial movements — as dramatically illustrated by the "serpent shadow" that appears on the steps of the Mayan pyramid of Chichen Itza at the equinoxes.

3) Culture Rooted in Daily Life

Beyond formal scholarship, astronomy has always been woven into everyday culture. Agricultural timing, fishing seasons, and the routes of ocean voyagers were all read from the stars — knowledge passed down as local oral tradition. For maritime peoples, stars were literally the road signs of the sea.

The political dimension of astronomy should also be noted. As historian Goto Akira writes: "Because celestial phenomena cannot be controlled by human beings, a person who could find regularity in them — and thereby predict the future — could appear to dominate the cosmos."

3. Japan's Astronomical Culture

1) Ancient Japanese Cosmology — The Astronomical Dimension

The seedbed of natural science — observation of the natural world — can be found wherever human culture began. In East Asia, the Yellow River basin of China developed distinctive proto-sciences including astronomy, whose influence spread outward to Japan.

The *Kojiki* and *Nihon Shoki* (composed c. 712 and 720 CE) carry within them the names of celestial deities — Amaterasu Ōmikami (the sun goddess), Tsukuyomi no Mikoto (the moon god) — suggesting that the ancient Japanese were a people deeply attuned to the heavenly bodies.

The ceiling of the stone chamber of the Kitora Tumulus in Nara Prefecture bears a celestial map with more than 350 stars, connected by red lines to represent at least 74 constellations. Astronomical analysis by the National Astronomical Observatory of Japan dates the observations to around 300 CE (± 90 years) at a latitude of approximately 33.9°N — corresponding to Chang'an or Luoyang in China, or to Asuka in Japan — most likely reflecting the influence of cultural exchange with ancient China.

2) The Heian Period: Calendar and Onmyōdō

In the Heian period, the Onmyōryō — an office of the imperial court — oversaw the astronomical, calendrical, yin-yang, and time-keeping arts. The Onmyō-no-kami (director) led a staff of specialists in astronomy, yin-yang divination, calendar-making, and water-clock supervision.

The Senmyō Calendar (adopted 862 CE), one of Japan's official calendars, was used for an extraordinary 823 years — not because it was superior but because the end of the Tang Dynasty missions cut Japan off from Chinese calendrical knowledge, and Japan's own calendar science lacked the capacity to correct the growing discrepancies.

The famous onmyōji (yin-yang master) Abe no Seimei (921–1005 CE) inherited the astronomical tradition from his teacher Kamo no Yasunori, and his name has been associated in popular imagination ever since with the arts of divination and celestial reading.

3) Western Astronomy Arrives in Japan

"Astronomy as science" reached Japan from the West in the sixteenth century, brought by Jesuit missionaries — and initially as a tool of evangelisation. The Jesuits intended cosmology as an intellectual weapon against Buddhism and as proof of God's existence: the vast, orderly cosmos could only exist by the power of Deus (God).

Yet a revealing pattern emerged: in a letter of April 9, 1552, to the Jesuit Superior General, Francis Xavier wrote that "the Japanese greatly delight in learning about the movements of celestial bodies, eclipses, and the phases of the moon, and being able to explain these things is very useful for winning the goodwill of the people." What drove the process was Japan's own deep curiosity about nature — not merely the missionaries' intentions. Astronomical knowledge transmitted as a conversion tool exceeded its purpose, feeding a genuine intellectual hunger that was already present.

4) Telescope Makers and Public Observation Events in the Edo Period

The telescope reached Japan in 1613 — just a few years after Galileo first turned one to the sky — when the East India Company presented a military telescope to Tokugawa Ieyasu. By the eighteenth century, Japanese craftsmen were making their own.

Iwahashi Zenbei of Izumi province was among the earliest Japanese makers of astronomical telescopes. The earliest recorded public observation event in Japan was held on August 26, 1793, by the physician Tachibana Nankei at his residence using one of Iwahashi's instruments. Thirteen participants observed the sun, moon, Venus, Saturn, Jupiter, star clusters, and the Milky Way — and Tachibana's sketches of the sun and planets survive in the collection of the National Astronomical Observatory of Japan.

Kunitomo Tōbei, a gunsmith from Ōmi Province, made Japan's first reflecting telescope in 1832 and conducted detailed sunspot observations over fourteen months — a scientific achievement comparable to Heinrich Schwabe's contemporaneous discovery of the eleven-year sunspot cycle in Germany. His sketches are preserved at the Nagahama Castle History Museum.

Asada Gōryū, a physician-turned-astronomer, founded the Senjikan astronomical school in Osaka and trained outstanding students including Takahashi Yoshitoki (who reformed Japan's calendar through the Kansei Reform) and Hazama Shigetomi. Inō Tadataka — the surveyor who made Japan's first accurate maps — was a student of Takahashi, making him a "grand-student" of Asada.

5) Daily Life and the Astronomical-Meteorological Tradition

Before the Chinese calendar was imported in the sixth century, Japan had no "calendar" as such — but had a rich tradition of natural almanacs and folk astronomical knowledge passed down as local oral tradition. Knowledge of seasonal stars guided agricultural timing, fishing, and oceanic navigation.

This deep integration of astronomical knowledge into the fabric of daily life is a key reason why the concept of a "public" observatory — a place where anyone could come to observe and learn — found such fertile ground in Japan. The sky was never the exclusive province of the elite; it belonged to everyone.

4. References (Appendix 1)

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