14 · Japanese Celestial Cartography before the Meiji Period

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CELESTIAL MAPS IN ANTIQUITY AND THE MIDDLE AGES

Although there are few materials to tell us what kind of celestial maps there were in ancient and medieval Japan, we may assume that most were of Chinese derivation, either brought to Japan or copied there in manuscript form.[1] We have two types of evidence on which to base this claim. One is the archaeological evidence at Takamatsuzuka, a tomb in Nara Prefecture, and the other includes more standard maps and documents.

THE STAR CHART ON THE CEILING OF TAKAMATSUZUKA

The map of the heavens on the ceiling of the late seventh- or early eighth-century Takamatsuzuka is valuable in that it is the earliest known example of Japanese celestial cartography.[2] Evidence of Chinese influence is found in the twenty-eight lunar lodges, which were important in Chinese and, later, Japanese astronomy. The twenty-eight lunar lodges form a square, in the middle of which are the constellations Shiho (Four supports) and Hokkyoku (Stars of the North Pole) (fig. 14.1).[3]

In addition to the celestial ceiling, the walls of the tomb are covered with colorful paintings. They show the four sacred animals (*shi shinjū*) that are the tutelary gods of the four directions in Chinese tradition: *seiryū* (blue dragon) on the eastern wall, presumably *suzaku* (red bird) on the southern wall (almost completely ruined when the tomb was entered in the fourteenth century), *byakko* (white tiger) on the western wall, and *genbu* (turtle and snake interlocked) on the northern wall across from the entrance. Paintings of the sun on the eastern wall and the moon on the western wall use gold and silver foil, and beneath them a number of horizontal, parallel red lines represent clouds or mist. Sporadically placed along these lines are blue or green mountain signs, most likely an ancient way to show that the sun and the moon are seen beyond the mountains and clouds.

Rather than calling it a *seizu*—a star map that faithfully represents the relative positions of specific constellations—we might better refer to the ceiling of Takamatsuzuka as a *seishōzu*, a schematic picture of certain stars and constellations. The diagrammatic arrangement of the work neglects their relative locations.

Other examples of tombs displaying the twenty-eight lunar lodges are found in China and Korea (see above, esp. pp. 523–24, 537, 548–49). The lunar lodges on the ceiling along with portraits of the four sacred animals and human beings create a cosmos inside the tomb. A later Japanese example of a *seishōzu* with the lunar lodges is on the ceiling of the Naginataboko, a great, elaborately decorated, medieval carriage. Replicas of the Naginataboko are still used in the annual Gion festival in Kyōto (plate 32).

OTHER CELESTIAL MAPS AND PERTINENT DOCUMENTS BEFORE THE EDO PERIOD (TO A.D. 1600)

Other celestial maps, books, and documents attest to the

1. For a concise, accurate history of Japanese astronomy in English, see Shigeru Nakayama, *A History of Japanese Astronomy: Chinese Background and Western Impact* (Cambridge: Harvard University Press, 1969); it does not, however, discuss celestial cartography. For this latter topic, the following Japanese sources are recommended: Imoto Susumu, "Honchō seizu ryakkō" (Summary of researches on celestial maps made in Japan), pts. 1 and 2, *Tenmon Geppō* 35 (1942): 39–41 and 51–57; idem, "Zoku honchō seizu ryakkō" (Summary of researches on celestial maps made in Japan, continuation), *Tenmon Geppō* 35 (1942): 67–69; idem, "Maboroshi no seishuku zu" (A lost celestial map), *Tenmon Geppō* 65, no. 11 (1972): 290–92; Yabuuchi Kiyoshi (Yabuuti Kiyosi), "Chūgoku, Chōsen, Nihon, Indo no seiza" (Chinese, Korean, Japanese, and Indian constellations), in *Seiza* (Constellations) Shin Tenmongaku Kōza (New lecture series on astronomy), vol. 1, ed. Nojiri Hōei (Tokyo: Kōseisha, 1957), 123–56; and Watanabe Toshio, *Kinsei Nihon tenmongaku shi* (History of modern Japanese astronomy), 2 vols. (Tokyo: Kōseisha Kōseikaku, 1986–87), vol. 2, esp. 737–846.

2. See Takamatsuzuka Kofun Sōgō Gakujutsu Chōsakai (Joint Committee for the Scientific Investigation of Takamatsuzuka Burial Mound), *Takamatsuzuka kofun hekiga chōsa hōkokusho* (Report on the investigation of the Takamatsuzuka fresco by the Agency for Cultural Affairs) (Kyōto: Benrido, 1974). The internal dimensions of the tomb are 2.6 meters from north to south, 1.0 meter from east to west, and 1.13 meters in height.

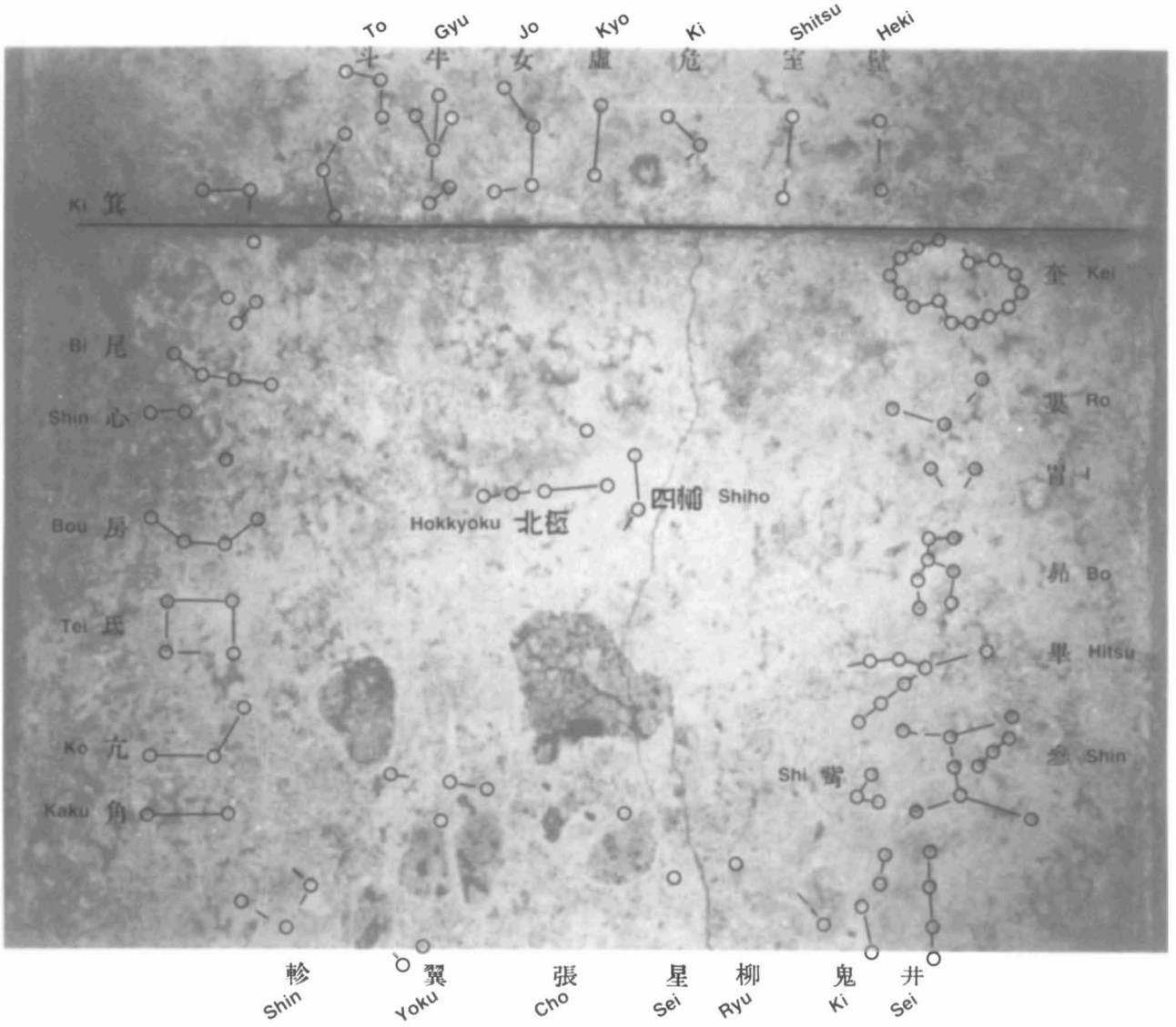
3. In Shiho only three of the four stars remain intact, and in Hokkyoku four out of five. The ceiling is damaged, and some stars have either fallen off or been peeled off by thieves. Takamatsuzuka is also discussed above, see pp. 352–53.

FIG. 14.1. MAP OF THE HEAVENS ON THE CEILING OF TAKAMATSUZUKA (CA. 700). Each star is indicated by thin gold leaf nine millimeters in diameter. The stars are connected by red lines drawn using a straightedge to form constellations. Drawn as if viewed from below, the lunar lodges form four groups of seven (*shihō shuku*), situated in each of the cardinal directions (north is at the top). The number of stars in each

Chinese influence on Japanese celestial cartography. The families given hereditary charge of calendar making and astrology at the imperial court, for instance, compiled their celestial maps from Chinese originals and copies of them. Titles of Chinese celestial maps and books can be found in an ancient catalog at the Shōsōin (treasury) at Tōdai Temple and in Fujiwara no Sukeyo's *Nihonkoku genzaisho mokuroku* (A list of books at present in Japan, ca. 891).[4] Two examples of titles are *Seki shi seikei bosan* (Star catalog and text on the constellations and the practice of astrology of Master Shi) and *Bosan* (Star catalog) that were taken from the Chinese titles *Xingjing* (Star classic [on astrological divination]) and *Bu zan* (Descriptive catalog on the stars and constellations), works credited to the Wei astronomer Shi Shen (Japanese Seki Shin).

Further documentary evidence suggests that celestial maps might have existed in Japan by the first third of the twelfth century. The *Chūyūki* (Diary of the Nakamikado) of 1131 notes that when a fire broke out at the Onmyō no Tsukasa (the Yin-Yang Board, an imperial office in charge of calendar making, timekeeping, astrology, and

4. The *Nihonkoku genzaisho mokuroku* is in the *Zoku gunsho ruijū* (Classified series of various books: Continuation, 1923–28, in 71 vols.), 3d rev. ed., 67 vols. (Tokyo: Zoku Gunsho Ruijū, 1957–59), vol. 30, bk. 2.



lunar lodge is typical of ancient Chinese star maps. On the right, we show the ceiling with an overlay containing the names and characters for the lunar lodges (they do not appear on the original). The horizontal line toward the top is a joint in the rocks. Size of the square formed by the constellations: 80 × 80 cm. Photograph courtesy of Yabuuchi Kiyoshi, Kyōto.

divination) in 1127, all the instruments were destroyed except a *rōkoku* (clepsydra, or water clock) and a *kontenzu* (a map or model of the celestial sphere). The latter instrument might have been a celestial globe, but we cannot be sure, because the syllable *zu* was also the word for map.[5]

Such references give us insights into the early history of Japanese celestial cartography. Further insights are provided by the manuscript *Shi Shi bu zan* (Star catalog according to Master Shi) that was handed down in the Wakasugi family, descendants of the steward of the Tsuchimikado (formerly called Abe) clan, hereditary holders of the Onmyō no Tsukasa. This is one of two scrolls that appear to be separate parts of one larger document. Its sources include Chen Zhuo's fourth-century *Bu zan* and a tripartite *Bu zan* attributed to Shi Shen, Gan De (or Gan Wenqing), and Wu Xian. These sources are mentioned in bibliographies and so are known to have been

5. Nakatsukasa Munetada, the author of this diary, is also known as Fujiwara Munetada. The relevant section of the *Chūyūki* is found in the *Shiryō taisei* (Series of historical materials), 43 vols. (Tokyo: Naigai Shoseki, 1934–43), 12:286–87. It is also included in the *Hōgibu* (Volume on technical specialists, 1909) section of the *Koji ruien* (Historical encyclopedia of Japan, 1896–1914), 51 vols. (Tokyo: Yoshikawa Kōbunkan, 1982). See also Watanabe, *Kinsei Nihon tenmongaku shi*, 2:463–64 (note 1).

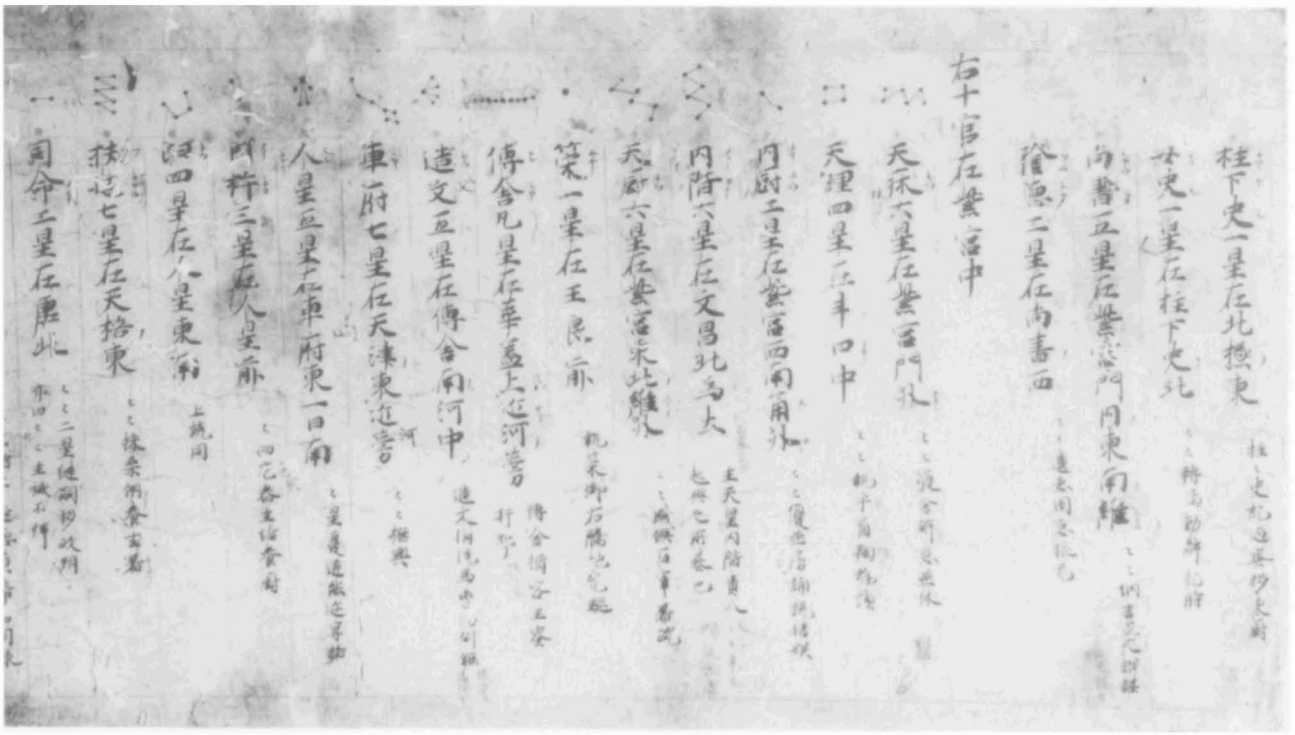


FIG. 14.2. PART OF THE *SHI SHI BU ZAN* MANUSCRIPT. This star catalog in scroll form, handed down in the Tsuchimikado clan, describes and illustrates the configuration of individual constellations according to ancient Chinese sources. Above the description of each constellation is a drawing in red of the configuration of stars. Size of the original: unknown. Kyōto Prefectural Museum. Photograph from Murayama Shūichi, ed., *Onmyōdō kiso shiryō shūsei* (Compilation of basic material on the techniques of divination) (Tokyo: Tōkyō Bijutsu, 1987), 193.

in Japan.[6] The scrolls contain brief descriptions of constellations, apparently based on the Chinese stellar records of Shi, Gan, and Wu attributed to the late Zhanguo (Warring States) period (403–221 B.C.).

It is not known how many times the original(s) brought from China were copied. We do know that about 1215 Abe no Yasutoshi made a copy and wrote remarks. Some of the constellations in Abe no Yasutoshi's version evidently were copied from the original (or a copy) and others copied from another source—the manuscript *Yoru no tsuki no susumu o tadasu no zu* (Star map for confirmation of the lunar motion at night).[7] Whereas the version used by Abe no Yasutoshi contained drawings, another source used a century later did not: according to Abe no Yasuyo in 1314, the original (or copy) that he used had no drawings, so he had to rely on books in the possession of the family in order to draw the constellations.[8] These remarks indicate that at least two different versions were used. The works of Abe no Yasutoshi and Abe no Yasuyo were later put together by an unknown copyist and annotated by Abe no Ariyo (1327–1402) (fig. 14.2).

Although these scrolls showed configurations of individual constellations, they contained no map of the heavens as a whole. The *Yoru no tsuki no susumu o tadasu no zu* (fig. 14.3), however, was a Japanese attempt to compile a celestial map that could be used to observe such phenomena as occultations of stars by the moon or close approaches between the moon and individual stars or constellations. Compiled by a member of the Abe clan at an unknown date, it was later copied by Abe no Yasuyo. Until it was destroyed in the Second World War,

6. These remarks are based on the reproductions of the two scrolls and bibliographical information in Murayama Shūichi, ed., *Onmyōdō kiso shiryō shūsei* (Compilation of basic material on the techniques of divination) (Tokyo: Tōkyō Bijutsu, 1987), 187–203 and 368–81. The scrolls are labeled A (*Seki shi bosan*) and B (*Zakka hō* [Various ways to tell fortunes]) in Murayama's book. Bibliographies such as *Nihonkoku genzaisho mokuroku* and other documents mention only the title of Chen's *Bu zan*, so we have no information on its contents. For more on Shi Shen, Gan De, and Wu Xian, see chapter 13 above.

7. In an epilogue dating from 1215, Abe states that "although there were some drawings in the original, I copied some from the *Yoru no tsuki no susumu o tadasu no zu* to replace those that were unconvincing in the original."

8. Watanabe, *Kinsei Nihon tenmongaku shi*, 2:763 (note 1), and Murayama, *Onmyōdō kiso shiryō shūsei*, 372 (note 6).

it was the oldest extant Japanese celestial map. A recent reconstruction in the form of a scroll was made from surviving pictures by Sasaki Eiji. The reconstruction captures the original's basic character, albeit with some uncertainties.[9] It consists of two maps of stars, one circular and the other rectangular. According to Watanabe Toshio, the boundaries for the lunar lodges were drawn based on values similar to those derived from observations by Yixing (682–727) during the Tang dynasty.[10] The Chinese constellations, the ecliptic,[11] and the Milky Way are also shown.

The books on Chinese constellations and the celestial maps mentioned above were all used for astrology, which in Japan—as in the rest of East Asia—was associated with governance and activities at the court. Commoners were excluded from its secrets, and the office of astrologer was made hereditary so that the practice could be controlled. According to the *Ryō no gige* (Commentary on the codes) of 833, private ownership of manuals on magic, books on astronomy, maps of stars, and devices such as armillary spheres was prohibited by law.[12] In ancient and medieval Japan circulation of celestial maps was therefore very limited. The only exception was during the period of civil wars (1467–1568), when the policy of secrecy was not heeded.

Two celestial maps from the period of civil wars are now the oldest existing Japanese star maps. Both are circular and show continuity with the Chinese tradition. The older map, *Ten no zu* (Map of the heavens) (fig. 14.4), is a hanging scroll that was probably made before 1547 (it seems to have been donated to Asakura Takakage, the lord of Echizen [now Fukui Prefecture], by Tanino Ippaku, a priest from Nara who was at Takedan Temple in 1547); the scroll is now designated an important national cultural property. Its distinctive feature is that within a narrow band representing the circle of constant visibility are entered the names of the twelve traditional *ji* (Chinese *ci* [Jupiter stations; literally, stations of the fictitious planet counter-Jupiter]). Although the Chinese divided the heavens into twelve equal *ji*, on this map they are unequal, and the degrees for each *ji* are noted. Another notable feature is the 366 meridians of right ascension radiating to the outermost boundary—the circle of constant invisibility—outside which lies the part of the celestial sphere constantly below the horizon; this is based on the Chinese degree (*du*, Japanese *do*), of which there were roughly 365¼ in a circle. Also included on the map are the celestial equator and Chinese constellations, but the ecliptic is not drawn in.[13] The second map, formerly in the possession of Imoto Susumu, was reportedly compiled during the Tenbun era (1532–55).[14] Its contents include Chinese constellations, the Milky Way, radially drawn straight lines to show the boundaries of the twenty-eight lunar lodges, the ecliptic, and three concentric circles that mark the circle of constant visibility, the celestial equator, and the circle of constant invisibility.

Another extant work from before the Edo period is a drawing of the stars by the emperor Go-Yōzei (r. 1586–1611). The map is very simple and includes Hokuto (the Big Dipper), Hokushin (or Hokkyoku-sei, the north star), and other stars in the north polar region that are recorded with the name Tengaisei (heavenly umbrella).[15]

9. The original was lost in an air raid on 25 May 1945. Sasaki Eiji, Fukui Prefecture, based his reconstruction on the photographs in Imoto, "Maboroshi no seishuku zu" (note 1) and also referred to the *Ten no zu* (Map of the heavens) at Takedan Temple (see below). Although in the original there were finely crosshatched lines, they are not drawn in the reproduction; there are also several errors in the names of the constellations. There is no record of the size of the original; the reproduction measures twenty-seven by seventy-eight centimeters (rectangular portion), twenty-seven by twenty-two centimeters with a radius of nine centimeters (circular portion), and twenty-seven by fifty-four centimeters for the section of annotations. Sasaki added an explanation of his reconstruction at the end of the reproduction.

10. Yixing, born Zhang Sui, was a patriarch of esoteric Buddhism and a leading astronomer. He had almost completed the Da yan calendar at his death in 727. This highly influential calendar was introduced to Japan in 735 and used from 763 to 861. See Watanabe, *Kinsei Nihon tenmongaku shi*, 2:760–65, esp. 762 (note 1), and Ōsaki Syōji, *Chūgoku no seiza no rekishi* (History of the Chinese constellations) (Tokyo: Yūzankaku, 1978). For more on Yixing, see above, esp. pp. 123, 533, and 538.

11. Ōsaki, *Chūgoku no seiza no rekishi* (note 10), says it is the path of the moon, not the ecliptic, but ecliptic seems correct.

12. The *Ryō no gige* is in the *Shintei zōho kokushi taikei* (Series of histories of our country revised and enlarged), 66 vols. (Tokyo: Yoshikawa Kōbunkan, 1929–64), vol. 22, chap. 10. See also the *Koji ruien*, *Hōgibu*, 284 (note 5).

13. The names and boundaries of the twenty-eight lunar lodges are shown around the periphery; individual ranges in right ascension are the same as those in *Rekirin mondōshū* (Questions and answers about the calendar, 1414) by Kamono Arikata.

14. According to Imoto, "Honchō seizu ryakkō" (note 1), the map was made into a hanging scroll. Around the edges of the map are quotations from the *Huntian yi* (Armillary sphere) by Zhang Heng (78–139) of the Later Han dynasty, the *Yueling zheng yi* (Commentary to the Monthly observances) by Kong Yingda (574–648), and other such works. The constellations of Beidou (Japanese Hokuto, the Big Dipper) and Beiji (Japanese Hokkyoku, the Stars of the North Pole), the twenty-eight lunar lodges, and the constellations of the three enclosures (*yuan*): Ziwei (Forbidden Purple, Japanese Shibi), Taiwei (Supreme Subtlety, Japanese Taibi), and Tianshi (Celestial Market, Japanese Tenshi) are represented by filled-in red circles. The other stars are shown as filled-in black circles. The Milky Way is painted with white wash, and the equator and the ecliptic are denoted by red and yellow circles, respectively.

15. Tengaisei in Japan may also refer to a silk umbrella placed above statues of the Buddha. The map is preserved at the library of the Imperial Household Agency. It was made into a hanging scroll and is significant only in that it was drawn by the emperor himself. No detailed study of the map has yet been made.

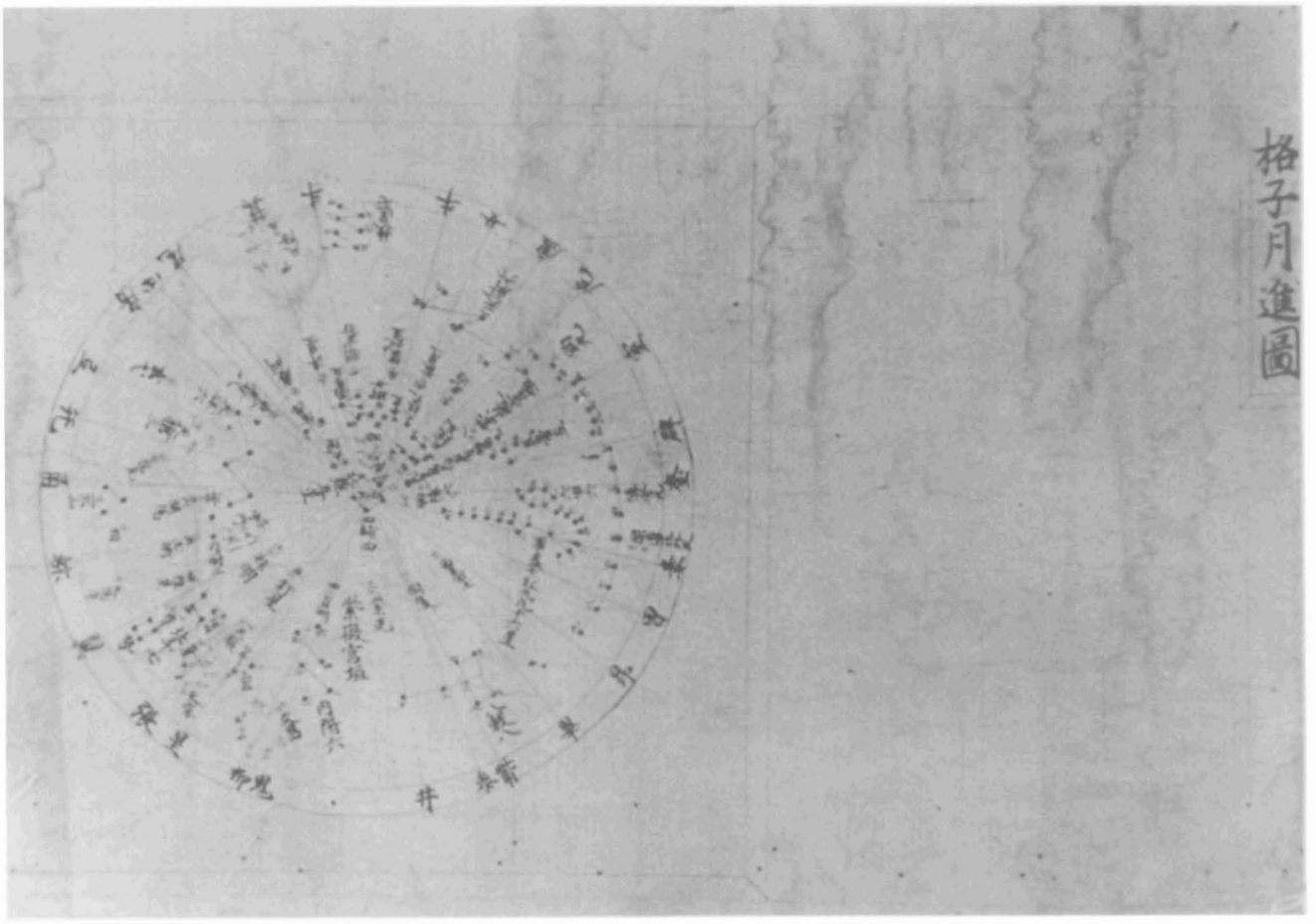


FIG. 14.3. THE *YORU NO TSUKI NO SUSUMU O TADASU NO ZU*. These two details show the circular star map, centered on the North Pole, and the equatorial zone of the rectangular map (from the vernal equinox [RA 0h] to the autumnal equinox [RA 12h]). On the latter chart the celestial equator is represented by a straight horizontal line across the middle. The irregularly

Celestial Maps in the Edo Period

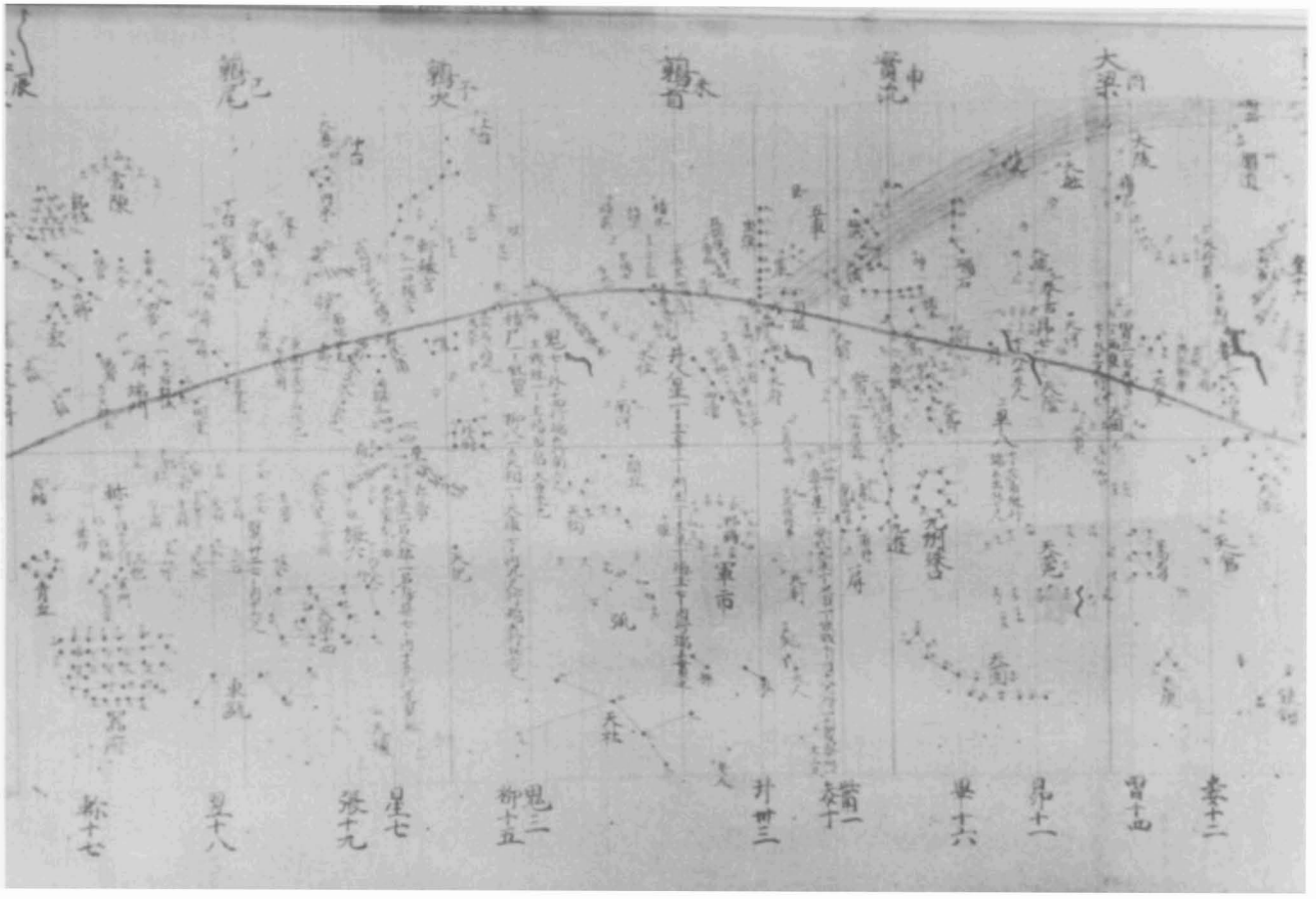
Influence of Chinese and Korean Celestial Maps

Early in the Edo period (1600–1868) Chinese books containing celestial maps were brought to Japan. Most influential were Chen Yuanjing's *Shilin guang ji* (Records of many things, ca. 1250), Wang Qi's *Sancai tuhui* (Illustrated compendium of the three powers [heaven, earth, and man], completed 1607, printed 1609), and You Yi's *Tianjing huowen* (Questions and answers on astronomy, 1672). The *Shilin guan ji*, a popular encyclopedia, contains entries about the life of commoners and was written for practical use. Two versions from the Yuan dynasty, three from the Ming, and one in Japanese still exist. The *Sancai tuhui* is illustrated throughout. You's *Tianjing huowen* attempted to reconcile ancient and recent Chinese theories with Western astronomy, but his understanding of both Chinese and European ideas was inadequate. Many of the quotations from books on Western astronomy written by Jesuits and those on Chinese astronomy were erroneous.[16] From the time of their arrival, books on astronomy published in Japan included celestial maps based on these works.

The Japanese reprint of the *Shilin guang ji*, which allegedly dates from 1699, is based on the Chinese edition of 1325 but contains both a rectangular and a circular celestial map that are lacking in the extant Chinese publication.[17] These two maps are valuable not only from the Japanese perspective but also from that of Chinese celestial cartography during the Song dynasty (960–1279). This is because they differ from maps in the *Xinyi xiang fayao* (New design for an armillary [sphere] and [celestial] globe), printed in 1094 by Su Song, and the famous

16. The *Tenkei wakumon chūkai zukan* (Annotations to illustrations contained in the *Tianjing huowen*, 1750) by Irie Osamu (see note 34 below) pointed out some of these errors. Some Buddhist priests were offended by You's work, since it did not agree with the Buddhist conception of the universe.

17. 1325 is the first Chinese printed edition. Later, inferior Chinese copies survive.



spaced vertical straight lines are lines of right ascension, marked by determinative stars (*kyo sei*), that serve as boundaries for the twenty-eight lunar lodges. Size of the original: unknown. From Imoto Susumu, "Maboroshi no seishuku zu" (A lost celestial map), *Tenmon Geppō* 65, no. 11 (1972).

Suzhou planisphere engraved on a stele in 1247 but based on a much earlier map.[18]

The *Tianjing huowen*, brought to Japan about 1672–79, combined ancient Chinese theories, the theories of the natural philosopher Zhu Xi (1130–1200), and the recent philosophical opinions of Fang Yizhi (1611–71) with knowledge that had been obtained from the Jesuits. Although the *Tianjing huowen* did not receive much attention in China, it was widely available in Japan and inspired many explanatory and critical books, especially after Nishikawa Masayasu (1693–1756) published the first Japanese version in 1730. Of particular importance was its illustration of the stars around the South Pole, which had not been shown on previous celestial maps; the book therefore provided the Japanese with their first knowledge of such stars. The section on astronomy and astrology in Terajima Ryōan's *Wakan sansai zue* (Illustrated encyclopedia of Japanese and Chinese things related to the three powers [heaven, earth, and man], 1715) took information from the *Tianjing huowen* and *Sancai tuhui*.[19] Both Chinese works also influenced later Japanese celestial maps.

Another work that influenced Japanese celestial cartography is the *Ch'ŏnsang yŏlch'a punyajido* (Chart of the constellations and the regions they govern), a star map

18. For the *Xinyi xiang fayao* see pp. 541–45 above and also Joseph Needham, Wang Ling, and Derek J. de Solla Price, *Heavenly Clockwork: The Great Astronomical Clocks of Medieval China*, 2d ed. (Cambridge: Cambridge University Press, 1986). I studied the Chinese text while reconstructing Su Song's water-powered armillary sphere and celestial globe tower (*shui yun yixiang tai*) for Seikō, the watchmaking company; the results of the study have not yet been published. The extant edition of the *Xinyi xiang fayao* is not the original. For a discussion of the Suzhou planisphere see pp. 545–48 and Yabuuchi Kiyoshi, *Chūgoku no tenmon rekihō* (The history of astronomy and calendrical science in China) (Tokyo: Heibonsha, 1969; rev. ed. 1990). A large number of rubbings of the Suzhou planisphere are found in Japan; some of these apparently were brought to Japan before the Meiji era and influenced Japanese celestial cartography.

19. Terajima Ryōan, ed., *Wakan sansai zue* (reprinted Tokyo: Tōkyō Bijutsu, 1982).

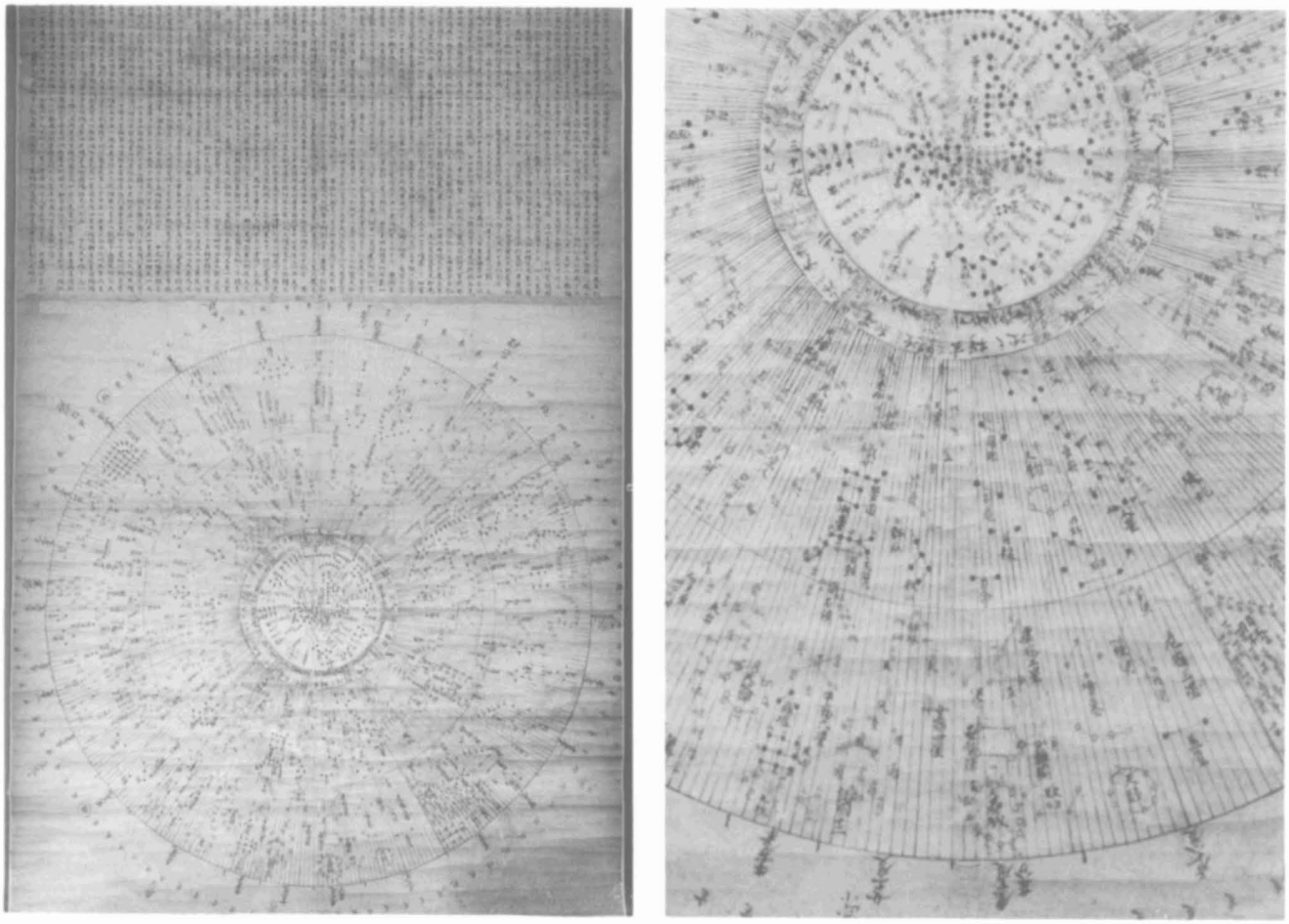


FIG. 14.4. THE *TEN NO ZU* AT TAKEDAN TEMPLE, FUKUI PREFECTURE, AND DETAIL. Shown are the circle of constant visibility, names and extents of the twelve *ji*, and the meridians of right ascension based on the Chinese degree. Above the map is written some constellation poetry known as *Hoten ka* (see below, p. 598). Surrounding the names of the lunar lodges one hundred directions are indicated by twenty characters (eight of the twelve earthly branches [*shi*], eight of the ten celestial stems, and four of the eight signs of divination), each used five times. The stars that came from Wu Xian are represented by open black circles and those of Shi Shen and Gan De are shown as red and black circles, respectively. Size of the original: 144.2 × 156.5 cm. Photograph courtesy of Sasaki Eiji, Asahi-cho, Fukui Prefecture.

engraved on a stone in Korea in 1395.[20] Although no rubbings or prints from the 1395 stele survive in Japan, its influence is apparent. Rubbings and woodblock prints from a Korean stone copy of 1687 (identical to the 1395 stele except that the title was moved to the top) are extant. There are prints with the letters and figures in white on a black background and others with black letters and figures on white, and some copies have a colorless Milky Way on a pale blue background. The *Ch'ŏnsang yŏlch'a punyajido* provided the information for Fukushima Kunitaka's *Bundo no kiku* (literally, "standard for degree mensuration"), an instrument made in 1668, and Shibukawa Harumi's *Tenshō retsuji no zu* (Map of the arrangement of stars and constellations, 1670) and *Tenmon bun'ya no zu* (Map showing divisions of the heaven and regions they govern, 1677).[21]

20. See pp. 560–61 above and Sang-woon Jeon (Chŏn Sang'un), *Science and Technology in Korea: Traditional Instruments and Techniques* (Cambridge: MIT Press, 1974), 26–28. (The Japanese version of Jeon's book is *Kankoku kagaku gijutsu shi* [Tokyo: Koma-Shorin, 1978].)

21. Shibukawa's works are all discussed below; the two mentioned here are black-and-white woodblock prints, some of which had colored paint added. The *Ch'ŏnsang yŏlch'a punyajido* and the celestial maps in the *Sancai tuhui* also might have been used as source materials for the first printed Japanese celestial map. This map is in the *Shisho inmō ryaku zukai* (An outline illustrated with maps for correcting mistakes in the four Confucian classics), edited by Ōhara Takekiyo in 1653. Because of differences in the arrangement of the stars and shapes of

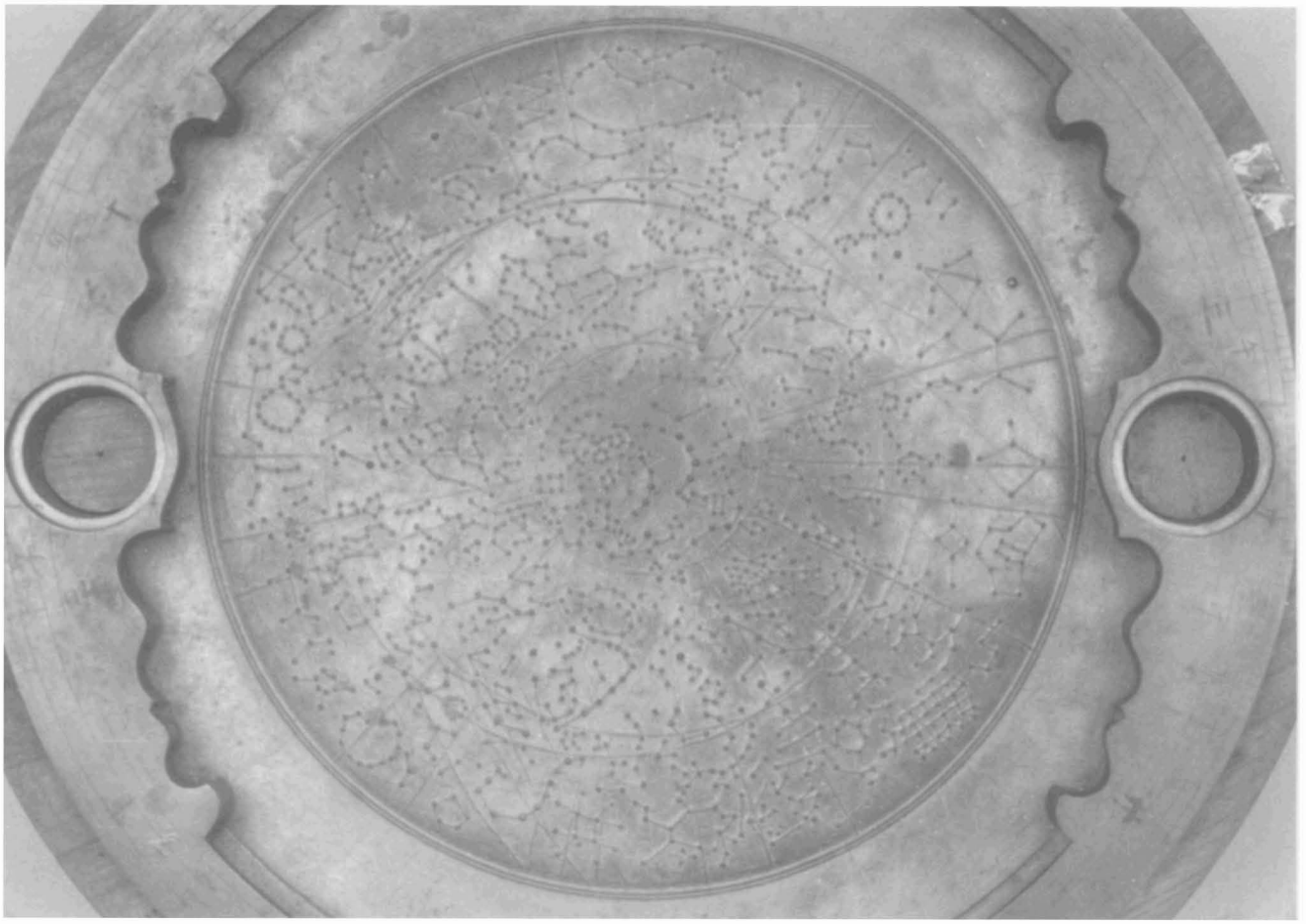


FIG. 14.5. FUKUSHIMA KUNITAKA'S *BUNDO NO KIKU*, 1683. This pan-shaped bronze instrument features a celestial map based on the *Ch'ŏnsang yŏlch'a punyajido* engraved in its concave center. On the edge are two small depressions for magnetic compasses. The original was made in 1668 on the orders of the military engineer Hōjō Ujinaga. According to Fukushima's engraving on the reverse, in 1683 the feudal lord of Hasuike, Nabeshima Naoyuki, ordered a smith named Chōken to copy the *Bundo no kiku*.
Size of the original: ca. 34 cm in diameter, celestial map ca. 24 cm in diameter. Saga Prefectural Library. Photograph courtesy of Kazuhiko Miyajima, Ōsaka.

Fukushima's *Bundo no kiku* is a pan-shaped bronze instrument featuring a celestial map based on the *Ch'ŏnsang yŏlch'a punyajido* engraved in the concave central part (fig. 14.5). The instrument discussed in chapter 13 is an accurate copy of the *Bundo no kiku* illustrated here. That copy is thought to have been taken from a sailing ship, and Needham speculates that it was used by navigators.[22] Fukushima's *Bundo no kiku* was described through illustrations and identified as a "*taien bundo*" (large circular protractor) in *Bundo yojutsu* (Techniques of protraction, 1728) by Matsumiya Toshitsugu (or Kanzan).[23] Matsumiya notes the star map, but he does not relate it to the instrument's function. The instrument's main uses were as a level, by filling the central depression

the constellations, however, we cannot firmly establish this relationship. The map is illustrated in Watanabe, *Kinsei Nihon tenmongaku shi* (note 1), and discussed by Imoto, "Honchō seizu ryakkō," pt. 2 (note 1). It is circular and spread out over two pages, with the North Pole in the center. Three concentric circles represent the circle of constant visibility, the equator, and the circle of constant invisibility; the outline of the Milky Way is drawn in. Other than the lunar lodges, there are few stars on the map, and they are depicted by black circles either left blank or filled in.

22. Joseph Needham, *Science and Civilisation in China* (Cambridge: Cambridge University Press, 1954–), vol. 3, with Wang Ling, *Mathematics and the Sciences of the Heavens and the Earth* (1959), 279 and 282. See also E. B. Knobel, "On a Chinese Planisphere," *Monthly Notices of the Royal Astronomical Society* 69 (1909): 435–45, esp. 436.

23. The *Bundo yojutsu*, a manuscript book on surveying techniques, is at the National Archives in Tokyo.

with water, and for measuring azimuths with reference to the graduations on the circumference.[24]

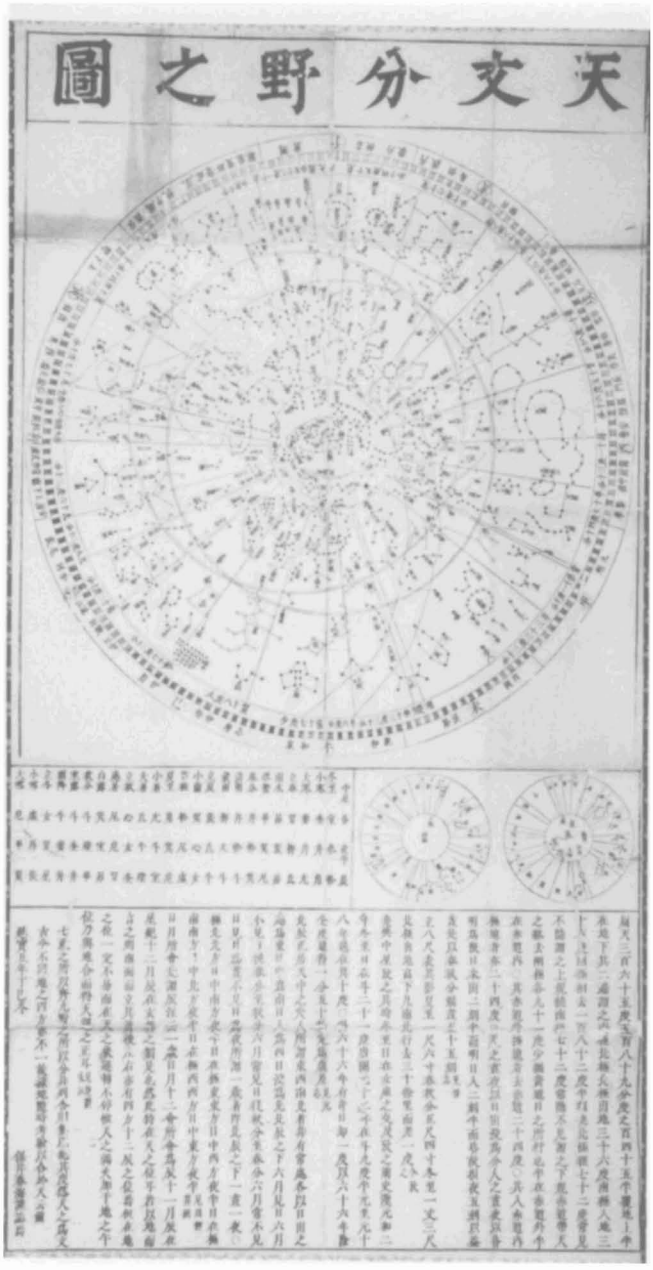


FIG. 14.6. *TENMON BUN'YA NO ZU* (MAP SHOWING DIVISIONS OF THE HEAVEN AND REGIONS THEY GOVERN), 1677, BY SHIBUKAWA HARUMI. This circular star map was based on the *Ch'ŏnsang yŏlch'a punyajido*. Shibukawa added a Japanese adaptation of Chinese "field allocation" astrology, in which terrestrial regions were associated with various celestial divisions.
Size of the original: 108 × 55.5 cm. Photograph courtesy of Kazuhiko Miyajima, Ōsaka.

SHIBUKAWA HARUMI'S STAR MAPS AND NEW CONSTELLATIONS

One of the greatest astronomers to have lived in Japan was Shibukawa Harumi (1639–1716), the son of Yasui Santetsu (1590–1652), a master of the game of go at the shogunate.[25] Shibukawa's infant name was Yasui Rokuzō. He changed his given name to Santetsu after his father died. Harumi is his pen name. He changed his surname to Yasui (written with a different first character) by the time his *Tenmon bun'ya no zu* was published in 1677. In 1702 he changed his surname again, this time to Shibukawa, which was the former name of the Yasui family.

Shibukawa is particularly known for his calendrical system, adopted in 1684 and named the Jōkyō calendar after the reign title (1684–88). Replacing the Senmyō (Chinese Xuanming) calendar, the Jōkyō calendar is notable because, unlike previous Japanese calendars that relied completely on Chinese theory, it was compiled from Shibukawa's own systematic astronomical observations. It was the first in Japan to be so produced, and it was widely adopted.[26] The calendar reform earned Shibukawa an appointment as official astronomer (*tenmonkata*) to the shogunate, a post that thereafter became hereditary. From this time onward Japan ceased to adopt Chinese calendars and made its own.

Before his calendar reform, Shibukawa compiled the *Tenshō retsuji no zu*, based partly on the *Ch'ŏnsang yŏlch'a punyajido*. However, he adopted the values for extents in right ascension of the twenty-eight lunar lodges from the Chinese Guo Shoujing's Shoushi calendar (season-granting system) of 1279.[27] The declination values of the determinative stars (*kyo sei*) that demarcated the lunar lodges were taken from the *Song shi* (History of the Song, 1346) as quoted in the *Tianwen da cheng guan kui jiyao* (Essentials of astronomy, 1653) edited by Huang

24. Kazutaka Unno, "A Surveying Instrument Designed by Hōjō Ujinaga [1609–70]," paper presented at the Seventh International Conference on the History of Science in East Asia, Kyōto, Japan, August 1993.

25. Go is played with black and white stones on a board marked with nineteen vertical and nineteen horizontal lines, the goal being to surround the larger portion of the board and capture the opponent's stones.

26. Nakayama, *History of Japanese Astronomy*, 120 (note 1).

27. The Shoushi calendar astronomical system survives in Song Lian et al., *Yuan shi* (History of the Yuan, comp. 1369–70); see the edition in 15 vols. (Beijing: Zhonghua Shuju, 1976), chaps. 52–55. The Shoushi calendar was not significantly influenced by Islamic astronomy. According to Yabuuchi, *Chūgoku no tenmon rekihō*, 145 (note 18), no Islamic influence is evident in computational procedures; it essentially followed Chinese tradition, except for some Islamic influence on the new instruments used to establish the system.

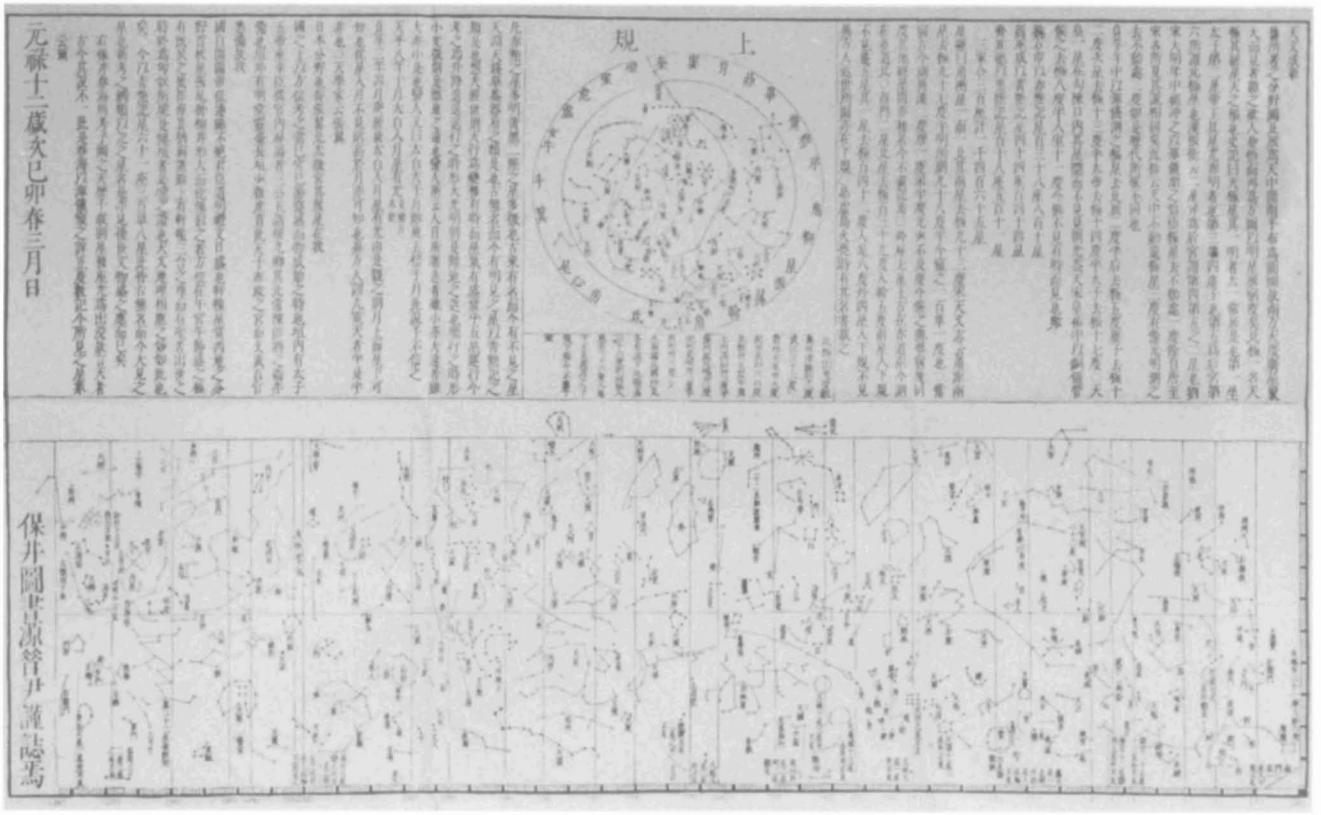


FIG. 14.7. *TENMON SEISHŌ ZU*, 1699, BY SHIBUKAWA HARUMI. The map was published under the name of Shibukawa's son Hisatada. Stars are shown as small black circles (Gan De's constellations) and as small open black circles painted yellow, red, and blue. The yellow are Wu Xian's constellations, those in red are Shi Shen's, and those in blue are Shibukawa's newly added constellations.
Size of the original: 49.9 × 82.5 cm. Photograph courtesy of Kazuhiko Miyajima, Ōsaka.

Ding.[28] To fix the position of constellations, the position of one star was measured and entered on the map; the other stars were then added without measurement as they were seen by the eye. Yamamoto Kakuan hints at the defects caused by such a method in his *Seimei kō* (Thoughts on the names of stars, 1744): "Even when observing the constellations with the help of traditional star maps, they cannot be recognized."[29]

In Chinese "field allocation" astrology, the twelve Jupiter stations were correlated with twelve ancient states of China and were used to interpret celestial omens, as were nine groups of the twenty-eight lunar lodges that were correlated with nine archaic provinces (see pp. 208–10 above). This correspondence was applied by Shibukawa to the regions of Japan in his *Tenmon bun'ya no zu* (fig. 14.6). Although this new correspondence is a major difference between the *Tenmon bun'ya no zu* and the *Tenshō retsuji no zu*, it is not the only one.[30] The location of Canopus (the star Nankyoku Rōjin [the old man in the southern polar region]; Chinese Laoren) also suggests that the *Tenmon bun'ya no zu* was revised to some extent. In both the Korean *Ch'ŏnsang yŏlch'a punyajido* and the *Tenshō retsuji no zu* it is placed to the southeast of Sirius (the star Rō [wolf]; Chinese Lang), far from its actual position to the southwest. The *Tenmon bun'ya no zu* shows it due south of Sirius, closer to its correct location. Shibukawa further revised the location of Canopus in his *Tenmon seishō zu* (Map of the arrangement of stars and constellations, 1699), in which it is almost in the right place.

The *Tenmon seishō zu* is divided into two parts, a circular celestial map above and a rectangular one below (fig. 14.7). In the top part, whose center is the North Pole, constellations in the north circumpolar region are

28. The declination values of the determinative stars in the *Tianwen da cheng guan kui jiyao* are said to be from the treatise on musical scales and astronomy in the *Song shi*, but they in fact differ slightly, and Shibukawa's values match those in the *Tianwen*. The *Tianwen*, 80 volumes including illustrations, was compiled from 143 books on astronomy and astrology. Weather phenomena and divination using animals and plants were also mentioned.

29. This quotation appears at the end of the *Seimei kō*; see Watanabe, *Kinsei Nihon tenmongaku shi*, 2:766–67 (note 1). There are no modern editions or reprints of the *Seimei kō*.

30. Watanabe, *Kinsei Nihon tenmongaku shi*, 2:733 (note 1), claimed that except for this innovation the maps were identical even in their mistakes.

drawn. Names of the lunar lodges are written around the outside, and latitudes of various parts of Japan are written below the map. In the columns on both sides of the circular map is a brief commentary on the constellations associated with the three archaic Chinese systems of Gan De, Wu Xian, and Shi Shen. Here it is mentioned that Shibukawa established new constellations and that they made this star map in accordance with positions of stars observed using an armillary sphere.

On the rectangular map, three horizontal lines are drawn: the uppermost represents the circle of constant visibility, the middle line the equator, and the lowest the circle of constant invisibility. A few star groups are also shown a little above the upper line. A scale of right ascension is marked at the bottom at both one-degree and ten-degree intervals. This follows the Chinese and Japanese tradition and marks 365 degrees. The vertical lines are the boundaries between the lunar lodges. At the right, graduations of celestial declination are marked at intervals of one and ten degrees, ranging over 108 degrees from top to bottom.

Besides the constellations that mark the twenty-eight lunar lodges, with their origins in antiquity, China also had a number of constellations that corresponded to sections of its bureaucracy. Sometimes if something unusual happened in one of these constellations, an astrologer would claim that the corresponding government department was responsible. This system dates from the Jin dynasty, when the director of the National Observatory, Chen Zhuo, integrated the constellations used by the three astronomical and astrological schools. To identify their origins, the constellations were classified under the names used by a Zhanguo astrologer. Wu Xian's set included 44 constellations of 144 stars; Shi Shen's had 138 constellations, 810 stars, and the twenty-eight lunar lodges; Gan De's contained 118 constellations of 511 stars. The Japanese government continued to use the Chinese constellations during Shibukawa's lifetime. Some stars visible to the naked eye were still not included in any established constellation. Shibukawa therefore used them to make 61 new constellations out of 308 stars, which he associated with the Japanese bureaucracy. He published this system in 1698 in his book *Tenmon keitō* (Astronomical encyclopedia). It appears in 1699 on the *Tenmon seishō zu*.[31] Whereas the three sets of Chinese constellations were colored in yellow, red, and black, as was customary on celestial maps, Shibukawa's uniquely Japanese constellations were colored in blue. The *Tenmon keitō*, furthermore, also included celestial maps based on original data obtained by Shibukawa, unlike the *Tenmon bun'ya no zu* and the *Tenshō retsuji no zu*. Both the *Tenmon keitō* and the *Tenmon seishō zu* show an improvement in the accuracy of the position of the stars.

Shibukawa's *Tenmonzu byōbu* (Drawings of the celestial sphere on a folding screen) is a six-fold gilded screen made sometime between 1697 and 1715 (fig. 14.8).[32] On the three and part of the fourth panels to the right is a large circular celestial map. The three panels on the left have two small circular celestial maps and a rectangular celestial map. The circular maps on the left are centered on the North and South Poles, the former, along with the rectangular celestial map, having come from the *Tenmon seishō zu*, and the latter probably copied from the *Tianjing huowen*. These are rather conventional, but the large map on the right is unusual in that, although it is centered on the North Pole and the circle of constant invisibility is the outermost circle, it is a mirror image of the stars, produced as if the celestial sphere were viewed from the outside.

SHIBUKAWA HARUMI'S INFLUENCE

Shibukawa's celestial maps had a great influence on contemporary and later celestial maps and globes. For example, the celestial maps in Iguchi Tsunenori's (or Jōhan) *Tenmon zukai* (Astronomy illustrated, 1689) and Namura Jōhaku's *Koreki binran bikō* (Handbook of old calendars, 1692), as well as Iguchi's *Tenshō hokusei no zu* (Celestial map of the Northern Hemisphere, 1698), are all copies of the *Tenshō retsuji no zu*.[33]

The *Tenmon zukai* is the first astronomical book published in Japan. Although all five volumes mention the study of mathematical astronomy, the first volume has circular star maps and the second has figures of the lunar lodges. Most of the stars are shown as black circles, but those of the lunar lodges and other notable stars in the circular star map are shown as white circles, as are the determinative stars in the figures of the lunar lodges. In the section on the lunar lodges, the starting points of the various lunar lodges are identical to those in the *Tenshō retsuji no zu*, including some that were in error. Namura's

31. The *Tenmon keitō* is an eight-volume astronomical manuscript, given to the shogunate family and the Ise Jingū (Ise Shrine). For matters related to astrology, the author followed the *Tianwen da cheng guan kui jiyao*; however, the contents are considerably simplified. As for astronomy, the author was greatly influenced by the *Tianjing huowen*, but he also criticizes it. Shibukawa mentions his observations and instruments for observation in detail. The *Tenmon seishō zu* was made according to these data.

32. Shibukawa's *Tenmonzu byōbu* was deposited in the Ōsaka City Museum by Nanba Matsutarō and is discussed in Akioka Takejirō, "*Kon'yo bankoku zenzu byōbu* sōsetsu, Shibukawa Harumi byō narabini Tō Kōsekishi byō no sekaizu tenmonzu byōbu" (General remarks on the *Kon'yo bankoku zenzu byōbu* [a folding screen on which a world map is drawn], and some remarks on folding screens with world maps and star maps by Shibukawa Harumi and by Tō Kōsekishi), *Hōsei Daigaku Bungakubu Kiyō* 8 (1962): 1–28.

33. Watanabe, *Kinsei Nihon tenmongaku shi*, 2:827–30 (note 1).

Koreki binran bikō contains a star map identical to the one in Iguchi's *Tenmon zukai.*

Iguchi's *Tenshō hokusei no zu*, showing the Northern Hemisphere, was published in 1698 with his *Tenshō nansei no zu* (Celestial map of the Southern Hemisphere). They are 52 centimeters wide and 125 centimeters long. Copies are rare, and the maps have not been studied in depth. In contrast to the star maps in the *Tenmon zukai*, no meridians separate the lunar lodges. The stars of the lunar lodges and notable stars in other constellations are shown as white circles.

Many other contemporary maps were influenced by Shibukawa's work, notably the revised star maps in Irie Osamu's *Tenkei wakumon chūkai zukan* (Annotations to illustrations contained in the *Tianjing huowen*, 1750),[34] which was the second volume of Irie's explanation and revision of You Yi's *Tianjing huowen*. In the beginning of the second volume Irie writes: "Though Yasui Harumi achieved excellent results in the study of constellations, the circular star map he originated did not show the shapes of constellations correctly. His later rectangular star map finally showed the real shapes. I copy the arrangement of stars from the latter using a compass and a ruler, then make revised maps and show them after the originals." The *Tianjing huowen* has eight types of circular star maps. Irie reprinted the eight original maps and printed revisions of all except the star map of the region of constant invisibility. If the original illustration or explanation was incorrect, he showed a corrected one (or one he thought was correct), basing his revisions on Shibukawa's *Tenmon seishō zu*. The map of the region of constant invisibility, "Nankyoku shoseien kenkai seizu," was not revised because "this region cannot be seen from Japan and some other countries, so it was not illustrated in old celestial globes. Western astronomy was introduced to China, and Westerners who traveled across the sea in the south observed and made this. We cannot see it from Japan, so it is impossible to revise." Of the revised map of the region of constant visibility, "Hokkyoku shibien kenkai kaisei zu," Irie wrote: "I have copied three kinds of star maps of the whole heaven; each has good points and bad points compared with the originals. Yasui Harumi's *Tenmon seishō hōzu* [*Tenmon seishō zu*] is almost real, though it is not perfect, and it is well known, so I revised this a little and made each revised map. I would like people who see these to try to revise them [further]." He then printed copies from the *Tenmon seishō zu* below the revised map of the Milky Way and the constellations along it in the southern sky ("Nankyoku kakansei kenkai kaisei zu").

There is also a celestial globe dating from 1701 at Dōshisha University that was based on Shibukawa's *Tenmon bun'ya no zu*. On the papier-mâché globe are the stars of Wu Xian, Shi Shen, and Gan De, distinguished by gold, red, and black. Gold foil is pasted on the Milky Way. Although it was made after Shibukawa's new constellations had been established, they are not on the globe. It has the same errors as on the *Tenmon bun'ya no zu*, and the connections between the stars are the same as on the *Tenmon bun'ya no zu*, so it seems that the globe was based on this map. The *kontenzu* that escaped the fire of the Yin-Yang Board in 1127 is thought to have been a celestial globe, but aside from this no celestial globe is mentioned before Shibukawa's time. The earliest extant Japanese celestial globes were made by Shibukawa and his contemporaries. These were large (about 50 cm diameter) and made of copper, but later ones were smaller (about 30 cm) and were made of papier-mâché and of paper pasted on wood or plaster. There are also examples lacquered in black.[35]

A later work apparently modeled on the *Tenmon seishō zu* is the celestial map in Hara Nagatsune's *Tenmon keii mondō wakai shō* (Questions and answers on astronomy, 1779).[36] The positions and sizes of the dots representing the stars and the boundary of the twenty-eight lunar lodges differ slightly from Shibukawa's map, and Hara's map does not distinguish between the constellations of three systems and the stars of the constellations established by Shibukawa. However, the annotations on the *Tenmon seishō zu* concerning which stars constitute each constellation are reproduced verbatim. Hara's map is noteworthy because it is one of the few star charts with the north and south transposed (the sphere appears as viewed from the outside) and with the names of the constellations in Chinese to which katakana (a phonetic syllabary) are attached to indicate pronunciation.

34. Irie Osamu (1699–1773) published *Tenkei wakumon chūkai* (Annotations to the *Tianjing huowen*) and *Tenkei wakumon chūkai zukan* as explanations for the *Tianjing huowen* (Japanese *Tenkei wakumon*). The former contains commentary on the introduction to the *Tianjing huowen*, by You Yi's friends, that explains the title of the book and technical terms. There are no illustrations. The *Tenkei wakumon chūkai zukan* comments on illustrations and explanations in the beginning of the text of the *Tianjing huowen.*

35. See Miyajima Kazuhiko, "Dōshisha Daigaku shozō Genroku 14 nen sei tenkyūgi no ichizuke" (The position of the celestial globe made in 1701 and owned by Dōshisha University), *Dōshisha Daigaku Rikōgaku Kenkyū Hōkoku* 21 (1981): 279–300. There is abundant literature introducing and reporting on individual celestial globes, but few works deal with them collectively: see Hirose Hideo, "Tenkyūgi oboegaki" (Memorandum on celestial globes), *Gotō Puranetaryumi Gakugeihō* 6 (1978), and Miyajima Kazuhiko, "Mukashi no tenmon giki" (Astronomical instruments of old days), in *Tenmongaku shi* (History of astronomy), a series of lectures on modern astronomy, vol. 15 (1983). For a list of globes in Japan based on my investigations (celestial globes) and those of Kazutaka Unno (terrestrial globes), see Hirotada Kawamura, Kazutaka Unno, and Kazuhiko Miyajima, "List of Old Globes in Japan," *Der Globusfreund* 38–39 (1990): 173–77.

36. I have not seen Hara's map, but it is reproduced and discussed in Watanabe, *Kinsei Nihon tenmongaku shi*, 2:833–34 (note 1).

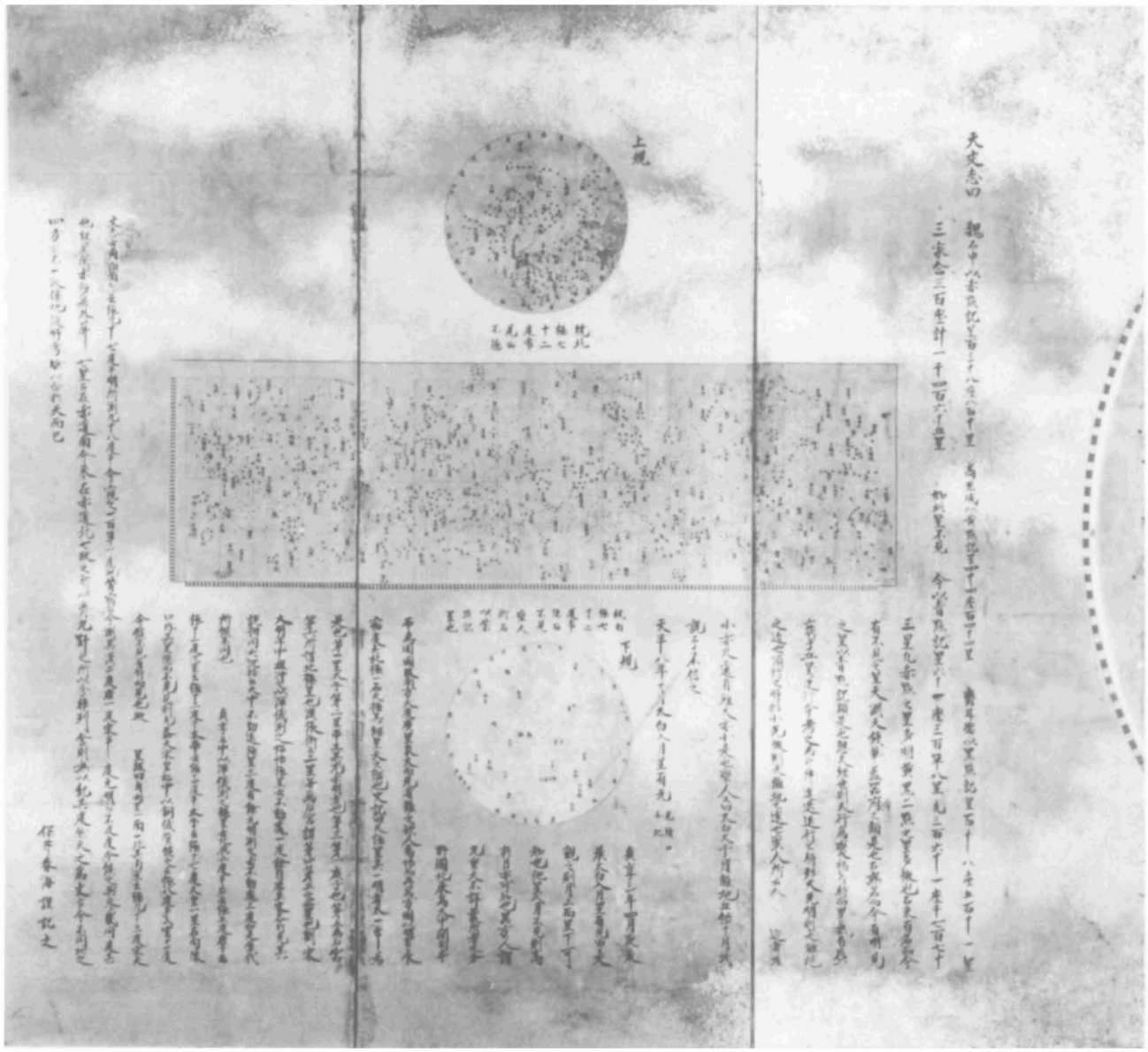
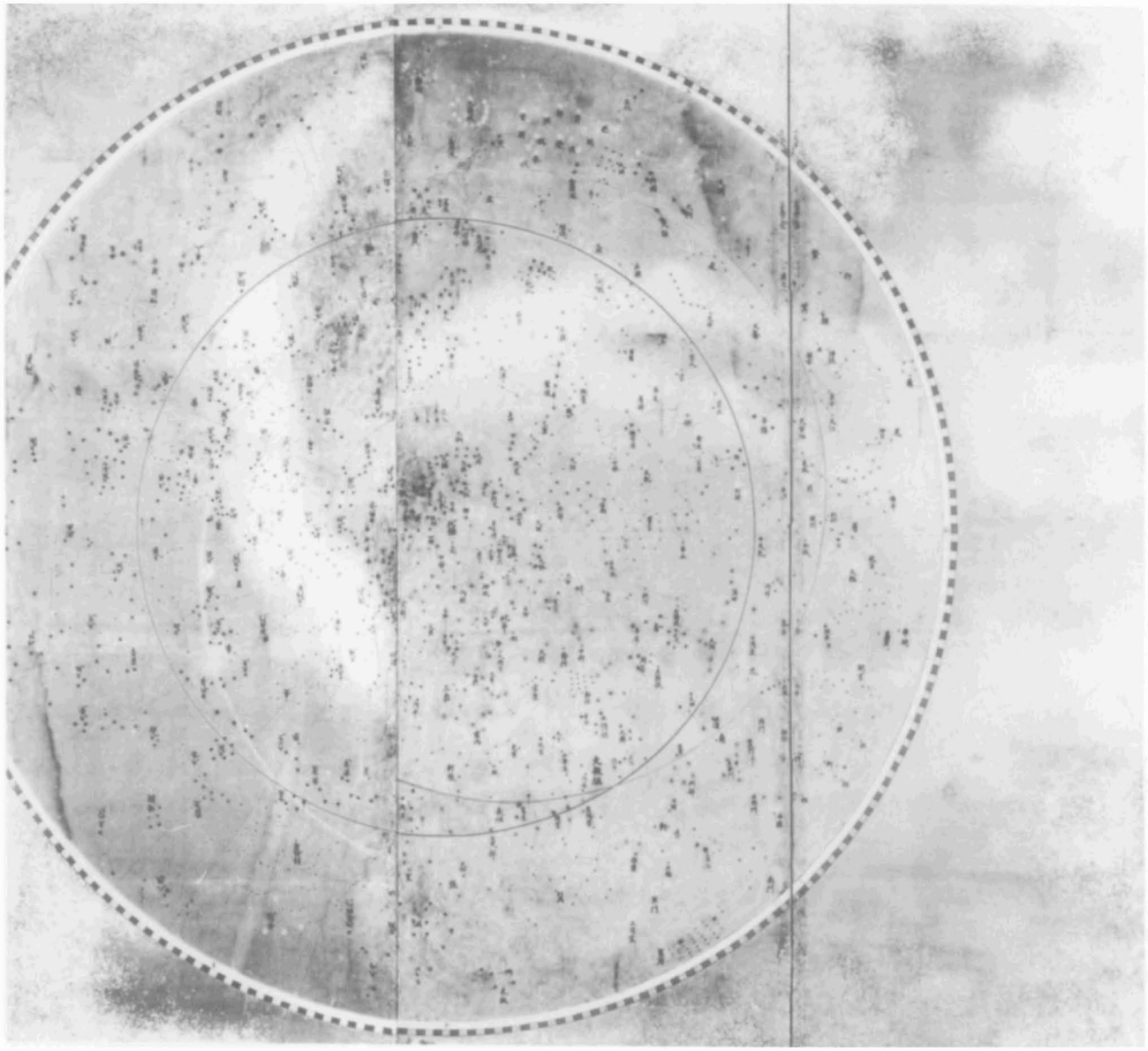


FIG. 14.8. *TENMONZU BYŌBU* BY SHIBUKAWA HARUMI, a six-fold screen with four celestial maps, three circular and one rectangular. The large circular map shows the stars of the Northern Hemisphere as though viewed from outside. Size of the entire screen: 184 × 377.5 cm. Ōsaka City Museum. Photograph courtesy of Nanba Matsutarō, Nishinomiya.

Iwahashi Zenbei (1756–1811), who produced a refracting telescope in Japan, invented a rotating diagrammical board called *heiten gi* (literally "planisphere"). Several colored disks with different radii one on top of the other rotate around the center. They represent (from the inside) the earth (with the North Pole at the center; radius ca. 4.5 cm), the tides with the moon's position, the day of the month with the sun's position determined by the lunar calendar, the twenty-eight lunar lodges, and last, the time of day (radius is approximately 12.5 cm). Basic astronomical knowledge is described in the accompanying text, *Heiten gi zukai* (Illustrated explanations of the *heiten gi*), primarily based on the *Tianjing huowen*. The maps included in this book are a rectangular map called "Kōsei no zu" (Map of the fixed stars), six pages, and two circular maps (two pages each)—one showing the northern polar region and the other the southern polar region. The rectangular map and the circular map centered on the North Pole are based on the *Tenmon seishō zu*. The other circular map centered on the South Pole is based on the *Tianjing huowen*.

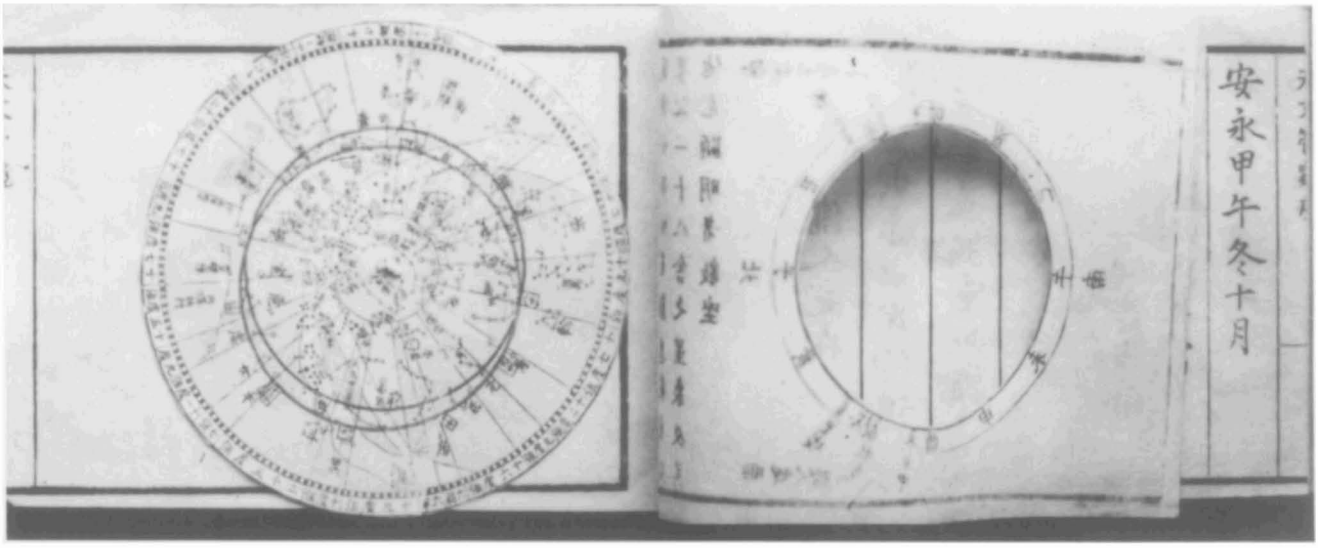


CELESTIAL MAPS BY NAGAKUBO SEKISUI

A work by the Mito geographer Nagakubo Sekisui, *Tenshō kanki shō* (Brief explanation of astronomical phenomena, 1774), contains a rare rotating planisphere, or volvelle, with the Chinese constellations.[37] The text describes why celestial chart boards were made and how to use them.

Tenshō kanki shō is a small pamphlet, and the circular map it contains is correspondingly small and fastened to one of the pages by a thread at its center (the North Pole) so it can rotate (fig. 14.9). The twenty-eight lunar lodges are depicted, but most constellations are omitted. The Milky Way is white on a blue background, the stars are either black or white circles, the equator is red, and the ecliptic is yellow. The position of the sun along the ecliptic is marked at twelve equal intervals including the winter

37. According to Watanabe, *Kinsei Nihon tenmongaku shi*, 2:832 (note 1), an 1824 work, *Tenmon seishō zukai* (Explanation of mapmaking in regard to the arrangement of the stars and astronomical phenomena), has the same content as the *Tenshō kanki shō*, including the rotating planisphere.



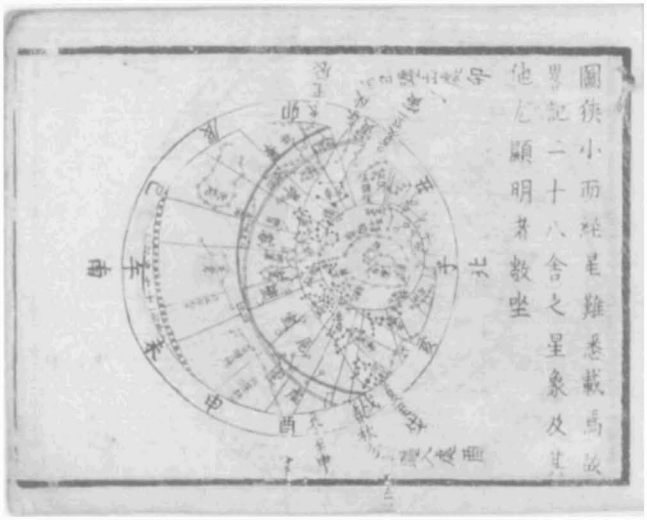


FIG. 14.9. ROTATING STAR MAP IN THE *TENSHŌ KANKI SHŌ* BY NAGAKUBO SEKISUI, 1774. In the first view is shown a rotating star map (left) over which the preceding page (right), with its cut-out circle representing the horizon, may be flipped, as in the second view. The star map is centered on the North Pole, and the equator (concentric circle) and ecliptic (eccentric circle) are also depicted.
Diameter of the rotatable star map: 10.8 cm; horizon circle: 7.7 cm. Owned by Kazu Tsuguto. Photograph courtesy of Kazuhiko Miyajima, Ōsaka.

solstice and the vernal equinox. In addition, the circle of constant visibility and the circle of constant invisibility are shown. Around the circumference, a scale in degrees and the extent of each of the twenty-eight lunar lodges are marked. Covering the map is a page with a circular window—the circle representing the horizon.

Nagakubo is also thought to be the author of an anonymous, undated *Tenmon seishō zu* (Map of the arrangement of stars and constellations) (fig. 14.10), which is larger and shows more stars than the planisphere in the *Tenmon seishō zukai*; the reason for this presumption is that the two works are similar in appearance and bear similar names.[38]

A scroll containing a rectangular celestial map, formerly in the possession of Kobayashi Yoshio (d. 1991), dates from 1796 and carries the inscription "I, Sekisui, drew this" (fig. 14.11). The arrangement of the stars and the notes on the map are duplicated precisely from Shibukawa's *Tenmon seishō zu*, except for the Milky Way, ecliptic, and thirty-five degree north declination line (corresponding to the latitude of Kyōto), lacking on Shibukawa's map.[39]

THE INFLUENCE OF JESUIT CELESTIAL MAPS AND STAR CATALOGS

When the Jesuits arrived in China toward the end of the Ming dynasty, they compiled star catalogs and maps from observations and tried to identify the stars in the Chinese constellations with those of the West. These Chinese

38. *Tenmon seishō zu* is homonymous with Shibukawa's *Tenmon seishō zu*, although there is a difference in the character *sei*. The former *Tenmon seishō zu* is illustrated by Watanabe, *Kinsei Nihon tenmongaku shi*, 2:833 (note 1), who believes Nagakubo produced the map. I was shown a celestial map by the late Kayahara Motoichirō that is identical to the *Tenmon seishō zu* reproduced in Watanabe. The map I saw was folded, and to its reddish brown cover was attached a piece of white paper that said "*Tenmon seishō zukai*, written by Master Chō Sekisui," which is Nagakubo Sekisui's pen name. I have also seen an identical celestial map owned by the University of Kyōto, and to its blue cover is attached a piece of white paper that says "*Tenmon seishō zu kan* [all of the *Tenmon seishō zu*]." Considering this, despite their slightly different titles, both the *Tenmon seishō zu* and the *Tenmon seishō zukai* must have been produced by Nagakubo.

39. About 1937, when he was studying at Daisan National High School, the astronomer Kobayashi was given the scroll, which had been found in the house of his English teacher, a Mr. Perkins.

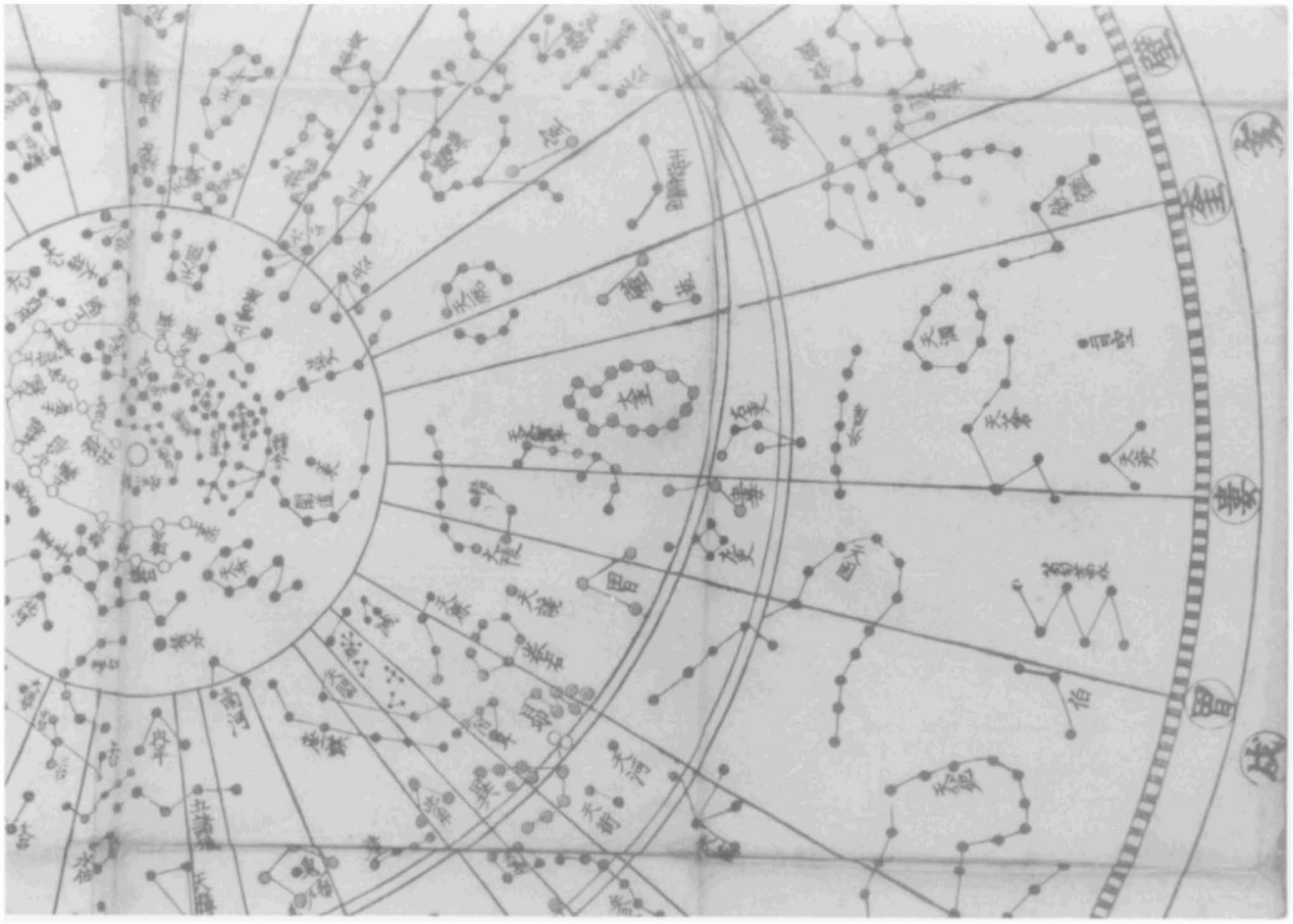


FIG. 14.10. ANONYMOUS, UNDATED *TENMON SEISHŌ ZU* AND DETAIL. On this celestial map, centered on the North Pole, the circles of the equator and ecliptic are shown as double black lines, the stars of the twenty-eight lunar lodges are painted red, and the rest of the stars are black circles or black dots. Size of the original: ca. 72 × 72 cm. Kyōto University. Photograph courtesy of Kazuhiko Miyajima, Ōsaka.

texts of the Jesuits and the aspects of European astronomy that they introduced—most notably the classification of stars by magnitude—had an influence on Japanese celestial cartography in the Edo period. We should be cautious about overrating their importance, however, as Nakayama suggests:

> Scholars who have studied the reports of such missions to China as Matteo Ricci and Johann Adam Schall von Bell tend to project their picture of seventeenth-century Chinese science onto that of Japan in the corresponding period and often conjecture that Japanese science also was substantially affected by the early contributions of the Jesuits. However, circumstances in the two countries differed greatly.
>
> The Japanese government in the beginning of the

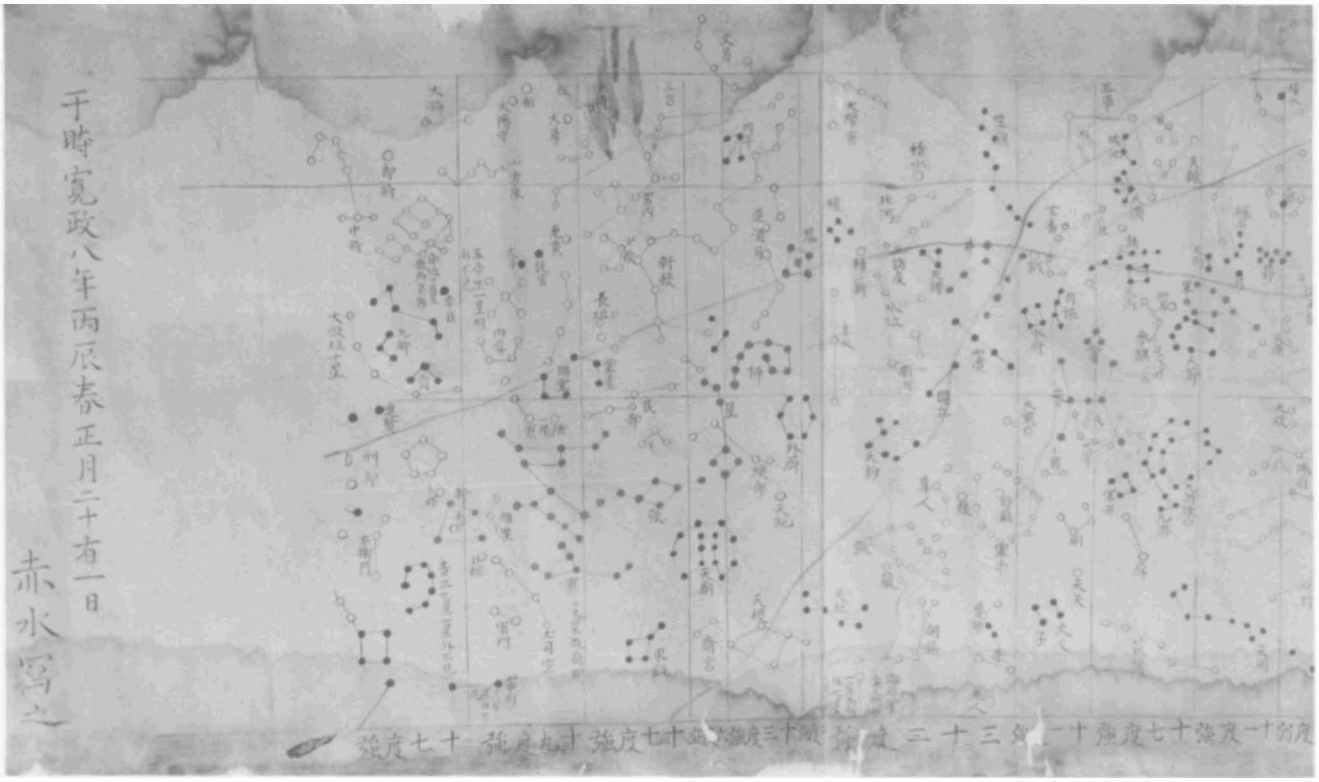


FIG. 14.11. SCROLL CONTAINING A RECTANGULAR CELESTIAL MAP DATING FROM 1796. This is based on the *Tenmon seishō zu* of Shibukawa. The field on which the constellations are drawn is surrounded by a black line, although there are a few constellations drawn in the top margin (north). The lower margin has the angular extent of each of the lunar lodges in degrees. The surrounding line, the equator, and the boundaries of the lunar lodges are drawn in black using a

> seventeenth century . . . strictly prohibited the diffusion of the Christian religion and Western learning in general. . . . The teachings of the missionaries in Japan thus were nearly eradicated.[40]

We can nonetheless see Jesuit influence in a few Japanese works from the eighteenth century and the first half of the nineteenth.

Jesuit scholarship had an influence through the *Yixiang kaocheng* (Treatise of astronomical instruments), originally compiled by Ignatius Kögler and others in 1744. In its revised version, 1755, it included the Qianlong star catalog (1752).[41] This star catalog provided star magnitudes and was probably used by the Japanese philosopher Miura Baien (1723–89) for his circular celestial maps of the Northern and Southern hemispheres (mounted as hanging scrolls), which classify the stars according to six magnitudes.[42] Traditionally, Chinese and Japanese drew stars larger on celestial maps to show they were important, but not necessarily brighter. More often than not, stars were shown as small circles of the same size without distinguishing brightness. Classification according to magnitude was introduced to China by the Jesuits. On Miura's maps, stars of the first and second magnitudes are shown as six- and five-pointed stars, respectively, with rays to highlight them. Stars of the third and fourth magnitudes are depicted as six- and five-pointed stars without rays, and stars of the fifth and sixth magnitudes are small circles with five or six rays.

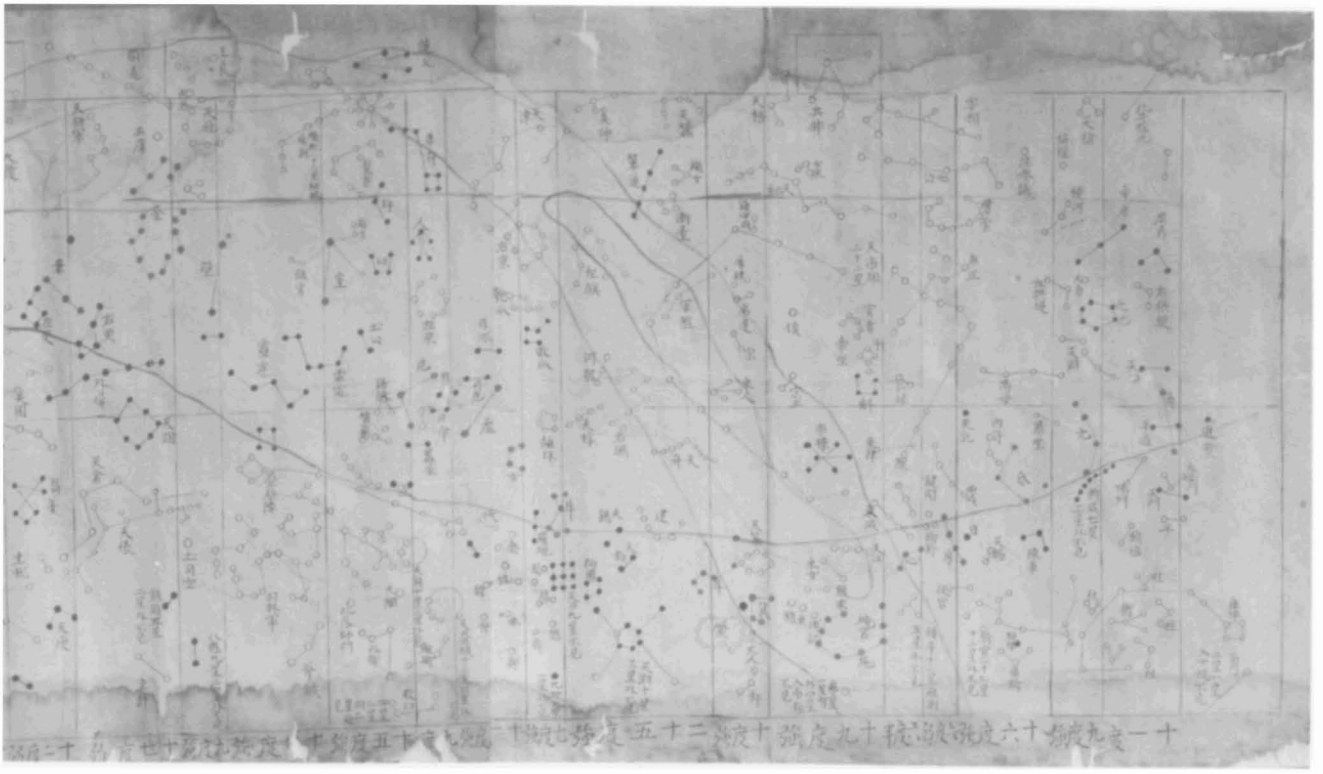
The European-influenced custom of classification by magnitude may also be observed in maps by Takahashi Kageyasu (1785–1829) and Ishizaka Jōken (1783–1844). In his celestial map, *Seiza no zu* (Illustration of constellations, 1802), which he compiled after correcting the star catalog in the *Yixiang kaocheng* by taking precession into account, Takahashi classified the stars according to five magnitudes.[43] Ishizaka's *Hōen seizu* (Rectangular and circular star maps, 1826) has six classes of magnitude. The stars of the first magnitude are represented with five rays; other magnitudes are represented by the size of the circle representing the star.

40. Nakayama, *History of Japanese Astronomy*, 79–80 (note 1).

41. See Joseph Needham et al., *The Hall of Heavenly Records: Korean Astronomical Instruments and Clocks, 1380–1780* (Cambridge: Cambridge University Press, 1986), 171.

42. The positions of and connections between stars are based on older materials. These maps are kept at the house where Miura lived; there is also a celestial globe there made by Miura.

43. See Watanabe, *Kinsei Nihon tenmongaku shi*, 2:836, and Imoto, "Honchō seizu ryakkō" (both in note 1), where the *Seiza no zu* is referred to as *Tenmon sokuryō zu* (Astronomical survey map). It is



straightedge. The outline of the Milky Way, the ecliptic, and the line of declination near 35° (the latitude of Kyōto) are drawn freehand in red. The stars of Shi Shen's constellations are shown in red, those of Gan De in black, and those of Wu Xian and Shibukawa as small open circles.
Size of the original scroll: 51.5 × 178 cm. By permission of Kobayashi Tsuruko. Photograph courtesy of Kazuhiko Miyajima, Ōsaka.

One other work to be mentioned here is the *Kaisei nijū hasshuku zu* (Revised map of the twenty-eight lunar lodges), formerly in the possession of Kayahara Motoichirō and of uncertain date and authorship, but probably by Shiba Kōkan (1747–1818).[44] This map shows the equatorial zone with the lunar lodges and their surrounding stars. The equator is drawn as a straight horizontal line, and the boundaries of the twenty-eight lunar lodges are drawn as vertical straight lines, although not from top to bottom but projecting barely beyond the constellations. The Jesuit influence is apparent in that the stars are distinguished by magnitude. The determinative stars of the lunar lodges are painted in red. Some of the stars in the lunar lodges and other constellations are connected to each other by straight lines forming individual constellations. An unusual characteristic is that the extent of the lunar lodges and the values for right ascension of the determinative stars are given to a precision that far exceeds observational accuracy.[45] The widths of the twenty-eight lunar lodges (the distances of right ascensions between the standard stars) coincide with those obtained about the year 1200. There were fairly accurate observational values at this time, but inexplicably these values were not used.

CELESTIAL CARTOGRAPHY TOWARD THE END OF THE EDO PERIOD

Late in the Edo period there were maps that exhibited European influences and maps with dominant traditional elements. Of the former, two should be mentioned. One

illustrated in *Hoshi no bijutsuten: Tōzai no kichōna koseizu o atsumete* (Exhibition of stellar arts: A collection of rare old star charts of East and West), exhibition catalog, ed. Chiba Shiritsu Kyōdo Hakubutsukan (Chiba City Local Museum) (Chiba, 1989), no. 12, where it is stated that the stars are divided into six classes of brightness. Watanabe incorrectly says that only five magnitudes are distinguished. The illustration in the *Hoshi no bijutsuten* is a rectangular map, and it appears that the stars are drawn with black lines, with and without rays on six- and five-pointed stars. The boundaries of the lunar lodges are drawn vertically, as lines of right ascension. Lines of declination are drawn horizontally at ten-degree intervals (reflecting the Western division of a circle into 360 degrees, although Chinese tradition uses a division into 365¼ degrees). For Takahashi's involvement in the von Siebold incident, see above, pp. 439–40.

44. The map is thirty-two by ninety-four centimeters, and on the left margin is written "Tōto [Edo] Shinsenza, edition of Shunharō," Shunharō being Shiba Kōkan's pen name.

45. For example, the first lodge (Kaku) is measured as eleven *do* (degrees), eighty-one *fun* (minutes), twenty-one *byō* (seconds), and fifty-seven parts, and the next lodge (Kō) is measured as twenty *do*, ninety-six *fun*, thirty-one *byō*, and twenty-three parts.

is Umetani Tsunenori's *Tenshō sōsei no zu* (Map of all the stars in the heavens, 1814).[46] The map is rectangular, with the equator represented by a straight horizontal line in the center. Straight horizontal lines at the top and bottom edges represent the circles of constant visibility and invisibility. The ecliptic is a freehand curved line. Some constellations, such as the Big Dipper, are drawn above the line of constant visibility. Shibukawa's new constellations are also shown. The boundaries of the twenty-eight lunar lodges are drawn as vertical lines. The arrangement of these boundaries and the stars in the constellations are quite different from the old system used in celestial maps such as the *Tenmon seishō zu* and the system of the *Yixiang kaocheng* and *Hōen seizu*. It is similar to the old system, however, in that the constellations are relatively few and there are many large errors in declination.

The second example is Satō Tsunesada's *Shinsei tenkyū seishō zu* (New star map of the celestial sphere, 1815), on which lines of right ascension and declination are drawn every ten degrees in imitation of the equatorial stereographic projection used for maps of the world.[47] Although there are some errors, the application of this projection to a celestial map is interesting: not only is it a rarity, but it also reflects European influence via maps of the world, which were being introduced to Japan by Dutch traders. The four sheets form a map showing two circular hemispheres. One has its lines of right ascension ranging from 0° to 180°, and the other from 180° to 360°, so that the appearance of the map is similar to a European world map divided into circular Western and Eastern hemispheres. The circumference is a double circle graduated alternately in black and yellow at one-degree intervals of declination. The equator, drawn as a horizontal straight line in the center of the map, is graduated in black and red alternately at intervals of two degrees of right ascension. The northern and southern tropics are drawn in yellow. The circles of constant visibility and invisibility are drawn in red, and all other lines of right ascension and declination are drawn in black. The stars are red and black, with constellations connected by black lines. The Milky Way and large and small Magellanic clouds are drawn in off-white. A trace of an amendment in the shape of the large Magellanic cloud is visible. The stars around the South Pole are also drawn.

Some maps show a continuity with tradition. One is an individual, remarkably accurate map of Chinese constellations; this is the *Tenshō kaisei no shin zu* (Revised star map), of uncertain date.[48] It is a pamphlet in which some constellations are drawn on every page. The brightness of stars is distinguished by size. The angular distance between stars is written in feet (*shaku*) and inches (*sun*), originally used to denote the length of objects on earth in China and Japan. Although equivalents differed by country, periods, and use, one *shaku* was approximately 22.5 to 33.3 centimeters, and ten *sun* equaled one *shaku*. Used to represent angular distance in this context, one *sun* equals about one degree.

An interesting map that was composed by the Tsuchimikado family in 1824 is the *Seizu hoten ka* (Star map poetry). Evidently it was based on the *Butian ge* (Song of the sky pacer)—the Chinese pronunciation of *Hoten ka*—a rhymed mnemonic used to teach the constellations written by Wang Ximing (pen name Dan Yuanzi, fl. ca. 590).[49] The map, included in a pamphlet and folded, measures twenty by ten centimeters. Abe no Haruchika's preface on the second page explains that it was published for beginners. The circular celestial map of the region of constant visibility appears on the third and fourth pages. Two types of stars are distinguished by black and white circles. In each constellation the stars are linked by straight lines and the names of the twenty-eight lunar lodges are written in the space between the second and third concentric circles. Shibukawa's constellations are not drawn. There is no poem on the circular celestial map, but there are verses from the *Hoten ka* in the book, probably within the rectangular celestial map.[50] As I mentioned above, the Tsuchimikado (Abe) family was in charge of astronomy and astrology at the imperial court. Because their work was secret, Watanabe points out that it is noteworthy that this celestial map was published.[51]

Tangentially, several copies survive of the Chinese work *Huntian yitong xingxian quantu* (Map indicating the arrangement of the stars throughout the entire heavens), with versions from 1822 and 1826 subsequently brought to Japan. The celestial map consists of eight sheets joined together. Since the map was engraved (intaglio) on wood, the prints are white on indigo (fig. 14.12).[52]

46. The *Tenshō sōsei no zu* is kept at the Chiba City Local Museum and illustrated in the *Hoshi no bijutsuten*, 22–23, no. 14 (note 43). On the left of the illustration is written "Umetani Tsunenori has produced this based on the Master Hokusui's celestial map that Umetani reduced to one-sixteenth of the original size" (the original of Master Hokusui was 266 × 809 cm). Master Hokusui is probably Asano Hokusui, the disciple of the writer, script writer, naturalist, and technician Hiraga Gennai (1728–79). Asano Hokusui gave lectures on ancient traditional astronomy, wrote a popular book on astronomy, and was active as an artist (Watanabe, *Kinsei Nihon tenmongaku shi*, 1:423 [note 1]).

47. The *Shinsei tenkyū seishō zu* is held at the Chidō Museum, Tsuruoka City, Yamagata Prefecture, and illustrated in *Hoshi no bijutsuten*, 10–11, no. 1, with explanation on 44 (note 43). Satō Tsunesada was a clansman of the Shōnai (northwestern part of what is now Yamagata Prefecture) clan.

48. Owned by Ogi Sadami, Nagoya, the map is reproduced in the *Hoshi no bijutsuten*, 22, no. 15, explanation on 45 (note 43).

49. See chapter 13 above, esp. p. 532.

50. Watanabe Toshio, personal correspondence.

51. Watanabe, *Kinsei Nihon tenmongaku shi*, 2:834–36 (note 1), discusses and reproduces the first four pages of this work.

52. I have introduced this here because neither of two important

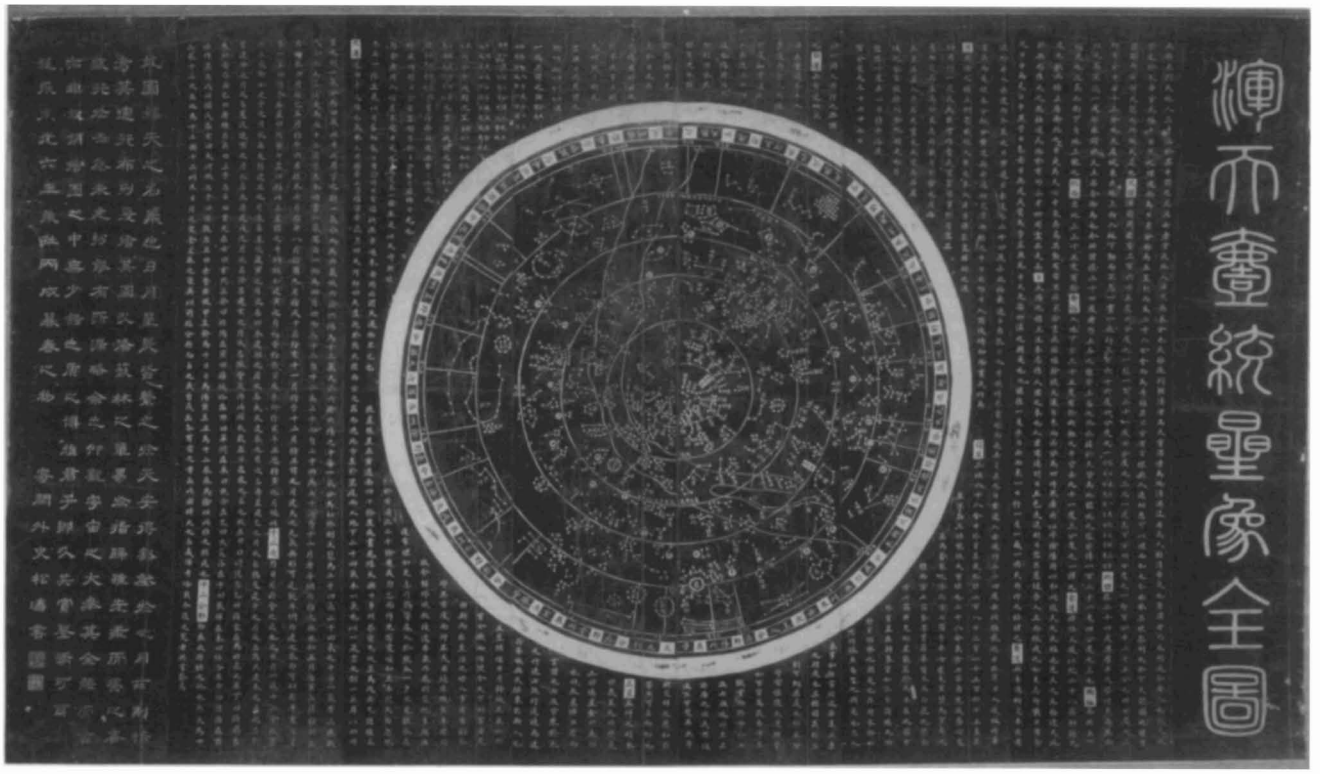


FIG. 14.12. *HUNTIAN YITONG XINGXIAN QUANTU*, 1826. On this Chinese map centered on the North Pole, the outline of the Milky Way is drawn, as well as the concentric circles of constant visibility, the Tropic of Cancer, the equator, the Tropic of Capricorn, and constant invisibility. Between the circle of constant invisibility and the outermost circle twelve *shi* and twelve Jupiter stations are marked.
Size of the original: 125 × 219.5 cm. Tsuyama Local Museum. Photograph courtesy of Kazuhiko Miyajima, Ōsaka.

CELESTIAL MAPS SHOWING WESTERN CONSTELLATIONS

Because of the Edo policy of national isolation until 1720, a few Chinese books such as the *Tianjing huowen* provided the only means for the Japanese to learn about European astronomy until the ban on importing foreign books was partially lifted. This led to the appearance of a great number of Chinese and Dutch books in Japan and to the rise of *Rangaku*, the study of European science through Dutch-language sources. After Shimoda was opened to American commerce in 1854, the study of Western science became known as *Yōgaku*, or "Western learning." *Rangaku* and *Yōgaku* laid the foundation for celestial maps based on Western astronomy to predominate in the Meiji period (1868–1912) and after.

One map from the Edo period by Shiba Kōkan, a polymath known for having popularized Copernican theory in Japan,[53] established this tendency toward European-style celestial maps. The copperplate print *Tenkyū zu* (Illustration of the spheres) (fig. 14.13) is the first Japanese celestial map to be published with Western constellations. It includes the Northern and Southern hemispheres, each centered on the ecliptic pole. From the center of the two circular celestial maps, straight lines of ecliptic longitude are drawn radially at twenty-degree intervals. On the chart of the Northern Hemisphere, eccentric circles indicate the equator and the Tropic of Cancer. In the Southern Hemisphere similar circles represent the equator and the Tropic of Capricorn. Both have circles of declination at 66°30′ representing the Arctic and Antarctic circles. The constellations are drawn in various colors.

The *Tenkyū zu* was made from a tracing of Frederick de Wit's *Planisphærium Cœleste* of about 1660–80, with

sources on Chinese celestial mapping, the Zhongguo Shehui Kexueyuan Kaogu Yanjiosuo (Archaeological Research Institute, Chinese Academy of Social Science [Academica Sinica]), *Zhongguo gudai tianwen wenwu tuji* (Album of ancient Chinese astronomical relics) (Beijing: Wenwu Chubanshe, 1980), and Pan Nai's *Zhongguo hengxing guance shi* (History of stellar observations in China) (Shanghai, 1989), mentions it.

53. See Sugano Yō, "Shiba Kōkan no chosho *Shutō dempō* to dōhan *Tenkyū zu* ni tsuite" (On Shiba Kōkan's book *Shutō dempō* [The introduction of vaccine] and the copperplate print *Tenkyū zu*), *Nihon Yōgakushi no Kenkyū* 5 (1979): 65–100. For outstanding research on Shiba, see Kuroda Genji, *Shiba Kōkan* (Tokyo: Tōkyō Bijutsu, 1972).

FIG. 14.13. COPPERPLATE PRINT OF SHIBA KŌKAN'S *TENKYŪ ZU*. The circular celestial map at the right is centered on the ecliptic North Pole and has the ecliptic as an outer circumference. In the top right corner Saturn is drawn, and at top left is Jupiter. On the left, the map centered on the South Pole has a waxing crescent moon in the upper corners, and surveying instruments are shown in the lower corners. To the left of the Northern Hemisphere are explanations, and to the

the names of Chinese constellations and stars attached and the two hemispheres transposed. The *Tenkyū zu* is interesting because it illustrates Western constellations. Traditional Chinese and Japanese celestial maps used only lines to connect the stars and did not have such figures drawn in.[54]

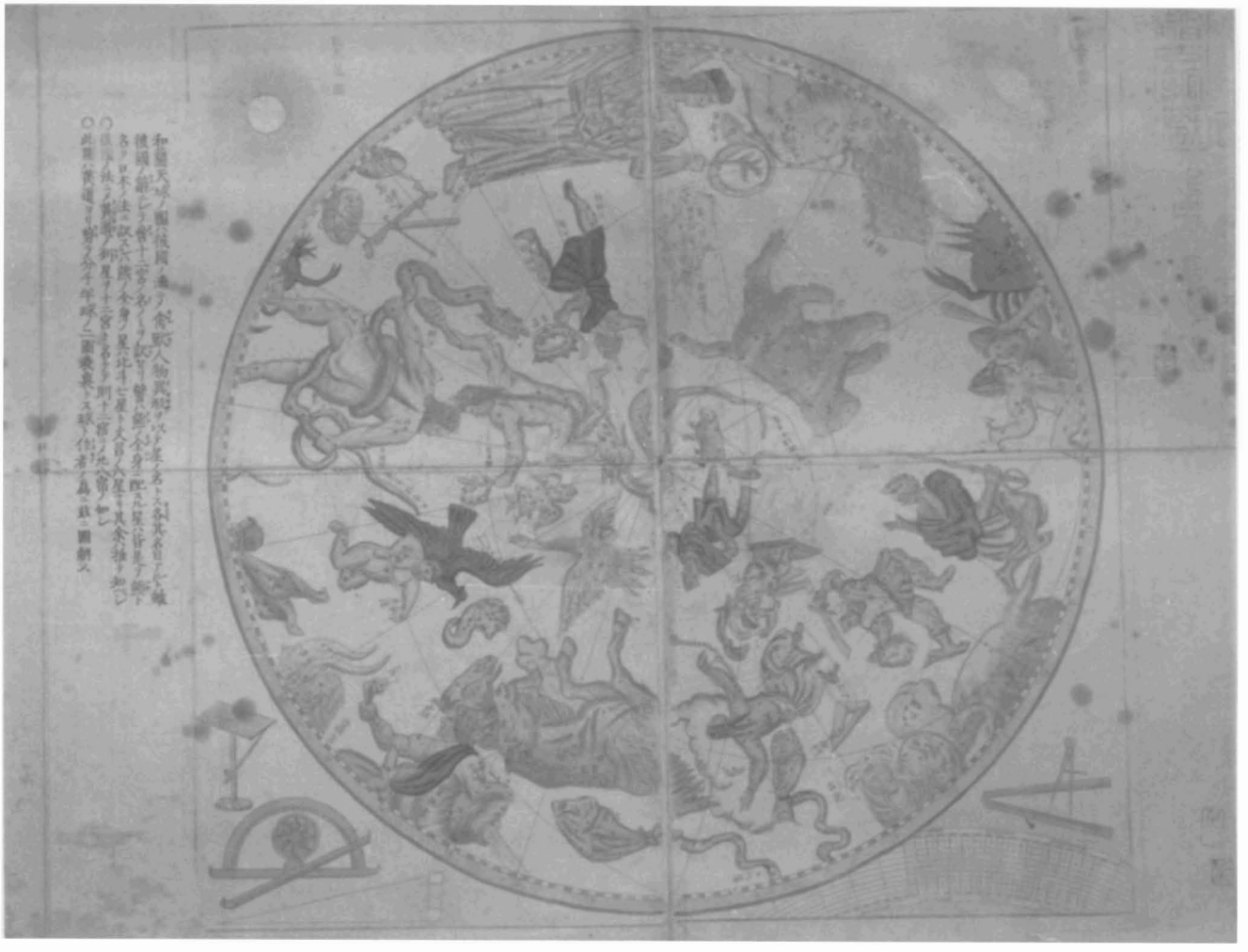
Hoshi Mandaras

Among the mandalas that are used for esoteric Buddhism are the so-called *hoshi mandaras* (star mandalas), both circular and rectangular (figs. 14.14 and 14.15).[55] Schematically, at the center is Mount Sumeru, the center of the Buddhist universe where the Buddha resides, and surrounding it are the figures of the Big Dipper god (the seven traditional stars and Alcor = 80 UMa), the god of the nine stars (sun, moon, five planets, and the imaginary celestial bodies Ketu and Rāhu),[56] the twelve signs of the zodiac, and the god of the twenty-eight lunar lodges.

54. The *Planisphærium Cœleste* was published in Amsterdam. It is said that de Wit's celestial map is based on the celestial map drawn on the top corner of Willem Jansz. Blaeu's *Nova totius terrarum orbis tabula*; see Imai Itaru, "Edo Jidai kagakushi no naka no Blaeu" (Blaeu in the history of science during the Edo period), *Rangaku Shiryō Kenkyūkai Kenkyū Hōkoku* 136 (1963), and Hirose Hideo, "Oranda tensetsu" (European astronomical theory), in *Yōgaku* (Western studies), 2 vols., ed. Numata Jirō et al., Nihon Shisō Taikei (Series of Japanese Thought), vols. 64–65 (Tokyo: Iwanami Shoten, 1972–76), vol. 1.

55. On Japanese mandalas and Buddhist cartography, see pp. 364–66.

56. These are the Sanskrit names. They usually indicate the lunar nodes.



left of the Southern Hemisphere are the names of Shiba Kōkan and Honda Saburōemon (the reviser) and the date of publication. The circumference of both hemispheres is graduated in one-degree increments. The names of Chinese constellations and stars are written on the map.
Size of the original: 40.7 × 90.1 cm. Owned by Miyamoto Masayuki. Photograph courtesy of Kazuhiko Miyajima, Ōsaka.

Aboriginal Celestial Cartography

Although many aboriginal Ainus lived in northern Japan (Tōhoku and Hokkaidō) as well as in the Kuriles and on Sakhalin, only a few remain today. Their original constellations have been handed down, but we have no evidence that star maps were ever compiled.

To the southwest of Japan proper are the Nansei or Ryūkyū Islands, comprising the Amamis, Okinawas, and Yaeyamas. The Ryūkyū kingdom in the Okinawa and Yaeyama Islands paid tribute to Japan from about the seventh century and to China from about the fourteenth, even during the Edo period, when it was controlled by the Satsuma clan based in Kyūshū. After the Sino-Japanese War of 1894–95 the islands came completely under Japanese control. Culturally, both China and Japan have exerted influence on the Ryūkyūs since antiquity, and this joint influence may still be seen. In regard to the indigenous view of the heavens, however, constellations that are not related to those of either China or Japan have been passed down to us.

An example of these constellations is found on a celestial map that has recently come to my attention (fig. 14.16).[57] It covers two pages in a book titled *Seizu* (Star map) that, according to its cover, was copied in 1827.

57. The map was first discussed by Yaeyama Museum curator Hanaki Yasuo in "Seizu ni tsuite" (On a star chart), *Ishigaki Shi Shi no Hiroba* (Ishigaki Municipal History Forum) 11 (1987): 1, 3–7. Although it has been known locally since that time, it has not come to the attention of many scholars in the main archipelago. I had the opportunity to examine it in 1992.

FIG. 14.14. A CIRCULAR *HOSHI MANDARA*. Mount Sumeru is at the center, surrounded by representations of celestial deities. The mandala dates from the end of the Heian period (794–1185).
Size of the original: 117 × 83 cm. Horyū Temple, Nara. Photograph courtesy of Yabuuchi Kiyoshi, Kyōto.

FIG. 14.15. A RECTANGULAR *HOSHI MANDARA*. The layout is similar to figure 14.14.
Size of the original: unknown. Sanukibō Temple. Photograph courtesy of Yabuuchi Kiyoshi, Kyōto.

The book contains information about the arrangement of the stars, the times and places of their appearance, the conditions of the winds and waves at sea, and farming. Most of the constellations on the map have been identified with modern stars and constellations, but some have not because they were used only locally or because additional data (such as direction, dates of compilation, times of appearance) are not in the book. Presumably the map depicts the night sky at a particular date and time, but this warrants further investigation.

Conclusion

One of the oldest extant star maps is that on the ceiling at the burial mound of Takamatsuzuka. Although it does not cover the entire heavens and is not accurate, including incorrectly drawn constellations, some parts are rather realistic. Chinese influence may be seen in all extant Japanese star maps, including that at Takamatsuzuka, until European astronomy was introduced. The boundaries of the twenty-eight lunar lodges at irregular intervals take the place of lines of right ascension or celestial longitude on European star maps. Only a few circles, notably the celestial equator and the ecliptic, correspond to Western circles of declination or ecliptic latitude. Seldom were

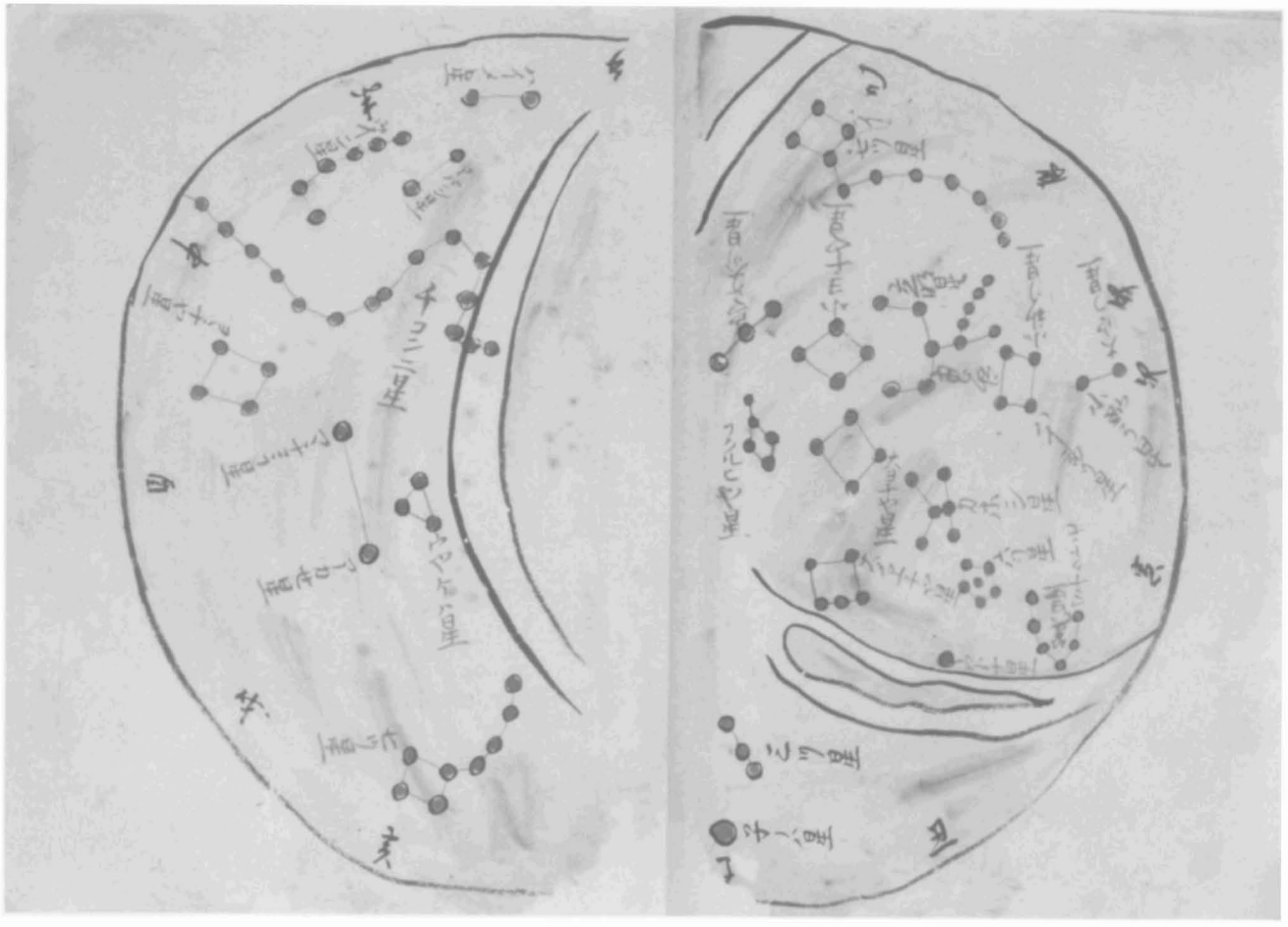


FIG. 14.16. MAP FROM THE RYŪKYŪ ISLANDS. The map is encircled by a black line around which are the names of the twelve *shi*, which represent the points of the compass. The outline of the Milky Way is also shown in black, and the stars are depicted by open black circles painted red and connected to other stars by red lines. The names of the constellations are entered in black or red, and prominently drawn at the bottom center is Ninoha-bushi, the Pole Star.
Size of the original: 25 × 21 cm. Yaeyama Museum, Ishigaki Island. Photograph courtesy of Kazuhiko Miyajima, Ōsaka.

stars represented according to brightness, nor were illustrations of the constellations drawn; the dots or small circles used to represent the stars were linked only by straight lines; and the constellations were Chinese, with the exception of the Japanese ones added in the seventeenth century by Shibukawa Harumi.

In the Edo period European astronomy was introduced originally through Chinese literature and then through Dutch works and other books. Gradually European elements in Japanese star maps increased, and the Japanese started to draw more constellations around the celestial South Pole. From the Meiji era to the present, Japanese maps of the heavens are mainly based on European astronomy.

Farmers and fishermen also had their own constellations, but it appears that they were hardly ever drawn. The indigenous peoples of northern Japan and Okinawa used other constellations. They are depicted in books from the island of Ishigaki in Okinawa Prefecture dating to the Edo period.