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Astronomy and Calendrical Science in Early Mikkyō in Japan: Challenges and Adaptations

Jeffrey Kotyk

Department of Asian Studies, University of British Columbia, 607-1871 West Mall, Vancouver, BC V6T 1Z2, Canada; jeffrey.kotyk@ubc.ca

Abstract: This study examines the use, adaptation, modification and omission of astronomical and calendrical elements in early Japanese Mikkyō (ninth century) in large part from the perspective of exact sciences. Shingon and Tendai inherited a Sinicized system of Indian astrology from their respective beginnings, but the significance of this fact in the study of Japanese religions is underrecognized despite the reality that astrology was both studied and technically required in Mikkyō. This study will examine how Mikkyō negotiated the demand for orthopraxical use of Indian models with the contingent realities of only possessing in practice a Chinese calendar and system of observational astronomy. Japanese monks were compelled to observe Indian astrology according to their own scriptures, which by extension necessitated knowledge of Indian astronomy, but substitutions and omissions had to be made in the absence of the required resources and knowledge.

Keywords: astronomy; Japanese Buddhism; calendar; astrology; Mikkyō

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1. Introduction

This study explores the reception and interpretation of astronomy (*tenmon* 天文) and calendrical science (*rekihō* 曆法) in early Mikkyō in Japan (with our interest here primarily being the ninth century). As we will observe, although astrology was clearly a component of Mikkyō both in Shingon and Taimitsu from their respective beginnings, less attention has been directed to how these traditions understood and implemented foreign astronomical and calendrical systems. This topic has been addressed in the past to some extent by Momo Hiroyuki, Yamashita Katsuaki, Yano Michio and myself, but here, we will specifically ask to what extent Mikkyō actually used the non-Chinese materials and how they negotiated the differences between these and Chinese astronomy, especially considering the impracticalities involved. In short, how much authenticity to Indian models was required or even pursued in practice (taking into consideration, of course, that Indian models were neither monolithic nor static over the centuries)?

This study seeks to push the interpretative boundaries around Mikkyō by examining the topic at hand primarily from the perspective of exact sciences (i.e., a methodology of inquiry based on precise and objective rules from which observations are measured in detail, such as the fields of astronomy and mathematics). This angle allows us to critically evaluate and compare astronomical and calendrical models in a technical manner. Its application within the fields of Classics and Indology was pioneered by David Pingree (1933–2005), who famously examined astrological texts of antiquity based on mathematics and astronomy.

This methodology might be applied to relevant materials in Mikkyō to evaluate the extent to which astronomy was practiced as an exact science. I argue that we might extend our understanding of Mikkyō to recognize astronomy (and by extension astrology) as an essential component within its orthopraxy at least in theory, but as we will observe upon closely examining the materials at hand, this science was not actually implemented according to Indian models, even when scriptures and authorities expressly called for this.

In fact, a close study reveals that Mikkyō used Chinese models, atop which was overlain Indian lore. We should recognize that Mikkyō did not practice authentic Indian astronomy or astrology.

That being said, we will demonstrate that Mikkyō tried to grapple with the complex challenges of incorporating various elements of astronomy and astrology within an entirely borrowed Chinese framework, all the while trying to remain faithful to Indian astral lore. To this end, I will provide a survey of the historical foundation atop which Mikkyō's engagement with astronomy occurred. I will then show that the non-Chinese concepts were ultimately just used in modified applications, in a purely symbolic manner, or omitted altogether. One exception to this observation, which I will point out, is the seven-day week, which was implemented in Mikkyō in a way no different from elsewhere in Eurasia, although it was used purely as a religious rather than civil way of reckoning the passage of time.

In short, Mikkyō attempted to engage in the exact sciences of astronomy and calendrical computations because their scriptures and inherited tradition called for this, but the end result was something very different from what was employed in India.

2. Historical Background: Chinese Astronomy and Calendrical Science in Japan

Premodern Japanese astronomy and the closely connected subject of calendrical science are in large part traced back to China and Korea. Tanisaki (2016), however, importantly points out a third-century Chinese account of the Japanese archipelago, which records that people there merely followed the custom of plowing in spring and harvesting in autumn. This was done without any knowledge of the "proper" (i.e., Chinese) year or the four seasons. Based on this and other data, Tanisaki theorizes that, in fact, an autochthonous solar calendar was utilized prior to the introduction of the lunisolar Chinese calendar. This theory, Tanisaki proposes, potentially explains the differences in a number of regnal years between the *Kojiki* 古事記 (712) and *Nihon shoki* 日本書紀 (720). These are the earliest extant Japanese histories. Tanisaki believes that the authors of these two histories faced the challenging task of converting over dates from an old calendrical system into the new model, which was based entirely on the Chinese system. The extant Japanese literature from antiquity shows no obvious traces of an earlier calendrical model, although as Goto (2021) has demonstrated, diverse indigenous astral lore was preserved in Okinawan and Ainu communities, among other peoples in Japan, up to the present day.[1]

Foreign calendrical models were introduced from abroad, and these became standard for the state and also Buddhist institutions in Japan. Advanced calendrical science would have become critical to the Japanese court only starting in the Asuka Period (592–710), when there was a conscious movement toward emulating the Chinese system of governance. One aspect of this model was a centralized government that utilized and moreover exclusively issued a standardized calendar for all subjects. The *Nihon shoki* (vol. 2, p. 538) records that in the year 602, the monk Gwalleuk (Kanroku 觀勒) from the kingdom of Baekje (Kudara 百濟) on the Korean peninsula offered to the Japanese court a calendar and books on astronomy (Kotyk 2018c, p. 41; Masuo 2013, p. 21). This type of literature would have presumably included material dealing with celestial omenology based on ancient Chinese sources. Predictions could be made concerning the state rather than individuals specifically on the basis of astral phenomena such as, for example, anomalous comets, eclipses (solar and lunar), and apparent irregularities in the movements of the planets. In a later decade, we observe that state resources were directed toward astronomy. Goto (2021, p. 33) points out this important fact. According to the *Nihon shoki*, during the reign of Tenmu 天武 (r. 673–686), "For the first time, a platform for divining the stars was erected 始興占星臺 (*Nihon shoki* vol. 3, p. 358)."[2] Looking ahead a few centuries, we see state regulations which govern astronomy and omenology. The *Engi shiki* 延喜式 (*Procedures of the Engi Era*, 927; *maki* 16, p. 4), which extensively describes religious and legal procedures, lists a professional title of Tenmon hakase 天文博士 (Academician of Astronomy). The primary responsibility of this appointment was to record in a daily log whatever anomalies might have been observed in the heavens above (Masuo 2013, p. 22).

Chinese calendrical science was adopted wholesale in Japan, as evidenced by the dating conventions used in the *Nihon shoki*. This science includes numerous elements. The sexagenary cycle, a repeating cycle of 60 terms comprised of the earthly branches (*chishi* 地支) and heavenly stems (*jikkan* 十干), was used to record the passage of days and years, exactly as was performed in China. This calendrical system is a lunisolar calendrical model with 12 months, recurring intercalary months, and 24 solar terms (Wilkinson 2000, pp. 176–87). The first day of each month occurs approximately on the New Moon (*tsuitachi* 朔), when the Sun and Moon are conjunct. The Moon is unseen at the New Moon, from which time it then commences its period of waxing. The 15th day occurs approximately on the Full Moon (*mochi* 望), at which time the Sun and Moon are positioned opposite to one another (e.g., when the Full Moon is setting in the west and the Sun is rising in the east). The Moon then commences its waning period. Early Japanese historical records already utilize this system to date events. It is highly probable, however, that this adoption already occurred some centuries prior to the eighth century.

The Chinese in antiquity discovered and observed the cyclical movements of the Sun, Moon, and five visible planets (Saturn, Jupiter, Mars, Venus, and Mercury). The astronomers of the court scientifically calculated their individual periodicities with increasing precision over time through the use of arithmetic and some physical instruments. They devised formulas for predicting their movements. This was already well-established by the first century CE. Their cosmology, however, was entirely different from that of the Greeks with their geocentric spherical earth model. The Chinese, in contrast, used a geocentric flat earth model without any reference to a terrestrial globe or sphere (the shape of the sky could be conceived of as spherical or semi-spherical (i.e., the *hun tian* 渾天). Cullen (1980, p. 42) observes that "Chinese astronomers, many of them brilliant men by any standards, continued to think in flat-earth terms until the seventeenth century." This same observation would apply equally to Japan. Japanese cosmology envisioned the world as flat until modern times, but this did not mean that they could not accurately track and predict the movements of the planets, since this was performed using arithmetical formulas that allowed for mostly accurate predictions. These formulas are utilized within a sidereal positioning system based on constellations of fixed stars, primarily in relation to the celestial equator. This system has 28 "lunar stations" (*nijū hachi suku* 二十八宿). These altogether comprise approximately 365.25° (the original Mesopotamian value of the celestial equator and ecliptic, which was adopted into Greek and Indian systems, is 360°). The positions of the planets are denoted using the degrees of the lunar stations in the East Asian system. (The degrees of the zodiac signs, which demarcate the ecliptic, were used in the Hellenistic system.)

I am unaware of any evidence which would suggest that peoples in the Japanese archipelago had systematic knowledge of the planets prior to the introduction of Chinese astronomy. This point would explain why the planets historically were generally known by their adopted Chinese names in Japan (e.g., *mokusei* 木星 and *saisei* 歳星 (Jupiter) are Chinese loanwords). One exception to this is Venus, as the evening star for which an indigenous name is attested in the *Wamyō ruiju shō* 倭名類聚抄 (*Digest of Classifications of Japanese Words*). This is a dictionary compiled by Minamoto no Shitagō 源順 around 931–938. The word 長庚, which is identified as Venus (i.e., the Chinese *Taibai* 太白), when visible in the evening in the west, is given the indigenous reading of *yūzutsu* 由不豆々 (*maki* 1, p. 2).[3] This word alone, however, does not denote or necessitate full knowledge of the planets and their orbits. One other exception is the very rare instances in Mikkyō, in which the planets are denominated with their Sanskrit and even Sogdian names transliterated into *kanji*, which we will discuss further below (Yano 2013, p. 110).

There also existed Japanese words for some of the constellations associated with the Chinese lunar stations. This fact is also evident from the astronomical vocabulary in the *Wamyō ruiju shō*. For example, the Japanese reading therein for the *kanji* 昴 (referring to the constellation Pleiades, though it is also a lunar station in Chinese astronomy) is given as *Subaru* 須八流 (*maki* 1, p. 3). However, one complicating factor is that, as Jonathan Smith (2015, pp. 19–21) points out, there is an alternative early reading, *Sumaru*, in other early Japanese sources. Concerning the origin of *Sumaru*, he suggests considering the Old Chinese *meru; hence, the Japanese reading might originally stem from an Old Chinese reading. In any case, a constellation and lunar station are not identical (the lunar stations as spatial segments only derive their names from constellations). Japanese speakers likely used the local readings in practice, such as *Subaru* and *Sumaru*, rather than the Middle Chinese readings. This is an early example of the localization of Chinese astronomy in Japan.

In light of the above discussion, we can observe that the Chinese calendar and system of astronomy were implemented wholesale in Japan early on, but it was not only the Chinese models which reached Japan. There was, in fact, abundant Indian astral lore which came to Japan via Buddhism. How much of this, however, was actually implemented?

3. Indian Astronomy in the Buddhist Literature

The Buddhist literature in Chinese translation also introduced new astronomical and calendrical concepts into East Asia. Some of these were important to observe for ecclesiastical purposes. The *vinaya* in particular establishes a schedule for the *saṃgha*. Not all of these concepts, however, were implemented by the Buddhist community in China, let alone in Japan; instead, they functioned as a kind of canonical lore, albeit without any practical implementation.

The Indian month was commonly divided into two parts (Skt. *pakṣa*s). These include the periods of lunar waxing (Skt. *śukla-pakṣa*) and waning (Skt. *kṛṣṇa-pakṣa*). Each *pakṣa* consists of 15 days (“lunar days” specifically, called *tithi*s). Some of these are auspicious, and therefore monastic meetings (Skt. *poṣadha*) were supposed to be scheduled on these days according to the monastic codes of the *vinaya*. An Indian belief in the descent of deities into the world on these days underpinned this model, which itself was not necessarily auspicious, since these deities could also create problems for humanity (Kotyk 2018a, pp. 148–51). This schedule could be easily implemented within the framework of the Chinese calendar, since one-to-one correspondences were easily made. There would have been no need to even adopt Indian nomenclature in this regard when the existing Chinese system functioned in a largely similar way.

Other elements of Indian timekeeping, however, were not so practically implemented in East Asia. One such element was the 28 or 27 *nakṣatra*s (the number varies according to Indic sources), which are similar to the Chinese lunar stations, but the Indian parameters in any one of several attested systems are entirely different from the Chinese models. (There were also slight modifications to the lunar stations in China over the centuries.) The various recensions of the *Śārdūlakarṇāvadāna*, for example, in Sanskrit, Chinese, and Tibetan define the lengths of the *nakṣatra*s in *muhūrta*s with different values (Zenba 1952, pp. 174–82). A *muhūrta* is a unit of time. India divided the day and night into 30 *muhūrta*s altogether, but East Asia utilized a different system of daily timekeeping, comprised of 12 “double hours” (*ji* 時) represented by the earthly branches (e.g., *zi* 子 (Jp. *shi*) signifies north and the period of time when the Sun is directly positioned there under the horizon, corresponding approximately to the time from 11:00 p.m. to 1:00 a.m. in modern equinoctial hours). The Hellenistic model of 24 h is not attested in any of the East Asian sources under consideration. We can see that the “double hours” were used on a daily basis throughout the travelogue of the Tendai monk Ennin 圓仁 (794–864), who visited China between the years 838 and 847. Ennin noted the time of day or night using this system but never mentioned the *muhūrta*s.[4] The *muhūrta*s were known relatively early on, since they are explained in the major treatise, whose title is reconstructed as **Mahāprajñāpāramitā-upadeśa* (*Dazhidu lun* 大智度論). This text is attributed to Nāgārjuna, and it was translated into Chinese by Kumārajīva in the early fifth century. This text even explains the seasonal adjustments to account for longer or shorter days.[5] Yet, as far as I am aware, nobody in China or Japan attempted to implement this Indian model of timekeeping, even though it was actually a part of Buddhist orthopraxy (it was also normative and moreover expected in Brahmanical society). This further meant that, by extension, a model of *nakṣatra*s based on the *muhūrta*s could not be implemented in a Chinese context without recourse to some formula for converting measurements, but it does not appear that anyone attempted to do this. Buddhists in East Asia instead simply used the Chinese lunar stations as functional equivalents when translating the *nakṣatra*s, even though in reality they were completely different systems.

The *nakṣatras* were introduced as a kind of element of canonical lore, which also brought with it the deification of the lunar stations in East Asia, where they were not originally considered to be sentient divinities like in India. This development occurred based on Buddhist literature, such as the aforementioned *Śārdūlakarṇāvadāna*. For instance, *Kṛttikā* (equated to *Subaru* 昴) is associated with the Vedic god of fire Agni (T. 1301, 21: p. 415b6-8). The Indian model of divine *nakṣatra*s is traced back even further to Vedic precedents. This model of *nakṣatra*–deity associations is given in the *Nakṣatrakalpa* of the *Atharvavedapariśiṣṭā* (I.4.3): "kṛttikā agnidevatyā (Bolling and Negelein 1909, p. 3)."[6] Later Buddhist texts, such as the *Candragarbha-parivarta* (*Yuezang fen* 月藏分) in the *Mahāsaṃnipata* collection (*Daji jing* 大集經), introduced the 12 zodiac signs (Mak 2015, p. 65). The zodiac signs were also regarded as deities in Buddhist literature, but these were not part of Buddhism in its earlier historical stage, since they are not attested in the Āgamas or Nikāyas. The zodiac signs were originally devised in Mesopotamia based on constellations (although they were not deified), and they eventually made their way into India following the introduction of Hellenistic astrology in the early centuries CE. The Mesopotamian system divided the ecliptic into 360°, and each zodiac sign was assigned a uniform 30°, while the positions of the planets were indicated using these degrees of the zodiac signs (Barton 1994, p. 14). The zodiac signs in East Asia, however, were never used for indicating planetary positions in premodern times.

The reality is that Indian timekeeping and astrological elements until the eighth century were not strictly necessary in Chinese Buddhism, outside of perhaps some limited conventions of the *vinaya*, at least where it was closely observed. The efficacy of Buddhist rituals was evidently not thought to be hindered due to ignorance of Indian hemerology (the practice of selecting auspicious days on the calendar). One's attainment of wisdom or awakening was certainly not delayed. The planets had no role in a bodhisattva's career. The situation, however, changed entirely following the introduction of Mantrayāna ("Esoteric Buddhism"), in which astrology was not only necessary for rituals but also one necessary factor in the model of accelerated attainment of buddhahood in a single lifetime.

4. Astrology as a Requisite Element in Mantrayāna

Unlike earlier forms of Mahāyāna, in which matters related to astronomy were strictly unnecessary for the success of a bodhisattva's career, the situation changed considerably with the advent of Mantrayāna in the seventh century in India. Śubhakarasiṃha (Ch. Shanwuwei 善無畏; 637–735), one of the early Indian pioneers of this practice who facilitated its introduction to China, translated the *Susiddhikara-sūtra* (Ch. *Suxidijieluo jing* 蘇悉地羯羅經). Therein, we observe the critical importance of astronomical knowledge:

> During a lunar eclipse, achieve supreme activities. During a solar eclipse, do upper, middle, and lower things related to attainment. On the fifteenth, seventh, first, or thirteenth of the month, or on the third, one should carry out [things related to] attainment and all activities. If carrying out supreme attainments, one should select a time with a *nakṣatra* and planet that is upper [in quality]. The method for middle and lower should be understood in this sort of manner; but among the *nakṣatra*s, Puṣya is foremost. In the case of a wrathful attainment, rely upon times suited to wrathful *nakṣatra*s and planets.[7] (T. 893a, 18: p. 625c9-16)

Here, not only is the selection of auspicious *nakṣatra*s held as important, but the reader is told that the foremost ritual activities are to be carried out during a lunar eclipse. Predicting a lunar eclipse in ancient times was no easy task, since it required knowledge of advanced mathematical astronomy. This way of timing specific rituals—a form of electional astrology—is unprecedented in the earlier Buddhist literature. A properly timed occasion based on astrological factors is also made necessary when creating a *maṇḍala* according to another major text: the *Vairocanābhisaṃbodhi* (Ch. *Dari jing* 大日經), which Śubhakarasiṃha and Yixing 一行 (673–727) translated in 724. (This text became foundational for both Shingon and Tendai in the following century.) Regarding the creation of the *maṇḍala*, the *Vairocanābhisaṃbodhi* reads as follows:

> On the morning of a propitious day, having determined a day on which the time, lunar mansion [*nakṣatra*], and planets are all in harmony, and at a time before the [morning] meal, with an auspicious sign [. . .]. (T. 848, 18: p. 4c4–5)[8]

The cleric presiding over the *maṇḍala* must select an auspicious time based on these factors. The *maṇḍala* is one element in the ritualized incorporation of the three mysteries of body, speech, and mind. The three mysteries are the means to complete awakening (i.e., buddhahood) in a single lifetime. This accelerated model does away with the need to pass through the 10 bodhisattva stages. This break from Mahāyāna ideas about a bodhisattva requiring three incalculable aeons is one of the major innovations of Mantrayāna. This potential for accelerated development—the goal in practice—is expressly affirmed in the *Vairocanābhisaṃbodhi* at the beginning of the scripture:

> Moreover, he assumed the appearance of *vajradhara*s and the bodhisattvas Samantabhadra, Padmapāṇi, and so on, and proclaimed everywhere in the ten directions the Dharma of the pure words of the mantra path so that [all the steps from] the initial generation of the [*bodhi*-]mind up to the ten stages may be progressively satisfied in this lifetime [. . .]. (T. 848, 18: p. 1b2-4)[9]

It is necessary to take into consideration astrology in order to properly create the *maṇḍala*, since it cannot be produced at any random time. The astrological factors to consider are further explained and emphasized in the Chinese commentary to the *Vairocanābhisaṃbodhi*, which incorporated the oral explanations of Śubhakarasiṃha, as well as Yixing's own notes.[10] It logically follows that knowledge of astrology is one requisite element in the wider set of skills and practices necessary to successfully achieve *bodhi* in a single lifetime according to the framework of Mantrayāna. The powers who preside over astrology (e.g., the planets, zodiac signs, and *nakṣatra*s) also therefore have a role in enabling this process toward *bodhi*, and hence they also appear in the *maṇḍala*.[11]

One problem is that the commentary to the *Vairocanābhisaṃbodhi* only offers a basic overview of astrology. The commentary moreover defers to the "Indian calendar" (Ch. *fan li* 梵曆), but barely any information on Indian calendrical science was available at the time in Chinese (Kotyk 2018b, pp. 17–18). A few years earlier in 718, the *Jiuzhi li* 九執曆 (*Calendar of the Nine Planets*; Skt. **Navagraha-karaṇa*) was translated by a member of the Gautama family, named either Siddhārtha or Siddha (Ch. Qutan Xida 瞿曇悉達), but this is a manual of advanced mathematical astronomy that moreover would have required previous familiarity with Indian timekeeping. Yixing might have had the opportunity to rectify this problem of a lack of authoritative materials in Chinese, which would explain the Indian calendar, given his background expertise in astronomy (he reformed the state calendar), but he died prematurely in 727. The need for an authoritative manual on astrology in Chinese remained after Yixing's passing. In the following generation, the eminent monk Amoghavajra (Ch. Bukong 不空; 705–774) and his team compiled the first draft of the *Xiuyao jing* 宿曜經 (*Sūtra of Lunar Stations and Planets*) in 759. This version was problematic, and a revision was undertaken in 764.[12] The text was adequate for understanding only the mere basics of Indian astrology, but it also introduced ideas about natal astrology (e.g., predictions about a person based on their time of birth). Astrology in Mikkyō came to be almost entirely understood based on this text after it arrived in Japan.

5. Astrology in Early Mikkyō: Challenges in Defining the Stars

The importance of the *Xiuyao jing* (Jp. *Sukuyō kyō*) to Mikkyō cannot be understated, since it became the primary manual to consult when scheduling rituals and other religious activities in Mikkyō, and it was moreover also read by people outside said tradition. Minamoto no Shitagō, for instance, cites it in the *Wamyō ruiju shō* with a variant *kanji*: *Sukuyō kyō* 宿耀經 (*maki* 1, p. 3). The *Xiuyao jing* was first brought to Japan by Kūkai 空海 (774–835), the founder of Shingon, when he returned home in 806. The text is recorded in his catalog of items brought from China (T. 2161, 55: p. 1062a23-24). In the following generation, Tendai monks also took an interest in astrology early on. Enchin lists the *Xiuyao jing* in his catalog of texts and other items brought back to Japan in 857 (T. 2172, 55: 1098b8). Takada (1992, p. 40) showed that Enchin composed some works on the *Xiuyao jing*: *Sukuyō gishū* 宿曜疑集 (*Compilation of Concerns on Xiuyao*) and *Sukuyōkyō mondō* 宿曜經問答 (*Questions and Answers on the Xiuyao jing*).

It is clear that Kūkai took an interest in the astrology of the *Xiuyao jing* and furthermore facilitated its implementation. This fact is demonstrated by the oral testimony recorded in the *Hino'o kuketsu* 檜尾口訣 (*Oral Transmission at Hino'o*). This is a record of Kūkai's instructions preserved by his disciple, Jichie 實慧 (786–847) of Tō-ji 東寺 (see discussion in Yamashita 1996, p. 297). The explanations address two problems: those of intercalary months and short months, neither of which are discussed in the *Xiuyao jing*. The following is recorded in the *Hino'o kuketsu*:

> Inquiry concerning which *nakṣatra*s to use during an intercalary month and method for assigning *nakṣatra*s for missing days in a short month. Recorded based on oral instructions. When there is an intercalary month, the *nakṣatra* convergences of the true month repeat themselves in the intercalary month. Supposing the twelfth month has an intercalary month, the *nakṣatra* convergence of 12/1 will be *Dhaniṣṭhā*, the *nakṣatra* convergence of [12/]15 will be *Maghā* and the *nakṣatra* convergence of [12/]30 will be **Pūrvabhādrapadā*. The *nakṣatra* convergences of an intercalary twelfth month will be identical like this. There are no differences. The preceding month is the true twelfth month. The intercalary month is the contingent twelfth month. The *nakṣatra* convergences and 30 days of the contingent month all use the *nakṣatra* convergences of the true twelfth month without any different *nakṣatra*s. The other months and intercalary months can be understood according to this.[13] (T. 2465, 78: p. 30c13-c21)

The *Xiuyao jing* provides a system of correspondences between each day of the lunar months and a *nakṣatra*. The days of the 12th month, for example, run as follows: (1) 虛 *Dhaniṣṭhā*, (2) 危 *Śatabhiṣaj*, (3) 室 *Pūrvabhādrapadā*, (4) 壁 *Uttarabhādrapadā*, (5) 奎 *Revatī*, (6) 婁 *Aśvinī*, (7) 胃 *Bharaṇī*, (8) 昴 *Kṛttikā*, (9) 畢 *Rohiṇī*, (10) 觜 *Mṛgaśīrṣa*, (11) 參 *Ārdrā*, (12) 井 *Punarvasū*, (13) 鬼 *Puṣya*, (14) 柳 *Aślesā*, (15) 宿 *Maghā*, (16) 張 *Pūrvaphālgunī*, (17) 翼 *Uttaraphālgunī*, (18) 軫 *Hasta*, (19) 角 *Citrā*, (20) 亢 *Svāti*, (21) 氐 *Viśākhā*, (22) 房 *Anurādhā*, (23) 心 *Jyeṣṭha*, (24) 尾宿 *Mūla*, (25) 箕 *Pūrvāṣāḍhā*, (26) 斗 *Uttarāṣāḍhā*, (27) 女 *Śravaṇa*, (28) 虛 *Dhaniṣṭhā*, (29) 危 *Śatabhiṣaj*, and (30) 室 *Pūrvabhādrapadā*. In the case of an intercalary 12th month (or any other month), one simply reproduces this exact sequence, and then the following ordinary month resumes.

This is a reasonable solution, but the reality is that this model of assigning days to *nakṣatra*s (which was devised by Amoghavajra and his team) is actually divorced from the precisely observed position of the Moon and would have appeared irregular from the perspective of any Indian astronomer at the time. The *Xiuyao jing* also interestingly describes an Indian model of 27 *nakṣatra*s of uniform dimensions that are aligned with the zodiac signs (Wakita 1897, vol. 1, pp. 6–8). The spatial dimensions are defined according to *pāda*s ("limbs, i.e., quarters") rather than *muhūrta*s. (This new model in Sanskrit is called the *navāṃśa*s, meaning "ninths" of a zodiac sign.) This is completely different from the earlier model described in the *Śārdūlakarṇāvadāna* and reflects a later reformulation of the astrometric parameters for measuring the stars in India. The resulting model is a practical system of dividing the ecliptic into manageable divisions. The described model is illustrated below (Figure 1).

Figure 1. Configuration of zodiac signs and *nakṣatra*s (lunar stations) described in *Xiuyao jing*. Graphic by Jeffrey Kotyk.

Amoghavajra and Kūkai were certainly aware of this model, but nobody in either Chinese or Japanese Buddhism ever attempted to implement it, as far as I am aware. This model was also endorsed in the commentary to the *Vairocanābhisaṃbodhi*, and hence we know that Śubhakarasiṃha himself was also aware of it (T. 1796, 39: p. 618a8-13).[14] It simply remained as an astrometric system left unused, albeit still known, in East Asia.

The other system of assigning days of the lunar month to *nakṣatra*s aligns easily with the East Asian calendar and, in practice, requires no knowledge of astronomy or even observation of the Moon. Adopting a new foreign system of astronomical measurements would have been impractical, even though, according to scriptures, an orthodox model of the *nakṣatra*s (such as that of the *navāṃśa*s) was technically necessary in order to time rituals according to Indian astrology. The author(s) of the *Susiddhi-kara* clearly had observational astronomy in mind when their writings pointed to the prediction of eclipses. The *Vairocanābhisaṃbodhi* also clearly states that *nakṣatra*s must be considered. The elite members of the Chinese *saṃgha* in the capital might have been able to directly consult with Indian astronomers about these matters in detail, but the Japanese *saṃgha* did not have this opportunity. Technical works on Indian astronomy, such as the *Navagraha-karaṇa*, were never brought to Japan (they were also not widely studied in China). Another obstacle to employing astronomy was the fact that unauthorized study of this topic was technically illegal according to the law codes of the Tang, although the relevant laws were enforced less and less in the later years of the dynasty (Whitfield 1998). Japanese monks such as Kūkai simply would not have had easy access to astronomy. Japanese students of astronomy as part of the *Kentōshi* 遣唐使 ("Missions to the Tang") would have studied astronomy (the Chinese, not Indian, system) under the supervision of the state. Local and foreign monks did not have this opportunity, apart from the unique career of Yixing, who was a court astronomer (Kotyk 2018d). The adaptations employed in Mikkyō resulted in a form of hemerology based only vaguely on the Indian calendar, which was clearly an inevitable compromise given the circumstances. The explanation in the *Hino'o kuketsu* continues as follows:

> Method for selecting the *nakṣatra* convergence on the missing thirtieth day in a short month. Suppose the first month lacks the thirtieth day. Even without that thirtieth day, that day still has a *nakṣatra* convergence, hence the first half of the first day of the following second month is assigned the *nakṣatra* convergence of the missing day in the first month, while the second half is that day's *nakṣatra* convergence. Thus, even if there are fluctuations with the days, in the case of a short month lacking a day, the *nakṣatra* convergence will always apply to a day. The actual *nakṣatra* of the first day in the following month does not change.[15] (T. 2465, 78: p. 30c21-c26)

This explanation further illustrates that the calendrical day, rather than the observed position of the Moon, is of primary importance. In the case of short months, one half of a day is assigned to one *nakṣatra*. This would be irregular if the position of the Moon were involved since, in practice, it would only account for half of the Moon's time in a given *nakṣatra*. This problem, however, does not arise, because the assigned *nakṣatra* is a nominal designation. This system devised by Amoghavajra attempts to align the days of the lunar month so that the Full Moons transit through the *nakṣatra* from which a given month derives its name in Sanskrit (e.g., the Full Moon, i.e., the 15th day, should be aligned with *Kṛttikā* 昴宿 in the 9th month), but the resulting model is unwieldy and not based on observation.

On this point, we might ask how Mikkyō understood *nakṣatra*s as asterisms (i.e., as actual constellations visible in the sky). There was an awareness that the asterisms connected to the Chinese lunar stations only vaguely correspond to *nakṣatra*s. In other words, the constellations which are used for spatial identification are, in fact, different between the Indian and Chinese models. Unlike the typeset editions of the *Xiuyao jing*, the manuscript of the *Xiuyao jing* from 1322, held at Dōshisha University (148.8 | F9632), reproduces the illustrations of asterisms. The text explicitly states that the *nakṣatra*s are different from what is used in China and provides illustrations:

> In the astronomy of the country of Tang, *Mao* is seven stars. Now according to the explanation in this sūtra, the stars are not the same as those of the Great Tang, thus we rely on the astronomy of the Great Tang. Each are illustrated following the corresponding lunar station.[16]

Early Indic sources such as the *Nakṣatrakalpa* of the Atharvaveda, *Śārdūlakarṇāvadāna*, and *Gargasaṃhitā* all define *Kṛttikā* as comprising six determinative stars, called *yogatārā*s (Pingree and Morrissey 1986, p. 102). The *Mātaṅga-sūtra* in Chinese also gives six stars (T. 1300, 21: p. 404c10-11).

The Japanese side did not necessarily always favor the Chinese definition, and in some instances, the Indian number is cited. For instance, the section on astronomy in the *Jiu Tang shu* 舊唐書 (*Old Book of Tang*), the dynastic history of the Tang finished in 945 by Liu Xu 劉昫 (887–946), clearly states in its section on astronomy that "*Mao* is seven stars 昴七星 (*Jiu Tang shu* 35.1300)." In contrast, the *Wamyō ruiju shō* (*maki* 1, p. 3) reads "The *Xiuyao jing* states that the asterism *Subaru* is six stars and of the fire god [Agni] 宿耀經云昴星六星火神也." It is significant that the *Xiuyao jing* was cited in this dictionary, since it demonstrates that in the 10th century, people outside the immediate Buddhist fold indeed read the *Xiuyao jing*, but more important to our present discussion, we can observe that the official star counts of state sources from China did not necessarily take precedence in Japan.

The ambiguity concerning star counts is also reflected in the iconographical record. It is through illustrations that we can also see how different models of uranography (the illustration and mapping of the heavens) were present in Japan. This points to the fact that Mikkyō possessed astronomical materials originating from diverse sources. For example, the famous *Kara zu* 火羅圖 (*Hora Diagram*) for *Mao*/*Subaru* displays seven stars (the Chinese number) alongside a bodhisattva or Buddha-like figure (Figure 2).

Figure 2. *Mao* 昴/*Subaru*/*Kṛttikā* (lunar station) in *Kara zu*. SAT Taishōzō Image DB ver. 0.2. Creative Commons attribution: ShareAlike 4.0 International License.

The illustration of the asterism in the *Kara zu* is noteworthy, in light of seven stars being illustrated. We can point to other variants in the literature available to early Mikkyō. There are unique icons in the *Qiyao xingchen bie xingfa* 七曜星辰別行法 (*Special Practices for the Seven Planets and Stars*; T. 1309). This is an illustrated manual that documents spirits who affect people on specific days of the month. It is nominally attributed to Yixing based on the fantastical story told in the text about him summoning down the stars (Kotyk 2018d, pp. 23–27). We know this text was brought to Japan by Eun 惠運 (798–869) in 847 as it appears in his catalog of items (T. 2168A, 55: p. 1088b11). The spirits, apart from a few, are all associated with lunar stations, but these depictions, primarily anthropomorphic and zoomorphic, are unlike anything seen in contemporary Indic or Chinese sources (Figure 3).

Mao/*Subaru* shows six stars, which correspond to the classical Indian number. *Nü*/*Urukiboshi*, however, displays what appears to be 2 asterisms with 11 stars in total. The Chinese number is four stars according to the *Jiu Tang shu* (*Jiu Tang shu* 35.1299). The corresponding *nakṣatra*, *Śravaṇa*, is three stars in the ancient Indian texts. We might compare these asterisms to three other sources: the Dōshisha manuscript of the *Xiuyao jing*, the "Dunhuang Star Chart" (British Museum Or.8210/S.3326), which is the oldest extant complete star chart from East Asia, and a later but quite valuable resource in the history of astronomy, the *Gujin lüli kao* 古今律曆考 (*Study of Ancient and Present Tunes and Calendrical Sciences*), which is a compendium with rich information on Chinese astronomy compiled by Xing Yunlu 邢雲路 (1549–?). In the last item, we see a detailed uranographical illustration titled *Yaodian zhong xingtu* 堯典中星圖 (*Star Chart from the Classic of Yao*). This displays the classical constellations connected to the Chinese lunar stations. When comparing these sources, it is evident that the respective illustrators were drawing from various sources. We might imagine that a scribe might have mistakenly merged the constellations of *Nü* and *Dou* 斗 in the case of *Nü* in T. 1309. A Mikkyō monk in the late ninth century with access to the *Xiuyao jing* and T. 1309 would have been looking at often dissimilar asterisms, which would have furthermore differed from "canonical" or official Chinese sources.

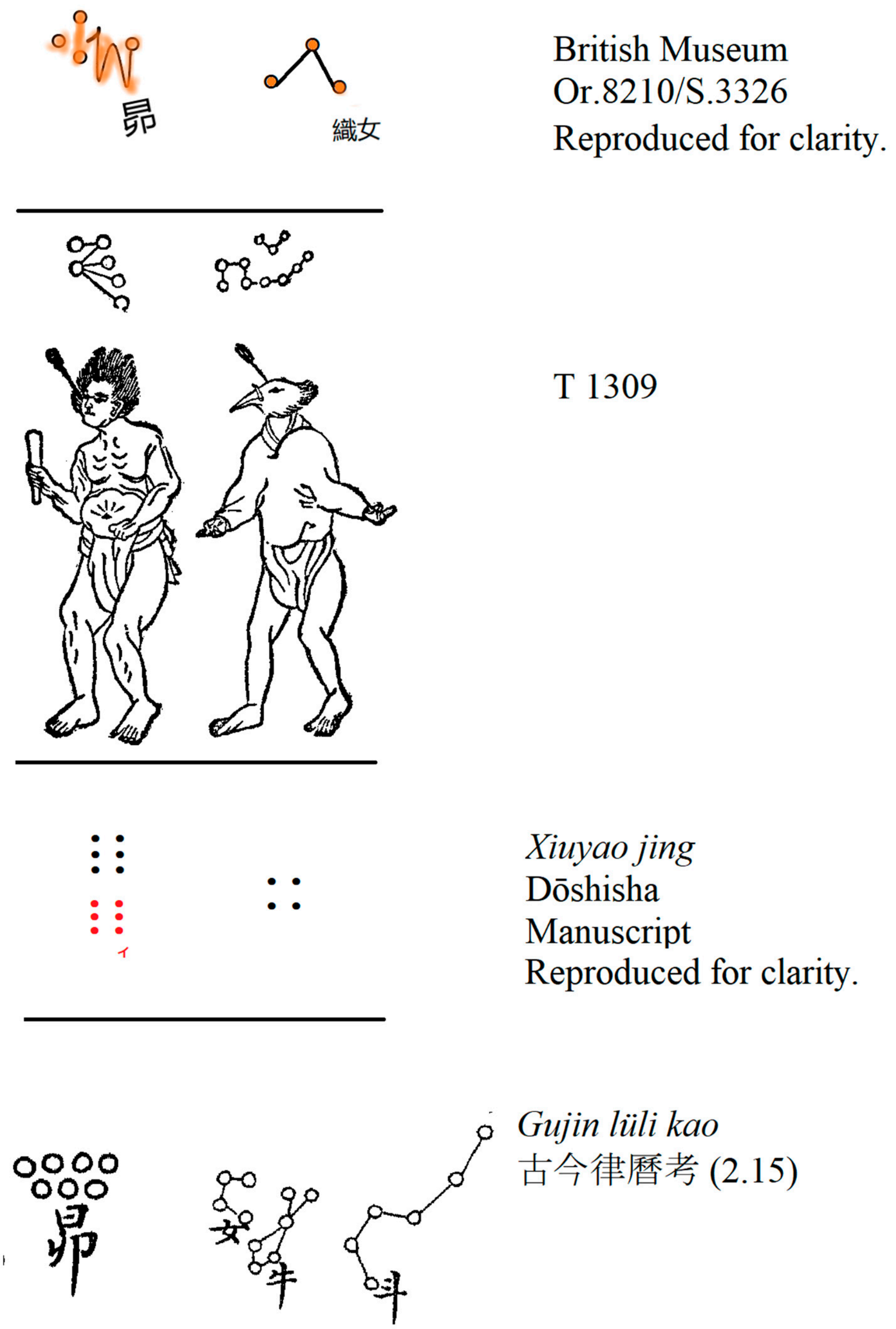

Figure 3. *Mao/Subaru* (asterisms on **left**) and *Nü/Urukiboshi* 女宿 (asterisms on **right**) compared. Image from *Gujin lüli kao* courtesy of Kanseki Repository. Attribution: ShareAlike 4.0 International (CC BY-SA 4.0).

The depicted anthropomorphic figures in T. 1309 are also anomalous and require a brief explanation. *Mao/Kṛttikā* is associated with Agni in Buddhist and more broadly Indic lore. *Nü/Śravaṇa* is associated with Viṣṇu (Yano 2003, p. 380). The depictions display nothing conceivably connected to Vedic deities. The clue to identifying the source of these figures is the illustrated nails driven into them. The text tells us their function as follows:

> It was instructed that should someone see the forms of the spirits with their eyes, then nail the top and bottom of the forms of the spirits and the following day bind them. The victim [of the spirit] will recover that day. When the nails are removed,

> the spirit will gain release and dare not come before one's gate.[17] (T. 1309, 21: 456c29-457a2)

I believe these spirits are *jinn* (*djinn*) based on their visual representations, often with bestial and zoomorphic features, and the fact that nails are used to bind them.[18] The latter in particular is a key element in *jinn* lore. Omidsalar (2000) explains that "the jinn are especially afraid of iron, and anyone who manages to insert an iron needle in their bodies or clothes, gains control of them because their great fear of iron prevents them from pulling the needle out of their persons or attire." If these spirits are in fact derived from *jinn* lore, then it is plausible that variant uranographical material also might have entered into the wider body of the astrological literature in East Asia, although this is only a speculative possibility at present. In any case, we can see that Mikkyō possessed variable illustrations of asterisms, but there was not an evident grasp on the canonical Indian asterisms linked to the *nakṣatra*s.

A similar observation can be made with respect to the zodiac signs. The zodiac signs appear in the *Taizō mandara* 胎藏曼荼羅, which is the *maṇḍala* of the *Vairocanābhisaṃbodhi* as preserved in Japan. There are even seed syllables assigned to each of the zodiac signs (Somekawa 2013). Yet, we might ask, did anyone in early Mikkyō know about the original constellations associated with the zodiac signs? How were the zodiac signs understood? Again, we can look back to the commentary to the *Vairocanābhisaṃbodhi*, where we read what is likely Yixing's voice:

> The ecliptic is divided into twelve chambers like the twelve [Jupiter] stations here [in China]. Each station has nine quarters [*pāda*].[19] (T. 1796, 39: p. 618a8-9.)[20]

Here, the zodiac signs are simply equated to Jupiter stations. The latter are an ancient Chinese concept that demarcates the celestial equator into 12 spaces based on the orbital period of Jupiter. This period is approximately 12 years, or more precisely, the sidereal orbital period is 11.86 years. A zodiac sign, in contrast, is one of 12 30° segments of the ecliptic (not the celestial equator). One of the tables in the first fascicle of the *Xiuyao jing* illustrates how Amoghavajra understood the zodiac signs as equivalent to Jupiter stations. For example, Scorpio (Ch. *Xie gong* 蝎宮) is positioned among three lunar stations—*Xin* 心, *Fang* 房, and *Di* 氐—but no spatial degrees are indicated (Figure 4). Scorpio is equated to "Great Fire" (Ch. *Da huo* 大火), one of the Jupiter stations. Below this, "fire" (Ch. *huo* 火) denotes Mars, since Scorpio is the domicile of Mars in classical astrology (Libra is the domicile of Venus). The doctrine of domiciles is a concept which was originally a part of Hellenistic astrology that was adopted into Indian astrology.[21]

Figure 4. Excerpt from table in *Xiuyao jing* showing lunar stations, Scorpio, and the Jupiter station Great Fire. See text reproduced by Wakita (1897, vol. 1, p. 12).

The zodiac signs were part of the canonical lore of Mikkyō, but they only exercised a symbolic role. As deities of the *Taizō mandara*, they appear in the *Taizō zuzō* (Figure 5) in forms mostly recognizable to anyone familiar with the classical zodiac. Here, we even see Sagittarius as a centaur-like or satyr-like bowman, one of the rare instances in which this type of icon is found in premodern East Asia.[22] Although Kūkai and Enchin would have known about Leo and Sagittarius, did they know which constellations were associated with the zodiac signs? Unlike the lunar stations, I am unaware of any uranographical depictions of zodiac signs in the Mikkyō corpus or any East Asian materials from the period in question. The zodiac signs in the *Kara zu* are each associated with one of the months, so in that way, they were connected to the passage of time, but this is different from a precisely defined tropical or sidereal zodiac. In this sense, in Mikkyō, the zodiac signs were even more symbolic in function than the *nakṣatra*s. This is noteworthy because in Indian astrology and astronomy, the zodiac signs were important in various ways, whether it be for making astrological predictions or positioning the planets.

Figure 5. Leo (**top left**), Sagittarius (**top right**), Pisces (**bottom left**), and Cancer (**bottom right**) in *Taizō zuzō* (a collection of icons of the *Taizō mandara*). Images adapted from TZ. vol. 2, pp. 284–86. Vectorized for clarity. SAT Taishōzō Image DB ver. 0.2. Creative Commons attribution: ShareAlike 4.0 International License. Note that in the icon of Pisces, the fish are not facing opposite directions, as was standard in classical representations elsewhere.

There is one example from the ninth century in which the zodiac signs were loosely connected to the degrees of lunar stations. This is found in the *Qiyao rangzai jue* 七曜攘災決 (*Secrets of the Seven-Planet Apotropaism*). This is a manual of horoscopy compiled sometime between 806 and 865 which includes ephemerides (astronomical tables) and enough information to calculate the positions of the planets, in addition to a number of spells and mantras to ward off the prognosticated baneful effects of the planets. Shūei 宗叡 (809–884) brought it to Japan in 865. It is recorded in his catalog of items brought from China (T. 2174A, 55: p. 1111b20-21). In this instance, the approximate numbers of degrees for each lunar station are listed under the zodiac signs, which seems to imply that a zodiac sign includes all the degrees of any lunar station subsumed under them (Figure 6). This results in uneven allocations; Aries is 27, and Taurus is 27, but Gemini is 48, although *Zi* 觜 ought to be 1, and therefore Gemini would be 39 (cf. table in Yano 1986, p. 30). The zodiac signs are not of significance in the text, so here they appear to only be loosely defined. Each zodiac sign is associated with an earthly branch, which again denotes Jupiter stations (i.e., Taurus is *you* 酉, which corresponds to "Great Bridge" (Ch. *Da liang* 大梁). Again, this is only a vague way of defining the zodiac signs.

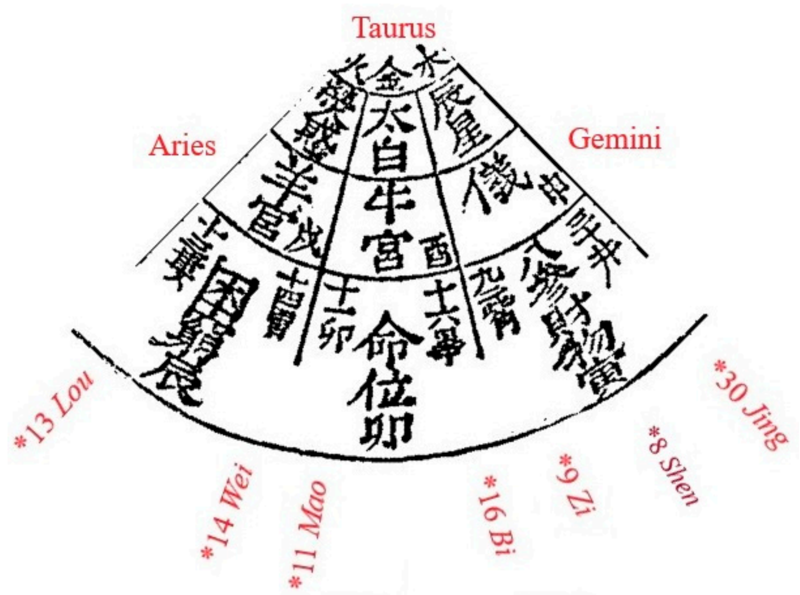

Figure 6. Excerpted quadrant (Aries to Gemini) from horoscopic table in *Qiyao rangzai jue* (T. 1308, 21: p. 451a).

6. The Seven-Day Week in Mikkyō

The above discussion demonstrates that astronomy, timekeeping, and uranography from India (and possibly elsewhere to some extent) were largely left unimplemented or even unstudied in Mikkyō. However, the seven-day week was, in fact, implemented from the very beginning. The concept of the week was easily implemented, since one need only keep track of the passage of days. The main source of information in Mikkyō about the days of the week was evidently the *Xiuyao jing*. The seven-day week was used primarily as a kind of schedule for religious activities rather than for timekeeping.

The earliest we can trace the seven-day week in the case of Japan is to Kūkai's return in 806, when he brought with him a copy of the *Xiuyao jing*. Shingon traditionally credits Kūkai with introducing the concept of Sunday to Japan. Shōken 聖賢 (1083–1147) in 1118 wrote the following:

> Before the Daidō reign era [806–810], calendar experts did not know of Sunday. This is why there was confusion about astrological auspiciousness and inauspiciousness. People often violated this. After the Great Master [Kūkai] returned to court, he transmitted this practice.[23] (*Kōya Daishi go kōden*, p. 661b14–17)

The essential concept here is that some days are more auspicious than others for certain activities. This is all explained in detail in the *Xiuyao jing*. The existing civil calendar, based on the Chinese system, divided the month into 3 segments of 10 days each (*jun* 旬). The seven-day week did not supplant this earlier system. During the ninth century, we also see Sunday cited alongside the conventional date. For example, the *Ono rokuchō* 小野六帖 by the Shingon monk Ningai 仁海 (951–1046) records the following date and highlights that it was a Sunday:

> 12/13 in year 10 of Jōwa, Sunday, at Tō-ji [6 January 844] (T. 2473, 78: p. 76b19).[24]

It is clear that Tendai also adopted the seven-day week early on. The biography of Ennin, the *Jigaku Daishi den* 慈覺大師傳 (*Biography of Great Master Jigaku*) by Minamoto no Fusaakira 源英明 (d. 939), states that in the year 849, Ennin had to identify an auspicious day on which to create the Vajradhātu-maṇḍala (*Kongōkai mandara* 金剛界曼荼羅). He found a suitable day using *sukuyō* 宿曜, which at this point seems to have primarily denoted hemerology based on the *Xiuyao jing* rather than astrology in the sense of prognosticating the fate of an individual. Ennin identified a *kanro nichi* 甘露日 or "Day of Amṛta" (8-2: 691b5–8). This is a concept from the *Xiuyao jing*, in which a "Day of Amṛta" (especially favorable for religious rites) becomes constituted when there is a specific configuration of a *nakṣatra* and day of the week (Wakita 1897, vol. 1, p. 33). In this case, Ennin found that lunar 5/8, which is associated with Hasta (Ch. *Zhen* 軫), fell on a Sunday, and thus this auspicious day was identified (Yamashita 1996, p. 297). The Sanskrit name underlying this concept is not given in any East Asian sources of which I am aware, but this concept is attested in Indic sources and even still in modern India as *amṛtasiddhiyōga*.[25] It is indeed noteworthy that Mikkyō and Indian astrology both continue to observe this practice.

The seven-day week, with each day associated with a planet, clearly became an important element within Mikkyō, but we must point out that, in reality, this is not strictly connected to astronomy. The positions of the planets are unrelated to the days of the week. The original system was Greco-Egyptian in origin, in which each of the 24 h of a day was associated with a planet in the order of Saturn, Jupiter, Mars, the Sun, Venus, Mercury, and the Moon (the Chaldean ordering, running from the slowest to fastest moving planets from a geocentric perspective). The ruler of the first hour of a day becomes the ruler of that day. This results in the ordering of Sunday (Sun), Monday (Moon), Tuesday (Mars), etc. (Yano 2003, p. 383). The planetary hours are unknown in East Asian sources, but the days of the week were adopted from the eighth century in China and then the ninth in Japan. The recurring cycle of seven days could be easily tracked alongside the progression of the sexagenary cycle without any need for observation of the sky. The week therefore was, strictly speaking, another form of hemerology, rather than an element of astrology requiring astronomical knowledge.

The iconographical data from early Mikkyō suggests that the seven planets were more associated with the days of the week, rather than being wandering stars in the sky to be carefully tracked. In this sense, the planets take on a more abstract form rooted in the passage of time (meaning they rule over days) rather than the movement of visible planetary bodies above, much in the same way that the *nakṣatra*s were not generally treated as asterisms or spatial divisions based on astrometrics in Mikkyō. We can infer that this was, in fact, the reality, based on the *Kuyō hiryaku* 九曜秘曆 (*Secret Calendar of the Nine Planets*). This text includes rich lore about each of the seven planets as days of the week, as well as the pseudo-planets Rāhu and Ketu, although comments about these two are limited (Figure 7). The well-preserved manuscript at the NYC Metropolitan Museum is a reproduction by Sōkan 宗觀 in the year 1125, but the postscript states that the original manuscript was an earlier copy produced in Tengyō 天慶 3 (940), although it is uncertain whether the text was originally a Chinese or Japanese composition.[26] This earlier copy was apparently a reproduction of an earlier manuscript, so we might assume the original text was composed sometime before 940, perhaps in the ninth century. The text provides mantras and even some spells to counter the influences of the planets. Illustrated icons of the planets in anthropomorphic and even zoomorphic forms are provided, a fact that highlights their deified quality (Figure 8). Several of these are entirely unlike earlier Indian precedents, but they share common features with Arabic and Persian codices of a somewhat later period (e.g., Venus as a lute player and Mercury as a scribe). An Iranian heritage has been proposed (Kotyk 2017b).

Figure 7. Ketu, Sun, Moon, and Jupiter (**right** to **left**) in *Kuyō hiryaku*. NYC Met. Public domain.

Figure 8. Sun in *Kuyō hiryaku*. NYC Met (1975.268.4). Public domain.

7. Conclusions

The above discussion has demonstrated that while Chinese calendrical science and observational astronomy were introduced to Japan, at the same time, there were abundant Indian materials directly or indirectly related to astronomy, astrology, and calendars also transmitted via Buddhism. Although these were arguably unimportant to earlier types of Buddhism (at least as far as the attainment of *bodhi* or advancement along the bodhisattva path were concerned), the situation changed considerably with the advent of Mikkyō. The scriptures and orthopraxy of Mantrayāna required an understanding of astrology and, in some cases, expertise in observational astronomy. Although such sciences were available to the *saṃgha* in India, the circumstances were different in China, where legal codes and even just the impracticalities of converting between Indian and Chinese systems existed. The situation became even more complex for Japanese monks who had to operate using borrowed Chinese models and only a handful of resources. Still, the available data shows that early Mikkyō monks were aware of astrology, and it was taken into consideration. This fact is not widely recognized in scholarship on Mikkyō.

When we examine how early Mikkyō received and understood the orthodox materials, in particular the *Xiuyao jing*, it becomes clear that many of the critical elements in Indian astronomy and astrology, such as the *nakṣatra*s and zodiac signs, were known but omitted from actual implementation. Regular observation of the planets and stars was not generally required in Mikkyō, which stands in contrast to what the Indian literature advises if not requires. Moreover, exact identification of the constellations connected to the *nakṣatra*s and zodiac signs was not undertaken in Mikkyō, perhaps because this information was not available. The *Xiujao jing* itself adopts Chinese lunar stations, but confusingly, it also explains in detail an astrometric system of *nakṣatras* and zodiac signs completely unlike the Chinese model. Other texts available to monks in Japan offered no more clarity on the matter. The zodiac signs were similarly employed in a nominal way, but they were not defined in any precise way, and instead they were left as minor figures in the *Taizō mandara*. This is an interesting example in the history of science in which the figures of the zodiac signs (e.g., Sagittarius as a satyr bowman or Aries as a ram) were available as illustrations, but the constellations associated with them were unknown. Instead, the zodiac signs were just tied to the Jupiter stations, which served as functional equivalents, even if they were technically incompatible. The seven-day week, in contrast, could be and in fact was implemented in Mikkyō, but this did not require any observational astronomy. The practice of astronomy changed considerably within Japanese Buddhism with the advent of Sukuyōdō 宿曜道, a community of astrologer-monks that lasted until the late 14th century, but this happened after the late 10th century and is outside the scope of the present study.[27]

An important observation to take away from this study is that although astronomy and calendrical science were critical components within Mikkyō, we have to recognize the severe limitations these communities faced with regard to access to expertise and clear explanations. Although one may speak of "Indian astrology" or even "Buddhist astrology" in Japan, there were actually so many major revisions and omissions of key concepts and practices to the point that we ought to recognize the limited extent to which non-Chinese systems were, in reality, understood and implemented. This situation is quite comparable to the premodern Japanese understanding of Sanskrit, which was largely limited to word lists, phonetics, and Siddhaṃ (all of these through a Chinese medium) but lacked any comprehensive study of grammar (Kotyk 2021b). The survey above shows that Mikkyō was more of an heir to a Sinicized form of Indian astrology, which itself was a product of Amoghavajra's time. Amoghavajra had to create an authoritative manual with which the local *saṃgha* could time rituals according to Indian conventions. The result was certainly functional, but from the perspective of Indian astronomers at the time, I think they would have detected many irregularities and compromises. In this sense, Mikkyō astrology was, we might say, more *based on* Indian astrology (and apparently some other types of astrology) than actually being a faithful transmission of it.

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Conflicts of Interest: The author declares no conflict of interest.

Abbreviations

SNKBZ	*Shinpen Nihon koten bungaku zenshū* 新編日本古典文學全集. 88 vols. Tokyo: Shōgakkan, 1994–2002.
T	*Taishō shinshū daizōkyō* 大正新修大藏經. Edited by Takakusu Junjirō 高楠順次郎 and Watanabe Kaigyoku 渡辺海旭 et al. 85 vols. Tokyo: Taishō Issaikyō kankōkai, 1924–1932.
TZ	*Taishō shinshū daizōkyō Zuzō-bu* 大正新修大藏經圖像部. Edited by Ono Genmyō 小野玄妙 et al. 12 vols (reprint). Tokyo: Daizō shuppan, 1988–1989.

Notes

1 For further discussion of Goto's monograph, see my review (Kotyk 2021a).

2 Goto translates this as "a platform for the first time was erected from which to do horoscopes by means of the stars". I suggested an alternative translation (Kotyk 2021a, p. 364), cited above, based on the fact that horoscopes did not yet exist in Japan in the seventh century. Compare with this translation by Aston (1972, vol. 2, p. 326): "A platform was for the first time erected from which to divine by means of the stars."

3 I must thank Alexander Vovin for pointing out this source (16 November 2021).

4 Ennin's travelogue is titled *Nittō guhō junrei kōki* 入唐求法巡禮行記 (*Pilgrimage Travelogue of a Journey to the Tang in Search of the Dharma*). From the very beginning of this work, Ennin denotes the time of day using the Chinese system. For example: "At the time of *mi* [hour of the snake, 9a.m.–11a.m.], we arrived at the Eastern Sea at Shiga no Shima 巳時到志賀東海." B18, no. 95, p. 5a6.

5 "'Solar and lunar [movements] and seasons.' A day is from sunrise to sunrise, comprised of an early part, middle part, and final part. The night is also three parts. One night and one day are comprised of thirty *muhūrta*s. During the spring and the autumn equinoxes, fifteen *muhūrta*s belong to daytime, and fifteen *muhūrta*s belong to nighttime. There is fluctuation at other times. The [summer] solstice of the fifth lunar month has eighteen daytime *muhūrta*s and twelve nighttime *muhūrta*s. The [winter] solstice of the eleventh lunar month has eighteen nighttime *muhūrta*s and twelve daytime *muhūrta*s." 「日月歲節」者, 日名從旦至旦, 初分, 中分, 後分; 夜亦三分. 一日一夜有三十時: 春, 秋分時, 十五時屬晝, 十五時屬夜; 餘時增減. 五月至, 晝十八時, 夜十二時; 十一月至, 夜十八時, 晝十二時. T 1509, 25: p. 409b25–29. See English translation by Kotyk (2020, p. 275). The use of *shi* 時 ("double hour") as a translation of *muhūrta* is interesting because the two units of time are incomparable in reality. There are 12 *shi* in a day but 30 *muhūrta*s in a day and thus approximately 120 modern minutes vs. 48 (notwithstanding seasonal variations).

6 See list of associations in Yano (2003, p. 380). The first known complete list of 28 *nakṣatra*s appears in the Atharva Veda. See Yano (2004, p. 333).

7 於月蝕時, 成就最上之物. 於日蝕時, 通上中下成就之物. 或月十五日或七或一或十三日, 或用三日, 應作成就及一切事. 若作最上成就, 應取上宿曜時, 其中下法類此應知, 然諸宿中, 鬼宿為最, 若作猛利成就, 還依猛利宿曜時等.

8 遇良日晨, 定日時分宿直諸執皆悉相應, 於食前時値吉祥相者 [. . .]. English translation by Giebel (2005, p. 19).

9 又現執金剛, 普賢, 蓮華手菩薩等像貌, 普於十方宣說真言道清淨句法. 所謂初發心乃至十地次第此生滿足 [. . .]. English translation by Giebel (2005, p. 4).

10 See translation and discussion of this section of the commentary in Kotyk (2018b).

11 Asterisms and planets were understood as deities in Mantrayāna, perhaps as a result of their importance within astrology. The *maṇḍala*s of not only the *Vairocanābhisaṃbodhi* but also that of the *Vajraśekhara-sūtra* (Jp. *Kongōchōkyō* 金剛頂經) include various celestial deities. The *Taizō zuzō* 胎藏圖象 and *Taizō kuzuyō* 胎藏舊圖樣 are illustrated manuscripts which were brought to Japan by the Tendai monk Enchin 圓珍 (814–891) and then recopied in later centuries. The icons therein are the prototypical forms as they were drawn in China based on Indian precedents (Mammitzsch 1990, pp. 30–32). There also existed star *maṇḍala*s in Japan, which are important, but postdate the period under present investigation. See Takeda (1995).

12 Yano (2013, pp. 226–64) has importantly shown that there exist two major recensions of the *Xiuyao jing*. He denotes them as Mainland and Japanese. The former is reproduced in the Taishō canon (T. 1299) but significantly postdates Amoghavajra and moreover includes a number of editorial revisions. The latter recension was first reproduced as a typeset edition by Wakita (1897), although the alternate Mainland recension was instead incorporated into the Taishō canon. The Japanese recensions are arguably more faithful to the original version created by Amoghavajra, as Yano shows.

13 勘宿曜經取潤月之宿及小月之闕日分宿法. 依口訣記. 若有閏月時, 其正月直宿即亦重直閏月, 謂假令十二月有閏月, 而其十二月一日直宿是虛宿. 十五日直宿是星宿, 乃至三十日直宿是星宿. 如是閏十二月直宿亦同之, 更無異也. 先月是正十二月, 閏月是傍十二月也. 故傍月直宿三十日皆用正十二月直宿, 更不異宿也. 餘月聞月准之知耳. Reading *shō* 星 (*Maghā*) as *shitsu* 室 (*Pūrvabhādrapadā*).

14 See the translation in Kotyk (2018b, pp. 15–17).

15 取小月闕第三十日直宿之法. 假令正月小闕第三十日, 雖無其第三十日, 而彼日分直宿猶有故, 次二月初一日半已上者正月闕日之分宿直也. 半已下者即彼當日宿直, 故雖大小異日有增減, 而小月闕日直宿無日不得. 次月初一日真宿無改代也.

16 唐國天文昴七星. 今案此經, 星不與大唐同, 故依大唐天文, 各圖於當宿之下.

17 教人眼見諸鬼形, 於鬼形上下釘手, 明日收禁之. 患人當日差訖. 與出却其釘, 鬼既得放更不敢到於門焉. Read *shou* 手 as *zhi* 之.

18 *Jinn* (Persian *parī*) are regarded as a class of spirits. They are common in Islamic cultures and are believed to regularly interact with the human world. See Omidsalar (2000) for details.

19 分周天作十二房, 猶如此間十二次, 每次有九足.

20 See the translation in Kotyk (2018b, p. 15).

21 For an outline of the domiciles in Hellenistic astrology, see Greenbaum (2015, pp. 407–9).

22 I must thank Sonja Brentjes (24 March 2022) for pointing out that this icon more closely resembles a satyr than a centaur. This point was made at my talk hosted by the Max Planck Institute (Berlin, Germany), Dept. III.

23 大同以往, 曆家無知密日, 是故日辰吉凶雜亂, 人多犯之, 大師歸朝之後傳此事. This account is in the *Kōya Daishi go kōden* 高野大師御廣傳 (*Extensive Biography of the Kōya Great Master*). See Yamashita (1990, p. 488). The translation of this line is from Kotyk (2018c, p. 42). The use of the word *mitsu* 密 for Sunday is significant because this is a transcription of the Sogdian word *Myr* (also written as Jp. *mitsu* 蜜) for Sun (which also denotes Sunday). There was clearly an Iranian input into East Asian astrology during the Tang, a point taken up by Kotyk (2017a). The *Xiuyao jing* lists the names of the weekdays in Persian, Sogdian and Sanskrit. We might expect that the Sanskrit transcription *āditya* (Jp. *aniteiya* 阿儞底耶) would have been preferred amongst Buddhists, but the Sogdian readings were apparently more popular in the Tang when naming the days of the week. See the table in Yano (2013, p. 110).

24 承和十年十二月十三日密日東寺. For converting premodern East Asian dates, see Academia Sinica's helpful tool: https://sinocal.sinica.edu.tw/ (accessed on 14 May 2022).

25 Molesworth's Marathi-English dictionary (Molesworth 1857, p. 41) provides the following definition: "अमृतसिद्धियोग amṛtasiddhiyōga *m* S A common term for certain periods in astrology, viz. the days of the week, beginning with Sunday, on which occur

respectively the following nakshatras, हस्त, श्रवण, अश्विनी, अनुराधा, पुष्य, रेवती, रोहिणी, [Skt. Hasta, Śravaṇa, Aśvinī, Anurādhā, Puṣya, Revatī, Rohiṇī]—the day having its proper nakshatra, or the occurrence of the proper nakshatra on the proper day."

26 For further data and information about a separate manuscript, see Nakano (1969).

27 On Sukuyōdō, see the studies by Yamashita (1990), Yano (2013), Momo (1975) and Kotyk (2018c).

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