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The Planetary Visibility Tables in the Second-Century BC Manuscript *Wu xing zhan* 五星占[1]

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Abstract: This article is a study of the planetary tables in the second-century BC manuscript *Wu xing zhan*. Products of computation in this and later texts are compared to what we know about contemporary bodies of planetary knowledge to highlight discrepancies between theory and practice, as well as pluralities of tradition, within the early imperial astral sciences. In particular, this study focuses on such tables' apparent use of a solar calendar (as distinct from the lunisolar civil calendar) for the purposes of planetary astronomy; it also attempts to explain anomalous features of the *Wu xing zhan*'s planetary tables in the context of early manuscript culture.

The silk manuscript *Wu xing zhan* 五星占 (Planetary Omens) was discovered in 1973 in Changsha, Hunan amid the manuscript horde at Mawangdui 馬王堆 tomb 3—a Western Han tomb sealed in 168 BC belonging, it seems, to Li Xi 利豨, the second marquis of Dai 軑.[2] The text, some 146 lines, is divided into eight units, the first five of which are

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[2] On the identity of the tomb occupant, see Chen Songchang (2003). Note that the manuscript itself is untitled, leaving the editors to assign it this descriptive title.

devoted to planetary omens for Jupiter, Mars, Saturn, Mercury, and Venus, respectively, and the last three to 70-year visibility tables and planetary models for Jupiter, Saturn, and Venus. The *Wu xing zhan* is a unique document, being at once the earliest reliable source for mathematical astronomy in China and the only one to have come down to us in manuscript form.[3] It also furnishes us with one of the only examples of calculated planetary tables from the pre-modern period.

The *Wu xing zhan* has attracted a significant body of scholarship in the four decades since its discovery, the results of which are synthesised in Liu Lexian (2004), to which we turn for the critical edition.[4] Takeda (2010) and Cullen (2011b) have since resolved a number of outstanding technical issues and raised new questions about the manuscript's place in the history of Chinese astronomy. Following in the footsteps of Teboul (1983), Takeda (2010) places the *Wu xing zhan* alongside other early models in a developmental line to the Triple Concordance *li* (*Santong li* 三統曆) of *circa* 5 AD; where earlier scholars tended to smooth that line via creative chronology, however, he offers loss and textual corruption as possible answers as to why later texts were worse. Flipping the question on its head, Cullen (2011b) argues that we must read the manuscript as a whole—as a divination manual—the tables and planetary models therein acting as norms for identifying and interpreting celestial anomalies, the question of *accuracy*, therefore, being beside the point. If these seem like radically different readings of 'Chinese astral science,' it is perhaps because we forget that actors counted two: *tianwen* 天文 'heavenly patterns' and *li* 曆 'sequencing.' As actors' categories, the one deals with observation and omenology, and the other, mathematical modelling, their (evolving) bifurcation manifest in practices, professions, textual genres, and bibliographic and historiographic classification from the first century BC on. Whether or not these terms apply backwards in time, or beyond the received tradition of elite literature, the dilemma posed by Takeda (2010) and Cullen (2011b) is one for which we already essentially have a name.[5]

This article will focus on two aspects of the *Wu xing zhan* tables as they reflect upon what we know from more traditional sources about the history of astronomy in China. The first is the matter of the plurality. The *Wu xing zhan*'s technical contents are inconsistent—inconsistent with later tradition,

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[3] In addition to the *Wu xing zhan*, there is also the unpublished *Wu xing* 五星 unearthed in 1977 from Shuanggudui 雙古堆 tomb 1 (closed 165 BC) in Fuyang, Anhui, for which see Hu Pingsheng (1998).

[4] See also the translations of Kawahara & Miyajima (1985) and Cullen (2011a), to which my own translations in this article are heavily indebted.

[5] The difference between *tianwen* and *li* genres is most clearly manifest in the respective eponymous treatises of the standard histories, for a taste of which see Chaussende et al. (forthcoming).

astronomical reality, and itself. As concerns its internal contradictions, I argue that a sensitivity to later actors' categories goes a long way to reconcile its contents, demonstrating how the tables conflate what are already discrete forms of planetary knowledge. Externally, I show how features of the tables' 'solar calendar' reflect a long-standing astronomical convention distinct from the lunisolar civil calendar generally thought to be the only way that 'the Chinese' could conceive of time.[6] Another aspect of these tables that I wish to explore is their status as products of practice. Most of what we know about early mathematical astronomy we know from *li* procedure texts preserved in the standard histories.[7] As polished syntheses, these texts tell us next to nothing about the 'scientific process' that went into their creation, nor what people did with them once they were done. Scholars have gone a long way to reveal the complexity of pre-print calendar culture, highlighting ambiguities between policy, practice, theory, and *realia* therein.[8] As concerns astronomy, we see similar clues as to how what appear like inviolable 'canons' (Martzloff, 2009; Sivin, 2009) were continuously modified and reconstituted in practice; planetary tables, be there less of them, might hold the key for similar reflection.[9] The question at the heart of this article is ultimately why the *Wu xing zhan* is the way it is, and in the final section I offer several conjectures based on what we know about early Chinese manuscript culture and the manuscript's own textual history.

Before we begin, let me say a few words about coordinates and conventions. As to astronomical units, our subjects work in *du* 度 ('measure/crossing'): a linear measure of the circumference of a great circle where one *du* equals the distance travelled by the mean sun in one day, and, thus, the number of *du* in one 'circuit of heaven' (*zhou tian* 周天) equals the length in

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[6] To preempt the objection that what I present in this article is not a 'calendar' as such, I remind the reader that 'calendar' is an observers' category without an exact equivalent in ancient Chinese, and that the definition of this observers' category, according to the *Oxford English Dictionary*, is "the system according to which the beginning and length of successive civil years, and the subdivision of the year into its parts, is fixed; as the Babylonian, Jewish, Roman, or Arabic calendar." As far as observers' categories go, this is one that allows for plurality, and it is one I believe to be appropriate to what follows.

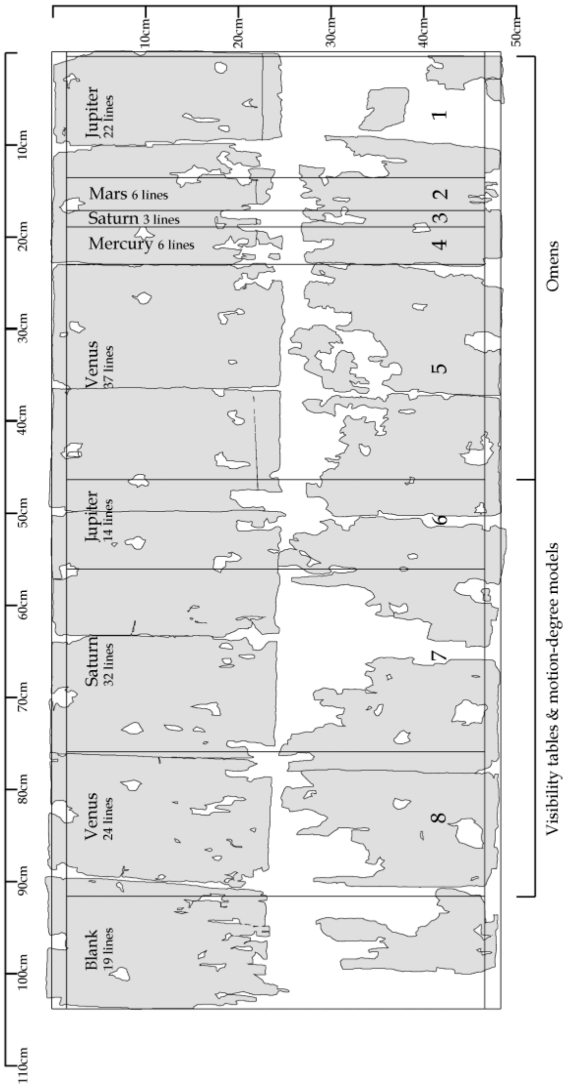
[7] For an introduction to the *li* procedure text genre, see Liu Hongtao (2003) and Sivin (2009).

[8] See for example Zhang Peiyu (2007), Huang Yi-long (1992), Deng Wenkuan (2002), Martzloff (2009), and Arrault (2002).

[9] The Han Quarter-remainder *li* (*Sifen li* 四分曆); is an excellent case in point: adopted in 85 AD, the emperor ordered a change of its calendrical parameters in the following year, the version preserved in *Hou Han shu* 後漢書, *zhi* 3, 3058-3081, containing furthermore a solar tabled dated 174 AD. On the evolution of the Quarter-remainder *li*, see Ōhashi (1982).

days of the tropical year. For most intents and purposes, 1 *du* = 1 day, and 360° ≈ 365¼ *du*. In this article, we will be dealing with *du* of right ascension (RA) as counted in 'lodge-entry *du*' (*ru xiu du* 入宿度) from the respective guide stars of the twenty-eight lodges (see Figure 4), which I number L01-L28, and also in 1/12-circuit, or 30°, 'stations' (*ci* 次). Note that for dates I use *y-m-d* format, e.g. 'Shihuang 2-VIII-1' for 'Shihuang year 1, month VIII, day 1'.

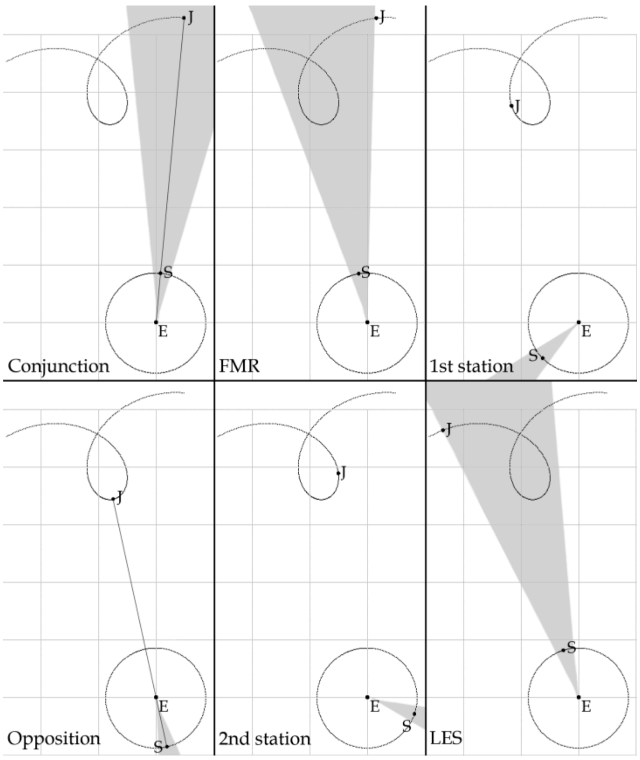
Figure 1. *Wu xing zhan* textual units



The Planetary Models

Before coming to the tables, let us outline the phenomena with which they are concerned and the different approaches thereto. Our first question is thus "what do planets do?"

Figure 2. The synodic period of Jupiter



NOTE: This diagram illustrates the characteristic phenomena of Jupiter (J) over the course of one synodic period as viewed geocentrically from Earth (E). The grey area indicates the hypothesised 'threshold of visibility' from the sun (S). Individual diagrams were modified from *Alcyone Ephemeris* v3.2.

The apparent motion of Jupiter is a good place to begin since the 'Year Star' (*Suixing* 歲星) invariably comes first in any list. Like Mars and Saturn, Jupiter is a superior planet, meaning that its orbit is larger than our own and that its apparent motion along the ecliptic is slower than that of the sun. When Jupiter is opposite the Sun in conjunction (*he* 合), it is 'hidden' (*fu* 伏)

and nowhere to be seen. However, within a week or two the Sun moves far enough past the planet that the latter finally "emerges in the morning in the east" (*chen chu dongfang* 晨出東方) before being washed out by the break of dawn—it experiences first morning rising (FMR). For the next 12 to 13 weeks, it rises earlier and earlier each morning, travelling forward through the stars, all the while gradually slowing until it comes to a stop (*liu* 留)—first station. At this point it begins to accelerate backwards in retrograde (*nixing* 逆行), reaching opposition (*chong* 沖) about 7 weeks later. In another 7 weeks it slows and comes to another stop—second station—before again moving forward or 'prograde' (*shun* 順). For the next 12 to 13 weeks it gradually accelerates while the Sun catches back up with it, setting earlier and earlier each night until it is again drowned out by the brightness of the Sun and "enters in the evening in the west" (*xi ru xifang* 夕入西方)—i.e. experiences last evening setting (LES). The length of time it takes a planet to complete these actions and return to the same position *vis-à-vis* the Sun is its synodic period (*S*). This is distinct from, though proportionally related to, its sidereal period (*P*), which is the amount of time it takes to return to the same position among the stars. The apparent motion of Venus and Mercury, the inferior planets, is more complex, but the example of Jupiter is sufficient for our purposes here.[10]

As to *li*, the earliest extant procedure text with which to compare the *Wu xing zhan* is Liu Xin's 劉歆 (c. 5 BC–23 AD) Triple Concordance *li* (*Han shu* 漢書, 21b.991-1011) of *circa* 5 AD. Its approach to planetary phenomena is defined by four elements. The first is the *shu* 數 'numbers' of the calendar and of the planet's synodic period, the latter derived from a resonance period of FMR to years. The second is a *xingdu* 行度 '*du* travelled' model of the planet's motion and visibility over the course of one synodic period; these models, one notes, are predicated on symmetry and on a fixed 'threshold of visibility' from the sun at which the planet appears and disappears. The third is the *li yuan* 曆元 'system origin,' a point in time and space where all calendro-astronomical cycles coincide and from which subsequent iterations are counted. The fourth is the *shu* 術 'procedures' of calculation.[11] The *Wu xing zhan* antedates the Triple Concordance *li* by some two centuries, but the planetary models in Sections 6-8 clearly anticipate the latter in terms of style, approach and theory. In later terms, Sections 6-8 provide the '*du* travelled:'

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[10] For more, see Teboul (1983), pp. 49-109.

[11] For more on early planetary *li*, see Teboul (1983) and Liu Hongtao (2003). Note that the Triple Concordance *li* is atypical of the later tradition in that it builds slight asymmetries into its '*du* travelled' models and in that later *li* count the synodic period from conjunction.

> 秦始皇帝元年正月，歲星日行廿分，十二日而行一度，終【歲行卅】度百五分，見三【百六十五日而夕入西方】，伏卅日，三百九十五日而復出東方。【十二】歲一周天，廿四歲一與大【白】合營室。
>
> On Qin Shihuang 1-I-[1], Year Star was (sic.)[12] travelling 20 parts (20/240 *du*) per day, travelling 1 *du* in 12 days, and [travelling 30] *du* & 105 parts in the course of [one year (*sui*)]. It is visible for 3[65 days before entering in the evening in the west], where it hides for 30 days. In 395 days it emerges again in the east. [In 12] years it makes one circuit through heaven, and every 24 years it goes into conjunction with Great [White] (Venus) in Hall$_{L13}$ (section 6, lines 89-90).

Compare this to the Triple Concordance *li*:

> 木，晨始見，去日半次。順，日行十一分度二，百二十一日。始留，二十五日而旋。逆，日行七分度一，八十四日。復留，二十四日三分而旋。復順，日行十一分度二，百一十一日有百八十二萬八千三百六十二分而伏。凡見三百六十五日有百八十二萬八千三百六十五分，除逆，定行星三十度百六十六萬一千二百八十六分。凡見一歲，行一次而後伏。日行不盈十一分度一。伏三十三日三百三十三萬四千七百三十七分，行星三度百六十七萬三千四百五十一分。一見，三百九十八日五百一十六萬三千一百二分，行星三十三度三百三十三萬四千七百三十七分。通其率，故曰日行千七百二十八分度之百四十五。
>
> Wood (Jupiter): First morning visibility at a half station from the sun. Prograde: travels 2/11 *du* per day, 121 days. First station: 25 days, then circles back. Retrograde: travels 1/7 *du* per day, 84 days. Second station: 24 days & 3 parts (of 7308711), then circles back. Return to prograde: travels 2/11 *du* per day, 111 days & 1828362 parts, then hides (LES). Visible for a total of 365 days & 1828365 parts, and, minus retrograde, travels a fixed 30 *du* & 1661286 parts through the stars. In total, it is visible for one year (*sui*), in which time it travels one station and later hides, its [average] daily motion being less than 1/11 *du*. Hidden: 33 days & 3334737 parts, travels 3 *du* &

[12] Upon comparison with the Saturn and Venus models, it would appear that the copyist skipped a line here designating the planet's location in Hall$_{L13}$. Unless otherwise noted, all insertions are as per the critical edition of Liu Lexian (2004), which explains how the missing text has been restored via calculation and/or textual parallels with received literature.

> 1673451 parts. [From] one [first] appearance [to the next]: 398 days & 5163102 parts, travels 33 *du* & 3334737 parts through the stars. Connect its rates, and it can thus be said that its daily travel is 145/1728 *du* (*Han shu*, 21b.998).

As to the model, the *Wu xing zhan* gives the superior planet a constant speed derived from its sidereal period with no accommodation for station or retrogradation (Jupiter's 20/240 *du* per day = 365¼ *du* ÷ (12 years × 365¼ days)); the text is furthermore silent about the threshold of visibility, because there appears to be none (Takeda, 2010, pp. 9-12). As to the 'numbers', the *Wu xing zhan* adopts relatively simple values, with S = 395 165/240 days, or 13/12 year, and P = 12 years, rounding S in this instance to 395. These are less *precise* than the Triple Concordance *li* (S = 398 5163102/7308711 days, P = 11.92 years; resonance period 1583 FMR : 1728 years), and they are also less accurate, but it is the fact of their *incommensurability* that stands out: where the Triple Concordance numbers derive from a theoretical understanding of the relationship between the sidereal and synodic period, the *Wu xing zhan* would appear to have arrived at their respective values through independent observation.[13] As to 'system origin,' the *Wu xing zhan* models place the FMR of Jupiter, Saturn, and Venus together at Hall.$_{L15}$ [5 *du*] on Qin Shihuang 秦始皇 1-I-[1], parallels with later descriptions of the Qin Zhuanxu *li* 顓頊曆 confirming a (hypothesised) coincidence of Establishment of Spring (*li chun* 立春) and *all* FMR on this date. Judging from excavated calendars, this date should correspond to 246 BC February 3.[14] The choice of system origin is clearly retrospective Qin 秦 (221-206 BC) propaganda, the planets at that time being spread out over half the sky, with half of them invisible, none of them in Hall.$_{L13}$, and their FMR having likely occurred several weeks apart (fig. 3).[15] A system origin need not be accurate in itself so long as functions

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[13] Mo Zihan (2011), pp. 126-129. An understanding of this proportional relationship is evident in the Triple Concordance *li*, which derives the superior planets' synodic arcs Δα (the distance travelled in one synodic period) from the length of the year E (= the circuit of heaven) and a synodic period expressed in terms of appearances A : years Y. In symbolic form:

$$\Delta\alpha = \frac{Y\text{-}A}{A} \times E$$

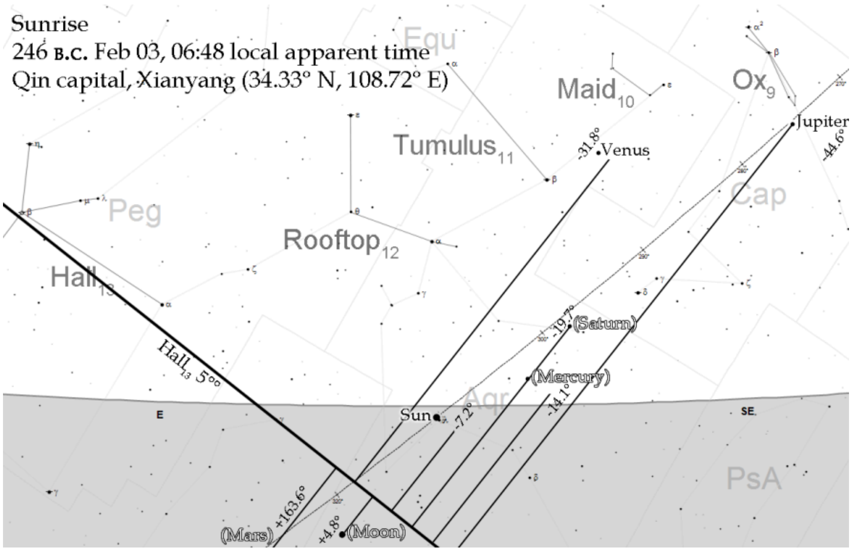
In modern terms, $\frac{1}{P} = \frac{1}{E} - \frac{1}{S}$, where P is the planet's sidereal period, S is its synodic period, and E is the earth's sidereal period. According to the Triple Concordance *li* formula, for example, the *Wu xing zhan's* synodic period for Jupiter would produce a sidereal period of 13 rather than 12 years. The results of this incongruence are evident in the discussion of the Jupiter table below.

[14] See Zhang Peiyu (2007) and Li Zhonglin (2010).

[15] The Zhuanxu *li* system origin is cited variously by Liu Xiang 劉向 (79-78 BC), Cai Yong 蔡邕 (133-192 AD), Liu Hong 劉洪 (fl. 167-206 AD), and Dong Ba 董巴 (fl. third century AD) in *Xin Tang shu* 新唐書, 27a.602–603; *Hou Han shu*, *zhi* 2, 3039

to produce accurate results for the intended age, of course, and the Triple Concordance *li*, for its part, makes similar if more cautious concessions to political symbolism (Cullen, 1991; 2007).

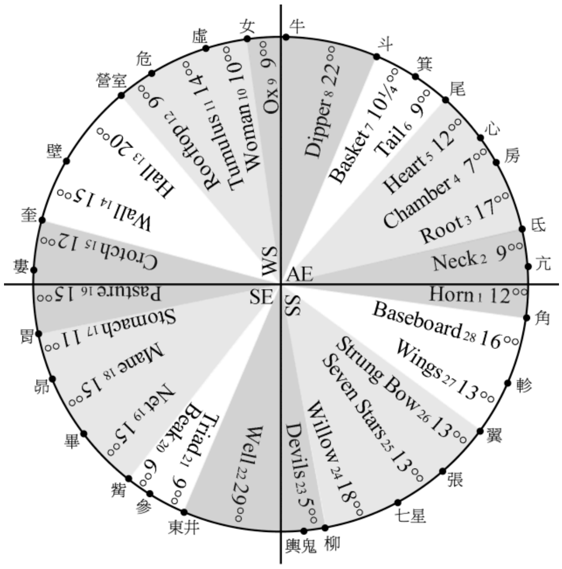
Figure 3. Eastern horizon at *Wu xing zhan* system origin



NOTE: Figure produced by *Alcyone Ephemeris* v3.2 and modified by the author to show the twenty-eight lodges. Distances from Hall.$_{L13}$ 5 *du* (taking η Pegasi as Hall.$_{L13}$ 0 *du*) are given in degrees of right ascension (RA). Parentheses indicate bodies not yet visible at dawn.

[commentary], 3042–3043; *Jin shu*, 17.502. On the *Wu xing zhan* system origin and its ties to the Qin dynasty, see Mo Zihan (2011), pp. 121-122.

Figure 4. The 28 lodges of the 'ancient degree' system



NOTE: the coordinates here are as per the third- and second-century BC *gu du* 古度 'ancient-degree' system, for which see Pan Nai (2009), pp. 29-41 and Sun Zhanyu (2011). The vertical and horizontal lines representing the solstitial (S) and equinoctial (E) colures, respectively. The two- and three-lodge zones indicated in differing shades are the twelve Jovian stations as we will encounter them in fig. 5.

The planetary models in Sections 6-8 of the *Wu xing zhan* are indeed simpler than those we find in the Triple Concordance *li*; the difference, however, is more one of degree than of kind. We can say this because planetary models are one of the places where the spheres of early *tianwen* and *li* literature overlap, and the sort of model cited above has all the characteristics of the latter. By way of comparison, the earliest reliable self-described works of *tianwen* are the *Huainanzi* 淮南子 (139 BC) "Tianwen xun" 天文訓 and the *Shiji* 史記 (91 BC) "Tianguan shu" 天官書; equally valuable is the *Kaiyuan zhanjing* 開元占經 (729 AD), which excerpts omen literature dating nebulously to the centuries before and after. This corpus relies equally on quantitative models, the point, however, is not the calculation of 'regularities' (*chang* 常) but the identification and interpretation of 'anomalies' (*yi* 異). Function determining form, *tianwen* models tend to be simpler and more conservative than contemporaneous *li*, and many operate in an (incommensurate) observational idiom of *altitude* and 'feet' (*chi* 尺) and 'inches' (*cun* 寸) of separation.[16] By far the most distinctive feature of early *tianwen* planetary models, however, is the intellectual influence of hemerology.

The science of 'day selection' (*zeri* 擇日) used a variety of hemerologies, the more sophisticated of which feature calendar deities who cycle like game pieces through schematic arrangements of the *tiangan dizhi* 天干地支 'heavenly branches & earthly stems,' their position within a correlative matrix determining the auspiciousness of times and directions for everyday activities. Judging from the growing corpus of excavated 'daybook' (*rishu* 日書) literature, such hemerologies seem to have enjoyed a certain cultural currency in the second and third centuries BC, and it is therefore not surprising to see their influence in other forms of divination. The clearest example of how hemerology fed into the astral sciences is Taiyin 太陰. Taiyin is a terrestrial deity that moves clockwise through the twelve branches at the rate of one per year, mirroring Jupiter's roughly twelve-year sidereal period. Once referred to as 'Counter-Jupiter,' it is actually Taiyin that determines the planet's position, FMR, and the progression of the twelve so-called 'Jovian years.' With ample parallels in early sources like the *Huainanzi* and *Shiji*, we find the following description in Section 1 of the *Wu xing zhan*:[17]

> 歲處一國，是司歲。歲星以正月與營宮晨【出東方，其名為攝提格。其明歲以二月與東壁晨出東方，其名】為單閼。其明歲三月與胃晨出東方，其名為執徐。…其明歲以十二月與虛【晨出東方，其名為赤奮若。其明歲與營室晨】出東方，復為攝提【格，十二歲】而周。皆出三百六十五日而夕入西方，伏卅日而晨出東方，凡三百九十五日百五分【日而復出東方】。
>
> [Jupiter] occupies one state per year, this is why it officiates the year. In month I, Year Star [emerges] in the morning [in the east] with Hall$_{L13}$, [and its name is Shetige. In month II of the next year, it emerges in the morning in the east with Eastern Wall$_{L14}$, and its name] is Chanye. In month III of the next year it emerges in the morning in the east with Stomach$_{L17}$, and its name is Zhixu… In month XII of the [twelfth] year [it emerges in the morning in the east] with Tumulus$_{11}$, [and its name is Chifenruo. The next year] it emerges [in the morning] in

[16] An excellent sampling of *tianwen* planetary models can be found in *juan* 23, 30, 38, 45, and 53 of the *Kaiyuan zhanjing*. On the use of altitude and civil length measures in *tianwen* observation, see Wang Yumin (2008).

[17] On hemerology, see Kalinowski (1986) and Liu Lexian (2002). On the hemerological mechanics of *tianwen* planetary models, see Mo Zihan (2011).

> the east [with Hall.$_{\text{L13}}$], and is again Sheti[ge. In 12 years] it makes its circuit. It always emerges for 365 days before entering in the evening in the west and hides for 30 days before emerging in the morning in the east. In a total of [days it re-emerges in the east] (lines 1-5).[18]
>
> 歲星與大陰相應也，大陰居維辰一，歲星居維宿星二，大陰居中辰一，歲星居中宿星【三】。□□□□□□□□□□□□□□□□□□□□□□□□□【歲】星居尾箕，大陰左徙，會於陰陽之界，皆十二歲而周於天地。
>
> The Year Star and Taiyin correspond. When Taiyin occupies a corner chronogram (earthly branch), Year Star occupies the two corner lodges, and when Taiyin occupies a centre chronogram, Year Star occupies the three centre lodges. ... [Year Star] occupies Tail.$_{\text{L06}}$ and Basket.$_{\text{L07}}$. Taiyin shifts left (clockwise) and they meet at the boundaries of *yin* and *yang*, circling heaven & earth, respectively, in 12 years (lines 42-43).

All of this makes perfect sense in the mechanics of hemerology, where we might expect Jupiter and its visibility phenomena to cycle incrementally forward through chronograms, years, and months like proper calendar deities, but the mechanics here contradict contemporary astronomical knowledge in two regards. First, when the Jovian cycle repeats, the hemerological model has FMR skip from 12-XII to 1-I (i.e. 13-I, exactly one month later) rather than 14-I (a full 13 months later, as we would expect), because a 12-year sidereal period is incompatible with a 13-month synodic period.[19] Second, the hemerological model treats the twenty-eight lodges as even counters when they are, in actuality, zones of uneven width. Whereas Section 6 has Jupiter travel 20/240 *du* per day, for example, Section 1 has it travel two- and three-lodge zones varying from 15 to 44 *du* over equal durations of time (compare fig. 4 and fig. 5).

The other quantitative models with which the *Wu xing zhan* opens belong to the same tradition of planetary hemerology. In Section 4, we have a model for Mercury that has the planet appear four times a year at the solstices and equinoxes—a model, well-attested in early *tianwen* literature, that bears no relation whatsoever to the planet's mean synodic period (115.88 days, cf. the Triple Concordance's 115.91 days).[20] In Section 3, we furthermore have a model for Saturn whose language, while defective,

[18] For the correction of the terminal fraction, see Mo Zihan (2011), pp. 126–129.

[19] On the Jovian/Taiyin year-count as it appears in *tianwen* literature, see Wang Shengli (1989) and Tao Lei (2003), pp. 73-97.

[20] See Teboul (1983), pp. 134–137, 143–145, and Morgan (2016).

parallels that of received *tianwen* models that have the planet move one lodge per year:

> 實填州星，歲□□□□□□□□□□□既已處之，有（又）【西】東去之，其國凶。
>
> Verily, the star that quells provinces (Saturn), each year... If it has already dwelt there but leaves to the [west] or east, that state is ill-fortuned (*Wu xing zhan*, section 3, line 51)
>
> 歲填一宿，其所居國吉。...又西東去，其國失土。...歲行十三度百十二分度之五，日行二十八分度之一，二十八歲周天。
>
> Each year [Saturn] quells one lodge. The state in which it dwells is fortuned. ... If it leaves to the west or east, that state will lose earth (territory). ... Its yearly (*sui*) travel is 13 *du* & 5/12 *du*, its daily travel is 1/28 *du*, and it makes one circuit of heaven in 28 years (*Shiji*, 27.1319-1320).[21]

In Section 7, the *Wu xing zhan* returns with a different model built around a sidereal period of 30 years (cf. its actual mean sidereal period of 29.49 years):

> 秦始皇帝元年正月，填星在營室，日行八分，卅日而行一度，終歲行【十二度卌二分】，【見三百四十五】日，伏卅二日，凡見三百七十七日而復出東方，卅歲一周于天，廿歲與歲星合爲大陰之紀。
>
> Qin Shihuang 1-I-[1], Quellor Star is in Hall.$_{L13}$. Its daily travel is 8 parts (of 240), travelling 1 *du* in 30 days, and travelling [12 *du* & 42 parts] by the end of the year (*sui*). [It is visible for 345] days and hidden for 32 days. In total, it emerges again in the east 377 days after [first] appearing. In 30 years it makes one circuit in heaven, and in 20 years it goes once into conjunction with Year Star for a Taiyin era (*Wu xing zhan*, section 7, lines 121-122).

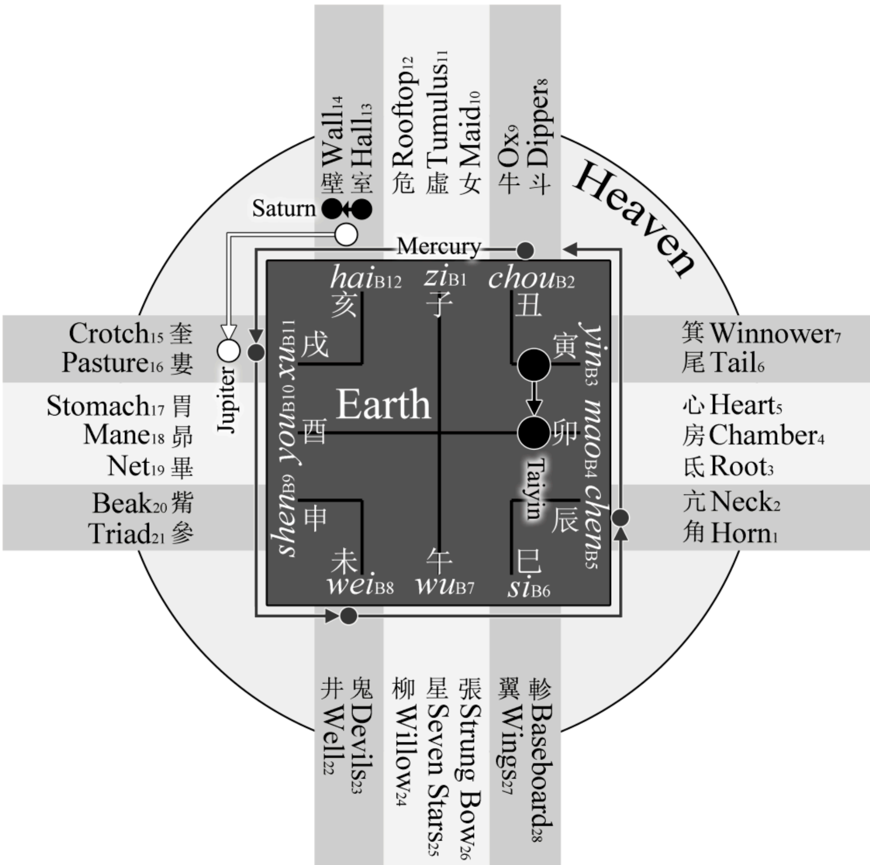
In sum, the *Wu xing zhan* contains what later actors would categorise as distinct bodies of planetary knowledge: *li*-like mathematical models, with astronomically intelligible numbers counted to a precision of 1/240 day and *du*, and *tianwen*-like omenological models, with hemerologically intelligible game-board movements counted in units of lodges. The fact that incommensurable models appear in *the same text* is odd by the standards of

---

[21] For parallel models, see *Huainan honglie jijie*, 3.90; *Kaiyuan zhanjing*, 38.2b–5b.

received literature. One could read this as evidence as to how such categories need not apply to earlier, excavated literature, but the fact the manuscript segregates the two in its first and second half suggests that something like the *tianwen*/*li* distinction may well go back to the second or third century BC.

Figure 5. Hemerological planetary models on a chord-hook diagram (year 1 of 60)



The Tables

Though it opens with omens for each of the naked eye planets, the *Wu xing zhan* devotes *li* tables to only three: Jupiter, Saturn, and Venus. The reason for omitting Mars is probably that "[its advance & retreat] are without constancy and cannot be taken as [a standard]" 【進退】無恒，不可為【極】 (section 2, line 45). The reason for omitting Mercury is less evident seeing as how Section 4, like other early *tianwen* literature, confidently reduces its characteristic phenomena to a four-point seasonal hemerology. Either the table maker felt no need—the seasonal hemerology repeats every year—or he considered the *li*-reality of the planet to be likewise 'without constancy.' As to the tables we *do* have, let us work backwards from Venus.

On the Venus table (Table 3), each column describes the 'month' (*yue* 月) of a visibility phenomenon, the lodge 'with' (*yu* 與) which the planet/sun rise, and the period between this and the next phenomenon. Every other column or so are numbers marked with 'remainder' (*yu* 余) vs. 'take' (*qu* 取) and the year in which said phenomenon occurs. The years are counted in reign periods, and those above 10 are abbreviated, such that years 11, 21, and 31 revert to 1. These years run (right to left) across several rows, each row (top to bottom) representing the planet's resonance period of 5 FMR : 8 years, such that the planet's visibility phenomena repeat exactly in each subsequent eight-year row. The number of days between each phenomenon is an exact match to the '*du* travelled' model following the table in lines 143-146.

First, let us consider the lodge-positions. Because the mean sun travels 1 *du*/day, and because the sun and planet are at the same position at 'emergence' and 'entry,' the number of *du* travelled over one synodic period necessarily equals the number of days elapsed. Counting from a system origin with the sun and planets at Hall.$_{L13}$ 5 *du* (as we can assume the compiler might have done), one can assess whether and how the planet's lodge-positions were calculated. Doing so, Mo Zihan (2011) demonstrates that the Venus table lodge-positions accord with calculation performed in this manner with the 'ancient degree' lodge system. We can say, therefore, the lodge-positions were not only *calculated*, but that they were calculated *correctly* in terms of internal consistency.

Table 1. *Wu xing zhan* Jupiter table (lines 77-88)

FMR with Hall$_{13}$	QSH 1	3 *234*	5 *222*	[7] *210*	9 *198*	[2] *186*
〃 Eastern Wall$_{14}$	2 *245*	4 *233*	6 *221*	[8] *209*	[10] *197*	[3] *185*
〃 Pasture$_{16}$	3 *244*	5 *232*	7 *220*	[9] *208*	1 *196*	[4] *184*
〃 Net$_{19}$	4 *243*	6 *231*	8 *219*	[40] *207*	2 *195*	[5] *183*
〃 Eastern Well$_{22}$	5 *242*	7 *230*	9 *218*	Han 1	XHui 1	[6] *182*
〃 Willow$_{24}$	6 *241*	8 *229*	30 *217*	2 *205*	2 *193*	[7] *181*
〃 Strung Bow$_{26}$	7 *240*	9 *228*	1 *216*	[3] *204*	[3] *192*	[8] *180*
〃 Baseboard$_{28}$	8 *239*	20 *227*	2 *215*	[4] *203*	4 *191*	[1] *179*
〃 Neck$_{2}$	9 *238*	1 *226*	3 *214*	5 *202*	5 *190*	2 *178*
〃 Heart$_{5}$	10 *237*	2 *225*	4 *213*	6 *201*	6 *189*	3 *177*
〃 Dipper$_{8}$	1 *236*	3 *224*	5 *212*	7 *200*	7 *188*	
〃 Serving Maid$_{10}$	2 *235*	4 *223*	6 *211*	8 *199*	Rgncy	

Table 2. *Wu xing zhan* Saturn table (lines 91-120)

FMR with	Hall$_{13}$	1 QSH	1 *216*	2 *186*
""	Hall$_{13}$	2 *245*	2 *215*	3 *185*
""	E. Wall$_{14}$	3 *244*	3 *214*	4 *184*
""	[Crotch$_{15}$]	4 *243*	4 *213*	5 *183*
""	Pasture$_{16}$	5 *242*	5 *212*	6 *182*
""	Stomach$_{17}$	6 *241*	6 *211*	7 *181*
""	Mane$_{18}$	7 *240*	7 *210*	8 *180*
""	Net$_{19}$	8 *239*	8 RoC	1 *179*
""	Beak$_{20}$	9 *238*	9 *208*	2 *178*
""	Attack$_{21}$	10 *237*	40 *207*	3 *177*
""	E. Well$_{22}$	1 *236*	Han 1	
""	[E.] Well$_{22}$	2 *235*	2 *205*	
""	Demons$_{23}$	3 *234*	3 *204*	
""	Willow$_{24}$	4 *233*	4 *203*	
""	Seven Stars$_{25}$	5 *232*	5 *202*	
""	Strung bow$_{26}$	6 *231*	6 *201*	
""	Wings$_{27}$	7 *230*	7 *200*	
""	Baseboard$_{28}$	8 *229*	8 *199*	
""	Horn$_{1}$	9 *228*	9 *198*	
""	Neck$_{2}$	20 *227*	10 *197*	
""	Root$_{3}$	1 *226*	1 *196*	
""	Chamber$_{4}$	2 *225*	2 *195*	
""	Heart$_{5}$	3 *224*	XHui 1	
""	Tail$_{6}$	4 *223*	2 *193*	
""	Basket$_{7}$	5 *222*	3 *192*	
""	Dipper$_{8}$	6 *221*	4 *191*	
""	Led Ox$_{9}$	7 *220*	5 *190*	
""	Serv. Maid$_{10}$	8 *219*	6 *189*	
""	Tumulus$_{11}$	9 *218*	7 *188*	
""	Rooftop$_{12}$	30 *217*	GE 1	

Table 3. *Wu xing zhan* Venus table (lines 123-142)

I, FMR with Hall$_{13}$. In 224d LMR with Horn$_{1}$ in VIII.		[Qin 1]		[9]	*238*	[7]	*230*	5	*222*	3	*214*	Han 1
Travels submerged for 120d and FES with Tumulus$_{11}$ in XII.	-21											
FES with Tumulus$_{11}$. In 224d LES with Wings$_{27}$ in VIII.		[2]	*245*	[10]	*237*	[8]	*229*	6	*221*	4	*213*	2
Hides for 16d and 96 parts and FMR with Baseboard$_{28}$.												
FMR with Baseboard$_{28}$ in VIII. In 224d LMR with Mane$_{18}$ in III.	+78											
Travels submerged for 120d and FES with... in IX.		3	*244*	[1]	*236*	9	*228*	7	*220*	5	*212*	3
FES with Wings$_{27}$ in VIII. In 224d LES with Pasture$_{16}$ in II.	+57											
Hides for 16d and 96 parts and FMR with Mane$_{18}$ in III.		4	*243*	[2]	*235*	20	*227*	8	*219*	6	*211*	4
FMR with Mane$_{18}$ in III. In 224d LMR with Basket$_{7}$ in XI.												
Travels submerged for 120d and [FE]S with Pasture$_{16}$ in III.	+52											
FES with Pasture$_{16}$… In 224d LES with Heart$_{5}$ in X.		5	*242*	[3]	*234*	[1]	*226*	9	*218*	7	*210*	5
… for 16d and 90 (96) parts and FMR with Basket$_{7}$ in XI.	-73											
FMR with Basket$_{7}$ in XI. In 224d LMR with Willow$_{24}$ in VI.		6	*241*	[4]	*233*	[2]	*225*	[30]	*217*	[8]	*209*	6
Travels submerged for 120d and FES with Heart$_{5}$ in IX.	-94											
FES with Heart$_{5}$ in IX. In 224d LES with Well$_{22}$ in V.		7	*240*	[5]	*232*	[3]	*224*	[1]	*216*	[9]	*208*	[7]
Hides for 16d and 96 parts and FMR with Devils$_{23}$ in IX.												
FMR with Devils$_{23}$ in VI. In 224d LMR with Western Wall$_{13}$ in I.	+5											
Travels submerged for 120d and FES with Well$_{22}$ in V.		8	*239*	[6]	*231*	[4]	*223*	[2]	*215*	[40]	*207*	[8]
FES with Well$_{22}$ in X. In 224d LES with Tumulus$_{11}$ in XII.												
...6d and 96 parts and FMR with Eastern Wall (Hall$_{13}$) in I.												

		199			*200*		*201*		*202*			*203*		*204*			*205*		
		4 *191*			3 *192*		2 *193*		Hui 1			2 *195*		1 *196*			10 *197*		9 *198*
		5 *183*			4 *184*		3 *185*		2 *186*			GE 1		7 *188*			6 *189*		5 *190*
							3 *177*		2 *178*			1 *179*		8 *180*			7 *181*		6 *182*

NOTE: The numbers in italics give the proleptic Julian year, BC. Where present, 'remainder' and 'take' numbers are marked +/−, respectively. Reign periods: QSH = Qin Shihuang; RoC = Rise of Chu 楚; XHui = Han Xiaohuidi 漢孝惠帝 (r. 192-188 BC); GE/Rgncy = Regency of Empress Lü 呂. Note that the table reverts to 1 in 179 BC at the beginning of Han Wendi's 文帝 reign (r. 179-157 BC). Underlining indicates contradiction.

The dates are more complicated, features of the *Wu xing zhan* tables being inconsistent with any civil calendar. The civil calendar of the time began on month X (Oct/Nov) not, as the tables do, on month I (Jan/Feb). The civil calendar was moreover lunisolar, fixing the *nian* 年 'civil year' of 12 or 13 lunar months (354-355 and 384-385 days, respectively) to the *sui* 歲 'solar/ agricultural year' of 365¼ days by means of a 19-year intercalation scheme (19 *sui* = 19 × 12 + 7 lunations = 235 lunations). The *Wu xing zhan*, by contrast, speaks only of *sui* and *yue*; it makes no mention of *nian* or intercalary months, nor are its tables' 12-, 30-, and 8-*sui* rows compatible with the 19-year civil scheme.[22] *Sui* are easy, the problem is how to understand the *yue*. Were we dealing with civil months, we should expect the Venus table month-dates to be different for each 8-*sui* resonance period, repeating only after 8 × 19 = 152 years, but such is not the case. Were we dealing with civil months, we would also expect the number of months

[22] On the distinction between *sui* and *nian* in the astral sciences, see Qu Anjing (2008), pp. 66–67. Note that *in non-astronomical contexts* this distinction is somewhat flexible, e.g. the *Jiuzhang suanshu* 九章算術 gives the length of a *sui* as 354 days (*Huijiao Jiuzhang suanshu* 匯校九章算術, 3.115), and the *Erya* 爾雅 identifies these terms as synonyms: "a *zai* (year) is a *sui*; the Xia called it *sui*, the Shang called it *si*, the Zhou called it *nian*, and Tang Yu called it *zai*" 載，歲也，夏曰歲，商曰祀，周曰年，唐虞曰載 (*Erya zhushu*, 5.18b).

elapsed between 224-, 120-, and 16-day intervals to correspond to a factor of ≈29.5, minus the occasional intercalary month, but 10 of 20 entries fall short of the requisite number in a way that no 8-year stretch of intercalation in effect between 246-177 BC can explain.

We could chalk this off to corruption, pointing to the fact that two of these month-dates are simply impossible, and another two disagree as they recur in adjacent lines. We could, like Cullen (2011b), experiment with hypothetical intercalation templates for individual tables in an attempt to reconcile what remains. Or, we could entertain the possibility that "the *yue* here is not that of the lunisolar calendar but refers instead to solar months" (Yabuuti, 1982, p. 6), which is to say 1/12-*sui*, 30 21/48-day solar periods counted from, in this case, establishment of spring (*li chun*).[23]

Everything would seem to point to Yabuuti's 'solar month'. The *sui* is clearly a solar year: "it takes eight *sui* [in total for Venus to emerge from and enter the east five times each and re]emerge in the morning in the east with Hall.$_{L13}$" 【凡出入東方各五，復】與營室晨出東方，爲八歲 (lines 145-146) with a synodic period of 584 96/240 days, because 5 × 584 96/240 = 8 × 365¼.[24] A solar year would seem to imply solar 'months.' The concept is

[23] Cullen (2011b), p. 231n24, dismisses Yabuuti (1982), "leav[ing] aside the possibility that a purely solar calendar year divided into twelve equal months lies behind this table, since there is no evidence for any such practice," despite the fact that "In each case we are told, to the nearest whole day, how far the event chosen falls after or before the end of the year, each year apparently being reckoned as 365 days" (Cullen, 2011a, 244n128). Reading *yue* as the months of a civil year of 354-355 or 384-385 days, he offers that "Trial and error shows that the best results are produced if an intercalation is inserted after the 9th months of year 3 and year 6 of the 8-year sequence. In that case, leaving on one side the two impossible months already mentioned, it is found that 15 out of the remaining 18 months can be predicted by using the stated intervals between events and assuming that the first event falls at the start of month 1… But as already mentioned, the pattern of intercalations in subsequent 8-year cycles must be different" (2011b, pp. 247-248). One notes that the closest that the civil calendar reconstructed by Zhang Peiyu (2007) and Li Zhonglin (2010) comes to Cullen's hypothetical sequence are the windows 206-199 BC, 198-191 BC, 190-183 BC (all with intercalary month IX^2 in year 2, year 5, and year 8), and 182-175 BC (intercalary month IX^2 in year 3, year 5, and year 8), which accommodate 14 of the 20 month-dates (other windows accommodate between 7 to 12).

[24] The 'remainder' and 'take' numbers point to a similar conclusion (Cullen, 2011a, 244-245). The table and '*du* travelled' have Venus alternate between periods of 224, 120, 224, and 16.4 days for a synodic period of 584.4 days. Reading the 'remainder' and 'take' numbers as the positive and negative difference in days between said phenomena and the beginning of the next year, we find the following:

not without precedent: 1/12-*sui* 'stations,' 'steps' (*chan* 躔), and 'medial[-*qi*]' (*zhong* 中) are at the heart of the Triple Concordance *li*, and so too does such a 'month' feature in the *Wu xing zhan* Jupiter table, below.[25] True, it is atypical for *yue* 'moon/month' to refer to such a period but neither is it unprecedented, as we will see later in this article. So, does Yabuuti's 'solar month' solve the problem of the Venus table month-dates? Yes and no. In theory, it certainly facilitates the neat repetition of the planet's synodic period in an 8-*sui* table. In practice, however, a solar month is consistent with 13 of the Venus table's 20 month-dates *per cycle*, faring only moderately better than the civil calendar over 70 years.[26] Again, whatever the intention of its compiler, internal contradictions tell us that the dates of Venus table suffer from some miscalculation or corruption.

Now that we have an idea of the questions surrounding the Venus table, let us return to the superior planets. The Jupiter table (Table 1) is relatively simple, omitting LES, month-dates, days elapsed, and 'take' and 'remainder' numbers. Tellingly, each column describes a *synodic* phenomenon (13/12 'months'), while each row represents a *sidereal* period (12 *sui*). Like the hemerology of Section 1, the table in Section 6 thus resets the planet's synodic phenomena every 12 years, skipping the 13^{th} year between FMR month XII and FMR month I. Given its respective synodic and sidereal periods, the two should coincide every 13 × 12 = 156 *sui*, but that would hardly allow a compact, repeating table. To that end, the compiler resorts to hemerology, but where *tianwen* hemerologies in the *Huainanzi* and *Shiji* uses the calendar deity Taiyin/Taisui to determine the time and place of FMR vis-à-vis heavenly stems and earthly branches, the *Wu xing zhan* opts for the ancient-degree 'solar steps'—the *li*-determined lodge-position of the

Year	±	Explanation of ± Day-Numbers
1	−21	224 + 120 = 344 = 365 − 21
2	+78	344 + (224 + 16.4 + 224) = 808.4 = (365 + 365.4) + 78
3	+57	808.4 + (120 + 224) = 1152.4 = (2×365 + 365.4) + 57
4	+52	1152.4 + (16.4 + 224 + 120) = 1512.8 = (2×365 + 2×365.4) + 52
5	−73	1512.8 + (224 + 16.4) = 1753.2 = (2×365 + 3×365.4)-73
6	−94	1753.2 + (224 + 120) = 2097.2 = (3×365 + 3×365.4)-94
7	+5	2097.2 + (224 + 16.4 + 224) = 2561.6 = (3×365 + 4×365.4) + 5
8		2561.6 + (120 + 224 + 16.4) = 2922 = (3×365 + 5×365.4) = **8×365.25**

[25] See Teboul (1983); Liu Hongtao (2003), pp. 15-22, 37-49.

[26] Assuming these 1/12-*sui* 'months' start from 1-I-1, LES1 falls 20 days into 2-VII rather than 2-VIII; FES2 falls 15 days into 3-VII rather than 3-VIII; LMR3 falls 23 days into 5-X rather than 5-XI; FES3 falls 21 days into 5-II rather than 5-III; FMR4 falls 18 days into 6-X rather than 6-XI; LMR4 falls 29 days into 6-V rather than 6-VI; and FMR5 falls 24 days into 7-V rather than 7-VI. Between 246-175 BC this accommodates a total of 117 of 180 month-dates, whereas the civil calendar accommodates 107 over the same period.

sun at 1/12-*sui* intervals through the solar year (Table 4).[27] In short, the Jupiter table mixes hemerological and astronomical knowledge.

Table 4. Comparison of *Wu xing zhan* Jupiter FMR with 'ancient-degree' solar steps

Mo.	Solar steps	*Wu xing zhan*		
		Table	Year-count	Taiyin sys
I	L13	L13	L13	L13-14
II	L15	L14	...	L15-16
III	L17	L16	L17	L17-19
IV	L19	L19	L19	L20-21
V	L22	L22	...	L22-23
VI	L24	L24	...	L24-26
VII	L26	L26	L26	L27-28
VIII	L28	L28	L28	L01-02
IX	L03	L02	...	L03-05
X	L05	L05	L05	L06-07
XI	L08	L08	L08	L08-09
XII	L10	L10	L11	L10-12

NOTE: Lodges are given in numbers; for reference, see Figure 5. The 'Solar steps' column gives the 'ancient-degree' solar steps found in third- and second-century BC daybooks (source: Wu Jiabi, 2003, p. 277, Table 12). Grey indicates a match between the 'ancient-degree' solar step and the 'monthly' FMR. Note that the solar step for month II falls right between lodges 14 and 15, making the *Wu xing zhan* Jupiter table a near match in this instance.

Other than being organised around a 30-year sidereal period, the Saturn table (Table 3) is identical to that for Jupiter, and it too is at odds with the motion-degree model that follows (lines 121-122). Like the case of Jupiter, the compiler takes recourse to the *tianwen* model, moving Saturn one lodge per year despite the unevenness of the lodges and the skill with which he was able to compute them in the case of Venus. In a concession to the 30-year period of the mathematical model, however, he repeats two of the

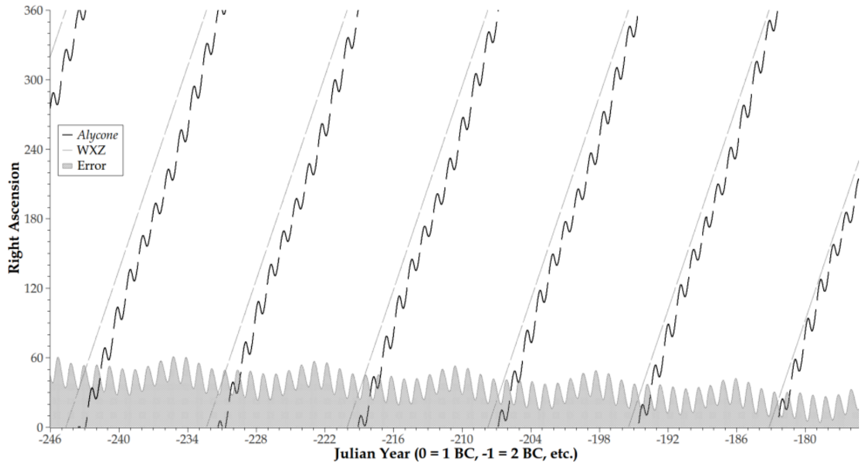
[27] For the hemerologically-determined lodge-positions of the Taiyin/Taisui system, see Kalinowski (1996). Mo Zihan (2011), pp. 126-129, presents the use of *li*-determined 'solar steps' both here and in the Jovian year-count in lines 1-5 (cited above) as further evidence of the use of the *Wu xing zhan*'s use of a solar 'month.'

twenty-eight lodges, choosing two of the largest ones. Here we have an interesting paradox: the compiler treats the lodges as all the same until it comes time to plug a gap, at which point he relies on his knowledge of how they are *not* all the same.

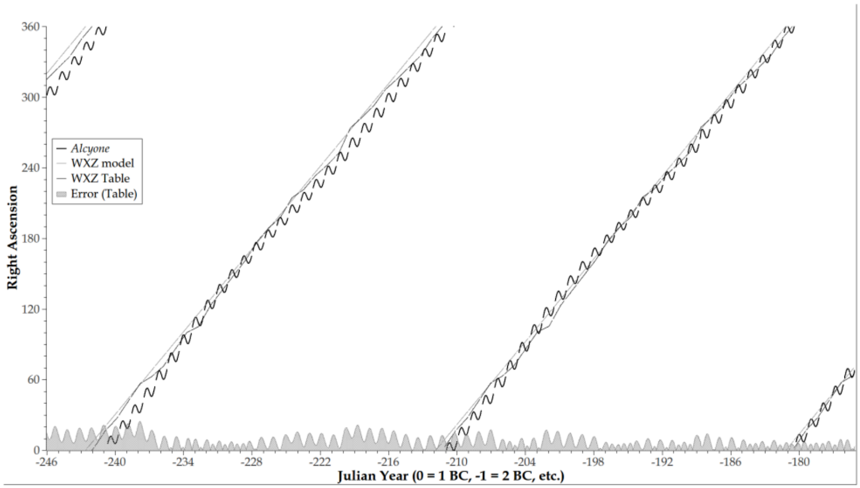
All this mixing and matching raises the question of accuracy. The question itself is somewhat fatuous: the historian can recite modern values for mean periods, but he cannot reliably retrodict visibility; whether *the owner* found the tables accurate furthermore depends on if he consulted them as solar or civil calendar or, indeed, at all. The question is nevertheless interesting as it speaks to the manuscript's use. Reading the dates in civil time, Cullen (2011b) concludes from a comparison of the visibility phenomena to computer software that the tables are largely off. By way of complement, in Graphs 1 & 2, I offer *positions* plotted for Jupiter and Saturn in *solar time* as compared with results calculated by *Alcyone Ephemeris* v3.2. Graph 1 illustrates what we might expect: the *Wu xing zhan* table's linear trajectory fails to capture the complexity of Jupiter's actual motions, and it begins and continues grossly out of sync. What is surprising is that the table's periods of invisibility (the line breaks) are more-or-less well aligned with results calculated via *Planetary, Lunar, and Stellar Visibility* v3.1. This is a curious result of how the hemerology resets the planet's synodic period every 12 years: the extra solar month (or 12 missing solar months) effectively compensates for the short 395.69-day synodic period.[28] Graph 2 illustrates much the same for Saturn, the exception being that Saturn, which began 24.9° closer to the idealised system origin, does essentially fall into sync over 70 years. What is surprising here is that the '*du* travelled' model (avg. error 9.55°) is so crude that the table's hybrid one-lodge-per-year model (avg. error 7.35°) actually outperforms it. At this level of sophistication, the hemerology looks to *bolster* the mathematical model.

[28] The mean synodic period of Jupiter is actually 398.88 days. At this rate, it should take around 4388 days for 11 synodic periods to elapse, some 35 days longer than the *Wu xing zhan* (13/12 year × 11 years × 365¼ days ≈ 4353 days). Like an intercalary month added at the end of the year, the extra solar month reduces this discrepancy to less than 5 days in 12 years.

Graph 1. ***Wu xing zhan*** **Jupiter table vs.** ***Alcyone Ephemeris*** **v3.2 computed RA**



Graph 2. ***Wu xing zhan*** **Saturn table vs.** ***Alcyone Ephemeris*** **v3.2 computed RA**



NOTE: The above graphs are plotted using a system origin of 246 BC Feb 3 00:00 (JD 163 1604.5), corresponding to Establishment of Spring, Shihuang 1-I-1 00:00 on the civil calendar. Whether the calendar (civil or otherwise) placed Establishment of Spring on I-1, or nearer to the true est. spring on Feb 8, the difference, given the errors involved, is negligible. For the 'Alcyone' line represents RA as calculated by *Alcyone Ephemeris* v3.2, from which removed periods of probably invisibility as calculated by *Planetary, Lunar, and Stellar Visibility* v3.1. For the '*Wu xing zhan*' line, I used '*du* travelled' velocities to calculate *du* travelled from Hall_{L13} 5 *du*, which I converted to RA, added to the precession-corrected RA of η Pegasi—the guide star of Hall_{L13}. For Jupiter, I removed periods of invisibility as per the table's hemerological model, while for Saturn I used its '*du* travelled' periods. The Saturn graph 'WXZ table' line, one notes, is calculated by assuming the planet travels one lodge per *sui* at a constant rate averaged from the width of each lodge as given in the 'ancient-degree' system. The 'Error' line represents the absolute value of the difference of the '*Wu xing zhan*' and 'Alcyone' lines.

In conclusion, the *Wu xing zhan* planetary visibility tables appear to use a solar time frame independent of the civil *nian* and *yue*. In the Venus table, the lodge-positions demonstrate the compiler's understanding of contemporary astronomical knowledge like lodge-widths and his ability to do simple calculations therewith, while the month-dates, on the other hand, would seem to contradict this. The Jupiter and Saturn tables, for their part, are an amalgam of contradictory knowledge from the omenological and computational sections of the text, which is curious, because we never see *tianwen* and *li* models adjoined, let alone *conjoined*, in the received tradition. Even more curious is the fact that this amalgam appears to produce negligible if not positive effects for the tables' accuracy. In the end, these tables look nothing like what later procedure texts instruct the user to compute, leaving us to wonder just how inchoate or atypical of later planetary tables they may be.

Later Planetary Tables

In addition to the *Wu xing zhan*, history has left us with two other sets of planetary tables from the early imperial period. These tables originate centuries apart in very different contexts, which make the idea that they had somehow influenced one difficult to believe. As independent creations at the greatest possible distance from the *Wu xing zhan*, it is interesting to see all that they share in common.

Recorded in the *Jin shu* 晉書, the next closest table appears in a *li* deliberation of 226 AD, where it is submitted into evidence in a contest between the Yellow Inception *li* (*Huangchu li* 黃初曆) and Supernal Image *li* (*Qianxiang li* 乾象曆). Inserted somewhat arbitrarily into the text of the debate is a table of predictive test results, each line of which follows the formula:

> 【星】以【年月日干支日】【晨/夕】【見/伏】；黃初
> 【月日干支日】【見/伏】，【先/後】【幾】日；乾象
> 【月日干支日】【見/伏】，【先/後】【幾】日。

> [Planet] [appeared/hid] in the [morning/evening] on [date]. Yellow Inception had it [appear/hide] on [date], [*x*] days [prior/after]. Supernal Image had it [appear/hide] on [date], [*y*] days [prior/after] (*Jin shu*, 17.500-502).

Table 5: *Jin shu* Yellow Inception debate planetary system test results

1	2	3		4	5	6	7
no.	**Phenomena**	**Observed**		**Supernal Image**		**Yellow Inception**	
				Prediction	error	Prediction	error
Jupiter							
1	FMR	222	Jun 20	Jun 13	−9d	Jun 11	−7d
Saturn							
2	FMR	221	Dec 27	Dec 22	−5d	Dec 19	−8d
3	LES	222	Dec 02	Dec 02	+0d	Nov 28	−4d
4	FMR	223	Jan 11	Jan 04	−7d	Jan 01	−10d
Venus							
5	LMR	222	Aug 09	Jul 21	−19d	Jul 18	−23d
6	FES	222	Nov 02	Oct 11	−23d	Oct 08	−25d
Mercury							
7	FMR	221	Dec 18	Dec 14	−4d	Dec 13	−5d
8	LMR	222	Jan 13	Jan 15	+2d	Jan 14	+1d
9	FES	222	Jun 14	Jun 14	+0d	Jun 13	−1d
10	LES	222	Jul 09	Jul 16	+7d	Jul 15	+6d
11	FMR	222	Aug 19	Aug 03	−16d	Aug 02	-17d
12	LMR	222	Aug 31	Sep 04	+4d	Sep 03	+3d
13	LMR	223	Jan 03	Dec 29	−5d	Dec 28	−6d
14	FES	223	Feb 16	Jan 31	−16d	Jan 31	−16d

NOTE: Column 1 gives the number of each phenomenon; note that the text states that there are 15. Column 2 gives the type of phenomena: FMR for 'morning appearance' 晨見 (first morning rising), LES for 'hiding' 伏 (last evening setting), and for the inferior planets, LMR for 'morning hiding' 晨伏 (last morning rising), and FES for 'evening appearance' 夕見 (first evening setting). Column 3 gives the reported date of observation, converted to the Julian calendar. Columns 4 and 6 give the reported predictions of the Supernal Image and Yellow Inception *li*. Columns 5 and 7 give the reported error from the observational results in Column 3.

It is safe to say that these test results, reproduced in Table 5, have nothing to do with the *Wu xing zhan* tables. What is interesting is how the two reflect upon actors' confidence—*li* procedure texts, as a rule, say nothing about how well their creators thought its components worked, or which they thought the most important. Tellingly, the table of 226 AD also excludes Mars. Echoing the *Wu xing zhan*, Li Yexing 李業興 complains as late as 539 AD that "the [planet] Sparkling Deluder sometimes fails to accord with its [predicted] *du* since the essence of its appearance & disappearance is inherently inconstant" 熒惑一星，伏見體自無常，或不應度 (*Wei shu* 魏書, 107B.2698). Third-century *li* men were no better equipped to handle the planet's variability, so it makes sense that they might exclude it from their tests. In a similar vein, the table of 226 AD emphasises first and last visibility. That *visibility* is used as a criterion of testing is noteworthy, since this is something equally beyond third-century *li* man's ability to predict with any accuracy, what with the atmospheric and subjective factors involved and his lack of anything more sophisticated than a fixed threshold of invisibility.[29]

The second set of planetary tables comes from the *Qiyao rangzai jue* 七曜攘災決. Preserved in the Japanese Taishō 大正 Buddhist canon, the text claims to have been "written and collated by the Brahmin monk of west India, Koṅta" 西天竺國婆羅門僧金俱吒撰集之 (*T* no. 1308, 426:b22) in the ninth century AD, shortly after which it was taken to Japan. Rather than the state-centred judicial astrology typical of *tianwen* literature, the *Qiyao rangzai jue* deals with horoscopy. It describes the nature and functions of the Seven Luminaries (sun, moon, and planets), Rāhu, and Ketu (here, the moon's ascending node and apogee, respectively), as well as how to counteract their untoward effects on personal fortune through apotropaic rituals. In the middle of the text we find '*du* travelled' models and tables for the five planets. As we have them now, the latter are arranged around resonance periods that have been assigned to Japanese reign periods from the eleventh to twelfth centuries, though it stands to reason that the details of the tables themselves may have existed prior to that time. Each column of the tables represents a year, and each row a *yue* 'month,' but it is difficult to understand where each row breaks in the Taishō edition because of the way that the text has been arranged for printing. Table 6 is thus provided according to the Japanese manuscript edition of 1122 AD studied in Yano (1986).[30]

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[29] On the problem of calculating visibility and later advances to this end, see Sivin (2009), pp. 32–33, 102–106, 516–550.

[30] See also Niu & Jiang (1997). For studies of the other horoscopic materials in the Taishō canon, see Yabuuti (1961) and Niu Weixing (2004).

Table 6. ***Qiyao rangzai jue*** **Jupiter table (excerpt)**

	長承元壬子 1132 / 己丑 1049	辛亥 1131 / 戊子 1048	庚戌 1130 / 丁亥 1047	己酉 1129 / 丙戌 1046	戊申 1128 / 乙酉 1045	丁未 1127 / 寬德元甲申 1044	丙午 1126 / 癸未 1043	
8	7	6	5	4	3	2	1	yr/mo
	24th appear L_{12} 12°°	L_9 L_{10}	L_8	L_6	3rd stop L_3 1°°	Retreat	Retreat L_{26}	I
	L_{12}	L_{10}	L_8	4th stop L_6 6°°	Retreat L_2	Retreat L_{28}	22nd rtrt-stop L_{26} 8°°	II
	L_{13}	L_{11}	6th stop L_8 12°°	Retreat	L_2	22nd rtrt-stop L_{28} 1°°	Stop L_{26}	III
	L_{13}	14th L_{11} 4°°	Retreat	Retreat L_6	21st L_2 0°°	Stop	Stop L_{26}	IV
	27th stop L_{13} 14°°	L_{11}	Retreat	22nd stop L_4 5°°	Garrison L_2	Stop	L_{26}	V
	Stop	L_{10}	24th rtrt-stop L_8 1°°	Garrison L_5	Garrison L_2	Stop	L_{27}	VI
⋮	Retreat L_{13}	28th rtrt-stop L_{10} 5°°	Garrison L_8	L_5 L_6	L_2	Stop	9th hide L_{27} 8°°	VII
	L_{13}	Stop	L_8	L_6	L_3	10th hide L_{28} 19°°	11th appear L_{27} 12°°	VIII
	5th retreat L_{13} 3°°	L_{10} L_{11}	L_8	L_6	9th hide L_3 8°°	10th appear L_1	L_{27}	IX
	L_{13}	L_{11}	L_8	10th hide L_6 14°°	11th appear L_3 12°°	L_1	L_{28}	X
	L_{13}	L_{12}	13th hide L_8 20°°	13th appear L_7 3°°	L_4	L_2	L_{28}	XI
	L_{13}	16th hide L_{12} 3°°	17th appear L_9 4°°	L_7 L_8	L_5	L_2	4th stop L_{28} 12°°	XII

Unlike the *Wu xing zhan*, the *Qiyao rangzai jue* tables detail the planet's position and/or behaviour in each month and the specific date of each characteristic phenomenon—first and last appearances, first and second station, and prograde and retrograde motion—which makes sense in the context of horoscopy where the question is the planet's position at any given time. Like the *Wu xing zhan*, however, the tables are arranged around the planet's resonance period, allowing the calendar years to repeat around it, each column of the Jupiter table being assigned to two sexagenary years in the Japanese calendar 83 years apart. The main difference in this arrangement then is that the *Qiyao rangzai jue* uses longer resonance periods befitting the relationship between sidereal and synodic period, i.e. 83 years = 76*S* = 7*P* for Jupiter. Also like the *Wu xing zhan*, the tables are compiled according to models that are significantly simpler than contemporaneous *li*. What is more, for these tables to repeat exactly over a given number of years the civil calendar will not do. Instead, the *Qiyao rangzai jue* explicitly employs a solar calendar, the details of which it describes later in the text:

> 每年十二月皆以月節為正。其伏見入月日數各從節數之。假令三月十日者。當數清明後十日是也…推之考驗。往古及今。年所留宿度。若應符契分毫無差也。
>
> The 12 months (*yue*) of every year are all based on the nodal *qi* of the [corresponding civil] months. The number of days into each month of hiding, appearance, etc. are each counted from the nodal *qi*. Suppose that we have III-10: one should count 10 days after Pure & Bright (the nodal *qi* of month III). … Calculate it and examine the results: back to antiquity and up to today the lodge-degrees where [the planets] linger each year, like matching tallies, do not differ by a fraction of a hair's breadth (*T* no. 1308, 448: b7-c4).

The *qi* 氣 refer to the 24 divisions of the solar year, which alternate between 12 'nodal' and 'medial' *qi*. It turns out that this is *exactly the same calendar* as that that which we see in the *Wu xing zhan* tables: a solar year of 365¼ days divided into 12 solar months and beginning on the nodal *qi* Establishment of Spring.

Faced with a Buddhist horoscopy text, it behoves one to question what connection the astronomy therein bears with local traditions. In this case, the connection is unmistakable. Certain of the planets' resonance periods do coincide with Indian-language precedents, but the features of the text's planetary astronomy are wholly consistent with Chinese practices: the sky is divided into 365¼ *du*; the text uses 28 lodges of uneven size, whose widths it sets in accordance with Chinese 'polar-ecliptical' coordinates; the motion-degree models are consistent in style and approach with the Chinese variety; and so too is the calendar, beginning halfway between Winter Solstice and Spring Equinox and being based on the 24 *qi* rather than the position of the sun in the Western zodiac.[31] From this it seems reasonable to attribute those features coinciding with the *Wu xing zhan* tables to Chinese tradition as well, be they the source of the *Qiyao rangzai jue* astronomy or local conventions to which foreign knowledge was adapted.

The Chinese Solar Calendar?

Through many vicissitudes, the lunisolar civil calendar continued to enjoy official status until the Republic of China adopted the Gregorian calendar on January 1, 1912. The *Qiyao rangzai jue*, however, was not the last mention of our establishment of spring solar calendar in pre-modern times. The idea appears again in Shen Gua's 沈括 (1031-1095) *Mengxi bitan* 夢溪筆談 of 1088. Shen complains that the use of the lunar month makes the civil calendar needlessly complex and injurious to agricultural timing. He proposes the following solution:

> 今為術莫若用十二氣為一年，更不用十二月，直以立春之日為孟春之一日，驚蟄為仲春之一日，大盡三十一日，小盡三十日。歲歲齊盡，永無閏餘。十二月常一大一小相閒，縱有兩小相併，一歲不過一次。如此，則四時之氣常正，歲政不相陵奪， 日月五星亦自從之，不須改舊法。唯月之盈虧，事雖有繫之者，如海、胎育之類，不預歲時，寒暑之節，寓之曆閒可也。…… 今此曆論，尤當取怪怒攻罵，然異時必有用予之說者。

[31] In contrast, Indian-language traditions divide the sky into 360° and 27 or 28 *evenly-sized* nakshatras, and it begins the solar year in Mesha, in March/April, which they divide by the zodiac rather than *qi* (though this does produce similar fortnightly periods); see Pingree (1978). For the identification of the lodge-widths reflected in the *Qiyao rangzai jue* solar-step table with Chinese 'polar-ecliptical' coordinates, see Yano (1986), pp. 29–30; Niu & Jiang (1997), pp. 243-244. While the *Qiyao rangzai jue*'s motion-degree models are typical of the Chinese *li*, similar models do appear in other civilizations. For example, Alexander Jones has brought to my attention a Venus model in the second-century AD Greek papyrus 4135 from Oxyrhynchus that looks remarkably similar to the *Wu xing zhan*'s and that has clear parallels in Babylonian and Indian traditions (Jones, 1999 vol. 1, pp. 81-84; vol. 2, pp. 10-13). Lastly, Clemency Montelle has also drawn my attention to parallels between the *Qiyao rangzai jue*'s resonance periods for Jupiter (83 years = 76*S* = 7*P*), Mars (79 years = 37*S* = 42*P*), and Saturn (59 years = 57*S* = 2*P*) with texts of the Indian Brāhmapakṣa tradition in Pingree (1970), p. 104.

> If today one were going come up with a [new] method, none would compare to using the twelve [nodal] *qi* as a civil year rather than twelve months (*yue*), and directly taking the day of the Establishment of Spring as the first day of the first 'month' (*yue*) of spring, and Excited Insects as the first day of the second 'month' of spring. Big [months] would run 31 days, and little [months] 30 days, each and every year being the same length, eternally free of the intercalary remainder. The twelve 'months' would always alternate between big and small, and even if there were two small ones together, this would happen at most once per year. In this way, the *qi* of the four seasons would always be correct, *sui* (agricultural) would not conflict, the sun, moon, and planets would also naturally accord with it without having to change the old methods. Though it is connected with things like tides and gestation, the waxing and waning of the moon alone has no relationship to the year and the rhythm of cold and hot, and thus noting it in the calendar would be fine. ... I expect this discourse of mine on *li* (the calendar) should meet special condemnation, but at some other time my idea will definitely see use (*Mengxi bitan jiaozheng* 夢溪筆談校證, entry 545).

There is nothing new about this calendar, as it is the exact same one we see in the *Wu xing zhan* and *Qiyao rangzai jue* tables. Shen Gua himself hints at its precedence—"the sun, moon, and planets would also naturally accord with it without having to change the old methods"—but can we imply from this the idea of a practical tradition of table-making (on which transmitted *li* literature is silent, no less) connecting sources centuries and centuries apart?[32]

Let us say that the exact same solar calendar was independently invented some three different times over the early imperial period—this would, at the very least, indicate to us that it was a perennially good idea. The *Wu xing zhan* and *Qiyao rangzai jue* make the functional advantage of such a calendar abundantly clear: it allows for compact repeating planetary tables such that, in the *Qiyao rangzai jue*'s words, "back to antiquity and up to today the lodge-degrees where [the planets] linger each year, like matching tallies, do not differ by a fraction of a hair's breadth" (above).

Were the necessary ideas for such a calendar in place by the third or second century BC? The concept of the solar year, with its obvious importance for seasons and agriculture, is evident in intercalation practices

[32] Of course, a useful parallel might be drawn here with the popular transmission of hemerological knowledge over the same period; see Kalinowski (1996) and Harper (2010).

going back to the earliest written records in China. In the pre-Qin classics we already see a lexical distinction between *nian* and *sui* that trickles into the language of the astral sciences. In the 'Yao dian' 堯典 chapter of the *Book of Documents*, for example, the ancient sage king Yao 堯 commands the Xi-He 羲和 brothers, "a period of 366 days, use intercalary months to fix the four seasons and complete the *sui*" 稘三百有六旬有六日，以閏月定四時成歲 (*Shangshu zhushu* 尚書注疏, 2.21b) and the *Rites of Zhou* describes the duty of the Grand Clerk as being to "set straight the *sui* and the *nian* (via intercalation) to order affairs" 正歲年以序事 (*Zhouli zhushu* 周禮注疏, 26.401b).

From there, it is not difficult to imagine that someone at the time of the *Wu xing zhan* was *able* to divide the *sui* by twelve, but was this common practice? It is often said that the first complete inventory of the twenty-four *qi* occurs in the *Huainanzi* (3.98-102), almost thirty years after the sealing of Mawangdui tomb 3. Of course, numerous *qi* names appear in works as early as the *Zuo zhuan* 左傳, *Guanzi* 管子 and *Lü shi chunqiu* 呂氏春秋 (239 BC), and complete inventories occur also in the "Zhou yue" 周月 and "Shi xun" 試訓 chapters of the *Yi Zhou shu* 逸周書 (which, like the *Zuo zhuan* and *Guanzi*, scholars tend to date vaguely to the fourth or third centuries BC). Historians of astronomy, however, generally reject the *Yi Zhou shu* chapters, because text critics have labelled them Han fabrications, and, coming around full circle, text critics like Huang Peirong 黃沛榮 label them fabrications because they contain complete inventories of the twenty-four *qi*.[33] Whatever our faith in the pre-eminence of the *Huainanzi*, the presence of the 'ancient-degree' solar steps in daybooks excavated from the third and second centuries BC now provides us with unequivocal precedence for the division of the solar year by twelve (Table 4).

What makes a connection between the *Wu xing zhan* and *Qiyao rangzai jue* tables conceivable (although by no means conclusive) is the fact that a solar calendar is, by definition, intrinsic to the lunisolar calendar and, thus, the practice of *li*. Wolfram Eberhard's description, now more than a half century old, is still quite apt:

> It can easily be shown that the Chinese were capable of developing a pure solar calendar. If an astronomer intends to make any astronomical calculation, for example, to calculate the date of the next new moon or the next eclipse of the moon or sun, he has to start from the move-

[33] Huang Peirong 黃沛榮 (1976), pp. 265-278, 282-283; cf. Huang Huaixin 黃懷信 (1992), pp. 111-115. Whatever the authenticity of the "Zhou yue" and "Shi xun" chapters, it is worth noting that other *Yi Zhou shu* materials previously considered suspect have appeared in the fourth-century BC Tsinghua University manuscripts, dispelling any lingering doubts about those particular chapters.

> ment of the sun. An examination of the formula which the Han astronomers used for their calculations shows that they developed a pure solar calendar system for their calculations and then converted it into the "civil" calendar of a luni-solar character. If the function of Chinese astronomy had been to provide a tool for the farmer, this "astronomical" calendar would have been the ideal tool, because the seasons were fixed in this calendar. The fact that the Chinese retained the luni-solar calendar until the twentieth century indicates that their interests were different. We must assume that they followed an old tradition which had fixed the popular festivals and observances of a religious cult by the phases of the moon (1957, p. 63).

The *li* man was no slave to the civil calendar. Not only did he vie for its reform throughout the ages, the very procedures of *li* literature required that, to do any astronomical calculation whatsoever, he must compute a provisional calendar as he goes along. Simple and repetitive, solar time is eminently suited to this purpose—it is for much the same reason that Greek astronomers came to adopt the 365-day Egyptian calendar for use in calculation (Neugebauer, 1942). More to the point, solar time determines solar position, which, in the Chinese motion-degree model, determines planetary position. It is for this reason that the Triple Concordance procedure text instructs the user to perform parallel calculations in solar and lunar time, the sole purpose of the latter (which invariably comes second) being to put a civil date on an astronomical event.[34] What is odd about the *Wu xing zhan* and *Qiyao rangzai jue* tables, therefore, is not that have solar time as their bases but that they omit the final steps of calculation.

The *Wu xing zhan* as Manuscript

If the *Wu xing zhan* planetary tables are indeed based on a solar calendar, it would seem that they would only be of use to someone able to recognise them as such and convert their dates into civil time. However, the fact that both the *Qiyao rangzai jue* and Shen Gua feel the need to provide instruc-

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[34] Note that the Quarter-remainder and subsequent systems simplify the parallel solar and lunar 'methods' of the Triple Concordance system by moving from the initial solar calculations—the number of synodic periods elapsed from high origin to the year previous that in question and the number of day/*du* past the winter solstice in which the previous conjunction fell—to the calculation of months and binome days, bypassing medial *qi* and solar stations. For a comparison of these methods, see Liu Hongtao (2003), pp. 37–49, 97–100.

tions for such conversion suggests that this may not have been common or self-evident knowledge. We cannot assume *ipso facto* that the *Wu xing zhan*'s owner understood its contents. If anything, the tables are so inaccurate, due to the limitations of the system origin and planetary models, that it would make little practical difference whether one consulted their dates in solar or civil time. Whether or not the compiler of the tables knew what he was doing remains a mystery, but what we know for certain is that the copyist did not: the manuscript is beautifully copied but rife with numerical corruption that is obvious and goes uncorrected (Mo Zihan, 2011).

So, what use could the manuscript and its tables have been to anyone? Cullen suggests that the latter might function within the context of the omenological half of the text to set parameters of normal behaviour through which to interpret observed phenomena:

> We need to recall what David Brown has written in the context of ancient Mesopotamian astronomy: one of the advantages of schematic depictions of celestial motions is that they automatically generate portents through their divergence from what is actually observed. A celestial diviner who had constructed something like the Venus table in the *Wu xing zhan* may well have felt a double satisfaction: on the one hand he had uncovered the ideal reality of what Venus ought to do, but on the other hand he also had the ability to interpret for his clients what it meant when Venus did not act as it should have done. Regard (and reward) for his professional competence was thus assured on two fronts (2011b, pp. 248–249).

I agree that this may well have been the case at some point in the text's history, but I suspect that the Mawangdui manuscript as we have it was not for use—that is, at least, not its computational sections. I say this for several reasons. At the time, it was customary to avoid the personal names of the rulers of the current dynasty, alive and dead, and to replace these words with equivalents. The *Wu xing zhan* avoids the name of Han Gaozu 高祖 (Bang 邦) but not that of Qin Shihuang (Zheng 政) or Han Wendi 文帝 (Heng 恒), before and after him. Assuming the rigorous application of such taboos, this suggests that the manuscript as we have it was copied between 206 and 180 BC, just about the time that the tables come to an end.[35] There is more than enough space left in the tables to fill them out to the manuscript's date of interment in 168 BC—so much, in fact, that one could fill the Saturn table out to 84 AD —but it seems that its owner was not interested in doing so. This brings us to an important point: *this is not a*

[35] Of course, it is important not to take these practices for granted. Chen Yuan (1997, pp. 64–66) notes numerous examples where the personal names of emperors were not avoided in the Han.

forward-looking table, nor could one hope to plot a forward-looking table in regnal years. The *Qiyao rangzai jue* avoids this problem by using the sexagenary year-count, which, unlike the rule of men, continues uninterrupted into the infinite future. The *Wu xing zhan*'s tables, in other words, were historical tables for who knows what purpose.

Harper (1998, pp. 42-67) argues at length that the medical literature found in Mawangdui tomb 3 reflects a culture of connoisseurship among the elite of the time, who not only sought to patronise and keep experts on retainer but also to consume texts. I suspect that we can also attribute the *Wu xing zhan*'s presence in this tomb to these factors—as just one more example of how, in the burgeoning manuscript culture of the time, expert knowledge began to circulate beyond expert circles and find its way into unlikely hands. At the same time that it facilitated this flow of information, however, manuscript culture also opened it to innovation and corruption at the popular level. It is in this context, I believe, that we can reconcile the way that the manuscript combines and hybridises contradictory planetary models with what we know of the received tradition's efforts to segregate them.

Conclusion

The goal of this article has been to explore the plurality of practices and the use of text within the scientific culture of a single time and place. Calculated planetary tables afford us a valuable window into the question, substantiating the difference between astral sciences and revealing discrepancies between theory and practice therein.

It is striking that the two sets of planetary ephemerides to have survived from the early imperial period are both built upon the same solar calendar. While this is at odds with the lunisolar civil calendar that received procedure texts instruct the user to produce, we know astronomers to have implicitly used such a calendar in their calculations because of the centrality of solar time to planetary models and other computational procedures. The *Wu xing zhan* and *Qiyao rangzai jue* tables are simply evidence that they may have done so *explicitly* as well, if for the added benefit of textual compactness.

The *Wu xing zhan* tables and *Jin shu* list note only planets' first and last visibilities, the latter taking these as the sole criterion for judging a planetary model's accuracy. With the exception of Buddhist horoscopy texts, this hints at a distinct emphasis in astronomical practice that is impossible to glean from procedure texts, which devote equal attention to all a planet's characteristic phenomena and the computation of daily positions. This emphasis is curious given the inability of such models to account for the complexities of visibility. On the other hand, both texts' de-emphasis of Mars reveals an appropriate lack of confidence concerning actors' ability to model this planet that too is impossible to glean from a procedure text.

Lastly, both the *Wu xing zhan* and *Qiyao rangzai jue* tables are calculated according to numbers and models that are radically simpler than those of contemporaneous *li*. Here again we see the plurality of traditions within the Chinese astral sciences: there was the state of the art and there was working knowledge, there was planetary astronomy and there was planetary hemerology. While the received tradition firmly segregates this knowledge into the categories *tianwen* and *li*, the *Wu xing zhan* hints that *in practice* the boundaries between them may have been somewhat porous. Lastly, these distinctions may also reflect a divide between expert and amateur, or elite and popular, traditions of the astral sciences within a manuscript culture, as technical knowledge began to circulate independently of experts and through the hands of dilettantes like Li Xi.

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