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# What Good's a Text?

## Textuality, Orality, and Mathematical Astronomy in Early Imperial China

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### Introduction

In the year 226, the fledgling Cao-Wei 曹魏 court (220–65) convened the brightest minds and greatest statesmen of a generation to deliberate upon a system of *li* 曆 “mathematical astronomy” authored by Han Yi 韓翊, the assistant director of the state astronomical office. It is difficult today to imagine a debate over US Naval Observatory time service policy drawing such a crowd, let alone its transcript earning a place in our imperial history, but these were different times. Let us think of it, rather, as a space race. Feckless and moribund for longer than living memory, the Han Empire (206 BCE – 220 CE) was no more; and in its place, through generations of treachery, alliance, and armed conflict, there arose three great powers—Cao-Wei, Sun-Wu 孫吳 (220–80), and Liu-Shu 劉蜀 (221–63)—the precarious balance of which was poised at any moment to devolve into total war. Our world, the ‘sub-celestial realm’, cannot be held together by force alone, it was commonly understood, but by mandate—the mandate of Heaven, a totalistic political, natural, and theological approval witnessed, most importantly, in the rapport maintained between celestial bodies and the body politic.<sup>2</sup>

And so it was that our fledgling court wove the story of its rise through an elaborate tapestry of prophecy, miracle, and augury.<sup>3</sup> In their haste, however, they neglected the one thread that ties everything together: like the empire from which it had been inherited, the state *li* of 86 was, by 220, a faltering relic begging for reform; and in 222, amid Cao-Wei hesitation, the Sun-Wu court laid claim to Liu Hong’s 劉洪 (*c.* 135 – *c.* 210) cutting-edge Supernal Emblem system (*Qianxiang li* 乾象曆).<sup>4</sup> It was

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<sup>2</sup> For a detailed exploration of the astronomical facets of the Mandate of Heaven, see David W. Pankenier, *Astrology and Cosmology in Early China: Conforming Earth to Heaven* (Cambridge: Cambridge University Press, 2013), esp. pp. 193–258.

<sup>3</sup> On the Cao-Wei court’s efforts to legitimate its acceptance of the last Han emperor’s abdication and transfer of the mandate, see Howard L. Goodman, *Ts’ao P’i Transcendent: The Political Culture of Dynasty-Founding in China at the End of the Han* (Seattle: Scripta Serica, 1998).

<sup>4</sup> *Sanguo zhi* 三國志 (Zhonghua shuju 中華書局 ed.), p. 47.1129. Note that I give the standard English titles of important historical texts and astronomical systems throughout. For a list of the historical astronomical systems covered in this article, see Nathan Sivin, *Granting the Seasons: The Chinese Astronomical Reform of 1280, with a Study of Its Many Dimensions and a Translation of Its Records* (New York: Springer, 2009), pp. 43–53, Table 2.1. For a survey of their features and astronomical constants, see Yabuuti Kiyosi 藪内清, ‘Astronomical Tables in

time to sink or swim. After several years of testing, Han Yi and his supporters in the Cao-Wei astronomical office were confident that they had the very sort of breakthrough needed to up the ante.<sup>5</sup> On the day of the debate, however, a former pupil of Liu Hong's, Xu Yue 徐岳, produced from nowhere a set of eclipse data favouring his master four to one.<sup>6</sup>

翊於課難徐岳：「乾象消息但可減，不可加。加之無可說，不可用。」

[Han] Yi raised difficulty with Xu Yue over the test results: “The Supernal Emblem’s *xiaoxi* 消息 can only be subtracted, it cannot be added. If you add it, there is no justification; it cannot be used!”

岳云：「本術自有消息，受師法，以消息為奇，辭不能改，故列之正法消息。」

[Xu] Yue said, “The original technique (*shu* 術) itself has *xiaoxi*; I have received my master’s method (*fa* 法), and it is the *xiaoxi* that make it astonishing. I am afraid that there is nothing that I could do to improve upon this, thus I have arranged here the proper method (*fa*) of *xiaoxi*.”

翊術自疏。

[Han] Yi backed down.<sup>7</sup>

We do not know what *xiaoxi* is (nor, apparently, did Han Yi);<sup>8</sup> we do, however, know more about Liu Hong than almost any other *li* expert of the early imperial period, thanks largely to Li Chunfeng’s 李淳風 (602–70) fascination with his historical impact—Liu’s work, he writes, marking “a turn towards the fine and tight (accuracy) vis-à-vis previous methods” 於前法轉為精密 and standing as “an exemplar for the

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China, from the Han to the T’ang Dynasties’, in *Chūgoku chūsei kagaku gijutsushi no kenkyū* 中國中世科學技術史の研究, ed. by Yabuuti Kiyosi (Tōkyō: Kadokawa shoten, 1963), pp. 445–92.

<sup>5</sup> The problem, according to Han Yi, was that “the Supernal Emblem system went too far in reducing the DIPPER PARTS (*Dou fen* 斗分) and that in time it would slip ahead of heaven” 乾象減斗分太過，後當先天 (*Jin shu* 晉書 [Zhonghua shuju ed.], p. 17.498). In the terminology of the time, the DIPPER PARTS (*Dou fen* 斗分) is the numerator of the fractional part of a *du* 度 at the end of the circumference of Heaven as well as that of the fractional part of a day at the end of the solar year ( $360^\circ \approx 365\frac{1}{4} du$ , and 1 tropical/sidereal year  $\approx 365\frac{1}{4}$  days). The use of the intercalary RULE (*zhang* 章) of 19 years : 235 months bound the values for the solar year and synodic month (i.e., the time from new moon to new moon) into a fixed proportional relationship, the adjustment of one value affecting the other. Liu Hong’s reduction of the Quarter-remainder system’s (*Sifen li* 四分曆) solar year of 365 $\frac{1}{4}$  days to  $215,130/589 \approx 365.2462$  days thus had the effect of reducing the length of the mean synodic month from  $27,759/940 \approx 29.530851$  to  $43,026/1457 \approx 29.530542$  days, 3.7 seconds shy of its true value at epoch (29.530585 days), which he did to address a significant lag that had manifest itself with the former’s predictions of the moment of syzygy. Han Yi’s adjustment produced a mean synodic month of  $356,700/12,079 \approx 29.530590$  days, only 0.5 seconds greater than the true value. After castigating Han for his presumption (below), Yang Wei introduced a similar adjustment in his Luminous Inception system of 237, adopting a value of  $134,630/4559 \approx 29.530599$  days, 1.2 seconds greater than the true value. See Daniel Patrick Morgan, ‘Knowing Heaven: Astronomy, the Calendar, and the Sagecraft of Science in Early Imperial China’ (Ph.D. diss., University of Chicago, 2013), pp. 282–85.

<sup>6</sup> For extended analysis of Han Yi’s Yellow Inception system (*Huangchu li* 黃初曆) and the debate of 226, see Morgan, ‘Knowing Heaven,’ pp. 271–362.

<sup>7</sup> *Jin shu*, p. 17.500.

<sup>8</sup> For the argument that this unfamiliar and unprecedented term relates to solar inequality, see Chen Jiujin 陳久金, ed., *Zhongguo gudai tianwenxuejia* 中國古代天文學家, *Zhongguo tianwenxueshi daxi* 中國天文學史大系 (Beijing: Zhongguo kexue jishu chubanshe, 2008), pp. 112–15; cf. Morgan, “Knowing Heaven,” pp. 325–28. Whatever it is, *xiaoxi* does not appear in any other system of the period, and Yixing 一行 (673–727), writing in the eighth century, bemoans the fact that “the technique has not been passed down” to his day (*Xin Tang shu*, p. 17B.622). Solar inequality otherwise first appears three centuries later in the work of Zhang Zixin 張子信 (fl. 526–76); see Chen Meidong 陳美東, *Zhongguo kexue jishu shi: tianwenxue juan* 中國科學技術史：天文學卷 (Beijing: Kexue chubanshe, 2003), pp. 298–303.

calculations of later generations” 後代推步之師表。<sup>9</sup> We know, for example, details of his administrative and military career, his participation in court astronomical work, works authored, and (for once) lines of textual and educational transmission. That said, anecdotes like this remind us of just how little we ever actually know.

Take for example Liu’s magnum opus. As preserved as integral documents in the standard histories, *li* “astronomical systems” are tools, or software, designed for the routinized computation of calendars and ephemerides, and, as such, reveal little of the “scientific process” from which they were distilled—what Liu Hong *did*, for example, whilst “absorbed in inner contemplation for more than twenty years” 潛精內思二十餘載。<sup>10</sup> Even as tools, however, these documents give us a misleading impression of integrity, for we know that *li* manuals were prone to abridgement and that, in practice, many *li* underwent accretion and modification over their public lifespans.<sup>11</sup> The Supernal Emblem system is a case in point. Preserved by Li Chunfeng in the *Book of the Jin* (648), the system text as we have it occupies less than a single *juan* 卷 (‘roll/volume’), while contemporary bibliographies record editions in only three and five *juan*.<sup>12</sup> Moreover, what suggests itself as a model for solar inequality—the “astounding” *xiaoxi*—appears nowhere therein and has, perhaps for that reason, fallen into historical obscurity. Equally important, the system text counts off from “Jian’an 11, *bingxu*.”<sup>23</sup> 建安十一年丙戌 (206), when we know Liu to have already submitted a written version of his system to the Han throne by 189.<sup>13</sup>

<sup>9</sup> *Jin shu*, pp. 17.498, 503. Li Chunfeng in fact frames the entirety of *juan* 17 of the *Book of Jin* around the historical impact of Liu Hong’s astronomy on subsequent generations of experts. For an explanation of Liu’s major accomplishments, see Christopher Cullen, “The First Complete Chinese Theory of the Moon: The Innovations of Liu Hong c. A.D. 200,” *Journal for the history of astronomy* 33 (2002), 21–39.

<sup>10</sup> *Jin shu*, p. 17.499. On the *li* astronomical text as *technology*, see Christopher Cullen, ‘Actors, Networks, and “Disturbing Spectacles” in Institutional Science: 2<sup>nd</sup> Century Chinese Debates on Astronomy’, *Antiquorum philosophia* 1 (2007), 237–67 (p. 244); Sivin, *Granting the Seasons*, p. 21.

<sup>11</sup> As to abridgement, historians of *li* have for centuries extracted relevant astronomical constants—their *yao* 要 “essentials”—as stand-ins for systems/procedure texts; see, for example, the *Book of Jin*’s treatment of Liu Zhi’s 劉智 Orthodox system (*Zheng li* 正曆) of circa 274, Wang Shuozi’s 王朔之 General system (*Tong li* 通曆) of 353, and Jiang Ji’s 姜岌 Triple Era *Jiazi*.<sub>01</sub> Origin system (*San ji jiazi yuan li* 三紀甲子元曆) of 384 (*Jin shu*, pp. 18.562–63, 565–70). This holds true to our day, modern historians tending to collapse procedure texts to a handful of values with which to perform one’s own calculations; see, for example, Yabuuti’s famous English-language surveys, ‘Astronomical Tables in China, from the Han to the T’ang Dynasties’; and ‘Astronomical Tables in China—from the Wutai to the Ch’ing Dynasties’, *Japanese studies in the history of science* no. 2 (1963), 94–100. For examples of the patching of *li* systems over the course of their public lifespans, see Morgan, ‘Knowing Heaven’, pp. 62–69.

<sup>12</sup> The *Book of Sui* records a Supernal Emblem system in three *juan* as part of the Sui 隋 (581–618) imperial holdings. It also notes that Liang 梁 (502–57) bibliographers recorded a five-*juan* edition “with commentary by Han Chief Commandant of the Kuaiji 會稽 Eastern Regiment Liu Hong, et al.” 漢會稽都尉劉洪等注, a five-*juan* edition with commentary by Kan Ze 闕澤 (below), and a *Qianxiang wuxing huanshu* 乾象五星幻術 (‘Supernal Emblem Planetary Magic’) in one *juan*, all of which were lost by the Sui (*Sui shu* 隋書 [Zhonghua shuju ed.], p. 34.1022). The *New Book of Tang* confirms that a three-*juan* edition would have certainly been available to the *Book of Jin*’s Tang 唐 (618–907) compilers (*Xin Tang shu* 新唐書 [Zhonghua shuju ed.], p. 59.1546). Note also that Wang Fan 王蕃, writing in the third century, quotes a portion of text concerning cosmology that appears nowhere in the received Supernal Emblem system: “The invention of *huntian* 渾天 (the ‘spherical heaven’ world model) came about from on high; test it against heaven, and it is credible and evidenced” 渾天之作, 由來尚矣; 考之於天, 信而有徵 (*Huntian shuo* 渾天說, cited in *Taiping yulan* 太平御覽 [Siku quanshu ed.], p. 2.14a).

<sup>13</sup> *Jin shu*, p. 17.504. According to Xu Gan 徐幹 (171–217/18):

至靈帝, 四分曆猶復後天【缺】半日, 於是會稽都尉劉洪更造乾象曆以追日月星辰之行, 考之天文, 於今為密。會宮車晏駕, 京師大亂, 事不施行, 惜哉!

By the time of Lingdi 靈帝 (r. 168–89), the Quarter-remainder system (*Sifen li* 四分曆) lagged as much as half a day [...] behind heaven, and so Chief Commandant of the Kuaiji Eastern Regiment Liu Hong constructed (*zao* 造) in its place the Supernal Emblem system so as to trace the movements of the sun, moon, and stars. Tested against *tianwen* 天文 (‘observational astronomy’), it proved tighter (more accurate) than the current [system]. Just then, [however], the palace chariots were driven at night (i.e., the

To be a historian of the ancient world is to grasp at straws: we can be certain that knowledge then, in a pre-print culture, must have been produced, circulated, taught, and discussed in a fashion at least as complex as it is today, but our only witness is the written word. Debate transcripts like those cited here offer us fecund ground for exploring the oral culture of the astral sciences, as Christopher Cullen's work on Eastern Han 東漢 (25–220) materials has only recently brought to our attention.<sup>14</sup> Debate, however, is invariably at the end—the public policy end—of practice; this article shall focus instead on mining written sources to capture a slice of the complexity of education, work, and transmission practices leading up to such debates. Among written sources, excavated manuscripts are particularly informative, being not polished gems passed down over centuries through active selection, redaction, and reproduction but *realia* once operative within the very cultures of practice that interest us. I begin therefore with manuscripts, which, by the nature of the corpora available to us, takes us several centuries prior to the heyday of the Supernal Emblem system.<sup>15</sup> Examining features of textual transmission evident in manuscripts on *li* and neighbouring genres of technical literature, we find considerable evidence of visual copying as well as mistakes and interventions particular thereto. From there, I will then return to the third century in an attempt to provide background for the Han Yi debacle in the nature of manuscript-age astronomy culture.

## Technical Knowledge and Manuscript Transmission

The *Wu xing zhan* 五星占 ('Planetary Omens') is an untitled silk manuscript in eight sections discovered in 1973 at Mawangdui 馬王堆 tomb 3—a tomb, sealed in 168 BCE, belonging to the young Li Xi 利豨, the second Marquis of Dai 軟侯. As depicted in Figure 1, the first five sections are devoted to planetary omens for the naked-eye planets, while the latter three provide for Jupiter, Saturn, and Venus (the easy planets) mathematical models and 70-year visibility tables spanning 246–177 BCE computed therefrom.<sup>16</sup>

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emperor died), the capital was in great tumult, and the matter [of reform] was not seen through. What a pity! (*Zhong lun* 中論 [Siku quanshu 四庫全書 ed.], p. B.13a).

According to the *Yuan Shansong shu* 袁山松書 (4th cent.), Liu was at this point “summoned to return (to the capital), but before arriving, was appointed governor of Shanyang 山陽” 徵還，未至，領山陽太守 (cited in *Hou Han shu* 後漢書 [Zhonghua shuju ed.], p. 3043 commentary). The term *zao* “construction” typically denotes the authorship of a written text in the context of the astral sciences, and the sequence of events here would suggest that Liu mailed a written version of his work to the throne for consideration. For reference, the memorial-preface to Yang Wei's 楊偉 Luminous Inception system of (*Jingchu li* 景初曆) of 237 implies a similar process of written submission; see *Song shu* 宋書 (Zhonghua shuju ed.), pp. 12.232–33; *Jin shu*, pp. 18.535–36.

<sup>14</sup> See Cullen, ‘Actors, Networks, and “Disturbing Spectacles” in Institutional Science’.

<sup>15</sup> In addition to the sources examined in this study, there are numerous later materials relating to the astral sciences preserved in the Dunhuang 敦煌 cave library, for which see Deng Wenkuan 鄧文寬, ed., *Dunhuang tianwen lifa wenxian jijiao* 敦煌天文曆法文獻輯校 (Nanjing: Jiangsu guji chubanshe, 1996). For a survey of their contents, see Marc Kalinowski, ed., *Divination et soci é dans la Chine m áli évale: éude des manuscrits de Dunhuang de la Biblioth èque nationale de France et de la British Library* (Paris: Biblioth èque nationale de France, 2003), pp. 35–211.

<sup>16</sup> The definitive transcription and philological analysis of the *Wu xing zhan* is to be found in Liu Lexian 劉樂賢, *Mawangdui tianwen shu kaoshi* 馬王堆天文書考釋 (Guangzhou: Zhongshan daxue chubanshe, 2004), pp. 29–99. For high-resolution photographs, see Chen Songchang 陳松長, ed., *Mawangdui boshu yishu* 馬王堆帛書藝術 (Shanghai: Shanghai shudian, 1996), pp. 8–9, 175–88. For a full-length Western-language translation and study, see Christopher Cullen, ‘Wu Xing Zhan 五星占 “Prognostics of the Five Planets”’, *SCIAMVS* 12 (2011), 193–249. Important studies post-dating Liu Lexian's masterful synthesis of previous scholarship include Takeda Tokimasa 武田時昌, ‘Taihaku kōdo kō: Chūgoku kodai no wakusei undōron’ 太白行度考—中国古代の惑星運動論, *Tōhō gakuho* 東方學報 85 (2010), 1–44; Christopher Cullen, ‘Understanding the Planets in Ancient China: Prediction and Divination in the *Wu xing zhan*’, *Early Science and Medicine* 16 (2011), 218–51; Mo Zihan 墨子涵 (Daniel

If his tomb is any indication of his proclivities in life, we might say that our marquis was an eclectic reader. Amid works on political philosophy, history, divination, medicine, and macrobiotic hygiene, we find three additional texts on celestial omens, the *Tianwen qixiang zazhan* 天文氣象雜占 (‘Miscellaneous Astronomical and Meteorological Omens’) and *Ri-yue feng-yu yun-qi zhan* 日月風雨雲氣占 (‘Sun, Moon, Wind, Rain, Cloud, and Qi Omens’), and portions of the three *Xingde* 刑德 (‘Punishment and Virtue’) manuscripts (below).<sup>17</sup> There is nothing surprising about his connoisseurship of omen literature. He was, after all, part of the high-level political and military apparatus to which such literature spoke, and he was educated in a classical tradition grounded ever more in metaphysics, mystery, prophecy, and portents. Celestial omens were, in fact, a common motif in the tombs, public monuments, and regalia of the period, being so ingrained in elite culture, Donald Harper argues, as to have formed a sort of common notational vocabulary.<sup>18</sup>

With the exception of calendars, however, manuscripts in the tradition of *li* are exceedingly rare, ours being one of only two recovered from the period thus far.<sup>19</sup> As I have discussed elsewhere, the *Wu xing zhan*’s planetary astronomy is odd—odd, that is to say, in terms of our expectations of both internal and intertextual consistency. It juxtaposes and fuses contradictory mathematical and hemerological models (the latter of which would have the planets move like pieces on a schematized game board); and, whatever the potential of these models, it anchors them to an overtly political zero-point (Shihuang 始皇 1-I-1 [3 February 246 BCE?], first morning rising at Hall.L13 5 *du* [21h01m53s RA at epoch]) that would introduce considerable systematic errors into predictions computed therefrom. Furthermore, the text is *passé* the zero-point is one intended to aggrandize the founder of the already vanquished and vilified Qin 秦 Empire (221–206 BCE); and the repeating tables, which could be easily expanded year-by-year into the following century, end nine years prior to interment.<sup>20</sup> The greatest inconsistency, however, is that between the quality of the production and the quality of the text.

At the time, silk was the premium writing material in common use, superior to its alternatives—bamboo and wood bookmats—in terms of quality, surface, portability, durability, contrast, and ink-absorption. Not surprisingly, there is evidence that silk was used for fine editions of important texts drafted first on bookmats, the latter being more amenable to correction and, given the relative labour-intensity of the materials

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Patrick Morgan), ‘Cong Zhoujiatai *Rishu* yu Mawangdui *Wu xing zhan* tan rishu yu Qin Han tianwenxue de huxiang yingxiang’ 從周家臺『日書』與馬王堆『五星占』談日書與秦漢天文學的互相影響, *Jianbo* 簡帛 6 (2011), 113–37; Morgan, ‘The Planetary Visibility Tables in the Second-Century BC Manuscript *Wu xing zhan* 五星占’, *East Asian Science, Technology, and Medicine* (forthcoming).

<sup>17</sup> For an overview of the Mawangdui manuscript horde, see Donald Harper, *Early Chinese Medical Literature: The Mawangdui Medical Manuscripts* (London: Kegan Paul International, 1998), pp. 14–21. For transcriptions and studies of the other omenological manuscripts, see also Liu Lexian, *Mawangdui tianwen shu kaoshi*.

<sup>18</sup> ‘Communication by Design: Two Silk Manuscripts of Diagrams (*tu*) from Mawangdui Tomb Three’, in *Graphics and text in the production of technical knowledge in China: the warp and the weft*, ed. by Francesca Bray and others (Leiden: Brill, 2007), pp. 169–89. On omenology in Han mortuary culture, see Wu Hung, *The Wu Liang Shrine: The Ideology of Early Chinese Pictorial Art* (Stanford: Stanford University Press, 1989), pp. 73–107; Lillian Lan-ying Tseng, *Picturing Heaven in Early China* (Cambridge: Harvard University Asia Center, 2011), pp. 89–147.

<sup>19</sup> The second manuscript, the *Wu xing* 五星 (‘The Five Planets’), was excavated from Shuanggudui 雙古堆 tomb 1 (closed 165 BCE) in Fuyang 阜陽, Anhui, in 1977 but has, to this date, never been published; see Hu Pingsheng 胡平生, ‘Fuyang Shuanggudui Han jian shushu shu jianlun’ 阜陽雙古堆漢簡數術書簡論, *Chutu wenxian yanjiu* 出土文獻研究 4 (1998), 12–30. On early imperial calendars, see Alain Arrault, ‘Les premiers calendriers chinois du II<sup>e</sup> si ècle avant notre ère au X<sup>e</sup> si ècle’, in *Les Calendriers: Leurs enjeux dans l’espace et dans le temps: colloque de Cerisy, du 1<sup>er</sup> au 8 juillet 2000*, ed. by Jacques Le Goff and others (Paris: Somogy, 2002), 169–91; cf. Morgan, ‘Knowing Heaven’, pp. 183–270.

<sup>20</sup> See ‘Cong Zhoujiatai *Rishu* yu Mawangdui *Wu xing zhan* tan rishu yu Qin Han tianwenxue de huxiang yingxiang’; ‘Knowing Heaven’, pp. 100–82; ‘The Planetary Visibility Tables in the Second-Century BC Manuscript *Wu xing zhan*’.

involved, more economic.<sup>21</sup> The Mawangdui corpus is also beautifully written, the site being, in fact, as important for the history of calligraphy as it is for the history of ideas. It may not ooze with the opulent archaism of the seal-inspired “ancient clerical script” we see, for example, in manuscript A of the Mawangdui *Laozi* 老子, but the *Wu xing zhan* is rendered in a standard and well-executed Han clerical script that is not without a certain modern elegance (see Figure 2).<sup>22</sup>

Beautiful as it is, the text is rife with mistakes—internal contradictions of a numerical nature that could only have been introduced by accident over the course of transmission. Of these, we shall examine three outstanding problems with the treatment of Venus in lines 123–146.<sup>23</sup>

First, the Venus table directly contradicts itself in two places. The table gives the planet’s four visibility phenomena<sup>24</sup> in an eight-year cycle, repeating itself as concerns the month-date (I–XII) and zodiacal lodge (L1–28) of ‘emergences’ (*chu* 出) as in the following excerpt from the top row of years six and seven:

十一月與箕晨出東方，二百廿四日，以六月與柳晨【入東】方。  
Emerges in the east in the morning with Basket.L07 (γ, δ, ε, η Sgr) in month XI, 224 days, [enters in the east] in the morning with Willow.L24 (δ–θ Hya) in month VI (line 135).

浸行百廿日，以九月心夕出西方，取九十四下。  
Travels submerged for 120 days, emerges in the west in the evening with Heart.L05 (σ, α, τ Sco) in month IX, take 94 from below (line 136).

以九月心夕出西方，二百廿四日，以五月與東井入西方。  
Emerges in the west in the evening with Heart.L05 in month IX, 224 days, enters in the west in the evening with Well.L22 (Gem) in month V (line 137).

伏十六日九十六分，以九月與與鬼晨出東方。  
Hidden for 16 days and 96 parts of a day, emerges in the east in the morning with Cartborne Devils.L23 (θ, η, γ, δ Cnc) in month IX (line 138).

以六月與輿鬼晨出東方，二百廿四日，以正月與西辟（壁）入東方，余五。  
Emerges in the east in the morning with Cartborne Devils.L23 in month VI, 240 days, month I, enters in the east in the morning with Western Wall.L14 (α And & γ Peg), remainder 5 (line 139).<sup>25</sup>

<sup>21</sup> Tsien Tsuen-hsueh 錢存訓, *Written on Bamboo & Silk: The Beginnings of Chinese Books & Inscriptions*, 2d ed. (Chicago: University of Chicago Press, 2004), pp. 139–144. Bookmats are more amenable to editing because the user can shave off characters, pop out and insert lines, and rearrange whole sections at will.

<sup>22</sup> On the calligraphy of the Mawangdui manuscripts, see Chen Songchang, *Mawangdui boshu yishu*, esp. pp. 1–6.

<sup>23</sup> To these we might also add, for example, the fact that the text drops the key phrase “emerges in the morning in the east with Hall.13” 與營室晨出東方 from the Jupiter model in line 89 or that the months of Jupiter’s first morning rising in lines 1–4 and 77–88 contradict one another.

<sup>24</sup> Namely, (1) first morning rising, the planet’s first morning appearance in the east after disappearing around inferior conjunction; (2) last morning rising, its last morning appearance before disappearing and going into superior conjunction; (3) first evening setting, its first evening appearance in the west after having moved past the sun; and (4) last evening setting, its last evening appearance before disappearing and going once again into inferior conjunction. For a description of the phenomena of the planets’ synodic periods and early Chinese models thereof, see Michel Teboul, *Les premières théories planétaires chinoises* (Paris: Collège de France, 1983).

<sup>25</sup> Lines 135–39. For a complete English rendering of this table, see Cullen, ‘Prognostics of the Five Planets’, pp. 244–45.

Two month-dates contradict one another: the month of “emerging in the east... with Cartborne Devils.<sub>L23</sub>” here (IX and VI, respectively) and the month of “entering in the west... with Wings.<sub>L27</sub> (v Hya – η Crt)” in lines 128 and 129 (IX and VIII, respectively). It would seem that there are additional mistakes in the table’s month-dates, since the latter accord imperfectly with either lunisolar (civil) or solar (astronomical) calendars, but their nature is less self-evident.<sup>26</sup>

The next two mistakes are self-evident only with respect to the principles governing early Chinese planetary *xingdu* 行度 (‘motion-degree models’). These are: (1) symmetry (from conjunction) and (2) a fixed arc of invisibility (*s*) from the sun at which visibility phenomena occur. For the inferior planets the consequence of these principles is that (3) the number of *du* 度 ( $365\frac{1}{4} du = 360 \text{ }^{\circ}$ ) travelled over the course of both a synodic period and a period of morning/evening visibility must equal the number of days elapsed over the same period.<sup>27</sup> The *Wu xing zhan* Venus model violates these principles in two regards.

秦始皇帝元年正月，大白出東方，【日】行百廿分，百日。行益【疾，日行一度，六】十日。行有（又）益疾，日行一度百八十七半[分]以從日，六十四日而復遯日，晨入東方，凡二百廿四日。浸行百廿日，夕出西方。太白出西【方，日行一度百八十七半分，百日】。行益徐，日行一度以待（待）之，六十日。行有（又）益徐，日行卅分，六十四日而入西方，凡二百廿四日。伏十六日九十六分。【太白一復】爲日五【百八十四日九十六分日。凡出入東方各五，復】與營室晨出東方，爲八歲。

In Emperor Qin Shihuang 1-I (began 3 February 246 BCE), Great White (Venus) emerges in the east, traveling 120 parts (“parts” being  $1/240 du$ ) [per day], 100 days. Movement increases in [speed: travels 1 *du* per day, 6]0 days. Movement again increases in speed: travels 1 *du* and 187 and a half [parts] per day following the Sun, 64 days, then catches up again with the Sun and enters in the morning in the east. This comes to a total of 224 days. It travels submerged for 120 days, and then emerges in the west. Great White emerges in the west, [traveling 1 *du* and 187 and a half parts per day, 100 days.] Movement slows: travels 1 *du* per day waiting for it (the Sun), 60 days. Movement again slows: travels 40 (*sic*) parts per day, 64 (*sic*) days, and then enters in the west. This comes to a total of 224 days. It hides for 16 days and 96 parts. [One return of Great White] takes 5[84 days and 96 parts of days. In total it emerges and enters in the east and west each five times, then again] emerges in the morning with Hall.<sub>L13</sub> ( $\alpha, \beta, \gamma, \delta$  Peg) in the east,

<sup>26</sup> On the difficulty reconciling the *Wu xing zhan* Venus table month-dates with the lunisolar civil calendar, see Cullen, ‘Understanding the Planets in Ancient China’, 247–48. For the argument that *yue* 月 (‘months’) here are in fact solar months (1/12 of the solar year), see Yabuuti Kiyosi, ‘Baōtai san go bo shutsudo no *Gosei sen ni suite*’ 馬王堆三號墓出土の「五星占」について, in *Tōhōgaku ronshū: Ono Katsutoshi Hakushi shōju kinen* 東方學論集：小野勝年博士頌壽記念, ed. by Ono Katsutoshi 小野勝年 (Kyōto: Ryūkoku daigaku tōyō shigaku kenkyūkai, 1982), pp. 1–12 (p. 6); cf. Morgan, ‘The Planetary Visibility Tables in the Second-Century BC Manuscript *Wu xing zhan*’.

<sup>27</sup> Because the inferior planet *chu* (‘emerges’) and *ru* 入 (‘enters’) at the same distance from the sun, it necessarily travels the same distance as does the sun over the course of a synodic period (whereby the planet returns to the same position *vis-à-vis* the sun) and a period of morning/evening visibility. Furthermore, because the *du* is defined as the distance travelled by the mean sun in one day, the sun (and the planet) thus describe an arc in *du* equal to the number of days elapsed. For a lucid explanation of these principles, see Teboul, *Les premières théories planétaires chinoises*, pp. 51–79.



constituting 8 years (lines 143–146).<sup>28</sup>

Table 1: *Wu xing zhan* Venus model

	grade	<i>du</i> per day	days	<i>du</i> travelled
Morning	1 Slow	120/240	100	50
	2 Medium	1	60	60
	3 Fast	1 187½/240	64	114
	<i>SUBTOTAL</i>	-	224	224
	4 Submerged	-	120	120 + 2 <sub>s</sub>
Evening	5 Fast	1 187½/240	100	178 30/240
	6 Medium	1	60	60
	7 Slow	40/240	64	10 160/240
	<i>SUBTOTAL</i>	-	224	248 190/240
	8 Hidden	-	16 96/240	16 96/240 – 2 <sub>s</sub>
	<b>TOTAL</b>		<b>584 96/240</b>	<b>608 190/240</b>

Note: extant values are marked in grey; other values are restored/calculated on the basis of the three aforementioned principles of ‘motion-degree models’.

First, grade 7 gives a speed of 40/240 *du* per day rather than 120/240, as we would expect. Second, while the evening visibility speeds are inverted from those of morning visibility, as we would also expect, their day-durations are not. This violates (3), the result of which is that the *du* travelled over grades 5–7 that do not equal the number of days elapsed, thus violating (2) as well. We can be certain that these are indeed *mistakes* because the table computed from this model in the previous lines obeys the aforementioned principles.<sup>29</sup>

How did this happen? The fact that the errors of the model have not entered into the table calculated therefrom, and that the model indeed *follows* the table, suggests that the Mawangdui manuscript is not a working paper but an imperfect copy of an earlier text. The conflation of 120 百廿 (\**pak-nip*) and 40 卅 (\**sip*) might be graphic, given the phonological dissimilarity of the two words and the absence of the number 40 anywhere in the surrounding text (where the copyist’s eyes may have skipped);<sup>30</sup> the conflation of month IX 酉 with month VII 酉 and month VI 酉, on the other hand, is clearly graphic in nature. Lastly, the (failed) inversion of the day-durations of grades 5–7 would seem to be a case of scribal intervention by a copyist with a weak understanding of what he was copying—taking the inversion as a mistake, we can imagine, he corrected the sequence based on that of the previous line. In sum, the mistakes here would appear to be visual in nature.

We find clear evidence of these same phenomena throughout technical manuscripts of the same period. Let us consider the bamboo calendars for Shihuang year 34 (213 BCE) found separately in the Yuelu Academy manuscripts and Zhoujiatai 周家

<sup>28</sup> Editors are able to confidently reconstruct lacunae where the text of the *Wu xing zhan* planetary models is deficient based on the formulaic nature of their language, textual parallels, the measured size of missing silk, and assumptions of mathematical coherence and coherence to principles (see above) evidenced elsewhere in the *li* tradition and, importantly, in the manuscript itself. To help visualize what is extant and what is inserted, please consult Table 1.

<sup>29</sup> I show that the table’s lodge-positions are in every case the exact number of *du* apart as the number of days elapsed in ‘Cong Zhoujiatai *Rishu* yu Mawangdui *Wu xing zhan* tan rishu yu Qin Han tianwenxue de huxiang yingxiang’, pp. 125–26, 132–34. Note also that if the number of days and *du* elapsed over one synodic period did not equal out, the planet would not return to Hall<sub>L13</sub> at the end of every eight-year resonance period, as posited by both the table and the Venus model itself.

<sup>30</sup> Phonetic reconstructions are according to Axel Schuessler’s Late Han Chinese in *ABC Etymological Dictionary of Old Chinese* (Honolulu: University of Hawai’i Press, 2007).

臺 tomb 30 (Figures 3 & 4).<sup>31</sup> Exemplars of the *zhiri* 質日 (‘duty log’) format, both manuscripts are divided into six registers, each of which begins with the sexagenary date of day 1 of the even months (beginning from month X) and runs right-to-left through the subsequent days of this and the next (odd) month. Because the civil calendar alternates between “large” and “small” months of 30 and 29 days, respectively, *zhiri* leave blank spaces at the end of “small” months (Figure 3, slip 29 reg. 1 and slip 59 reg. 2–6) to maintain the month-dates across registers.<sup>32</sup> This way, column 1 is day 1 of each odd month and column 31 is day one of each even month. In general, each register contains fifty-nine days, which causes the sexagenary series to repeat one place to the left in each subsequent register.

The discovery of the Yuelu version has confirmed suspicions that Zhoujiatai is corrupt. The problem, comparison reveals, is that the latter omits the blank at the end of “small” month X (register 1, slips 1–28) leaving no room for the last day of “large” months XII, II, IV, VI, or VIII in the subsequent registers. Aware of his mistake, its copyist skips the last day of month XII (*bingyin*.<sub>03</sub>) in register 2, but lapses in registers 3–5, displacing months III, V, and VII all one day forward; he does, however, correct himself in register 6. It is clear that this has happened because he has simply repeated the sexagenary dates of each register one place to the left of the one previous, running naturally 甲子 *jiazi*.<sub>01</sub> → 乙丑 *yichou*.<sub>02</sub> rather than 甲子 *jiazi*.<sub>01</sub> → 丙寅 *bingyin*.<sub>03</sub>, for example, in the case of register 3 (slips 28–29). That this was indeed *visual* is confirmed by the fact that where the occasional mistaken sexagenary date occurs it is repeated in each subsequent register, as highlighted in Figures 3 & 4.<sup>33</sup>

The *Suan shu shu* 算數書 (‘Writings on Reckoning’), a bamboo manuscript on mathematics from Zhangjiashan 張家山 tomb 247 (sealed c. 186 BCE), tells a similar story.<sup>34</sup> As in the calendro-astronomy genre, the majority of mistakes here stem too from copying rather than computation, and the majority of *these* involve either eye-skipping/omission or the confusion of orthographically similar characters. In other words, the sums work out, but they contain the occasional number or measuring unit that has been miswritten.

For example, the text regularly confuses the orthographically similar numbers 1 一, 2 二, and 3 三; 1 一 and 7 十; and 30 卅 and 40 肆. We even have a mistake in the context of dealing with a mistake:

稅田。稅田廿四步<sup>L</sup>。八步一斗，租三斗。今誤券三斗一升。問：

<sup>31</sup> For transcriptions and photographs, see Chen Songchang, ed., *Yuelu Qin jian* 嶽麓秦簡 (Shanghai: Shanghai cishu chubanshe, 2010), vol. 1, pp. 10–18, 180–83; Hubei sheng Jingzhou shi Zhouliang yuqiao yizhi bowuguan 湖北省荆州市周梁玉橋遺址博物館, ed., *Guanju Qin-Han mu jian* 關沮秦漢墓簡牘 (Beijing: Zhonghua shuju, 2001), pp. 11–17, 93–99.

<sup>32</sup> On the format and meaning of the rubric *zhiri*, see Li Ling 李零, ‘Shiri, rishu he yeshu—san zhong jianbo wenxian de qubie he dingming’ 視日、日書和葉書——三種簡帛文獻的區別和定名, *Wenwu* 文物 2008.12, 73–80; Su Junlin 蘇俊林, ‘Guanyu “zhiri” jian de mingcheng yu xingzhi’ 關於「質日」簡的名稱與性質, *Hunan daxue xuebao (shehui kexue ban)* 湖南大學學報 (社會科學版) 24, no. 4 (2010), 17–22.

<sup>33</sup> Specifically, there is a mistake introduced in register 4 of both the Yuelu and Zhoujiatai Shihuang 34 calendars that is repeated (one place to the left) in registers 5 and 6 (Yuelu reads 乙丑 *yichou*.<sub>02</sub> → 丙申 *bingshen*.<sub>33</sub> → 丁卯 *dingmao*.<sub>04</sub>; Zhoujiatai reads 戊戌 *wuxu*.<sub>35</sub> → 己酉 *jiyou*.<sub>46</sub> → 庚子 *gengzi*.<sub>37</sub>). For more on this particular case and the production, transmission, customization, and corruption of calendars in pre-print China, see Morgan, “Knowing Heaven,” pp. 183–270.

<sup>34</sup> Zhangjiashan ersiqi hao Han mu zhujian zhengli xiaozu 張家山二四七號漢墓整理小組, ed., *Zhangjiashan Han mu zhujian (ersiqi hao mu)* 張家山漢墓竹簡 (二四七號墓) (Beijing: Wenwu chubanshe, 2001), pp. 81–98, 247–72. For the complete text, translation, and photographs of the *Suan shu shu*, see Chōkazan Kankan *Sansūsho Kenkyūkai*. 張家山漢簡「算數書」研究會, ed., *Kankan Sansūsho: Chūgoku saiko no sūgakusho* 漢簡「算數書」：中國最古の數學書 (Kyōto: Hōyū shoten, 2006). For a translation and study in English, see Christopher Cullen, *The ‘Suàn Shù Shū’ 算數書 “Writings on Reckoning”: A Translation of a Chinese Mathematical Collection of the Second Century BC, with Explanatory Commentary* (Cambridge: Needham Research Institute, 2004).

幾何步一斗？得曰：七步卅七（一）分步廿卅而一斗<sup>L</sup>。朮曰：三斗一升者為法。十稅田。令如法一步。

Duty on a field. There is duty on a field of 24 *bu*. <sup>L</sup> 8 *bu* [produces] 1 *dou*, the tax is 3 *dou*. Now in error it is ticketed at 3 *dou* 1 *sheng*. Question: how many *bu* give a *dou* [on that basis]? Result: 7 *bu* 23/37 (*sic*) *bu* [produce] 1 *dou*. <sup>L</sup> Method: make the 3 *dou* 1 *sheng* the divisor; 10-fold the field taxed; make it accommodate the divisor [to obtain] 1 *bu* (slips 68–69).<sup>35</sup>

The result here should clearly be 7 *bu* 步 23/31 as we are instructed to “make the 3 *dou* 斗 1 *sheng* 升 (= 31 *sheng*) the divisor” (and  $8 \times 30/31 = 7 \frac{23}{31}$ ), but the copyist has instead given us 37, the difference being a single brushstroke.

Elsewhere, the text tends also to confuse the orthographically similar capacity units *dou* 斗 ( $\approx 2$  liters) and *sheng* 升 (1/10 *dou*, or  $\approx 200$  cc). For example:

米粟并。有米一石，粟一石。并提之。問：米粟當各取幾何？曰：米主取一石二斗十六分升（斗）八，粟主取七斗十六分斗八。朮曰：直（置）米十斗，六斗，并以為法。以二石扁（遍）乘所直（置），各自為實。六斗者，粟之米數也。

Hulled and unhulled grain combined. There is 1 *shi* of hulled grain and 1 *shi* of unhulled grain. They are combined. Question: [the owners of] hulled and unhulled should each take how much? Reply: the owner of the hulled grain takes 1 *shi* 2 *dou* 8/16 *sheng* (*sic*); the owner of the unhulled gain takes 7 *dou* 8/16 *dou*. Method: set out hulled grain 10 *dou* and 6 *dou*, and combine to make the divisor; multiply all what has been set out by 2 *shi* so that each makes a dividend by itself. The 6 *dou* is the quantity of hulled corresponding to unhulled grain (slips 117–118).<sup>36</sup>

The owner of the hulled grain here should take 1 *shi* 石 2 *dou* 8/16 *dou* (12.5 *dou*) rather than 1 *shi* 2 *dou* 8/16 *sheng* (12.05 *dou*), of course, since  $10 \times 20/16 = 12.5$ .<sup>37</sup>

Hemerology (calendar divination) provides further examples of these phenomena. Take for instance the Mawangdui *Xingde*. The *Xingde* is a text in two parts: the first, a hemerology describing the seasonal, monthly, and daily circulation of the calendar spirits Xing 刑 (‘Punishment’) and De 德 (‘Virtue’) through, essentially, a schematized game board correlating the sexagenary cycle, cardinal directions, and five agents (wood, fire, earth, metal, water), combinations of which determine the advantage/disadvantage of particular times and directions for political and military decisions; and the second, a typical list of celestial omens. The Mawangdui horde contains three versions of the *Xingde* text (MS A, B, and C) copied at different times, in different colours, and in different calligraphic styles. In lines 95 and 96 of *Xingde* B, the copyist accidentally repeats a line as it appears exactly in *Xingde* A, his eye having clearly skipped to the wrong line as he copied visually from either *Xingde* A or a master copy identical in layout thereto.<sup>38</sup> Marc Kalinowski notes that we see evidence also

<sup>35</sup> Trans. Cullen, *The ‘Suàn Shù Shū’*, p. 60.

<sup>36</sup> Trans. Cullen, *The ‘Suàn Shù Shū’*, p. 74.

<sup>37</sup> There is considerably more to be said about copy errors and scribal intervention in the *Suan shu shu* than can be dealt with here, but Karine Chemla and I have embarked on a joint project on the copying and editorial practices evidenced therein that we hope to publish soon.

<sup>38</sup> Chen Songchang, ‘Boshu *Xingde* yi ben shiwen jiaodu’ 帛書『刑德』乙本釋文校讀, in *Hunan sheng bowuguan sishi zhounian jinian lunwenji* 湖南省博物館四十週年紀念論文集, ed. by Hunan Sheng bowuguan 湖南省博物館 (Changsha: Hunan jiaoyu chubanshe, 1996), pp. 83–87 (p. 87, note 26); cf. Marc Kalinowski, ‘La production des manuscrits dans la Chine ancienne: Une approche codicologique de la bibliothèque funéraire de Mawangdui’, *Asiatische Studien/ Études Asiatiques* 59, no. 1 (2005), 131–168 (pp. 160–61).

of scribal intervention:

Since most of the variants concern factual data such as the dates entered in the sexagenary grid and the description of the diurnal rotations of Xing-De for the eleventh year of Gaozu, there is every reason to think that copy B is an updating of copy A redacted some twenty years later by a specialist in calendrical techniques. Thus, the variants between the two copies do not necessarily indicate different textual traditions but rather seem to be the result of deliberate action by the copyist himself, even though he may well have used other versions of the text as he carried out his work.<sup>39</sup>

Kalinowski reaches a similar conclusion in his case study of the two daybooks (*rishu* 日書) recovered from the third-century BCE tomb 11 at Shuihudi 睡虎地 in Yunmeng 雲夢, Hubei.<sup>40</sup> Like those proliferating third- and second-century BCE tombs, Kalinowski shows, daybooks A and B from Shuihudi are miscellanies formed of small independent units that copyists arranged more-or-less arbitrarily across each text according to complicated processes of selection. Editorial intervention did not stop there though, as we see in the case of ‘Yi’ 衣 (MS A, slips 113–22v), for example, where, after reproducing the text of the master copy, the copyist provides an emended version of the same hemerology. “Il serait tout aussi absurde”, Kalinowski concludes, “de réduire l’activité des scribes de ce genre d’écrits à celle de simples copistes que de leur concéder le privilège d’être les auteurs des textes qu’ils composaient.”<sup>41</sup>

Mistakes, though they certainly occurred, are harder to identify in these materials. First, hemerology is an epistemic closed circuit that refers within a self-contained repertoire of symbols and mechanics and not, for example, to natural phenomena or basic mathematical operations that may be intersubjectively verified as “real” both within and beyond the culture and time in question. In other words, it’s harder to know if a calendar spirit is moving in the “right direction” than, say, a planet. Furthermore, due to the personal nature of daybooks as “copies de travail”, it is difficult to distinguish mistakes from, say, innovations or abbreviations. The fact that Shuihudi daybook A occasionally cuts off a sentence where its copyist ran out of space, for example, may not have posed a problem for the savvy reader (who was, perhaps, the copyist himself). That said, we might consider the possibility that the great variety exhibited in certain hemerologies might well be owed in part to scribal error—‘Xuange’ 玄戈, for example, which offers schemes for the (non-astronomical) movements of the stars Xuange and Zhaoyao 招搖 ( $\gamma$  and  $\lambda$  Boötis, respectively) that differ between each of the four manuscript versions currently extant.<sup>42</sup>

In sum, we have identified in this section two prominent features of textual transmission across mathematical and calendro-astronomical genres: positive evidence for visual copying as well as mistakes and conscious scribal intervention (both mal- and well-informed) particular to that process. We would extend the analysis of technical manuscripts further to include, for example, omenology, medicine, ritual, law, and

<sup>39</sup> ‘The *Xingde* 刑德 Texts from Mawangdui’, trans. by Phyllis Brooks, *Early China* 23–24 (1998–99), 125–202 (p. 128).

<sup>40</sup> ‘Les livres des jours (*rishu*) des Qin et des Han: la logique éditoriale du recueil A de Shuihudi (217 avant notre ère)’, *T’oung Pao* 94, no. 1 (2008), 1–48.

<sup>41</sup> ‘Les livres des jours (*rishu*) des Qin et des Han’, p. 24.

<sup>42</sup> On the ‘Xuange’ hemerologies, see Marc Kalinowski, ‘Les traités de Shuihudi et l’hémérologie chinoise à la fin des Royaumes-Combattants’, *T’oung Pao* 2d ser., 72, no. 4/5 (1986), 219–20; Liu Lexian, ‘Shuihudi Qin jian rishu “Xuange pian” xin jie’ 睡虎地秦簡「玄戈篇」新解, *Wen bo* 文博 1994.4, 74–76; cf. Liu Lexian, ‘Yintai Han jian *Rishu* chutan’ 印臺漢簡『日書』初探, *Wenwu* 2009.10, 92–96.

administration; the case of hemerology, unfortunately, reminds us of the difficulties of delimiting “mistakes” beyond the rather limited corpus of astronomical and mathematical manuscripts. So, how representative is our sample? The problem is as much one of quantity as context: as tomb documents—i.e., *copies* belonging to noblemen and administrators—the examples here may speak volumes about the “popular science” of the day, but they are at several steps’ remove from the working texts/knowledge of the sort of experts with which we began and, now, return.

## Towards an Oral Culture of Textual Astronomy

The last two decades, the early China field has witnessed a surge of interest in the role of orality and memory in the production, reproduction, storage, and transmission of the texts that have come down to us in written form.<sup>43</sup> The debate is sometimes made out to be one of orality *versus* writing, but this is a false dilemma, for even in the age of print and the Internet, oral, written, and non-verbal transmission are as symbiotically interwoven as they have ever been;<sup>44</sup> the question, rather, is *whether* we can find evidence for orality in written sources sufficient to say something—*anything*—about it. The sinologist is at a significant disadvantage here vis-à-vis the classics scholar (from which he takes his inspiration):<sup>45</sup> our early sources offer us little by way of description (or prescription), and, as I shall develop in a companion study to the present article, our manuscripts would seem to speak *positively* only to the sort of *visuality* of text explored above.<sup>46</sup> The scope of exploration has been limited thus far to traditional topics of sinology—poetry, classics, philosophy, and history—and there is a sense, judging from personal conversations, that technical literature is beyond the reasonable purview of orality, what with its heavy reliance on lists, numbers, diagrams, tables, and, in the case of *li*, multi-generational databases. The case of India, however, where such texts were composed, sung, memorized, and transmitted for generations independent of the written word, should inspire us to expand our search to the, as I have elsewhere characterized it, “indoor,” “textual astronomy” of *li*.<sup>47</sup>

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<sup>43</sup> See Martin Kern, ‘Methodological Reflections on the Analysis of Textual Variants and the Modes of Manuscript Production in Early China’, *Journal of East Asian archaeology* 4, no. 1–4 (2002), 143–81; Kern, ‘The *Odes* in Excavated Manuscripts’, in *Text and ritual in early China*, ed. by Martin Kern (Seattle: University of Washington Press, 2005), pp. 149–93; David Schaberg, *A Patterned Past: Form and Thought in Early Chinese Historiography* (Cambridge: Harvard University Asia Center, 2001), pp. 315–324; Dirk Meyer, *Philosophy on Bamboo: Text and the Production of Meaning in Early China* (Leiden: Brill, 2012).

<sup>44</sup> For nuanced studies of the dynamic symbiosis between oral and written knowledge in history, see Claude Hagège, *L’Homme de paroles: Contribution linguistique aux sciences humaines* (Paris: Fayard, 1985); cf. Françoise Waquet, *Parler comme un livre: L’oralité et le savoir (XVIe - XXe siècle)*, *L’évolution de l’humanité* (Paris: Albin Michel, 2003).

<sup>45</sup> The early China orality movement is inspired in large part by breakthroughs made by classics scholars concerning the role of oratory and recitation in classical Greece, e.g. Eric Havelock, *Preface to Plato* (Cambridge: Belknap Press Harvard University Press, 1963), and Rosalind Thomas, *Literacy and Orality in Ancient Greece* (Cambridge: Cambridge University Press, 1992).

<sup>46</sup> Unfortunately, the scope of the present volume does not allow me to treat the issue of textual transmission concerning manuscripts within the purview of mainstream sinology. The tendency is often to treat technical genres as exceptions, but I believe this to be more a symptom of the perceived distance between the “sciences” and “humanities” to the modern mind than any such distinction imposed by our historical subjects themselves. My own work with textual variants in Warring States (480–222 BCE) Chu manuscripts has in fact convinced me that there is very little difference between the cultures of text transmission witnessed across genres of, for example, mathematics, astronomy, philosophy, and even poetry (presented in ‘A Positive Case for the Visuality of Text in Warring States Manuscript Culture’, presented at The Rise of Writing [University of Chicago, 15–16 October 2011]). I hope soon therefore to publish a companion piece to the present article that it may help close this perceived divide.

<sup>47</sup> Based on the traditional bifurcation of the Chinese astral sciences in terms of literary genre and practice, both individual and institutional, I characterize *li* as “indoor” or “textual astronomy” vis-à-vis the “outdoor”/“observational” field of *tianwen* 天文 “heavenly patterns” (‘Knowing Heaven’, p. 87). On orality in Indian

If the texts available to us are any indicator of those in circulation, it would seem that the written word was not particularly reliable. Having myself entered astronomy through the *Wu xing zhan*, I can attest from personal experience to the confusion that the contradictions, corruption, and unstated assumptions of just such a text is liable to cause someone working in a vacuum.<sup>48</sup> Likewise, the equatorial widths of the twenty-eight zodiacal lodges as listed in daybook B from Fangmatan 放馬灘 tomb 1 (sealed third century BCE) and the lacquer dial from Shuanggudui 雙古堆 tomb 1 (sealed 165 BCE) exhibit considerable differences with both one another and received sources.<sup>49</sup> Not only were many of the grand celestial phenomena/omens in the standard histories fabricated, as Huang Yi-long 黃一農 has shown, but experts were (sardonically) aware of this.<sup>50</sup> Importantly, as Han Yi reminds us, we are dealing with a world where one runs the risk of disastrously staking your reputation on an out-of-date edition of your competitor's work.

The lesson here is that texts can be more hindrance than help unless you already know what you are doing. In general, the greater the expert, the greater his vehemence against the value of the written word, even as he himself is writing texts. Take for example Wang Fan's 王蕃 (written) criticism of Lu Ji's 陸績 cosmology in the third century:

至以日景驗之，違錯甚多，然其流行，布在衆書，通儒達士，未之考正，是以不敢背損舊術，猶攄所見。

Si l'un soumet (la théorie adoptée par Lu Ji) à l'épreuve des ombres du Soleil, on s'aperçoit que la valeur du rayon céleste est beaucoup trop grande. Or, du fait que cette théorie est très répandue et reproduite dans une multitude d'écrits, les lettrés moyens et ordinaires n'ont pas cherché à en vérifier (l'exactitude). Aussi n'ont-ils jamais osé s'opposer par la critique aux anciens procédés et se sont contentés de suivre ce qui leur était proposé (dans ces ouvrages).<sup>51</sup>

How then was one to go about mastering *li*?<sup>52</sup> For functionaries, we know the astronomical office to have begun providing on-the-job training sometime around the Sui 隋 (581–618), when its staff began to include erudits (*boshi* 博士) and trainees (*sheng*

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astronomy, see Agathe Keller's contribution to the present volume as well as Pierre-Sylvain Filliozat, 'Ancient Sanskrit Mathematics: An Oral Tradition and a Written Literature', in *History of Science, History of Text*, ed. Karine Chemla (Boston: Kluwer Academic, 2004), 137–57; Yano Michio 矢野道雄, 'Oral and Written Transmission of Exact Sciences in Sanskrit', *Journal of Indian Philosophy*, 34, no. 1–2 (2006): 143–60.

<sup>48</sup> Particularly confusing in this regard is the fact that its tables run on a calendar that is at once necessarily distinct from the civil calendar and wholly unexplained. Compare this to the ninth-century *Qiyao rangzai jue* 七曜攘災決 ('Formulae for Averting Disaster by the Seven Luminaries'), whose tables would seem to run on an identical scheme, an astronomical solar calendar, but which actually provides the reader with an explanation thereof and a simple method of converting table-dates into civil time; see Morgan, 'The Planetary Visibility Tables in the Second-Century BC Manuscript *Wu xing zhan*'.

<sup>49</sup> See, for example, Pan Nai 潘籟, *Zhongguo hengxing guance shi* 中國恆星觀測史, 2d ed. (Shanghai: Xuelin chubanshe, 2009), pp. 29–41; Sun Zhanyu 孫占宇, 'Fangmatan Qin jian rishu "Xing du" pian chutan' 放馬灘秦簡日書「星度」篇研究, *Kaogu* 考古 2011.4, 70–79.

<sup>50</sup> *Shehui tianwenxue shi shi jiang* 社會天文學史十講 (Shanghai: Fudan daxue chubanshe, 2004), pp. 1–71.

<sup>51</sup> *Kaiyuan zhanjing* 開元占經 (Siku quanshu ed.), pp. 1.15a–b; trans. Marc Kalinowski, 'Le calcul du rayon céleste dans la cosmographie chinoise', *Revue d'histoire des sciences* 43, no. 1 (1990), 3–34 (p. 13). This is not the only occasion where we see astronomical experts criticize amateurs for blind reliance on texts in the early imperial period. See also, for example, Cai Yong's 蔡邕 (133–192) criticisms of the court debate in 175 studied in Cullen, 'Actors, Networks, and "Disturbing Spectacles" in Institutional Science', pp. 253–64.

<sup>52</sup> Note that I make a conscious distinction throughout this study between the categories "expert" and "professional", which only sometimes overlap in a single individual. For more on the cast of characters seen participating in early imperial *li*, see Morgan, 'Knowing Heaven', pp. 76–94.

生) in *li*, *tianwen*, clepsydrae, and omenology.<sup>53</sup> Unfortunately, this is all that there is to be said about calculators and technicians, so we must turn instead to the sort of elite experts and administrators sufficiently famous to attract the attention of imperial historiographers (and, where they occur, the supporting actors entailed in their stories). As we know, omen and prophecy literature and mathematics were integral element of the office-holding elite's education in this period.<sup>54</sup> As for mathematical astronomy, we know that some like Sima Qian 司馬遷 (c. 145 – c. 86 BCE), Liu Xin 劉歆 (c. 50 BCE – 23 CE), Zheng Zhong 鄭眾 (d. 83), and brothers Zong Cheng 宗誠 and Zheng 整 (fl. 174–80) belonged to family traditions.<sup>55</sup> Mathematical astronomy was also taught in schools. Zhang Heng 張衡 (87–140) and Zheng Xuan 鄭玄 (126–200) learned them at the Imperial Academy, and it was from Liu Xin's private lectures that Zheng Zhong's father Xing 興 (fl. 14–33) learned *li*—the latter a model of private education that we know in the provinces to have attracted hundreds of pupils to the subject.<sup>56</sup> There were also those who learned from social inferiors, suggesting relationships of private tutorial. Empress Dowager Deng Sui 鄧綏 (81–121), for example, learned the astral sciences from literata Ban Zhao 班昭 (c. 45 – c. 117), and Sima Qian learned his star lore from the wonderworker Tang Du 唐都 (fl. 104 BCE).<sup>57</sup>

What did this education look like? This is difficult to say: our sources simply note the 'transmission' (*chuan* 傳) and 'reception' (*shou* 受) of 'methods' (*fa*), 'techniques' (*shu*), 'models' (*shi* 式), and *li* from one person/institution to another, and without the sort of excavated school materials that, for example, proliferate in cuneiform corpora,

<sup>53</sup> See *Sui shu*, p. 28.775; *Tang liu dian* 唐六典 (Siku quanshu ed.), pp. 10.13a–16a (commentary); cf. Chen Xiaozhong 陳曉中 and Zhang Shuli 張淑莉, *Zhongguo gudai tianwen jigou yu tianwen jiaoyu* 中國古代天文機構與天文教育, *Zhongguo tianwenxueshi daxi* (Beijing: Zhongguo kexue jishu chubanshe, 2008), pp. 297–304.

<sup>54</sup> On the importance of omenology and prophecy literature in elite culture, see Note 18 and Jack L. Dull, 'A Historical Introduction to the Apocryphal (*ch'an-Wei*) Texts of the Han Dynasty' (Ph.D. diss., University of Washington, 1966); Lü Zongli 呂宗力, *Power of the Words: Chen Prophecy in Chinese Politics, AD 265–618* (Oxford: Peter Lang, 2003). On mathematics, see Christopher Cullen, 'People and Numbers in Early Imperial China: Locating "Mathematics" and "Mathematicians" in Chinese Space', in *Oxford Handbook of the History of Mathematics*, ed. by Eleanor Robson and Jacqueline A. Stedall (Oxford: Oxford University Press, 2009), pp. 591–618.

<sup>55</sup> Both Sima Qian and Liu Xin's fathers were famously involved with mathematical astronomy, and Qian inherited the post of Prefect Grand Clerk from his father, Tan 談 (165–110 BCE). As the son of Zheng Xing, Zheng Zhong "received the *Zuo Tradition of the Spring and Autumn Annals* from his father, was vigorous in his studies, and understood the Triple Concordance system" 從父受左氏春秋，精力於學，明三統歷 that his father had learned, in turn, from Liu Xin (*Hou Han shu*, p. 36.1224). Brothers Zong Cheng and Zheng appear at court in 174–80 as experts on eclipse prediction like their grandfather, Zong Gan before them (*Hou Han shu*, *zhi* 2, pp. 3040–41).

<sup>56</sup> For Zhang Heng, see *Hou Han shu*, p. 59.1897. For Zheng Xuan, see *Hou Han shu*, p. 35.1207. Zheng Xing, we're told, "followed Liu Xin as a disciple for his lectures on the correct and great meaning (of the classics); Xin praised Xing's talents, making him compose 'regulation' and 'sentence and verse' commentarial exegesis as well as collate the Triple Concordance system" 將門人從劉歆講正大義，歆美興才，使撰條例、章句、傳詁，及校三統歷 (*Hou Han shu*, p. 36.1217). As to provincial schools, the *Hou Han shu* "Fang shu liezhuan" 方術列傳 tells us about the provincial wonder-workers Liao Fu 廖扶 and Fan Ying 樊英 associated, among other things, with *tianwen* and *xing suan* 星算 ('star calculation'), respectively, and were known to have taught large numbers of disciples (*Hou Han shu*, pp. 82A.2719–21). It is in this sort of environment, for example, that Yang Tong 楊統 (fl. 76) is said to have learned "the techniques of *tianwen* and [astronomical] calculation" 天文推步之術 from a "Zheng Boshan of his same commandery" 同郡鄭伯山 in Xindu 新都, near Chengdu (*Hou Han shu*, p. 30A.1074).

<sup>57</sup> The daughter of historian Ban Biao 班彪 (3–54) and the sister of General Ban Gu 班固 (32–92), Ban Zhao was a prominent literata, and in 108 Empress Dowager Deng sought her out to learn "the classics as well as *tianwen* and mathematics" 經書，兼天文、算數 (*Hou Han shu*, p. 10A.424). Tang Du was one of the outside experts called in to participate in the Grand Inception system reform project of 104 BCE, his responsibility being *li* numbers, stars, and the division of Heaven (*Shiji* 史記 [Zhonghua shuju ed.], pp. 26.1260, 27.1349, 112.2965; cf. Christopher Cullen, 'Motivations for Scientific Change in Ancient China: Emperor Wu and the Grand Inception Astronomical Reforms of 104 BC', *Journal for the history of astronomy* 24, no. 3 [1991], 185–203). For his role educating Sima Qian, see *Shiji*, p. 130.3288.

neither do we know what form curricula may have taken.<sup>58</sup> We do, by way of reference, know a little about how the standard curriculum (of the elite) was taught in this period. The standard curriculum concentrated on writing and, then, the reading, recitation, and memorization of classics. Primary education began at home, the student typically taking a master at around the age of eight. In the case of private schools, masters tended to take more students than they could personally instruct and thus relied upon a tiered system whereby a manageable core of personal disciples were responsible for educating the outer rungs, who, it is sometimes said, may well never lay eyes on the master; at the same time, however, masters would often hold ‘lectures’ (*jiang* 講) of a more public nature, attracting scholars beyond the walls of their school, wherein they would explain and take questions on a given text.<sup>59</sup> In the case of home schooling, ‘teaching assistants’, tutorial, and personal exchange (below), we know next to nothing, but we can assume a more informal oral back-and-forth on the basis of written and/or memorized texts. In the case of *li*, we know the latter, less formal, situation to be more common among the men and women who mattered (and the fact of the geographic proximity invariably involved in this ‘reception’ would seem to further confirm the centrality of oral exchange). In the case of *tianwen* 天文 omen literature, Li Chunfeng, for one, claims to have committed twenty-five titles to memory in his youth through “practice and recitation” 習誦;<sup>60</sup> but where *li* specifically stands out from the case of the classics is that *practitioners are never mentioned as having begun their studies through independent reading*.

Let us return now to Liu Hong and the debate of 226 with which we began in the introduction and ruminate upon the circumstances surrounding Assistant to the Grand Clerk Han Yi’s public shaming. Han Yi, it would seem, was not the idiot that his detractors made him out to be. His prognosis that “the Supernal Emblem [system] went too far in reducing the DIPPER PARTS and that in time it would slip ahead of Heaven” 乾象減斗分太過後當先天 was, we now know, right on the money.<sup>61</sup> The Clerk’s Office performed extensive tests on Han’s new system, the results of which, delivered the Prefect Grand Clerk (*Taishi ling* 太史令) himself, were deliberated upon at length at the highest levels of government before a public debate was even considered. To have gotten this far, we can imagine that the results of the Clerk’s Office trial must have ranged somewhere between inconclusive to superior (I know of no case where an *yi* 議 debate was convened to discuss the merits of a proven failure). Furthermore, out of the dataset presented by Xu Yue—three solar and two lunar eclipses occurring between 5 August 221 and 19 January 223—Han loses to the Supernal Emblem system as we know it (without *xiaoxi*) two-to-three by a margin of only ten minutes.<sup>62</sup>

<sup>58</sup> See, for example, Niek Veldhuis’ monumental study, ‘Elementary Education at Nippur: The Lists of Trees and Wooden Objects’ (Ph.D. diss., Rijksuniversiteit Groningen, 1997). On mathematics, specifically, see Christine Proust, *Tablettes mathématiques de Nippur*, Varia Anatolica XVIII (Istanbul: Institut français d’études anatoliennes Georges Dumézil, 2007); Eleanor Robson, ‘Mathematics Education in an Old Babylonian Scribal School’, in *The Oxford Handbook of the History of Mathematics*, pp. 199–228.

<sup>59</sup> What little we know about education in China’s early imperial period is surveyed in Thomas H. C. Lee, *Education in Traditional China: A History*, Handbuch der Orientalistik. Vierte Abteilung, China 13 (Leiden: Brill, 2000). See also Yu Shulin’s 余書麟 wonderful study of Han-era private education, ‘Lianghan sixue yanjiu’ 兩漢私學研究, *Shida xuebao* 師大學報 11 (1966): 109–48.

<sup>60</sup> *Yisi zhan* 乙巳占 (Shiwan juan lou congshu 十萬卷樓叢書 ed.), p. 1.11a.

<sup>61</sup> *Song shu*, p. 12.231; *Jin shu*, p. 17.498. For an explanation of Han Yi’s prognosis, see [Note 5](#).

<sup>62</sup> Specifically, observation placed the presumed mid-point of the lunar eclipse of 5 January 223 at “a quarter past *chou*.<sub>B02</sub>” 丑少 or 02h30/02h40 (the computed maximum being 02h00 local apparent time in Luoyang), for which the Supernal Emblem (without *xiaoxi*) placed the instant of full moon at “half-past *hai*.<sub>B12</sub>” 亥半 or 23h00/23h10, and Han Yi’s Yellow Inception system at “a twelfth past *mao*.<sub>B04</sub>” 卯強 or 06h10/06h20. For my analysis of Xu Yue’s test results, see ‘Knowing Heaven’, pp. 316–35. Note that while Han Yi only barely underperformed the Supernal Emblem system (without *xiaoxi*), the second dataset produced by Xu—a list of 15 planetary visibility phenomena observed between 18 December 221 and 16 February 223—does place him in at a clear



This is not bad, but the problem was that he found himself facing off on the day of the debate against not the Supernal Emblem system as *we* know it, nor the Supernal Emblem system as *he* knew it, but yet a third Supernal Emblem system (Xu Yue's) of which neither he nor the state astronomical office had any idea existed.

So, what was it that Han Yi had in hand (or mind)? The *Book of the Jin* provides us with the following information about the transmission of Liu Hong's astronomy:

獻帝建安元年，鄭玄受其法，以為窮幽極微，又加注釋焉。

Xiandi 獻帝 (r. 189–220) Jian'an 建安 year 1 (196), Zheng Xuan received his method (*fa*), and considering it to plumb all that is recondite and crown all that is subtle, he further added commentary and explanation to it.<sup>63</sup>

其劉氏在蜀，仍漢四分曆。吳中書令闕澤受劉洪乾象法於東萊徐岳，又加解注。中常侍王蕃以洪術精妙，用推渾天之理，以制儀象及論，故孫氏用乾象曆，至吳亡。

The House of Liu 劉 were in [the state of] Shu 蜀, where they kept the Han Quarter-remainder system. Prefect of the Palace Writers for the State of Wu, Kan Ze 闕澤 (d. 243), received Liu Hong's Supernal Emblem method (*fa*) from Xu Yue of Donglai 東萊 and added exegesis and commentary to it. Regular Palace Attendant Wang Fan considered [Liu] Hong's technique (*shu*) marvellous, and he used it to extrapolate the principles of Spherical Heaven [world-model cosmology] to formulate an instrument (armillary sphere) and discourse. Thus it was that the House of Sun 孫 used the Supernal Emblem system until the demise of Wu 吳.<sup>64</sup>

Interestingly, the text of the Supernal Emblem system as we have it counts from a date ten years *after* Zheng Xuan received and wrote upon the self-same 'method'. It was in this year, 196, that Zheng happened to have been in Xuzhou 徐州, one or two days' ride (120 km) from Shanyang 山陽, where Liu Hong was then serving as governor (*taishou* 太守)—a coincidence from which Chen Meidong 陳美東 infers face-to-face transmission.<sup>65</sup> Zheng and Liu's circumstances were such that it is difficult to identify one or the other as the clear social superior (and perhaps this did not matter).<sup>66</sup> Zheng was seventy at the time, about ten years Liu's senior, and was well-established as a textual scholar and educator who, especially after his fourteen years' imprisonment a decade earlier, had made it his life's mission to avoid political engagement. Liu, on the other hand, was a successful military man and civil administrator of noble birth whose intellectual output in writing and at court some decades earlier were strictly limited to the field of mathematical astronomy. Having expressed a love and aptitude towards mathematics since his youth, we can imagine that it might have been

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disadvantage. The fact that the debate surrounding Han Yi's Yellow Inception system is focused on lunisolar phenomena, however, suggests that the latter would bear less on considerations of a policy decision than the former.

<sup>63</sup> *Jin shu*, p. 17.498.

<sup>64</sup> *Jin shu*, p. 17.503; also *Song shu*, p. 12.259.

<sup>65</sup> 'Liu Hong de shengping, tianwenxue chengjiu he sixiang' 劉洪的生平、天文學成就和思想, *Ziran kexue shi yanjiu* 自然科學史研究 5, no. 2 (1986), 129–142 (p. 132).

<sup>66</sup> Our impression that, outside the hierarchically-structured contexts of family, school, or tutelage, technical knowledge may also have been passed between peers is likewise suggested by the case of Zhai Fangjin 翟方進 (d. 7 BCE). A self-made man of humble origins who had risen to the rank of chancellor (*chengxiang* 丞相), Zhai is said to have taught the *Zuo Tradition* to Liu Xin (an influential statesman and intellectual of noble birth), his mastery of which would inform the core of the latter's later astronomical endeavours. He also taught "stellar/planetary *li*" 星曆 to Tian Zhongshu 田終術, the mayor of the capital (*Han shu* 漢書 [Zhonghua shuju ed.], pp. 36.1967, 84.3421).

Zheng who sought out Liu.<sup>67</sup> Judging from the contents of imperial bibliographies, the Zheng Xuan version of the Supernal Emblem system seems to have fallen more-or-less immediately out of circulation; when and where it was extant, however, we can be certain that it represented an earlier version of the Supernal Emblem system(s) we now know.<sup>68</sup>

The story of Xu Yue is more mysterious. We know nothing of his life or political career except that he was a man of Donglai. The proximity of his hometown to Qucheng 曲城 (70 km), where Liu was enfeoffed as a marquis sometime before, after, or during his appointment as governor of Shanyang, suggests that Xu too received personal instruction from Liu Hong. Whatever the status of the Supernal Emblem system that he received—be it before or after the Zheng Xuan version—Xu was apparently the vector for its transmission south, Kan Ze and Wang Fan being both members of the Sun-Wu court. As vectors go, this one is oddly tortuous. First, it is unclear under what circumstances Xu Yue and Kan Ze would have met. Xu Yue was a northerner who appears at the Cao-Wei court with no known official duties that might take him elsewhere; Kan Ze, on the other hand, was a man of humble beginnings from Kuaiji 會稽 whose career took him little further than the Sun-Wu court in Jianye 建業. Furthermore, if Kan indeed “received” the Supernal Emblem system whilst prefect of the palace writers (*zhongshuling* 中書令), an office he held in the 230s, it would mean that transmission occurred across particularly tense state lines (the King of Wu declared himself emperor in 229) a decade or more after the Sun-Wu court had already adopted a Supernal Emblem system.<sup>69</sup> Second, by random coincidence, it was actually while serving in Kan’s hometown of Kuaiji in the 180s that Liu Hong finished his work on a/the Supernal Emblem system and presented it (unsuccessfully) to the Han court.<sup>70</sup>

It is worth noting, furthermore, that while the Liu-Shu court in the southwest maintained the (failing) astronomical system of their predecessors, from whom they claimed their ancestry, we must suspect that they did so out of reverence rather than ignorance. During the reign of Sun Xiu 孫休 (r. 258–64), for example, we know Supernal Emblem enthusiast Wang Fan to have been dispatched as an emissary to the Liu-Shu court, where it is said that he made a considerable impression.<sup>71</sup>

This, unfortunately, is all that may be gleaned from our sources, and it raises far more questions than it answers. What came of the Supernal Emblem system in Shu? How did Xu Yue and Kan Ze meet? What was Liu Hong’s contemporary impact in Kuaiji, and why was his astronomy *reintroduced* to the region from the North? Who, indeed, is this Xu Yue guy? Why was the Cao-Wei astronomical office so out of the loop? What is *xiaoxi*? Just how many different versions of the Supernal Emblem system were circulating at the time? And where does our one-juan *Book of Jin* text of the Supernal Emblem system fit in all this? One is left with the impression that what we have here is but a narrow glance at the very surface of a network of practice and transmission whose complexity, in the time before print, may very well have rivalled those of our own age. What we can say is this: the Supernal Emblem system crystallized in written form after “more than twenty years” of “contemplation” (above), and it continued to evolve at the hands of its creator, commentators, and users for at least that long thereafter as, decade after decade, ‘methods’, ‘techniques’, ‘models’, and *li*

<sup>67</sup> On Zheng Xuan’s engagement with mathematics, see for example Cullen, ‘People and Numbers in Early Imperial China’, p. 606.

<sup>68</sup> The only potential candidate is the five-juan edition by “Liu Hong, et al.” recorded in the Liang imperial catalogue and mentioned above in [Note 12](#).

<sup>69</sup> For Kan Ze’s biography, see *Sanguo zhi*, pp. 53.1249–50.

<sup>70</sup> On the life and times of Liu Hong, see Chen Meidong, ‘Liu Hong de shengping, tianwenxue chengjiu he sixiang’; cf. Morgan, ‘Knowing Heaven’, pp. 73–75.

<sup>71</sup> For Wang Fan’s biography, see *Sanguo zhi*, pp. 65.1453–54.

were ‘received’ from the source, written down, commented upon, and transmitted along lines of personal exchange.

## Conclusion

Whatever Supernal Emblem system it was that was available to Han Yi, it was no match, not even in his own estimation, for one (i.e., Xu Yue’s) whose credibility was vouched for by recent and personal transmission from the source. Already humiliated, Han was dealt a vindictive finishing blow by the expert Yang Wei 楊偉 that drew the debate to its humiliating conclusion:

今韓翊據劉洪術者，知貴其術，珍其法。而棄其論，背其術，廢其言，違其事，是非必使洪奇妙之式不傳來世。若知而違之，是挾故而背師也；若不知而據之，是為挾不知而罔知也。

Now, the fact that Han Yi bases himself on Liu Hong’s techniques (*shu*) means that he knows to esteem his techniques (*shu*) and treasure his methods (*fa*). And yet he dismisses his discourse, forsakes his techniques (*shu*), abandons his words, and strays from his endeavour. The inevitable result of this will be to make Hong’s marvellous model (*shi*) cease to transmit to future ages. If he strays from it knowingly, then has intentionally forsaken his master; if he bases himself upon it unknowingly, then he has ignorantly arrived at a confused understanding.<sup>72</sup>

The picture that emerges from our analysis in this article is considerably more complex than our old understanding of the astral sciences as the exclusive domain of hereditary practitioners secreted in a tightly-controlled government laboratory. Instead, we see a field composed of eclectic characters connected by an elaborate network of personal, professional, educational, and family ties extending unfettered across institutional, geographic, and even war-torn political divides.<sup>73</sup> *People* circulated texts, and as they did, the texts evolved, and so too did the knowledge systems from which they sprang (and of which they were but snapshots in time). “The Supernal Emblem system—*which* Supernal Emblem system?” we should ask ourselves, taking comfort in the fact that our historical subjects were as confused by their texts as we are. Understandably, confusion bred scepticism among experts, who, much like the experts of our own day, evaluated one another’s credibility based more on criteria of experience, peer review, association, and the date and reputation of the oral instruction received.

Of course, given that they appear (unexplained) in the context of agonistic oratory, how are we to know if Xu Yue’s data are even genuine?<sup>74</sup>

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<sup>72</sup> *Jin shu*, p. 17.503.

<sup>73</sup> For canonical statements of the old view, see for example Joseph Needham, *Science and Civilisation in China*, vol.3: *Mathematics and the Sciences of the Heavens and the Earth* (Cambridge: Cambridge University Press, 1959), pp. 186, 193; Nathan Sivin, ‘Cosmos and Computation in Early Chinese Mathematical Astronomy’, *T’oung pao* 2d ser., 55, no. 1/3 (1969), 1–73 (esp. p. 4). To be fair, the “old view” is somewhat more appropriate for the period beginning with the Tang and Song 宋 (960–1279). For important recent studies exploring the openness of the state astronomical office and the variety of participants involved, see Cullen, ‘Actors, Networks, and “Disturbing Spectacles” in Institutional Science’; Chen Meidong, *Zhongguo gudai tianwenxue sixiang* 中國古代天文學思想, *Zhongguo tianwenxueshi daxi* (Beijing: Zhongguo kexue jishu chubanshe, 2007), esp. pp. 17–32; Sivin, *Granting the Seasons*, pp. 58–59, 151–70.

<sup>74</sup> There is something fishy here. Xu Yue’s data are the only extant witnesses to the *xiaoxi* method. It is interesting to note, moreover, that despite his diatribe against Han Yi in regard to *xiaoxi* and tinkering with the Supernal Emblem system, Yang Wei himself omits *xiaoxi* from his own improvement upon the self-same system in 237 (i.e., the Luminous Inception system, cited in *Song shu*, pp. 12.232–64; *Jin shu*, pp. 18.535–62). There is no evi-

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dence with which to accuse Xu Yue of fabrication *per se*, but it also wouldn't be the first time that someone produced false documents at court to prove a point. The possibility is thus worth humouring.

**Figure 1: *Wu xing zhan* 五星占 dimensions and textual units**

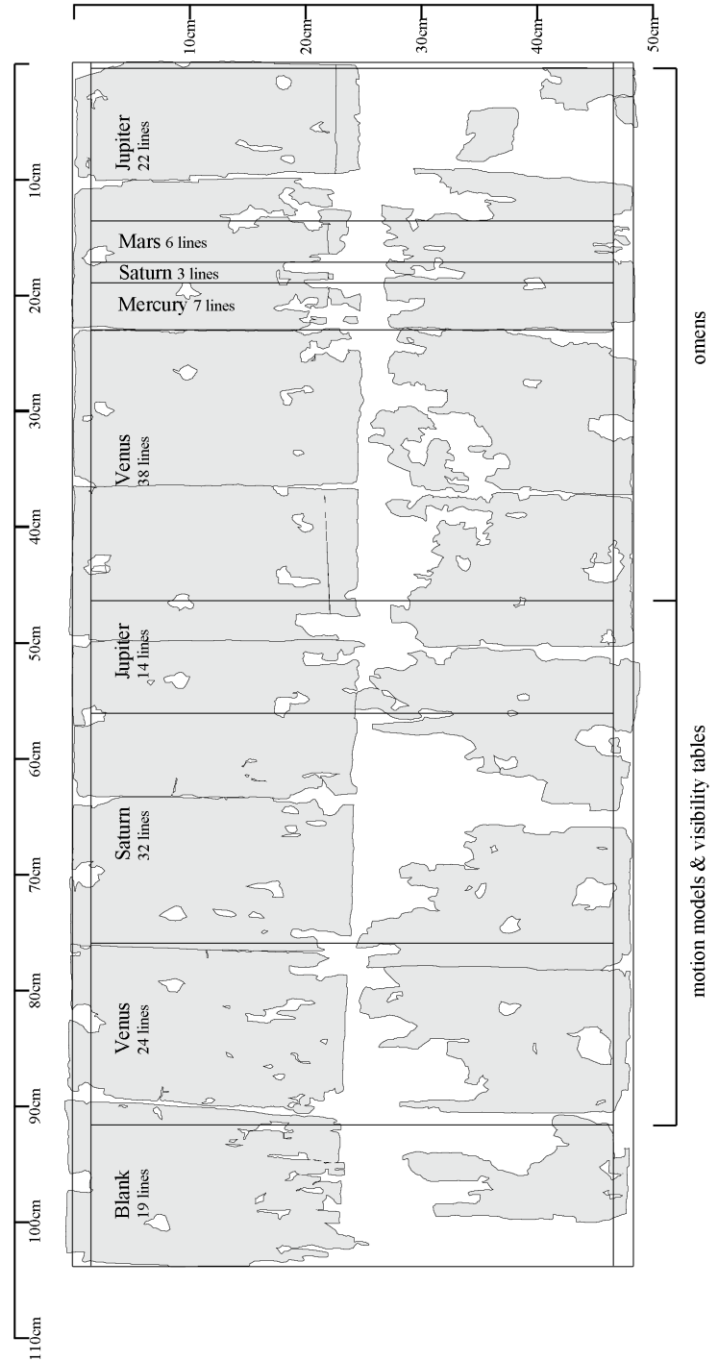
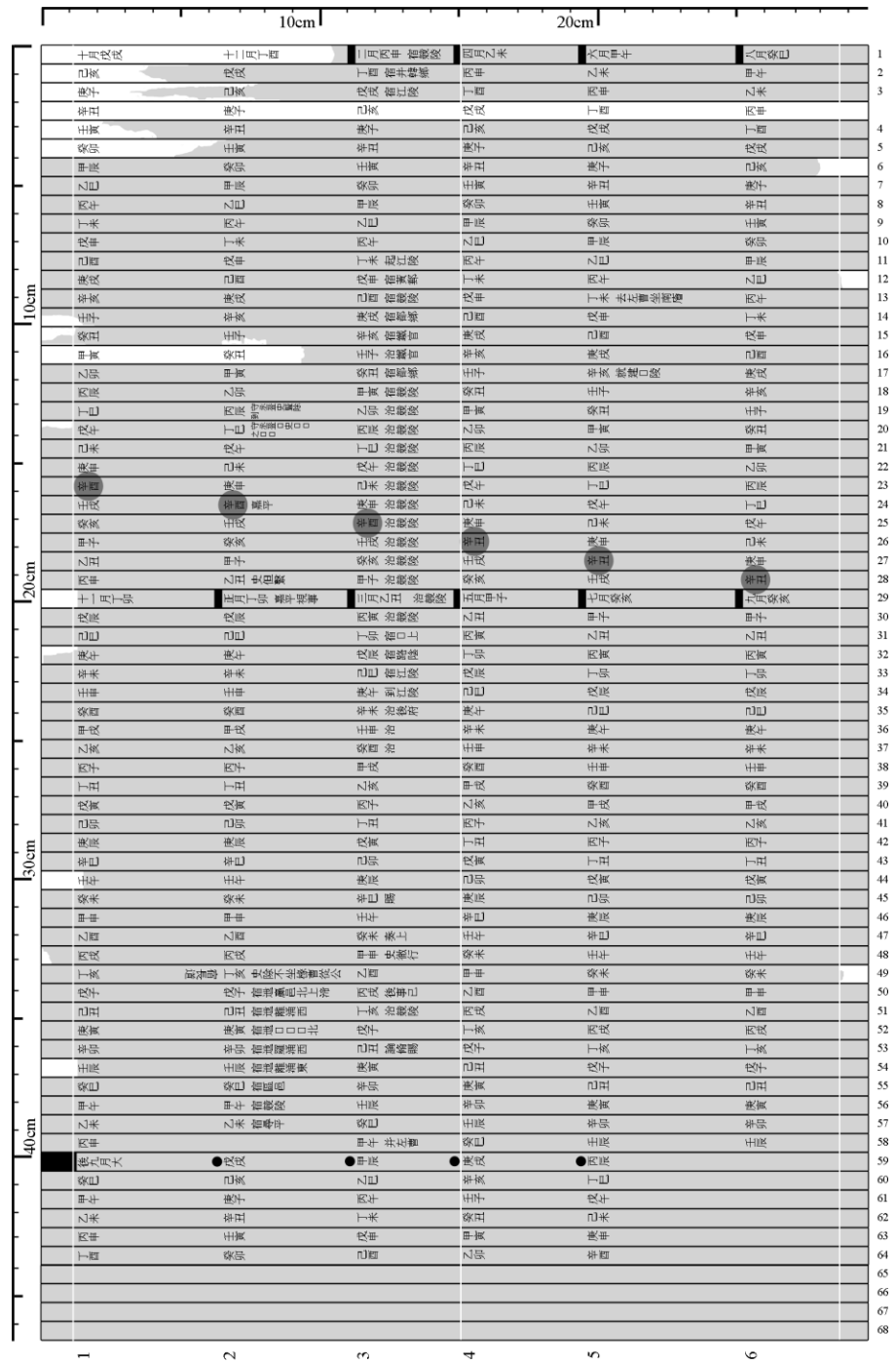






Figure 4: Zhoujiatai tomb 30 Shihuang 34 (213 BCE) calendar





**Figure 5: Map of Supernal Emblem system transmission**

