

Introduction

I recently published in the *Journal for the History of Astronomy* a study of the lunar theory of Liu Hong 劉洪 (c. AD 135- 210), an expert on mathematical astronomy and harmonics at the court of the Eastern Han 漢 dynasty (AD 25 - 220). My article was in effect a sampler from a larger study of Liu Hong's technical astronomical writing, which I intend to publish elsewhere.

But my talk today is not going to be about writing the technical history of Chinese astronomy. For the fact is that I did not start my work on Liu Hong because I was interested in his technical mathematical astronomy purely for its own sake, but rather because it became clear to me that until I understood it I should not be able to get control of some other material of much more general interest. And it is that other material that I should like to examine now.

The *Hou Han shu* 後漢書 material

The documents I want to discuss are to be found in a three-part treatise on mathematical harmonics and astronomy that nowadays forms part of the *Hou Han shu* 後漢書 "History of the Later [i.e. Eastern] Han dynasty". The title under which this treatise appears is *Lu li zhi* 律曆志 "Record of the pitchpipes and [astronomical] system". The *Hou Han shu* is of course the third of the 24 'standard histories' *zheng shi* 正史, a series of works whose first representative was completed around 90 BC, and which cover the history of pre-modern China more or less dynasty by dynasty. These works were usually sponsored in some sense by the government of the day, or rather the day after, since each dynasty tended to write the history of its predecessor. The government's initial involvement with this particular book was however limited to beheading its author Fan Ye 範曄 (AD 398-446) for political reasons, before he was able to finish it.

So the treatise on mathematical harmonics and astronomy was actually added later, with other treatises borrowed from an earlier history of the Eastern Han dynasty, the "Extension of the Han history" *Xu Han shu* 續漢書 by Sima Biao 司馬彪 (c. AD 240 - c. AD 306), which is now lost. Sima Biao himself was likewise using material originated by others, since in the discussion that concludes the section of his treatises dealing with mathematical harmonics and astronomy, he tells us that he has directly adopted material compiled in response to an imperial command issued at some point in the period AD 178 - 184, during the Eastern Han dynasty itself.

Sima Biao's treatise takes up about 100 pages in a modern critical edition. Its first part is a discussion of mathematical harmonics and its basis in cosmology, and its third part is a full specification of the officially approved system of mathematical astronomy current for most of the Eastern Han. My interest centres today on the second part, which gives detailed documentation of a series of astronomical controversies beginning around AD 32, and continuing until AD 180, just before the relevant documents were collected.

With an audience such as this one, I do not need to stress the fact that the

official or at least semi-official nature of much Chinese historical writing, together with the record-keeping habits of the highly regulated Chinese bureaucracy, leads to a style of writing which frequently includes transcriptions of large chunks of primary sources. So although we must ask all the obvious questions about the biases imposed by the editorial process of selection, omission, ordering, abbreviation and no doubt in some cases plain distortion or falsification, we are a lot closer to what was actually said than we are in many instances more familiar to historians of (say) the ancient Mediterranean world.

Nor, I think, do I need to explain to this audience what are the papers from long-dead discussions of mathematical astronomy doing in the official historical record. We all know that the ritual responsibilities of the emperor led to an almost unlimited demand for precision in predicting certain astronomical phenomena. Given that a small shift in the timing of a predicted astronomical event near midnight can move the date of a ceremony by a whole day, the potential demand for accuracy was unlimited. And getting the day of a ceremony right could matter a great deal. As one emperor remarked in AD 85 when discussing a proposed astronomical reform:

" One day before the [official] day of Establishment of Spring, then it is the [real] day of Establishment of Spring according to the Quarter-Remainder reckoning. If on that basis one was to open prisons and end great punishments, one would at once be violating the *qi* [cosmic energies]; to look for peace and tranquillity following the pattern of the seasons would be a distant prospect."

One may profitably compare with the Chinese case the picture revealed by Heilbron, whose *The Sun in the Church* has powerfully evoked the counter-reformation Papacy's demand for astronomical professionals to settle the date of Easter correctly. The Chinese state had similar needs, but to an even greater degree. To meet those needs, the Han emperors had a permanent salaried staff of astronomical observers and calculators, organised under the supervision of the Grand Clerk, *Tai shi ling* 太史令, who was himself part of the department of the Chamberlain for Ceremonials *Tai chang* 太常. The Grand Clerk had at his disposal an observatory with instruments of various kinds, staffed by the *shi guan* 史官 'Clerk's officials' and just as important had custody of official records of regular observations going back to the start of the dynasty, and to some extent beyond that.

Now to clear some issues out of the way, I will say that part of the duties of the Grand Clerk and his staff consisted of watching for, recording and interpreting unpredictable and transient phenomena such as meteors, comets and novae. But these do not concern us in the present context: such matters are not referred to in the sources we shall discuss here, and are in fact dealt with in a quite separate series of treatises in the standard histories, under the heading *Tian wen zhi* 天文志 "Record of the celestial patterns". The treatise that concerns us is not about *tian wen*, but *li fa* 曆法 the methods for constructing predictive systems of mathematical astronomy. And a good deal of the energy behind the debates we shall examine comes from the fact that it was considered appropriate and indeed essential for the Chinese state to authorise one official astronomical system, whose accuracy thus became an important political issue that concerned not

only the specialists of the Grand Clerk's department, but in addition the large number of generalist officials whose background made them feel equipped or indeed impelled to join the discussion. Questions of *li fa* were no more thought to be properly reserved for salaried astronomers than discussion of the British Government's annual Budget proposals are properly reserved for Treasury accountants. Indeed, as we shall see, there was a significant grouping at the Han court that considered itself *more* qualified to discuss astronomy than the *shi guan* 史官 the "Clerk's officials" themselves.

Using a unique resource

Now it seems clear that this material is unusual in the context of ancient science, and is almost certainly unique. This uniqueness may be characterised in two ways: by the detailed nature of the documents themselves, and also by the situation of those who generated these documents.

Firstly, for the documents: as you will see shortly from the examples I shall put before you, they enable us to trace the details of the arguments between the disputants quite closely. If we look at the literature of astronomy in the ancient Hellenic and Mesopotamian worlds, this cannot be done. We know that Greek science was frequently agonistic, and we can see clear signs of that in Ptolemy's writing, where he is obviously anxious to justify his procedures in the face of a potential attack, but we cannot see the actual agōn proceeding before our eyes, with the two sides having their say. In ancient Mesopotamia, we can see clear signs of struggle, even shrillness, in the efforts that the Ummānu, (Scribes or Scholars) made to ensure that the king attended to their interpretations of omens rather than those of their rivals. As one 7th or 8th century BC clay tablet has it, in a report to the king of Assyria:

'[He who] wrote to the King, my lord "Venus is visible" is a vile man, an ignoramus, a cheat!' (cited in David Brown, *Mesopotamian Planetary Astronomy-Astrology*, Groningen, (2000), p.240)

If however we look for open discussion of the ways in which the technical details of astronomy were to be validated, we do not find much: The elaborate mathematical schemes of late Mesopotamian astronomy can hardly have evolved without technical discussion, but there are almost no signs of this in the written record. One example of what we do have runs:

'Concerning Mercury, about which the king my lord wrote to me: yesterday Issar-sumu-eres had an argument with Nabu-ahhe-eriba in the palace. Later, at night, they went and all made observations; they saw (it) and were satisfied.'

Hermann Hunger *Astrological Reports to Assyrian Kings, State Archives of Assyria*, Vol VIII p. 50, (2002) Helsinki.

Beyond such slim material, we can only proceed by conjecture.

Further, the situation of the Chinese astronomical officials makes them

particularly interesting. For a start, they are officials. They do their astronomy as respected if not exalted members of a bureaucracy, in a strong institutional setting. Who did Ptolemy work for, if anyone? We do not know. What relation if any did he have to existing institutions such as the Library or Museum at Alexandria? Again we draw a blank. One of the things that has been held to make ancient science so different from modern science as to be well-nigh incommensurable is its lack of an institutional setting: in ancient China the institutional setting of astronomy is there in spades, and its workings are accessible to us in considerable detail.

Now astronomy in ancient Mesopotamia certainly was a state institution. But apart from the fact that the Mesopotamian Ummânu are silent on topics on which we should like to hear from them, their relations to the state seem to have been much less empowering than those of their Chinese colleagues. They address the king directly and personally, and are dependent on the daily swings of his attention or favour. To judge from their occasional desperate pleas to the ruler for 'a donkey' or 'some sandals', even not to be left to die of neglect and want, they perceive themselves as at best short-term contract researchers, dependent on handouts, or, as one of them puts it on 'left-overs'

The Chinese astronomers of the Eastern Han were in a much better case. They had regular salaries, offices, the chance of promotion, guaranteed time off, and even uniforms. In theory all this was at the emperor's whim, but in practice established custom gave considerable security. In the only instance in the material before us where the emperor does intervene in disciplinary proceedings taken against officials on the losing side of an important dispute, he acts to suspend proceedings, on the grounds (it is said by a commentator) that everyone should have their say. And further, even though all their debates were in theory conducted under the emperor's eye, the actual decisions often seem to have been made by their fellow-officials, a group whose sense of collegiality was notoriously seen by the emperor as a threat sufficient to justify him in developing an alternative corps of political advisors and drafters of policy, the palace eunuchs. And although ancient China has been described as having a form of intellectual life that was consciously non-agonistic and concerned to produce consensus, there does seem have been not only a fair amount of tolerance for what has been called 'the disturbing spectacle of experts disagreeing in public', but even a sense that such spectacles were necessary if technical problems were to be effectively settled. If one was seen to be in the wrong as a result of such a confrontation, one might face negative consequences, but there seems to have been little reluctance about confrontations occurring, whether on the part of the agonists or of those who held the ring.

Different types of material demand different research tools, and one should try to be both open and reflective about the research tools one chooses. Thus in studying the astronomical and astrological activities of the Mesopotamian Ummânu, David Brown attempted to apply the Kuhnian language of paradigm shifts, and claimed that he could locate a "Revolution of Wisdom" in the shift from the Enuma-Anu-Enlil (EAE) paradigm of omen interpretation on the basis

of idealised outline numerical schemes to the Prediction of Celestial Phenomena (PCP) paradigm using relatively accurate mathematical procedures, a shift he locates somewhere in the 7th and 8th centuries BC.

Whether or not that works well is not the issue here, although I think it probably does. But I have to say that I am interested in the possibility, if no more than that, of applying some non-Kuhnian tools in the present case. Here, you see, we have a community of actors concerned with the rhetoric of persuasion in a strong institutional setting which defines their roles and is in turn defined and shaped by their actions. The range of actors here is very varied: there are human beings, certainly, but also observational instruments both old and new, systems of official rank, databanks of observations both official and unofficial, sacred texts with the words of the ancient sages, rules of official procedure and even seating plans for the buildings in which debates take place. There are also systems of mathematical software the so-called *lifa* "[astronomical] systems, with some actors attempting to promote them to effectively "black box" status as unchallengeable facts, while others work to subject them to more provisional and questioning modalities, meanwhile pushing their own candidates for "black box" status - instruments as well as software - in turn. How far this tentative borrowing from Latour is justified (and for present purposes I mean specifically the Latour of *Science in Action*) you will shortly be in a position to judge. I would say, in passing, that it seems to me that it is much more fruitful for me to engage in instrumental reflection about what research tools can usefully be applied to this material rather than to tie myself into essentialist knots about whether or not the activities of the Grand Clerk's officials, or the Ummânu should be *called* 'science' or not. If the use of common research tools produces moderately fruitful and meaningful results when applied to activities in the first and twenty-first centuries, then those activities have that much in common. I do not say that there is nothing else one can usefully ask about them, but what that extra something is will need to be argued for with some care, and I shall not try to do that now.

Essential background

Here are some essential markpoints for the debates we are about to sample.

Politics	Astronomical system
Western Han dynasty: from 206 BC	Zhuan Xu system in use, as under Qin dynasty
adopted	104 BC: Taichu "Grand inception" system
Wang Mang interregnum AD 9-23	"Grand Inception" rebranded as Santong "Triple concordance" system
Eastern Han from AD 25	AD 85 "Han" ("Quarter remainder") system
adopted	
End of Eastern Han in AD 220	

I shall now, so far as time permits, make a few remarks on some of the following case studies taken from the material to be studied.

Case studies 1: Yang Chen 楊岑 and the lunar eclipses of AD 62-69

至永平五年，官曆署七月十六日月食。待詔楊岑見時月食多先曆，即縮用筭上為日，因上言「月當十五日食，官曆不中」。詔書令岑普候，與官曆課。起七月，盡十一月，弦望凡五，官曆皆失，岑皆中。庚寅，詔書令岑署弦望月食官，復令待詔張盛、景防、鮑鄴等以四分法與岑課。歲餘，盛等所中多岑六事。十二年十一月丙子，詔書令盛、防代岑署弦望月食加時。四分之術，始頗施行。是時盛、防等未能分明曆元，綜校分度，故但用其弦望而已。

When it came to the fifth year of the Yongping period [AD 62], the official system set out that the moon would be eclipsed on the sixteenth day of the seventh month [AD 62, September 8,]. [But] the Expectant Official Yang Chen saw that at that time lunar eclipses were generally in advance of the [predictions of] the system, so he [simply] counted one back to find the day, and hence sent up a memorial saying "The moon should be eclipsed on the fifteenth day; the official system is off target." An edict ordered Chen to observe carefully, and to check with the official system. Starting from the seventh month, and going up to the eleventh month, there were in all five [cycles of] crescents and full moons, all of which were missed by the official system, and all of which were hit by Chen.² On a gengyin.²⁷ day [? no month mentioned, but presumably on the first such day after the end of the eleventh month, and hence probably on the second day of the first month of the next year, AD 63 February 18] an edict ordered Chen to set out crescents, full moons and lunar eclipses [omit 官], and further ordered the Expectant Officials Zhang Cheng, Jing Fang, Bao Ye and others to check the Quarter-remainder methods with [those of] Chen. After more than a year, the instances where Cheng and the others were on target exceeded Chen's by six. In the twelfth year, the eleventh month, day bingzi.¹³ [27th day of month; AD 69 December 29] an edict ordered Cheng, Fang and the others to replace Chen in setting out the instants of occurrence of crescents, full moons and lunar eclipses. [Thus] Quarter-remainder methods first began to be used to some extent. At that time Cheng, Fang and the others were not yet able to distinguish clearly what the system origin should be, or to comprehensively compare the fractions and degrees, so only their crescent and full moon [predictions] were used.

Things to note:

The role of the "outsider" Expectant Officials *dai zhao* as critics of "official" practice by the *shi guan*..

Modalising the official software: a procedure OK in retrospect, but dangerous when it is not yet doubted. Chen succeeds in rendering the official system open to discussion, but in fact someone else walks in through the door he has opened. The commissioned observational trial: a fairly common official reaction to situations of conflict of this kind.

The preference for the systematic over the *ad hoc*.

But not all outsiders win: The contrasting case of Wang Han in AD 179. He produces an independent series of lunar eclipse records, together with an alternative prediction scheme. But despite his rank as an eight order grandee (but not an Expectant Official) he is "sent back to his village" with contumely after examination allegedly showed that his records did not match entirely with those of the officials, and in any case (it was said) his prediction method was an

obsolete scheme that had already been seen through. The original edict commanded examination into the question of whether or not he possessed a "master method" *shi fa*, that is, a piece of intellectual property validated by reputable authority. The verdict passed was 雖有師法，與無同 · "even if he had a master method, it the same as if he had none"

Case studies 2: Jia Kui 賈逵 and the ecliptic instrument AD 92-103

The long citation from Jia Kui's memorial is said specifically to be "for later citation by those who deliberate on such matters". A comprehensive attack on the conservative practice of the *shi guan* by an office holder who was formally leader of the "Expectant Officials".

His main topics: position of the winter solstice, the necessity for periodic revisions of astronomical systems, since none of them can stay permanently in step with the cosmos. NB in running this argument, he refers to checks of predictions against records of 70 solar eclipses during the Han dynasty, and 24 before that time.

Also ... the problem of lunar motion and the use of the ecliptic. Here we see him making the claim that what seemed unpredictable and hence portentous irregularities in lunar motion referred to the equator were in fact regularities when referred to the ecliptic.

逵論曰：「臣前上傳安等用黃道度日月弦望多近 · 史官一以赤道度之，不與日月同，於今曆弦望至差一日以上，輒奏以為變，至以為日XX縮退行 · 於黃道，自得行度，不為變 · 願請太史官日月宿簿及星度課，與待詔星象考校 · 奏可 ·

Your servant has previously submitted a memorial pointing out that when Fu An and his colleagues used the Yellow Road [ecliptic] to measure the [positions of] sun and moon at half and full moons, they were mostly correct. But the Clerk's officials, who only used the Red Road [equator], were not in agreement with the sun and moon. They were often more than a day wrong in comparison with the present system, so they went ahead and memorialised this as being a portent, even to the extent of making out that the sun had suffered a setback and moved retrograde! On the Yellow Road the degrees of motion turn out naturally, and no such 'portents' occur. I requested that the Grand Clerk's records of the lodges of the sun and moon, together with the stellar data should be checked, and compared with the stellar phenomena [observed by] the Expectant Officials. My memorial was approved.

Here we see Jia Kui operating a dual strategy of citing previous work, but demanding a new test, based on what he seems to assume will be the very detailed records of the Grand Clerk's office. Just how detailed these were appears later in his memorial, when he is discussing the moon's varying speed:

以今太史官候注考元和二年九月已來月行牽牛、東井四十九事，無行十一度者；行婁、角三十七事，無行十五六度者，如安言 ·

If one uses the observational records of the present Grand Clerk from the ninth month of the second year of the Yuanhe period [85 AD Oct 7 to Nov 5] onwards to examine 49 instances

in which the moon has moved through Ox and Well [49 complete lunations would take us to the end of the intercalary seventh month of Yongyuan 1, AD 89 Aug 25 to Sep 22], there is none in which [the actually observed motion along the path of the moon from day to day] has been 11 *du* [as one would have expected if it had moved 13 *du* on the Red Road]. And for 37 instances in which it has moved through Harvester and Horn, there is none in which [the actually observed motion across the heavens from day to day] has been 15 or 16 *du* [as one would have expected if it had moved 13 *du* on the Red Road].⁵ This is just as [Fu] An said.

And in his final complaint against the conservative practice of the Grand Clerk's office he cites the agreement of "the Expectant Star-Clerks Yao Chong, Jing Bi and others, twenty persons in all", all of whom point to the need to use the ecliptic as a reference, and to the inadequacy of instruments based on the equator alone.

Finally, in AD 103, Jia Kui's campaign paid off: An edict was issued commanding the construction of a new bronze armillary sphere with an ecliptic ring. This instrument thus had inscribed into its very construction the new view of celestial motions that Jia Kui wished to force on the Grand Clerk's office. It could not be used without conceding the truth of his view: what was inscribed on the instrument would inscribe itself into the clerks' daily practice. So he had won at last? No, not quite. The Clerks had a trick up their sleeves: They simply claimed that although the new instrument was (no doubt) more accurate than its predecessors, it was just too complicated to use because of the problem of adjusting the extra ring. Evidently if your opponent wants to force you to use his clever new black box, one way out is simply to claim that it is *too* clever.

Case studies 3: Cai Yong 蔡邕, the *yi* 議, and the great debate of AD 175

The apparatus of persuasion: the *yi* 議 as both report and debate; its frequent appearance as a corporate act of the officials in the Eastern Han. The *Yi* was common in the Eastern Han as an act of collective deliberation on policy matters. In its fullest form it involved the preparations of written submissions, but also included oral arguments. It did not necessarily involve the presence of the Emperor.

In the case I shall discuss, the emperor is not present. Interestingly, a scholar writing on Eastern Han institutions under the Song dynasty (Xu Tianlin 徐天麟, fl. AD 1200 in *Dong Han huiyao* 東漢會要) claimed that the *yi* to be discussed here could serve as a type-specimen for all *yi* of the period. So the events described here were nothing unusual.

The pretext of the debate was the question of the "system origin", that is the instant of time at which the astronomical system should begin to run, and from which its interlocking cycles should be counted off.

靈帝熹平四年，五官郎中馮光、沛相上計掾陳晁言：「曆元不正，故妖民叛寇益州，盜賊相續為害。曆當用甲寅為元而用庚申，圖緯無以庚申為元者。近秦所用代周之元。太史治治曆中郭香、劉固意造妄說，乞本庚申元經緯明文，受虛欺重誅。」乙卯，詔書下三府，與儒林明道者詳議，務得道真。以群臣會司徒府議。[一]

[-] 蔡邕集載：「三月九日，百官會府公殿下，東面，(校)〔太〕尉南面，侍中、郎將、大夫、千石、六百石重行北面，議郎、博士西面·戶曹令史當坐中而讀詔書，公議·蔡邕前坐侍中西北，近公卿，與光、晁相難問是非焉。」

In the fourth year of the Xiping reign period of Lingdi [AD 175-6] the Gentleman of the Interior for Miscellaneous Uses Feng Guang and the Accounting Clerk to the Chancellor of Pei, Chen Guang stated: "The system origin is incorrect, so that evil folk are rebelling and thieving in Yizhou, and robbers and bandits make endless trouble. Although the system should use a jiyain.⁵¹ origin, it uses a gengshen.⁵⁷ origin. Among the Charts and Wefts, there is none that uses a gengshen origin. It is near to the origin that Qin used in supplanting Zhou. The Gentlemen of the Interior for Regulating the Calendar Guo Xiang and Liu Gu thought up wild doctrines, and urged that one should treat the gengshen.⁵⁷ origin as basic [and that] the Warp and Wefts had clear texts [to this effect]. They should receive heavy punishment for empty deceptions." On day yimao.⁵² an edict referred the matter to the Three Offices [i.e. of the sangong], for detailed reports by the most enlightened of the literati, with the aim of getting at the truth of the Dao. They met to deliberate with the whole flock of officials in the office of the Minister of Education.

NOTE: The *Collected Works of Cai Yong* contains this: "On the third month, the ninth day, all the officials met below the hall of the fugong ?? facing east. The Commandant [Read taiwei for xiaowei?] faced south, and the Palace Attendants, Leader of the Court Gentlemen, Grand Masters, and those with emoluments of 1000 and 600 piculs faced north in serried ranks. The Court Gentlemen for Consultation and the Erudits faced west. A clerk of the Director of the Civil Affairs Section was placed in the midst of the seats and read out the edict and the formal reports. Cai Yong came forward and sat to the north-west of the Palace Attendants, near to the Ducal Ministers. Then with he joined with Guang and Huang in raising problems and questions with one another on the rights and wrongs [of the matter]."

The seriousness of the charge made by Guang and Huang: the attack on the system origin is an attack on the cosmic alignment of the state. The claim that the system is contrary to Scripture.

The mechanism of the *yi* formal written submissions, followed by oral debate. Cai Yong's rhetorical arsenal:

Systems have been changed in the past: the 104 BC reform was disputed in 78 BC, but had been vindicated after a thorough check against observation - even thought its details were *not* warranted in any scripture.

Further, the claims of Guang and Huang involve calculations that ultimately contradict the scriptures they themselves cite!

And the prediction of Guang and Huang for the conjunction of the current month is in fact wrong by two days!

Further, actual measurements contradict the source material used, and the verdict of hardware is appealed to, in the form of a challenge:

"Moreover, Guang and Huang take the *Kaolingyao* as their source, so that the numbers of degrees in the lodges and the winter solstice position of the sun have errors compared with the old texts by Gan and Shi used by the Clerks nowadays, and do not stand up to a check. Examining the celestial patterns with today's Huntian tuyi [celestial sphere plotting instrument], for its part it too is not in accord with the *Kaolingyao*. If Guang and Huang are really able to depend on their methods, [let them] go on to make an observational instrument, in order to pursue the celestial degrees, so that far off they may have verification from the writings of the tu, and near at hand they may find a check in the Three Luminaries. Then they could change and supplant Gan and Shi, and the matter having been submitted to the experts, it would really be fitting to make use of [their proposal]. [But] when I raised objections to

Guang and Huang, all they did was to quote the Charts and Apocrypha, and their answers were not satisfactory."

Further, the present system has been supported by imperial edict at the time it was promulgated, backed without copious scriptural citations. Previous attacks on it have been found baseless. "This is not something that those submitting reports to this assembly of ministers are able to change."

And there Cai Yong's presentation ends. It is unclear who else besides Guang and Huang spoke, though there is evidence elsewhere that it was considered normal for quite large numbers of officials to contribute to such a debate, whether orally or in writing. At any rate, the decision seems to have been in the hands of the Three Ducal Ministers:

太尉耽、司徒隗、司空訓以邕議劾光、晃不敬，正鬼薪法。詔書勿治罪。[一]

[一] 臣昭曰：不有君子，其能國乎？觀蔡邕之議，可以言天機矣。賢明在朝，弘益遠哉！公卿結正，足懲淺妄之徒，詔書勿治，亦深「壺各」之致。

The Commandant Chen, the Minister of Education Gui, and the Minister of Works Xun indited Guang and Huan for *lèse majesté* on account of Yong's report, and sentenced them to penal banishment. But an edict ordered that their offence should not be proceeded against.

Note: The vassal [Liu] Zhao says: Without gentlemen, how could one have a state at all? Looking at Cai Yong's report, one can say it gets to the basic workings of Heaven. If the worthy and perspicuous are at court, then their vast benefits reach afar. If the ducal ministers bind themselves to rectitude, that is enough to settle mean and irresponsible people. The edict ordering that the prosecutions [of Guang and Huang] should not proceed is surely a full expression of [the spirit of] "Why not all [speak your mind]" [as in the Analects of Confucius].

We should note with attention the claim made here that issues so complex as those on the table in AD 175 could only be settled by a "gentleman" *jun zi*. Truthful reporting of observation is not the issue here: the truth of the Grand Clerk's records is not disputed, even though they embody the results of the silent and frequently patronised *shi guan*, mere functionaries or operants. The point about the *jun zi* is not that he is reliable on one critical point or other, but that he alone can make judgements embracing the full variety of relevant factors, ranging from the scriptures on which Huang and Guang placed almost all their weight, to the need for technical change and the importance of instrumentation as a means to reliable knowledge.

Epilogue: Liu Hong's new Black Box, the *Qianxiang Li* 乾象曆

I said at the outset that my wish to understand this material had been the main reason why I embarked on a technical study of Liu Hong's system of mathematical astronomy. But now I feel that the record of

these Eastern Han debates does itself cast light on Liu Hong's work. He was almost certainly working on the construction of the software for his new would-be "black box" during the closing stages of the disputes of the Eastern Han, in which he was involved as a major player, especially in relation to the theory of eclipses. Listing the problems raised in these debates, it is hard to find one of them that is not faced and solved in his system.

Conclusions

This has been no more than a series of sample sketches of the material that is available from the Eastern Han. That material itself is only a part of what is available on related topics in the standard histories of later dynasties, when such disputes continued. But sticking to the Eastern Han, I hope I have said enough to support my main conclusions:

1. We have before us the first adequate materials for writing the history of an ancient institution concerned with predictive and quantitative knowledge of the cosmos, checked by observation using quite sophisticated instrumentation operated by teams of record-keeping professionals, whose activities were the subject of relatively open argument by people whose views mattered at the highest levels of the state.
2. This material does give scholars an opportunity to add some nuances to the view of Chinese intellectual life in the early imperial age as being averse to the openly agonistic mode.
3. Some of the tools developed by modern historians and sociologists of science do seem to be potentially useful, at least in heuristic terms, in studying this material. If in the end they turn out not to be as applicable as might appear, they may at least end up a little sharper than they were at the start of the discussion.