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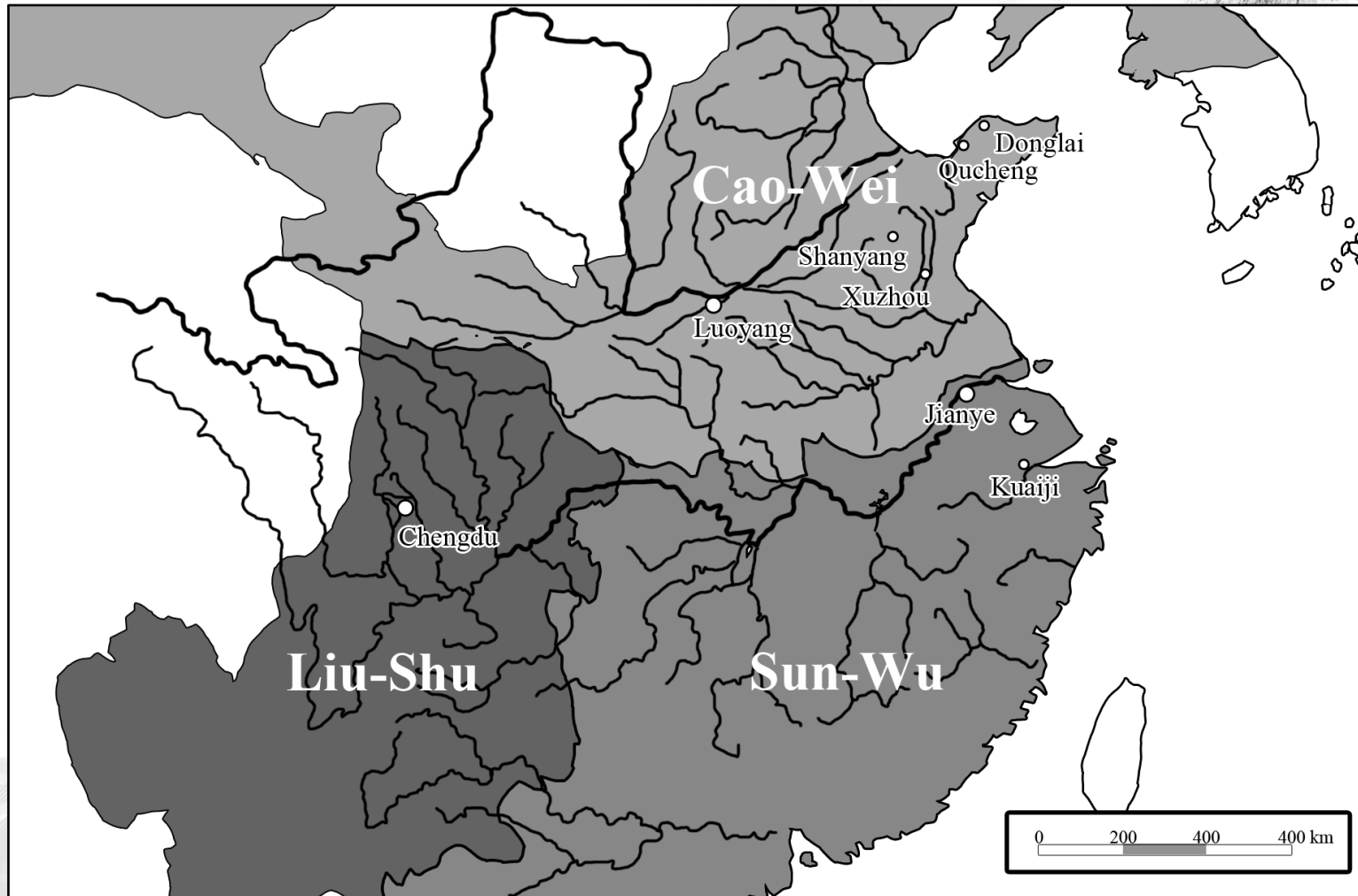
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MATHEMATICAL SCIENCES
IN THE ANCIENT WORLD

The Shaming of the Assistant Director: A Debacle in Third-century Chinese Mathematics Reconsidered in the light of Manuscript Culture, Biography, and the Historiography of Science

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The Three Kingdoms (220 – 280 CE)



Lì reform

- 85/6 Han adopts the Quarter-remainder *lì*.
- 220 Hàn abdicates to Cáo-Wèi (north)
- 222 Sūn-Wú (south) adopts Liú Hóng's Supernal Emblem *lì*
Cáo-Wèi astronomical office finds & resolves a problem in the Supernal Emblem *lì*:

太史丞韓翊以為乾象減斗分太過，後當先天，造黃初曆，以四千八百八十三為紀法，千二百五為斗分。

Assistant Grand Clerk Hán Yì thought that the Supernal Emblem system went too far in reducing the DIPPER PARTS, and that in time it would slip ahead of heaven, so he constructed the Yellow Inception system, using an ERA DIVISOR of 4883 and a DIPPER PARTS of 1205 (*Book of Jin*, 17.500).

- 223-6 Cáo-Wèi astronomical office runs 3-year test ;
hearing before the Three Excellencies ;
Emperor orders additional year of testing & final debate.

The debate of 226

Xú Yuè, Liú Hóng's student, claims that of 5 eclipses between 221 – 223, Supernal Emblem « with *xiāoxi* » is closer 4/5 times.

翊於課難徐岳：「乾象消息但可減，不可加。加之無可說，不可用。」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。」翊術自疏。

[Hán] Yì raised difficulty with Xú Yuè over the test results : « The Supernal Emblem's *xiāoxi* can only be subtracted, it cannot be added. If you add it, there is no justification ; it cannot be used ! »

[Xú] Yuè said, « The original method itself has *xiāoxi* ; I have received the master method, and it is the *xiāoxi* that makes 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 of *xiāoxi*. »

[Hán] Yì backed down (*Book of Jin*, 17.500).

Yáng Wěi (astronomer, imp. secretariat) : Hán Yì has either « intentionally forsaken his master » or « ignorantly arrived at a confused understanding. »

A debacle reconsidered

Sources : *Book of Sòng* 宋書 (488), & *Book of Jìn* 晉書 (648)

Problem :

- Hán Yì is actually right about the « DIPPER PARTS »

	Mean synodic month	error
Liú Hóng	$43026 : 1457 = 29.539542d$	-3.7s
Hán Yì	$356700 : 12079 = 29.539590d$	+0.5s
Modern val.	29.539585d	

- « *Xiāoxi* » disappears from the Supernal Emblem system, Chinese astronomy, and all other historical documents by the 8th cent. We do not know what it is.

Texts & manuscript culture :

What is a *lì*?

Supernal Emblem system 乾象曆

- A written text attributed to Liú Hóng (c. 135 – c. 210) and preserved in the *Book of Jin* (648)
 - Numbers, procedures & tables for calculating calendrical & astronomical phenomena.
- A « system » of calendro-astronomy officially promulgated in Sūn-Wú 222–280.

Example passage :

置入紀年，外所求，以餘數乘之，滿紀法為大餘，不盡為小餘。以六旬去之，命以紀，算外，天正冬至日也。

Set out the years entered into the current ERA, excluding that sought. Mount this by the REMAINDER NUMBER, and [the number of times] it fills the ERA DIVISOR makes the big remainder ; that which is not exhausted makes the small remainder. Remove [all] cycles of the six ten-day weeks from it, and name it out according to the ERA, counting exclusively. That is the date of winter solstice in astronomical month I (*Book of Jin*, 17.506).

Texts & manuscript culture :

What is a text ?

Manuscript culture

- Text is embodied, be it hand-written, memorized, spoken, or sung.
- Text is alive, be it over the lifetime of its author or its escape from him/her.

The case of the Supernal Emblem system

- Liú Hóng submits a « Supernal Emblem system » to Hàn throne in 189, but *Book of Jìn* version bears the date 206.
- Hán Yì & Xú Yuè have different versions in the 220s.
- Hán Yì's calculations match the *Book of Jìn* version.
- *Book of Jìn* version uncommented, in one *juàn* (« roll »), but medieval biblio-graphies record
 - three- & five-*juàn* versions,
 - commentaries by Zhèng Xuán (126–200) & Kàn Zé (3rd cent.).

Q : Why are we privileging the Xú Yuè version ?

Texts & manuscript culture :

Manuscript studies & history of mathematics

Wǔxīng zhān 五星占
 (silk MS, Mǎwángduī tomb 3, sealed 168 BCE)

Common numerical mistakes :



month VI VIII IX

	speed	time	distance
	0;120	100	50
	1;0	64	64
	1;187.5	64	114
Total :		224	224
	1;187.5	100	178%
	1;0	64	64
	0;120	64	32
Total :		224	274%

Un-inversion of series :

Year-tables filled out after date of authorship & copying



Texts & manuscript culture :

Manuscript studies & history of mathematics

Suànshù shū 算數書

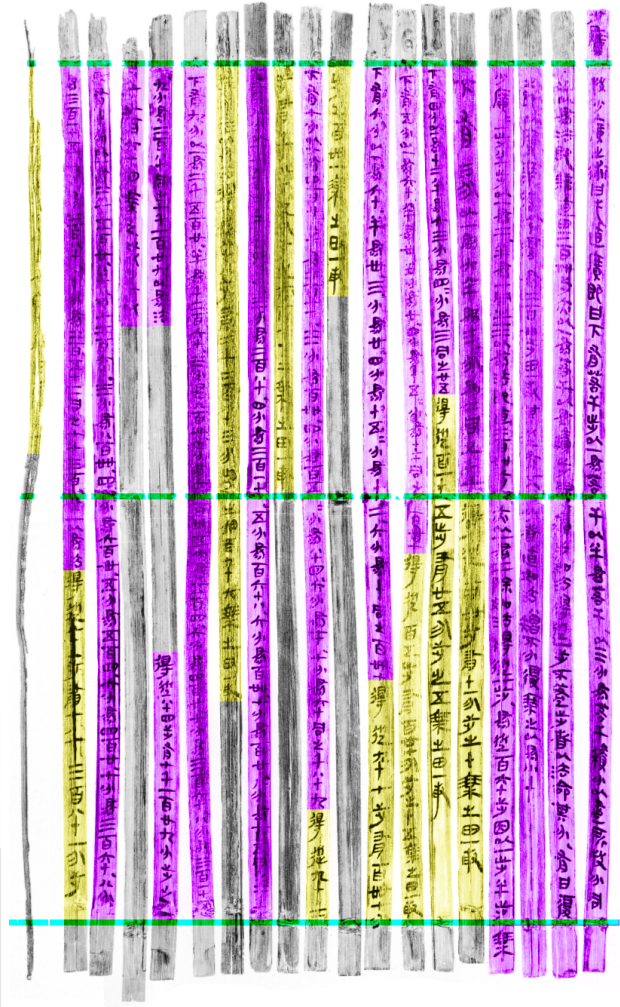
(bamboo, Zhāngjiāshān M247, sealed 186 BCE)

Two hands alternating in the body of the text :

- Hand A assigns passages & problems,
- Hand B fills them out,
- Hand A fills out Hand B's blanks

Three « checkers » in bottom margin :

- Checkers mark where copying & calculations are correct/incorrect,
- Hands A & B corrects marked passages.



Texts & manuscript culture :

Math texts as the key to Chinese manuscript studies

Math texts have more :

- Prose, verse, stories, philosophy
- Universal, abstract procedures
- Tables
- Diagrams

Math texts allow us to do more :

- We can unambiguously identify a « mistake » vs. « variant ».
- We can identify what actors considered a mistake and what they did about it.
- We can define a typology of mistakes that evidence methods of textual reproduction.
- We can separate hand writing aesthetics from literacy/numeracy/competency.
- We can disprove the « funerary objects » 明器 hypothesis for tomb MSS.
- We can speak more substantially about orality.

Texts & manuscript culture :

The written word is not enough

Tentative conclusions :

- Written numbers easily corrupted, mostly by visual inattention & misapprehension.
- Corruption is rampant,
 - e.g. « ancient lodge widths » 古度 from Fàngmǎtān M1 daybook (3rd cent. BCE), Shuāngǔdūī M1 lacquer dial (165 BCE) & Liú Xiàng's (1st cent BCE).
- Some knowledge circulated in written form, independent of reasoning & understanding.

Wáng Fān's *Húntiān xiàng shuō* (3rd cent.) on the problem of book learning :

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，猶據所見。

If we submit it (Lù Jì's theory) to testing via the sun's shadow, [we find that] it is faulty & jumbled quite a lot. Even so, it enjoys popular circulation, reproduced in all the books, and informed scholars & accomplished gentlemen never [think to] investigate & correct it. This is because they do not dare to abandon & diminish old techniques and, so, continue to diffuse what [they have read]. (*Kāiyuán zhānjīng*, 1.15a-b).

People, prosopography & oral culture :

Face-à-face

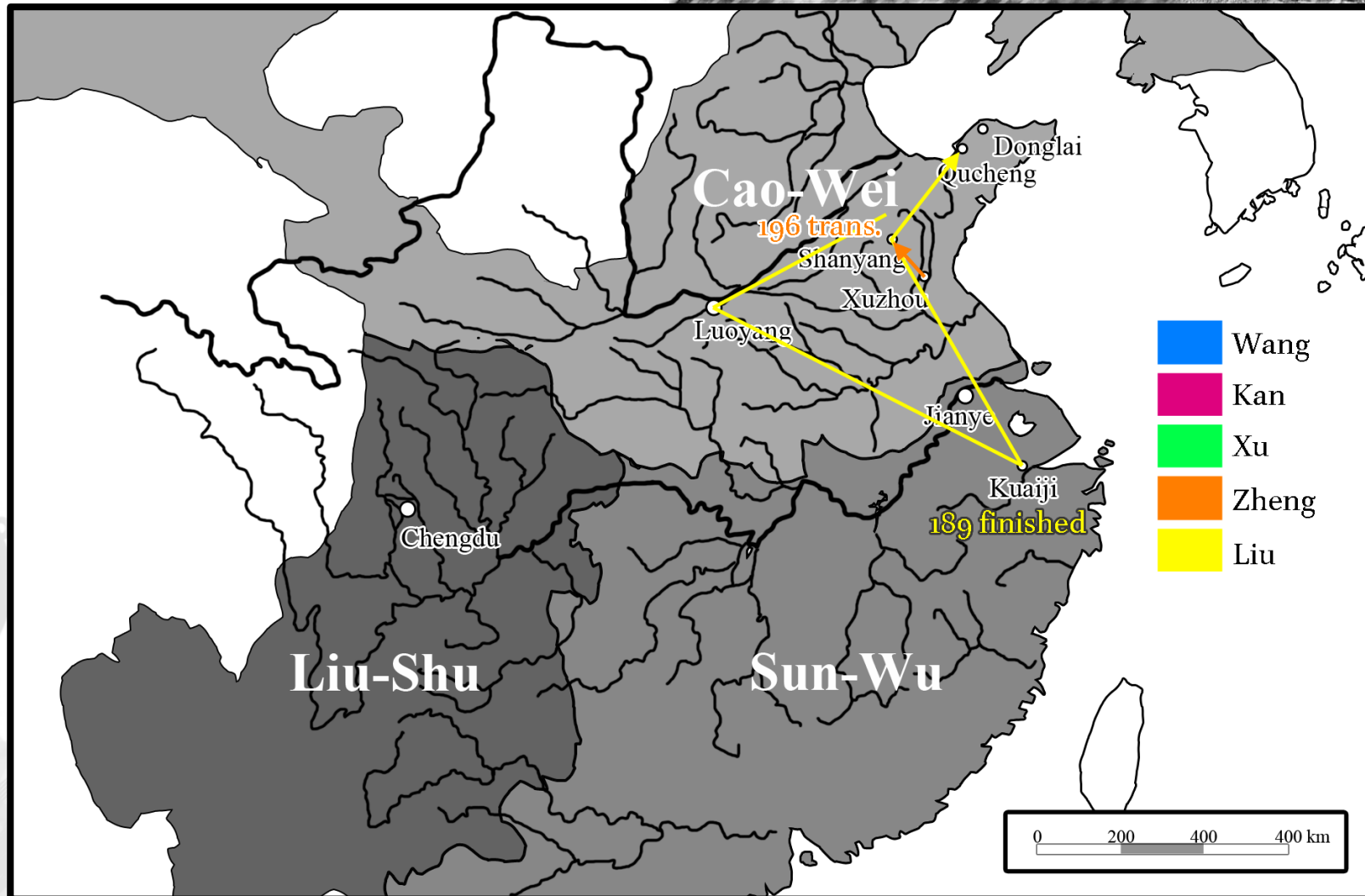
Questions :

- How do you learn *lì*, if books are unreliable ?
- Why accept Xú Yuè's version of the Supernal Emblem system over Hán Yì's ?

Lì-learning in the Hàn :

- Family inheritance (司馬遷、劉歆、鄭眾、宗誠、宗整)
- School, Imperial Academy (張衡、鄭玄) or private school (鄭興、廖扶、樊英)
- Home tutorial (班昭 → 鄧綏、唐都 → 司馬遷)
- Personal exchange (see below)
- Independent reading

People, prosopography & oral culture : The transmission of the Supernal Emblem system



People, prosopography & oral culture : The transmission of the Supernal Emblem system



People, prosopography & oral culture : The transmission of the Supernal Emblem system



People, prosopography & oral culture : The transmission of the Supernal Emblem system



Historiography of science :

Sources for the 226 debate

Book of Sòng « Monograph on Harmono-metrology & Calendro-astronomy »

- Compiled 488 by Shěn Yuē (441-513) on the basis of astronomer Hé Chéngtiān's (c. 370-447) lost history.
- Treatment : abbreviated.
 - Liú Hóng makes quantitative & theoretical advancements over Quarter-remainder system of 86.
 - Hán Yì's proposed improvement, four years of testing & review.
 - The debate and its result.
 - Yáng Wěi (imperial secretariat) gets a *lì* accepted at the Cáo-Wèi court in 237.

Book of Jìn « Monograph on Harmono-metrology & Calendro-astronomy »

- Compiled 648 by astronomer Lǐ Chúnfēng.
- Treatment : extended...

Historiography of science :

Lǐ Chúnfēng's 7th-century framing of the 226 debate

Book of Jin « Monograph on Harmono-metrology & Calendro-astronomy », *juàn 2*

- Liú Hóng makes quantitative & theoretical advancements over Quarter-remainder system of 86.
- Praise :

以術追日、月、五星之行，推而上則合於古，引而下則應於今。其為之也，依易立數，遁行相號，潛處相求， ... 又創制日行遲速，兼考月行， ... 方於前法，轉為精密矣。 ... 鄭玄受其法，以為窮幽極微，又加注釋焉。

Used to trace the sun, moon & [planets], his technique accords backwards with antiquity & forwards with the current day. What he did was set up his numbers according with the *Changes*, such that fleeting motions called out to one another & hidden places sought one another out... He instituted the acceleration & retardation of solar motion while at the same time investigating lunar motion... Only then was there a turn towards the fine & tight (accuracy) vis-à-vis previous methods. ... Zhèng Xuán received his method, proclaiming that it plumbed & lay bare all that is recondite & subtle, and, moreover, he added commentary & explanation to it (*Book of Jin*, 17.498).

- Chronicle & transcript of the debate
- Full citation of the Supernal Emblem system

Historiography of science :

Lǐ Chúnfēng's 7th-century framing of the 226 debate

Book of Jin « Monograph on Harmono-metrology & Calendro-astronomy », *juàn 2*

- Liú Hóng makes quantitative & theoretical advancements over Quarter-remainder system of 86.
- Praise :

洪術為後代推步之師表，故先列之云。

[Liú] Hóng's techniques were the exemplar of the computations of the subsequent age, thus do I first enumerate them as follows (*Book of Jin*, 17.503).

- Chronicle & transcript of the debate
- Full citation of the Supernal Emblem system

Historiography of science :

Working within the genre

Yáng Wěi, Luminous Inception system (237)

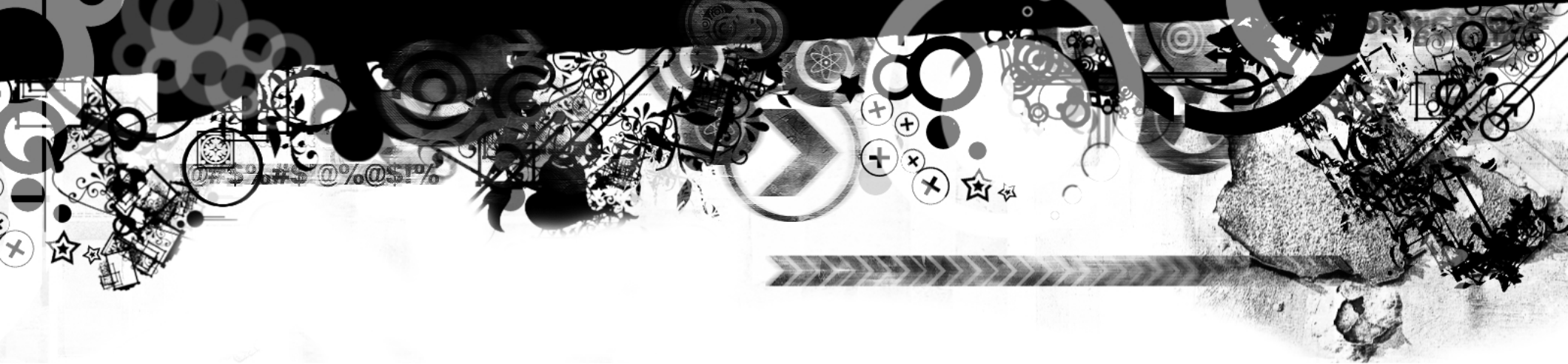
- Dynasties : Cáo-Wèi (220–265), Jìn (265–420), Liú-Sòng (420–479), N. Wèi (386–534).
- Implementation : 237 – c. 451
- Differences from the Supernal Emblem system :
 - clever eclipse model,
 - increases « Dipper parts » (mean synodic month lengthened)
 - no *xiāoxi* (?)
 - political success.

Standard history « Monograph on Harmono-metrology & Calendro-astronomy »

- To include official *lì* of the dynasty in question :
 - Jìn : Luminous Inception system ;
 - Liú-Sòng : Luminous Inception system ...

Conclusion

- **Question** : how is it that Assistant Director Hán Yì was publicly & historically shamed for working from an outdated version of Liú Hóng's Supernal Emblem system ?
- Manuscript culture :
 - « Text » liable to evolve & devolve away from its author,
 - credibility thus lies in face-to-face transmission.
- Biography/prosopography :
 - Face-to-face transmission can penetrate war-torn political boundaries more readily than social/institutional ones ;
 - textual transmission reveals non-state networks & polymathy of individuals.
- Historiography of science :
 - What ancient « facts » are available to modern scholars are the product of medieval framing.



Thanks !