



That the Sphere may Triumph: the History and Historiography of Cosmography after the Han

Daniel Morgan (ERC project SAW, CNRS – Paris 7)



Cosmography

Actors' categories :

- 天體 « the form of heaven »
- 天論 « discourses on heaven »

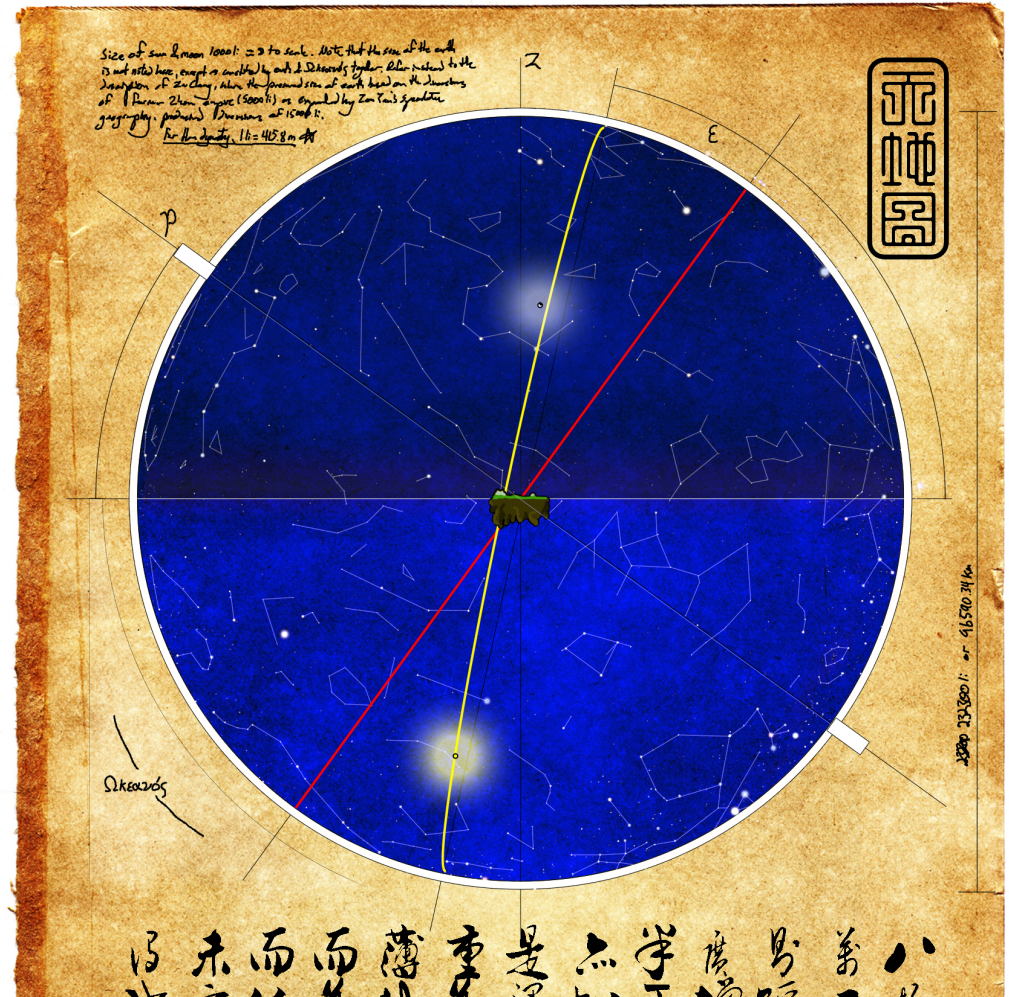
Observers' category : « cosmography »

My use of the term 'cosmography' rather than 'cosmology' is a deliberate distinction. By the first of these terms I mean a description that (at least ostensibly) is mainly concerned with the shape and size of the heavens and the earth, and with the disposition and motions of the heavenly bodies — a cosmic equivalent of geography. By the second term I mean any theory of how the universe works in a more metaphysical sense. In China I would call discussion of Yinyang and Five Phase thinking cosmology in this sense (Cullen [1993], p. xi, n. 2).

渾天 Sphere heaven

Zhang Heng 張衡 (87-140), *Lingxian* 靈憲

- Heaven is eggshell, earth is yolk.
- (Flat) earth at center, floating on the ocean.
- Heaven has N & S pole, Red & Yellow Road (equator & ecliptic).
- Heaven turns around earth, generating day & night, seasons and life, its momentum carried over from the origins of the world.
- Sun is sole source of light, illuminating moon & stars, even under water.
- Five « traveling stars », which change speed & direction as they get closer & farther from heaven (which turns the opposite way).



蓋天 Awning heaven

Anon., *Zhoubi* 周髀

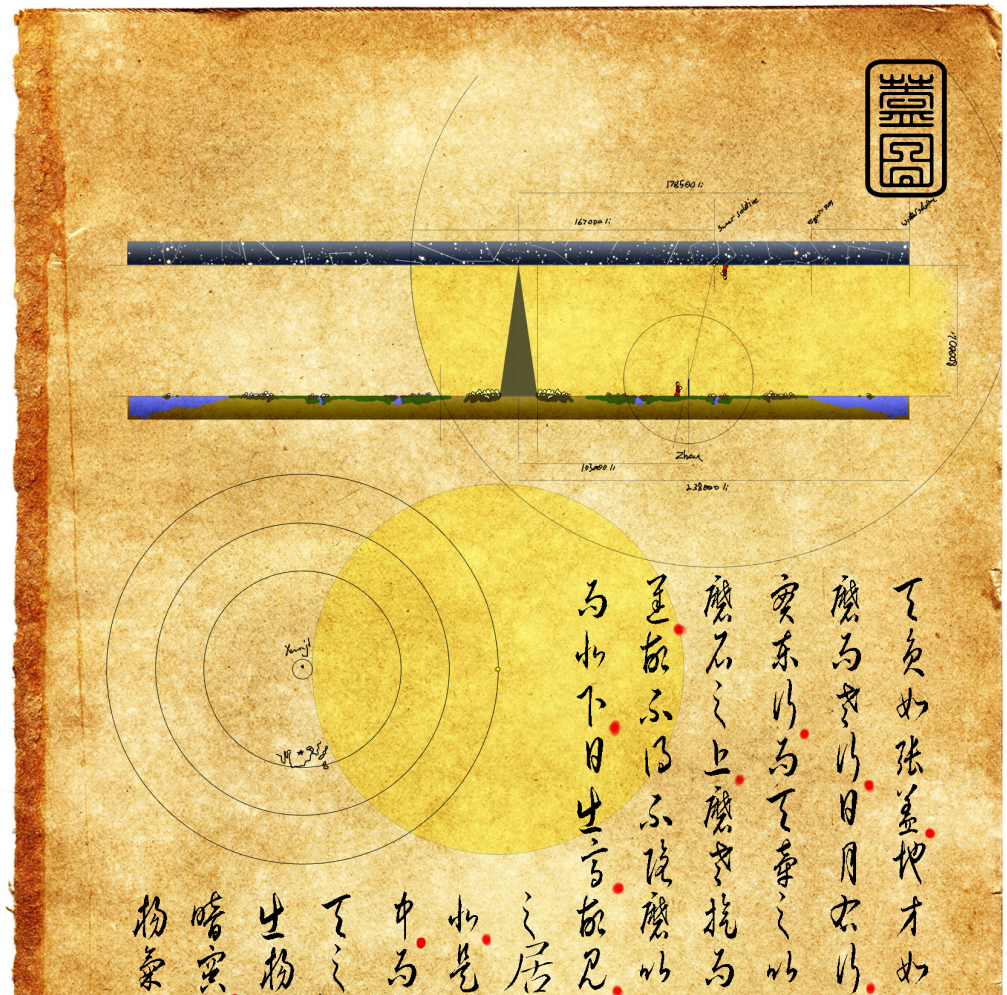
Wang Chong 王充 (27-100), *Lunheng* 論衡

Benefits :

- Heaven perfect mirror of earth
- Heaven *above* earth
- Sun doesn't go in the ocean

Costs :

- Sun & moon move up and down concentric tracks for seasonal changes in altitude & temperature.
- Optical illusion makes heaven & earth appear to converge at horizon (& sunset)
- 167,000 *li* line of sight/light.
- Eclipses: because *yin* & *yang*.



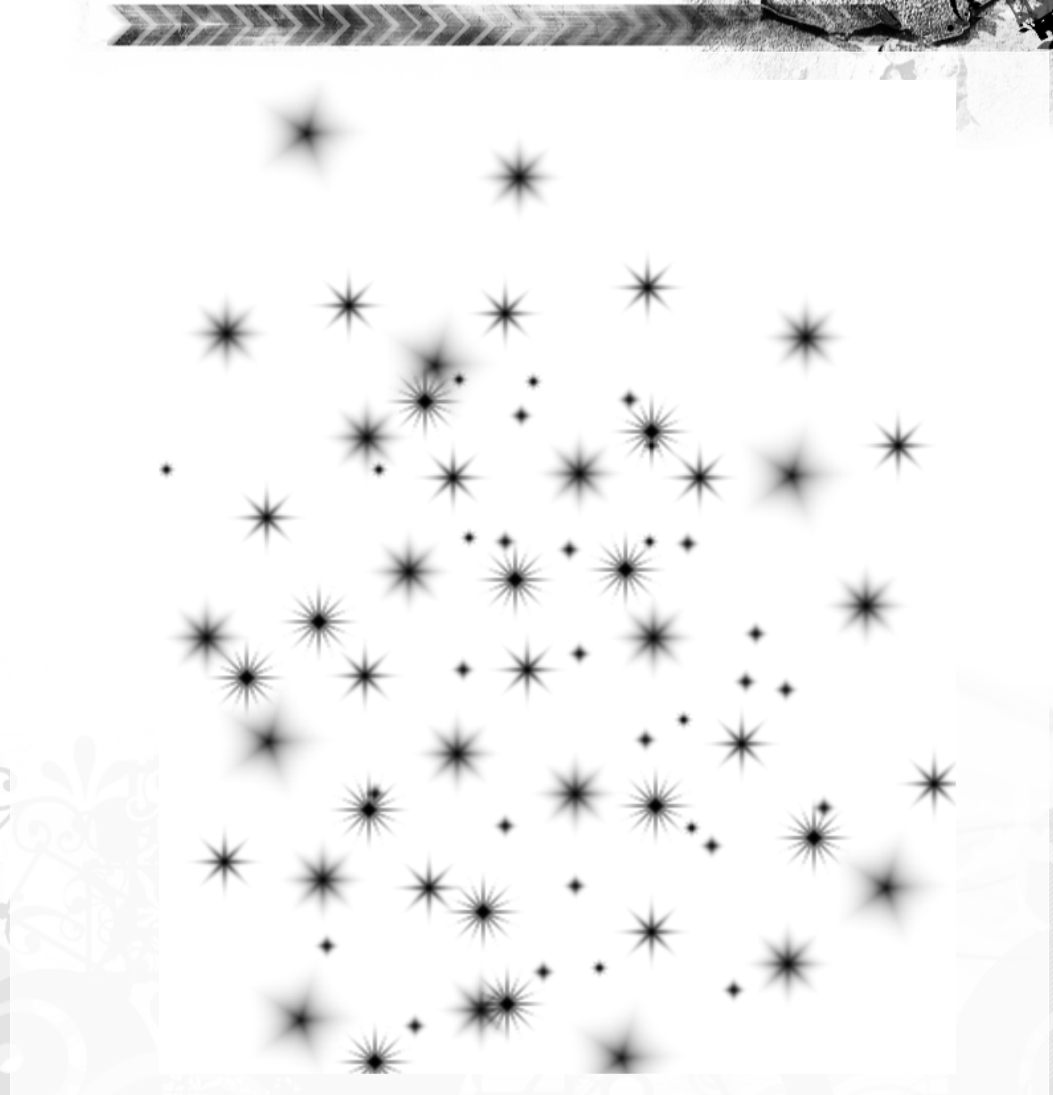


宣夜 Expansive night



Source : ???

- There is no heaven
- Everything moves around suspended by *qi*



Modern scholarship

The canonical short version :

- Originally : there were three « schools » 家 of cosmography.
- 2nd cent. : the debate is over, sphere heaven won (because it was better).
- 8th cent. : the debate is *really* over, it is silly, no one cares.
- 16th cent. : Jesuits introduce the *spherical Earth*, get people thinking again.

(Forke [1925], Maspero [1929], Eberhard [1936], Needham [1959], Kalinowski [1990]..)

Longer versions :

- C. Cullen, « Cosmographical discussions in China from early times up the T'ang Dynasty » (Ph.D. diss., U London, 1977)
- 陳美東：『中國古代天文學思想』（中國科學技術出版社，2007年）

The narrative seed

Cai Yong 蔡邕 (133-192), *Memorial from Shuofang* 朔方上書：

論天體者三家，宣夜之學，絕無師法。『周髀』術數具存，考驗天狀，多所違失。惟渾天僅得其情，今史官所用候臺銅儀，則其法也。

The discourse on heaven's form is comprised of three expert-lineages (*jia*), but the study of Expansive Night has died out and has no master method. Both the techniques & numbers (*shu shu*) of the *Gnomon of Zhou* survive, but when examined (*kao*) & verified (*yan*) against the case of heaven, there is much that misses the mark. It is only Sphere Heaven that completely grasps the true circumstances. The observatory bronze instrument employed by the Clerk's Office of our day is patterned upon this model (*fa*).

The narrative seed continued

... 惟渾天僅得其情，今史官所用候臺銅儀，則其法也。立八尺圓體，而具天地之形，以正黃道，占察發斂，以行日月，以步五緯，精微深妙，百世不易之道也。官有其器而無本書，前志亦闕而不論，本欲寢伏儀下，思惟微意，按度成數，以著篇章。罪惡無狀，投畀有北，灰滅雨絕，勢路無由。宜問羣臣，下及巖穴，知渾天之意者，使述其義。

... It is only Sphere Heaven which completely grasps the true circumstances. The observatory bronze instrument employed by the Clerk's Office of our day is patterned upon this model: a sphere erected eight-*chi* (1.95 m) [in diameter] and possessed of the forms of heaven & earth by which one aligns the Yellow Road (ecliptic) to observe the release & restrain (of luminary motion), by which one moves the sun & moon, and by which one paces the five woofs (planets) — fine and subtle, profound and mysterious, it is a *dao* that shall remain unchanged for a hundred generations. The officials have the apparatus but not the original book(s), and the previous monographs are, for their part, faulty and do not discuss it. I had desired originally to lie beneath the instrument and contemplate its subtleties and master its numbers according to *du* ($365\frac{1}{4} du = 360^\circ$) so as to write it up into a piece; for my inexcusable crime, [however], I have been banished to the north to be annihilated by dust and broken by rain and denied access to any route to influence. It would be appropriate [then] to inquire among [Your] ministers, and down all the way to [hermit] grottoes, about someone knowledgeable about the idea of Sphere Heaven and order him to recount its substance.

The narrative seed in context

- ?? : *Zhou bi* 周髀 presents the case for « awning heaven »
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- 178 : Cai memorializes throne that the « sphere » is victorious and endangered, must study the Grand Clerk's bronze instrument.
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- 179 : Zheng (Zheng Gong) writes about the sphere heaven
- 192 : Cai dies

The narrative seed in context

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- 103 : commission of 太史黃道銅儀 « Grand Clerk's Yellow-Road bronze instrument »
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 - *Ling xian* 靈憲 (most important treatise on « sphere heaven »)
 - *Huntianyi* 渾天儀 (treatise describing the construction of the armillary sphere)
 - 164 (?) : « miraculous » water-driven demonstrational armillary.
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- ?? : *Zhou bi* 周髀 presents the case for « awning heaven »
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- 179 : Cai released from banishment, sent to Wu 吳 , finds a copy of *Lunheng*.
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Conclusion :

- Cai Yong's prognosis of second-century cosmography ignorant ? Rhetorical ? Both ?
 - Either way, not the best spokesman.
- 125 : Zhang Heng 張衡 (78-139) named Prefect Grand Clerk 太史令, creates – *Ling xian* 靈憲 (most important treatise on « sphere heaven »)
 - 132 : *Houhanshu* 後漢書 (treatise describing the construction of the armillary sphere)
 - 132 : Cai Yong 蔡邕 « water-driven demonstrational armillary »
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Sources for the history of cosmography

Compilations

宋書 *Song shu* 天文志 « *Tianwen zhi* » (493)

- Compiler, **Shen Yue** 沈約 (441-513), relies on He Chengtian 何承天 (c. 370-447) & Xu Yuan 徐爰 (394-475) monographs.

晉書 *Jin shu* 天文志 « *Tianwen zhi* » (648)

隋書 *Sui shu* 天文志 « *Tianwen zhi* » (656)

- Monographs solicited from **Li Chunfeng** 李淳風 (602-670), expert.

開元占經 *Kaiyuan zhanjing* (729)

- Compiled by Gautama Siddhārtha 瞿曇悉達, expert.
- Lost Tang – Qing, negligible historical impact.

...Assorted citations...

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- *Song shu* « Tianwen zhi »

Li Chunfeng 李淳風 (602-670), expert

- *Jin shu* « Tianwen zhi »
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~~Gautama Siddhārtha 瞿曇悉達 (fl. 729)~~

- *Kaiyuan-zhanjing*

Shen Yue's version (493)

- Cai Yong memorial on « three schools », anxiety about loss of the sphere (citation)
- (The sphere)
 - Lu Ji 陸績 (188-219) « first extrapolates the sphere heaven idea » 始推渾天意 .
 - Wang Fan 王蕃 (3rd cent.), *Huntianxiang shuo* 渾天象說 (citation)
 - He Chengtian 何承天 (c. 370-447): Wang Fan is right ; also, the sun's entry into ocean causes evaporation that replenishes the rivers (citation)
 - History of « sphere instruments » from Sage Kings to 436 : Yao's « rotating mechanism jade traverse » 璇璣玉衡 was a prehistoric jade armillary sphere ; mention of « sphere heaven » in Western Han proves instrumentation.
- (The losers)
 - « Awning heaven » : against attribution to the Western Zhou ; description ; criticism
 - Summary of « Curious chatter » post-178 :
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蓋天之術，云出周公旦訪之殷商，蓋假託之說也。其書號曰周髀。髀者表也。周天之數也

The technique of Awning Heaven is said to have emerged from Duke Dan of Zhou's (11th cent. BC) visit to the Yin-Shang, but this due to false attribution. The book is called *Zhoubi*: *bi* meaning « gnomon », and *zhou* « the number of the circumference of heaven » (*Song shu*, 23.679).

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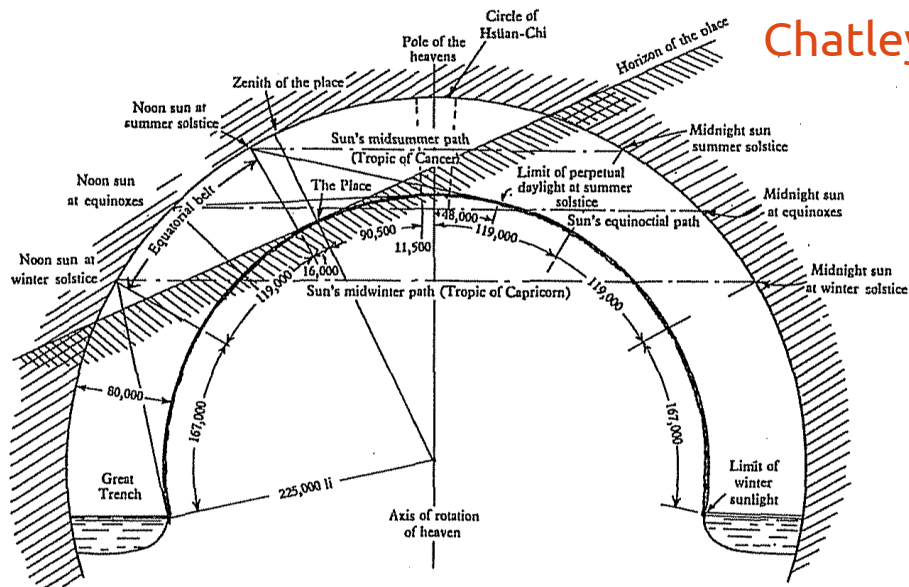
Shen Yue's version (493)

天如覆蓋，地如覆盆，地中高而四隕，日月隨天轉運，隱地之高，以為晝夜也。天地相去凡八萬里，天地之中，高於外衡六萬里，地上之高，高於天之外衡二萬里也。

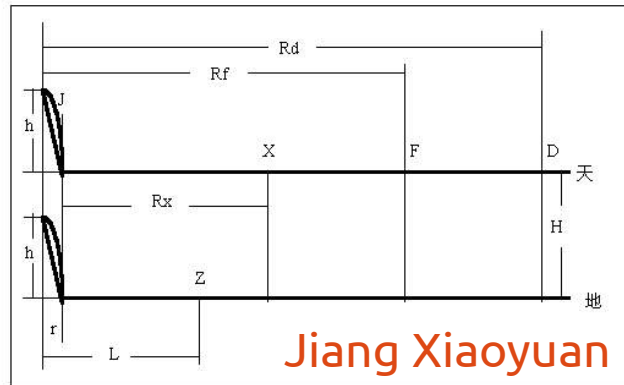
Heaven is like a covering (chariot) awning, and earth is like an overturned basin. The earth is tall in the center and tapers at the four [edges]; the sun and moon revolve with the rotation of heaven, and this makes day and night as they are hidden by the height of the earth. Heaven and earth are at a total of 80,000 *li* apart, and the center of heaven and earth is taller than the outer *heng* (the path of the sun at winter solstice) by 60,000 *li*. The height of the top of earth is taller than heaven's outer *heng* by 20,000 *li* (*Song shu*, 23.679).

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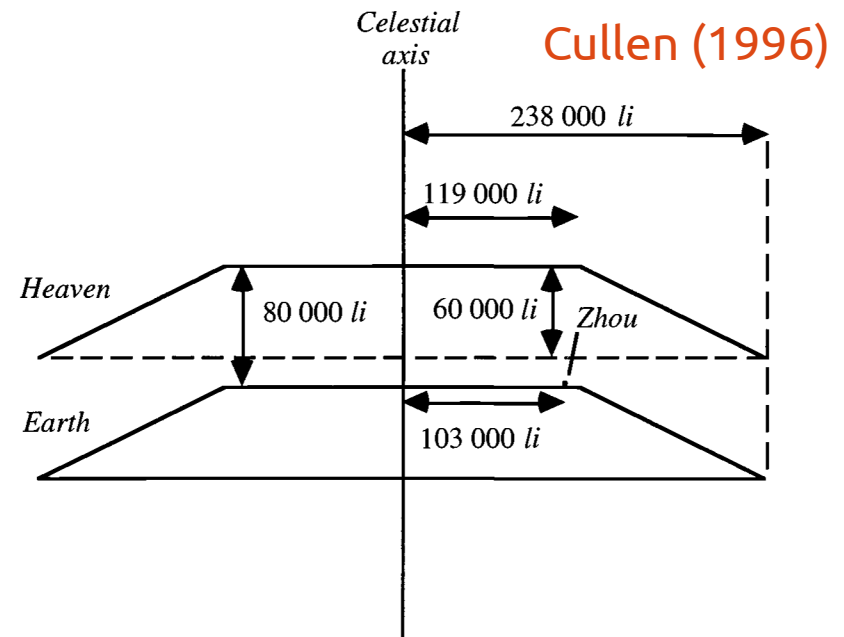
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Chatley (1938)



Jiang Xiaoyuan (1996)



Cullen (1996)

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These three opinions are all [nothing but] curious chatter and miss the mark by a great distance (*Song shu*, 23.680).

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Li Chunfeng's *Jin shu* version (648)

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- « **Expansive night** » : description from Xi Meng 郗萌 (1st cent.)
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儀象 Instruments

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周人志之，故曰『周髀』。

The men of Zhou recorded it, thus is it called *Zhoubi* (*Jin shu*, 11.278).

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- These three opinions are all [nothing but] curious chatter and miss the mark by a great distance (***Song shu*, 23.680**).

- Wang Fan 王蕃 (3rd cent.), *Huntianxiang shuo* 渾天象說 (citation)

自虞喜、虞聳、姚信皆好奇徇異之說，非極數談天者也。

From Yu Xi, Yu Song, and Yao Xin [on], everything is whimsical and fantastical opinions, these are not people who discussed heaven by plumbing numbers (***Jin shu*, 11.280**).

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- He Chengtian 何承天 (c. 370-447): Wang Fan is right ; also, the sun's entry into ocean causes evaporation that replenishes the rivers (citation)
- Wang Fan 王蕃 (3rd cent.): see *Jin shu* « Tianwen zhi »
- On the problem of the apparent size of objects at meridian and horizon within « sphere heaven »

儀象 Instruments

...

Li Chunfeng's *Sui shu* version (656)

天體 Cosmography

- Cai Yong memorial on « three schools », anxiety (short citation)
- « Awning heaven » : description ; for attribution to Western Zhou, even Fuxi ; Liang Wudi 梁武帝 (r. 502-549) did the same thing.
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自外與王蕃大同。王蕃渾天說，具於『晉史』。

From the outside, this is largely the same as Wang Fan. Wang Fan's *Huntian* [xiang] shuo is contained in the *History of Jin* (*Sui shu*, 19.512).

Li Chunfeng's *Sui shu* version (656)

天體 Cosmography

- (*Jin shu* contents)
- On the problem of the apparent size of objects at meridian and horizon within « sphere heaven »
 - **5th cent. BC*, *Liezi* 列子** : Confucius can't solve argument between children about *when* the sun is closest to us in the day (at horizon, it's bigger ; at meridian, it's hottest).
 - **1st cent. BC, Huan Tan 桓譚 – Yang Xiong 揚雄 conversation** : (1) stars more dispersed at the horizon ; (2) noonday heat result of accumulation, not proximity.
 - **2nd cent. AD, Zhang Heng, *Lingxian*** : setting/rising sun *appears* larger because of dark background, like fire appears larger at night.
 - **3rd cent. AD, Shu Xi 束皙** : juxtaposition of objects — big cauldron, small room — changes their apparent size.
 - **4th cent. AD, Jiang Ji 姜岌** : « the mess of explanations is due to the human eye » 紛然之說, 由人目也 ; « sphere instrument » measurements *disprove* dispersion of stars at horizon ; luminosity and color of sun at horizon due to layer of « wandering *qi* » 遊氣 on earth's surface.
 - **6th cent. AD, Zu Geng 祖暅** : observation & measurement are only credible evidence, and they confirm « sphere heaven » ; arguments based on books, « reason » 理 and pure mathematical extrapolation are « exaggerated nonsense » 夸誕之辭 .

Li Chunfeng's *Sui shu* version (656)

天體 Cosmography

Zu Geng 祖暅：

自古論天者多矣，而羣氏糾紛，至相非毀。竊覽同異，稽之典經，仰觀辰極，傍矚四維，覩日月之升降，察五星之見伏，校之以儀象，覆之以晷漏，則渾天之理，信而有徵。輒遺眾說，附渾儀云。

Since antiquity, there have been many who have discoursed upon heaven, but the big names all disagree to the point of mutual destruction. I have humbly reviewed their differences, I have investigated the matter in the classics, I have looked up to observe the stars & pole, I have gazed out at the four corners (of the earth), I have perceived the rise & fall of the sun & moon, I have inspected the appearance & disappearance of the five stars (planets), I have checked it by means of instruments & models, I have reexamined it by means of clepsydra, and [I can tell you that] the principals of sphere heaven are credible & evidenced. I have thus decided to toss out the diverse opinions (*shuo*) [of my predecessors] and just stick to my [armillary] sphere instrument... (*Sui shu*, 19.514).

- **6th cent. AD, Zu Geng 祖暅** : observation & measurement are only credible evidence, and they confirm « sphere heaven » ; arguments based on books, « reason » 理 and pure mathematical extrapolation are « exaggerated nonsense » 夸誕之辭 .

Li Chunfeng's *Sui shu* version (656)

考靈曜先儒求得天地相去十七萬八千五百里，以晷影驗之，失於過多。既不顯求之術，而虛設其數，蓋夸誕之辭，宜非聖人之旨也。學者多固其說而未之革，豈不知尋其理歟，抑未能求其數故也？王蕃所考，校之前說，不啻減半。雖非揆格所知，而求之以理，誠未能遙趣其實，蓋近密乎？

... From the [weft text] *Kaolingyao*, former scholars got the figure 178,500 *li* for the distance between heaven & earth, [but] when examined by means of gnomon shadows it misses the mark in excess. Furthermore, rather than reveal its procedure for attaining [this figure], [the text] just emptily posits the number — **probably just an expression of exaggerated nonsense** — which is certainly not the directive of the Sages. Most scholars hold stubbornly to this opinion (*shuo*) without changing it — do they not know to seek out its principles, or the reason for this number cannot be sought? Wang Fan's investigation, compared to previous opinions, reduced [this figure] by no less than one half. It was not something he knew from observation but [only] through reasoning (*li*), so he was truly unable to get at the substance of the matter from afar — how could this be close & tight? (*Sui shu*, 19.514).

- **6th cent. AD, Zu Geng 祖暅** : observation & measurement are only credible evidence, and they confirm « sphere heaven » ; arguments based on books, « reason » 理 and pure mathematical extrapolation are « exaggerated nonsense » 夸誕之辭 .

Li Chunfeng on instrumentation

Sui shu « Tianwen zhi » headings

(1) Introduction

(2) Cosmography & Instrumentation

- 天體 Cosmography
- 儀象 Instrumentation
 - ◊ 渾天儀 « Sphere heaven instrument » (observational armillary sphere)
 - ◊ 渾天象 « Sphere heaven effigy » (demonstrational armillary sphere)
 - ◊ 蓋圖 « Awning diagram » (star chart / dial instrument ?)
 - ◊ 晷影 « Gnomonics »
 - ◊ 漏刻 « Clepsydra »

(3) Catalog of astral lore

(4) 五代災變應 Five Dynasties Disasters, Incidents, and Responses

Li Chunfeng on instrumentation

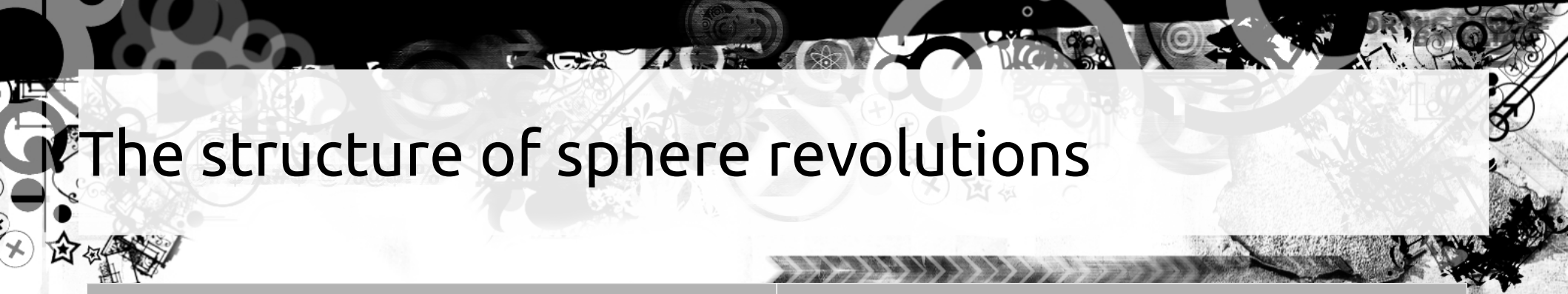
Sui shu « Tianwen zhi » instrument catalog

Point 1 : the catalog focuses on the use of instruments to disprove *Zhōu-bì* « shadow rule », i.e. 1000 *li* in the macrocosm equals 1 *cun* at the observer.

Point 2 : the « sphere heaven instrument » heading devotes one paragraph to refuting the antiquity of sphere heaven : the *Book of Document's* 璇璣玉衡 « rotating mechanism jade traverse » is *not* an armillary sphere, but the Northern Dipper (UMa).

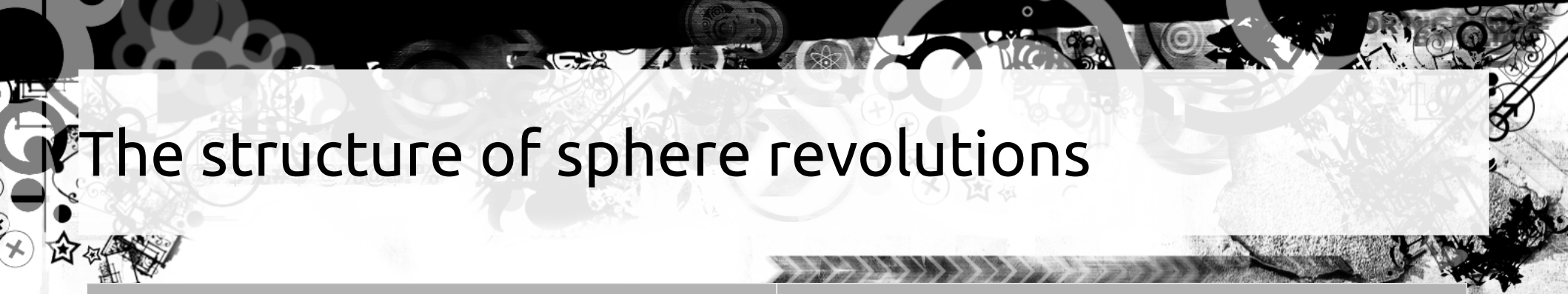
載筆之官，莫之或辨，史遷、班固猶且致疑，馬季長創謂璣衡為渾天儀。

No brush-toting official (historian) ever makes the distinction, even [Grand] Clerk [Sima] Qian (c. 145 – c. 86 BC) and Ban Gu (32-92) cast the matter into doubt (by explicitly identifying it with Northern Dipper), [but] it was Ma [Rong] (79-166) who first conceived of saying that [*xuanji*] *yuheng* was the sphere heaven instrument (*Sui shu*, 19.516).



The structure of sphere revolutions

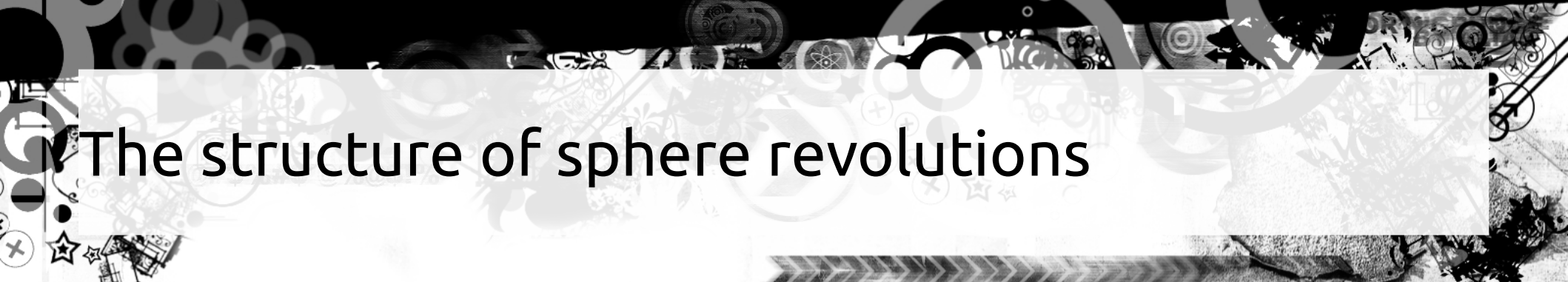
Shen Yue	Li Chunfeng
Cai Yong : 3 schools, sphere wins, anxiety	Cai Yong : 3 schools, sphere wins, anxiety
Sphere heaven : ancient :^)	Awning heaven : ancient :^(\
Awning heaven : not ancient :^	Expansive night : ancient ? :^?
Expansive night : not ancient :^	3rd - 4th cent. models : new :^(\
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	Sphere heaven refinement (5 th c. BC – 5 th c. AD)
	Instruments : for proving the sphere



The structure of sphere revolutions

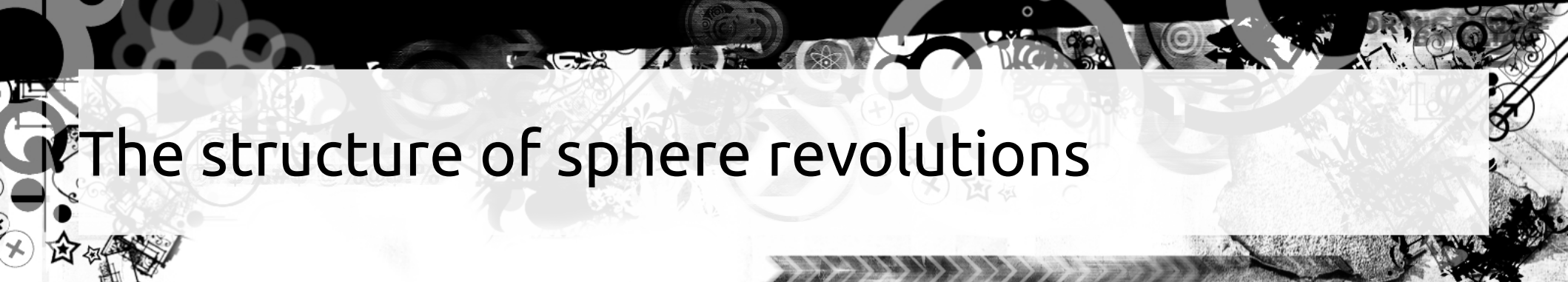
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Li Chunfeng on Shen Yue

- Li borrows *heavily* from Shen's monograph.
- Li does not mention Shen or his *Song shu*
- Li argues against Shen's position
- Li indirectly criticizes Shen :

載筆之官，莫之或辨，史遷、班固猶且致疑 ...

No **brush-toting official (historian)** ever makes the distinction, even [Grand] Clerk [Sima] Qian and Ban Gu cast the matter into doubt ... (*Sui shu*, 19.516).

天文志

History	Date	TWZ auth.
<i>Shiji</i>	91 BC	Sima Qian
<i>Han shu</i>	111	Ban Zhao/Ma Xu ? → Ban Gu
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<i>Song shu</i>	493	He Chengtian, Xu Yuan → Shen Yue
<i>Wei shu</i>	554	Wei Shou
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The sphere in the 7th-century north

Northern observational astronomy :

- c. 390 : Jiang Ji (Later Qin Chang'an) launches the empirical approach to cosmography.
- 5th – 6th c. : Northern Wei, Northern Zhou, and Sui experts significantly develop observational astronomy and cosmography

Li Chunfeng :

- 627-634 : construction of state-of-the-art bronze observational armillary sphere
- 641 : appointed Assistant Grand Clerk
- 641 : authors *Faxiang zhi* 法象志 in 7 *juan* on « the sphere »
- 646 : finishes *Jin shu* « Tianwen zhi » history of « the sphere »
- 648 : appointed Prefect Grand Clerk
- 656 : finishes *Sui shu* « Tianwen zhi » history of « the sphere »

Conclusion : the sphere is flourishing.

The sphere in the 5th-century south

- 220 : Han falls, all « sphere instruments » disappear.
- 3rd – 4th c. : Wang Fan, Ge Hong construct *demonstrational* spheres
- 323 : Han-Zhao 漢趙 (304-329) construct observational « sphere instrument » in Chang'an.
- The Xiongnu « sphere instrument » changes hands to the Later Zhao (319-351), Former Qin (350-394), and Later Qin (384-417)
- 412 : Tuoba Northern Wei construct giant iron observational sphere.
- 417 : Jin General Liu Yu 劉裕 (363-422) sacks Chang'an, transports the Xiongnu « sphere instrument » to Jiankang.
 - The difference in latitudes ($34^{\circ}21'$ vs. $32^{\circ}02' N$) is a problem.
- 420 : Liu Yu overthrows the Jin, establishes the Liu-Song dynasty (420-479).

Conclusion : sphere tragedy.

Two historians, two histories

Differences

- Context : 5th century south vs. 7th century north.
- Expertise : one is an astronomer, the other works from astronomers' writings.
- Vision of history : one is an optimist, the other is a pessimist.
- Vision of future : we are losing the sphere vs. we are improving the sphere.
- Personal tensions : Li Chunfeng hates Shen Yue ???

Question : « What about when they agree on something ? »

- There are three « schools ».
- Sphere heaven is true.

Point of agreement : « three schools » ?

School count

- **178, Cai Yong :** 三家 « three schools »
- **493, Shen Yue :** 三家 « three schools »
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- **656, Li Chunfeng :** 三家 « three schools »

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Liu Zhuo 劉焯, 604 memorial : « three schools »

亦既由理不明，致使異家間出。蓋及宣夜，三說並驅，平、昕（軒）、安、穹，四天騰沸。至當不二，理唯一揆，豈容天體，七種殊說？

For its part, [the fact that] the natural order/rationale (*li*) is unclear has brought about the emergence of different *jia*: the three theories (*shuo*) [**sphere,** **awning,** and **expansive night** race neck-in-neck; the four heavens **level,** **baseboard,** **secure,** and **vault** roil (in competition). The apogee (of truth) ought not to be plural when the natural order (*li*) is singular to observe/measure, so how could it permit **seven different theories** about the form of heaven? ... (*Sui shu*, 19.521).

Point of agreement : « three schools » ?

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- 178, Cai Yong : 三家 « three schools »
- 493, Shen Yue : 三家 « three schools »
- c. 510, Zu Geng : 衆說 « diverse theories »
- 604, Liu Zhuo : 七種殊說 « seven different theories »
- 648, Li Chunfeng : 三家 « three schools »
- 656, Li Chunfeng : 三家 « three schools »
- 8th cent., Yixing : 六家之說 « six schools of theories »

Point of agreement : « three schools » ?

Li Chunfeng, *Yisi zhan* 乙巳占 (656) :

- 論天體象者，凡有八家：一曰渾天，即今所載張衡『靈憲』是也；二曰宣夜，絕無師學；三曰蓋天，『周髀』所載；四曰軒天，姚信所說；五曰穹天，虞聳所擬；六曰安天，虞喜所述；七曰方天，王充所論；八曰四天，祆胡寓言。凡此八家，渾天最親，今獨取之，以載于此。

As to discourses on the bodies and forms of heaven, **there are a total of eight *jia***: **one**, sphere heaven, i.e. that which I record here from Zhang Heng's *Lingxian*; **two**, expansive night, which has died out and has no master method; **three**, awning heaven, recorded in the *Zhoubi*; **four**, baseboard heaven, explained by Yao Xin; **five**, vault heaven, drafted up by Yu Song; **six**, secure heaven, described by Yu Xi; **seven**, square heaven, discoursed by Wang Chong; and **eight**, quadruple heaven, sayings attributed to Yao-Hu. Oh these eight *jia*, sphere heaven is the dearest (to the truth), which is why I have selected it alone to document here (*Yisi zhan*, 1.1a-b).

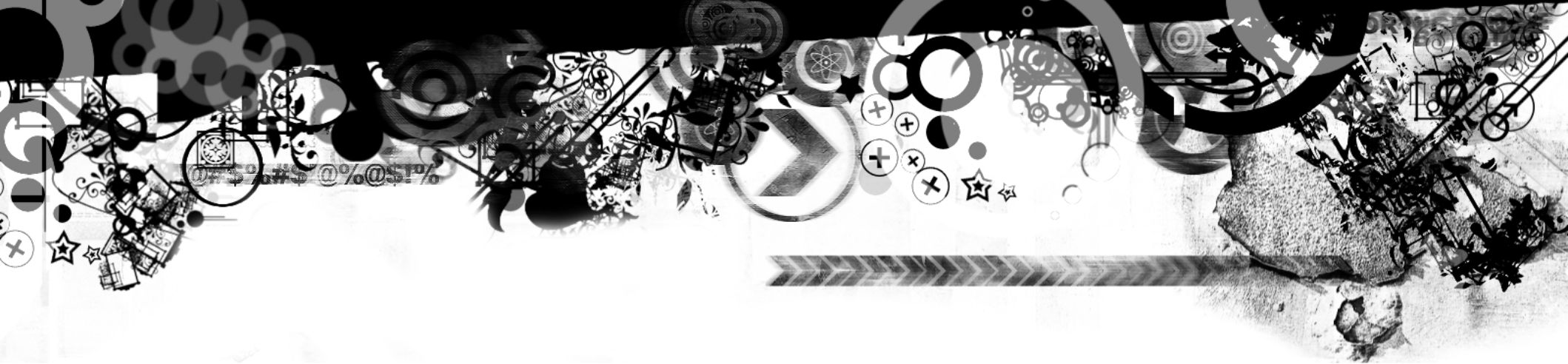
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- 648, Li Chunfeng : 三家 « three schools »
- 656, Li Chunfeng : 三家 « three schools »
- 656, Li Chunfeng : 八家 « eight schools »
- 8th cent., Yixing : 六家之說 « six schools of theories »

Conclusion

- The history of cosmography in China is the product of two men :
 - Shen Yue 沈約 (441-513)
 - Li Chunfeng 李淳風 (602-670)
- « Tianwen zhi » structure :
 - Li Chunfeng appropriates and reorganizes Shen Yue's work
 - Li shapes this history to match a vision of *progress*.
- What about Cai Yong and the « three schools » ?
 - Contextualized, the Cai Yong memorial is problematic.
 - No one can agree on how many schools there are.
 - *Maybe*, the « three schools → sphere » model of history is part of a 5th, 6th & 7th century debate.



Merci