Shih Shên's Catalogue of Stars, the Oldest Star Catalogue in the Orient

By

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It has been generally conceived that the star catalogue in Ptolemy's *Almagest* is the most ancient document now preserved which gives a description of stars with sufficient exactness to admit of comparison with modern observations.

But by the investigation of the description of stars contained in 開元占經 "K'ai Yüan Chan Ching", it reveals that the epoch of the observations of K'ai Yüan stars by far anticipates that of the Almagest, and even that of Hipparchus' observations.

開元占經 "K'ai Yüan Chan Ching" is said to have been published by 瞿曇悉達 "Ch'ü T'an Si Ta", early in the K'ai Yüan years (713 741 A.D.) of the 唐 T'ang dynasty.

It is composed of 120 volumes, and nearly all the paragraphs contain astrological prophecies, among which there are inserted pure astronomical observations, under the headings of "Shih Shên says" 石申曰, but the original work, from which the author of "K'ai Yüan Chan Ching" quoted these observations, is entirely unknown.

Using these astronomical observations, the author tried to determine the epoch of the observations.

The difficulty of the problem mainly lies in the following two facts:—

a) The observed values are very liable to have been affected by mistakes in copying.

b) The positions of the stars are given with extremely brief descriptions, so that the identification of the stars is very laborious, or even impossible in some cases.

It will be convenient, in treating the problem, to divide the stars into three groups. The three groups are:

(i) The twenty-eight Sius 二十八宿 or twenty-eight zodiacs,

(ii) Shih's Chung Kuan 石氏中官 or Shih's northern asterisms,

(iii) Shih's Wai Kuan 石氏外官 or Shih's southern asterisms.

The twenty-eight zodiacs are as follows:

The eastern group:—角 Chio, 亢 K'ang, 氐 Ti, 房 Fang, 心 Sin, 尾 Vei, 箕 Chi.

The northern group:— 斗 Tou, 牛 Niu, 女 Nü, 虛 Hsü, 危 Wei, 室 Shih, 壁 Pi.

The western group:— 奎 K'uei, 婁 Lou, 胃 Wei, 昴 Mao, 畢 Pi, 觜 Tsui, 參 Shên.

The southern group:—井 Tsing, 鬼 Kuei, 柳 Liu, 星 Sing, 張 Chang, 翼 I, 軫 Chen.

Shih's asterisms are the groups of stars of constellations authorized by Shih Shên, 石申, and the northern asterisms are 62 in number, beginning from 攝提 Sheh T'i to 太一 T'ai I, and the southern asterisms are 30 from 庫樓 K'u Lou to 稷 Tsi.

But of these 62 northern asterisms the observations of 6 asterisms —from the forty-seventh to the fifty-second—are missing.

The general description of each asterism runs as follows.

1. Name of the asterism.

2. Number of stars contained in the asterism.

3. Position of the asterism with reference to the neighbouring asterisms.

4. A principal star is specially mentioned, for which the following observations are given:—

5. Hour Angle of the principal star measured from the first point of the Siu or zodiac, in the domain of which the star lies.

6. North Polar Distance.

7. Celestial latitude.

For each of 28 zodiacs, the 3rd item is replaced only by numerals expressed in degrees, and also together with another under the heading of "at an earlier age".

But there is no explanation of these numerals. Being compared with the similar records in the authentic Histories of the later dynasties, they were interpreted as the equatorial widths of the zodiacs, and it is comprehensible that they are not the longitudinal ones.

All of the observed values are expressed in degrees with or

without subscriptions, but the graduation of the degrees is in the classical Chinese mode, and not in the sexagesimal one.

Up to recent times, in China, the circumference of the heavens has been reckoned as $365\frac{1}{4}$ degrees, instead of 360 degrees, this number with such an odd fraction having originated from the number of days in a tropical year. But it is believed that practically the mode of the graduation remained unaltered in spite of the development of the knowledge of the length of the year, although there are found records which give more accurate theoretical values of the circumference. Then the total sum of the widths of the 28 zodiacs should be equal to $365\frac{1}{4}$ degrees; but the sum of the observed widths betrays this expectation, and it becomes $366\frac{1}{4}$ degrees. But this discrepancy may be explained quite naturally by supposing:—

(1) The observational errors in the widths of the 28 zodiacs, if accumulated, may account for the excess of one degree.

(2) The width of the zodiac Ti 氐 seems too great, when the similar records in the authentic historical works of later dynasties are taken for reference, and if it be 15 degrees instead of 16 degree, the total sum of the widths agrees with $365\frac{1}{4}$degrees.

Interpretation of Subscriptions

The subscriptions recorded are of such kinds:

半, 太, 少, 强, 弱, 半强, 半弱, 少强, but there is no explanation. The English translations of these words are found in Lee Yu Wen's (李王汶) A New Chinese-English Dictionary as follows:

半 (Pan) a half; 太 (T'ai) too, very; 少 (Shao) few, little;

强 (Ch'iang) strong, powerful; 弱 (Jao) weak, feeble.

But the meanings of these words as subscriptions are not very evident and it is rather difficult to get a reasonable explanation.

If the observed value of an angle is given in a round number of degrees, it should be interpreted, in the European mode, as meaning that the true angle is more or less than the observed value within the limits of the accuracy, or in the range of half a degree.

From this point of view, it is most reasonable to interpret the meanings of these subscriptions in such a way:—

半, half a degree greater than the nominated degree.

太, a quarter of a degree greater than the nominated degree.

少, a quarter of a degree smaller than the nominated degree.
強, an eighth of a degree greater than the nominated degree.
弱, an eighth of a degree smaller than the nominated degree.
半強, five eighths of a degree greater than the nominated degree.
半弱, three eighths of a degree greater than the nominated degree.
少強, a sixteenth of a degree greater than the nominated degree.

However, it is found that the usage with regard to these subscriptions in later works betrays the above supposition, and more over from the investigation of the observed materials recorded in K'ai Yüan Chan Ching itself, it must be concluded that the subscription Shao 少 signifies 'greater than the nominated degree'. In connection with this interpretation, it should be mentioned that the observed value 初度 "Ch'u Tu" was understood to be entirely equal to *zero degree*, for if otherwise, there should not be any such observations as 一度 "I Tu", but this is contrary to the fact. This interpretation seems queer to those who are accustomed to the general use of the character 初 as in 初日 "Ch'u Ji", i. e. the first day, where 初 stands for 一 the first, and hence 初日 is followed by the second day 二日, omitting 一日.

And, on one hand, in 宋書天文志 "Sung Shu T'ien Wen Chih" are found the following descriptions:—

兩極相去一百八十二度半強. The northern and southern poles are apart by one hundred, eighty two and a half degrees strong.

赤道帶天之紘去兩極各九十一度少強. The equator lies apart from the poles by ninety-one degrees a little strong.

This fact implies that there is a certain difference in the usage between the two pairs 太, 少 and 強, 弱,

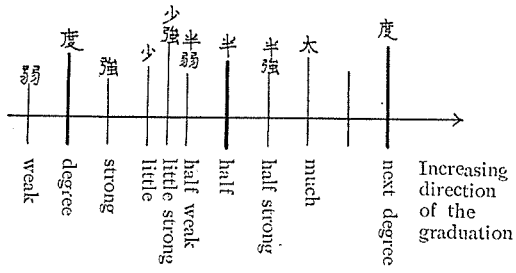
In fine, the former interpretation of these subscriptions must be improved, that is to say, the meanings of 太, 少 T'ai, Shao must be altered as follows:

太, T'ai: three quarters of a degree greater than the nominated degree.
少, Shao: a quarter of a degree greater than the nominated degree.
少強, five-sixteenths of a degree greater than the nominated degree.

This interpretatation may be represented by the figure.

When the frequency of these subscriptions in the observations is investigated statisticall , it is found that 半, 太 and 少 are of rather

Fig.1



frequent occurrence and their frequency of occurrence is nearly equal, but each of the other appears only once.

From this fact, it is evident that the subscriptions were properly used, and were not merely inserted afterwards.

Miscopying

From the nature of Chinese numerals, the omission of one stroke in it transforms one numeral entirely into another.

The following interchanges may be observable :—

(1) Interchange between one, two, three 一, 二, 三
(2) ,, ,, five and nine 五, 九
(3) ,, ,, four, west, both 四, 西, 兩
(4) ,, ,, six, eight and large 六, 八, 大
(5) ,, ,, one and ten 一, 十

Since the 28 Sius or zodiacs divide the equator into 28 parts, each zodiac signifies a certain equatorial distance, so the interchange between zodiacs means a difference of several or several tens of degrees.

In the records of K'ai Yüan Chan Ching, the following mistakes are found :—

	Difference of Right Ascension
亢 into 尾	+38 Chinese degrees
心 ,, 亢	−31 ,,
牛 ,, 斗	−25 ,,
軫 ,, 斗	+91 ,,

There are almost no means of verifying the observed values recorded in K'ai Yüan Chan Ching, but a few other astrological works were consulted, which bear records, though only fragmental, of Shih Shên stars.

1. 天文要錄, T'ien Wen Yao Lu. It is composed of 50 volumes, and seems to have been published by 李鳳 Li Fung about 664 A.D., since in the preface there is found the date of the Report to the Emperor, which is May 17th of the first year of the Lin Tê era 麟德 in the T'ang dynasty, the first year corresponding to 664 A.D..

But the work is now fragmentally preserved, and of the 28 zodiacs, only 13 zodiacs, 角 Chio, 房 Fang, 尾 Vei, 箕 Chi, 女 Nü, 壁 Pi, 婁 Lou, 昴 Mao, 畢 Pi, 觜 Tsui, 參 Shên, 鬼 Kuei, 星 Sing, are recorded.

For Chung Kuan, there are only 30 asterisms recorded, and although for Wai Kuan all the asterisms are recorded, only the numbers of stars and the descriptions of positions are given and the observed values of co-ordinates are entirely lacking.

2. 天地瑞祥志 T'ien Ti Shui Shiang Chih. It is supposed to have been published about 666 A.D. by 守眞 Shou Chên and is composed of 20 volumes.

But this work also is now fragmentary. Only 9 volumes remain, and the records of all the 28 zodiacs and the larger part of Shih Shên's Chun Kuan stars are lost. Only 19 asterisms of Shin Shên's Chun Kuan stars and all but one of Shin Shên's Wai Kuan stars are recorded. And the observed values are given for all except one asterism 天樽 T'ien Tsuan which is known to belong to Kan's asterism 甘氏中官 from other literature. This work is especially valuable because it contains the observed values of the asterisms which are lacking in K'ai Yüan Chan Ching.

The above two works are now preserved only in Japan—the originals in Marquis Maeda's library and also copies from them in Kyoto University Observatory—and no copies now remain in China.

Identification of the stars

The identification between Shih Shên's stars named in K'ai Yüan Chan Ching and Bayer's stars is very difficult, but for the first step, the following work was taken for reference.

Catalogue d'Etoiles observées à Pekin sous l'Empereur K'ienlong (XVIII^e Siècle) by Rev. Paul Tsuchihashi and Stanislas Chevalier, S. J.

This catalogue is based on the star catalogue in 欽定儀象考成 Ch'in Ting I Siang K'ao Ch'êng which was compiled by P. Kögler, then the Astronomer Royal in Peking.

The catalogud in Ch'in Ting I Siang K'ao Ch'êng contains 3083 stars, and the following star co-ordinates are therein given :—

1. Celestial longitude and latitude,
2. Right Ascension and Declination,
3. Annual Variations of R.A. and Decl.,
4. Magnitude,

the epoch of co-ordinates being 1744.0.

Rev. P. Tsuchihashi, using the above co-ordinates and variations, computed the right ascensions and declinations of stars for the epoch 1875.0, and comparing them with the positions of a modern catalogue, he identified nearly all the stars with Bayer's stars and stars whose positions are accurately known.

The stars in Ch'in Ting I Siang K'ao Ch'êng which are transmitted from the ancients are all numbered for each asterism, like the Flamsteed number, but the order of the numbering is entirely unconnected with the right ascension and the magnitude. The catalogue also contains stars newly added to the ancient star list, and the southern stars which are not visible in China.

The laborious work of Gustav Schlegel, 星辰考原 Uranographie Chinoise has been also referred to, for the identification of stars. But M. Schlegel's work seems to owe very much to 天元歷理 T'ien Yüan Li Li of 徐發 Su Fa, and the identification of ancient asterisms with modern star catalogues by Su Fa is not the same as that by P. Kögler, there being considerable differences between them with regard to certain asterisms. In all, the identification of asterisms is the first thing to be done.

And then the principal star in each asterism should be found such that the observed values are reconcilable with it. Of the three observations, the polar distance of the star is most liable to change with the ages, so that by the use of this property, the epoch of observation is sought for. Contrary to this, the variation of a star's latitude is very slow, and is given by the expression,

$$\frac{d\beta}{dt} = 0.''4711 \sin(\lambda + N_0) \text{ according to Newcomb.}$$

$\frac{d\beta}{dt}$ means the annual variation of the star's latitude, and λ is the longitude, N_0 being a certain constant angle under extremely slow variation. Consequently the variation of latitude amounts to half a degree after 3800 years at least. So it seems that the observed latitudes are the most reliable factors for the verification of the principal stars, but the observation of the latitudes is essentially, very difficult and, especially in early ages, the observed values are affected by somewhat large errors; hence it is impossible to discriminate the stars by their latitudes.

For the identification of the stars which belong to the asterisms it is very helpful to consult ancient Chinese star charts. The ancient

star charts now preserved are very few in number; the following two may be mentioned.

1. 南宋淳祐天文圖, Nan Sung Ch'un You Star Chart.
2. 洪武天象圖, Hung Wu Celestial Chart.

Both are engraved on stone monuments, and rubbings of them are preserved here in Kyoto University Observatory.

The former is believed to be the oldest star chart in the Orient and is now preserved in a Confucian temple in 蘇州 Su Chou, China. The monument measures about 186 cms by 106 cms. There are also two other similar monuments, one of which bears a geographical chart, and to the explanation of the chart there is added the following paragraph :—

> The above four charts are presented by 黃裳 Huang Shang to 翊善 I Shan. 致遠 Chin Yüan got these charts in 蜀 Shu and has engraved them on these stone monuments for long preservation.
> Mid-winter of 丁未 Ting Wei year of the Chun You era.

The Ting Wei year corresponds to 1247 A.D., consequently the Star Chart may be considered to represent the constellations in those days or in earlier ages.

The second one is now preserved in 昌慶苑 Shô Kei Yen in Seoul (Keijo), Korea. The original one, according to the epilogue, had been in Heijo, Korea, but was lost for ever in the river as a result of a war. A copy of the Chart was found later as its remnant, then the stars were re-observed and the improved Chart was engraved on the monument. It is dated December, the twenty eighth year of the Hung Wu era, corresponding to 1395 A.D..

When the two charts are compared, there are found many differences in detail, although the general features of the constellations in both the charts are nearly the same.

P. Kögler, the author of 欽定儀象考成 "Ch'in Ting I Siang K'ao Ch'êng", seems to have taken for reference, the star catalogue in 靈台儀象志 Ling T'ai I Siang Chih", which was published in 1674 by R.P. Verbiest 南懷仁, then the Astronomer Royal in China. As for the identification of the stars, neither P. Kögler nor R.P. Verbiest mentions any star catalogues or charts of reference, which might be suspected to have been handed down and preserved in Peking Observatory. But it is perceptible that the stars in Ch'in Ting I Siang K'ao Chêng coincide very closely with those of the Nan Sung Ch'un You Star Chart.

On the other hand, thorough investigations show that Shih Shên's observations given in K'ai Yüan Chan Ching accord well with the stars in the Hung Wu Celestial Chart.

It should be remembered that the stars authentically named by ancient astronomers, not only by Shih Shên, but also by 甘公 "Kan Kung" and 巫咸 "Wu Hsien" were not handed down as they were from age to age. And it is now very difficult to restore the stars named by Shih Shên originally. Morever, although the Chart is helpful in the identification of the stars, it is not so effective for special asterisms and for feeble, isolated stars, since the Chart has not been so rigorously plotted that the relative configuration can be affirmed easily in modern star charts.

The above statement may be emphasized especially for the southern stars, since the Chart has been drawn as so-called 蓋天圖 "Kai T'ien T'u", such that the declination parallels are represented in circles around the north pole and the hour circles are radial, so that the southern part of the celestial sphere is very much enlarged in the Chart and morever deformed. Consequently it is unavoidable that there should be several missig southern asterisms which can not be confirmed in modern charts.

Shih Shen's Catalogue of Stars

The following is Shih Shên's Catalogue of stars found in K'ai Yüan Chan Ching, and partly supplemented by the records in T'ien Ti Shui Shiang Chih. (See p.63—66.)

Notes to the Catalogue

The identification of stars in asterisms was carried out after through discussion; for the discussions, the author's other work in Japanese "Study of Shih Shên's Star Catalogue" should be consulted.

Twenty-eight Sius

Chio: 2 stars α, ζ Vir. The first is the principal star. In the computation, N.P. distance was read as 90 following T'ien Wen Yao Lu.

K'ang: ϕ, ι, κ, λ Vir. κ Vir is the principal star.

Ti: β, γ, ι, α Lib. α Lib = Pr.

Fang: β, δ, π, ρ Sco. for Kou Ling, ω^1, ω^2 Sco. π Sco = Pr.

Sin : σ, α, τ Sco. σ Sco=Pr. The meaning of "The second star beforehand" is obscure. It may be "the first" instead of "the second".

Vei : ε, μ, ζ, η, θ, ι, $\varkappa$, λ, υ Sco. μ Sco=Pr. N.P. Distance is probably erroneous. 120 degrees in Yao Lu.

Chi : γ, δ, ε, η, Sgr. γ Sgr=Pr.

Tou : ζ, τ, σ, ϕ, λ, μ Sgr. φ Sgr=Pr.

Niu ; α, ν, β, π, o, ρ Cap. β Cap=Pr.

Nü : ε, μ, 4, 3 Aqr. ε Aqr=Pr.

Hsü : β Aqr ; α Equ. β Aqr=Pr.

Wei : α Aqr, θ, ε Peg. α Aqr=Pr. Fên Mu :— γ, ζ, π, η Aqr.

Shih : α, β Peg. α Peg=Pr. Li Kung :— η, o, μ, λ, υ, τ Peg.

Pi : α And ; γ Peg. γ Peg=Pr. In Yao Lu, N.P.D.=88 degrees.

K'uei : β, μ, ν, π, δ, ε, ι, ζ, η And ; ψ', χ, ϕ, υ, l, τ, σ Psc. ξ And=Pr ; δ, η And seem to have been as Pr. at different ages.

Lou : α, β, γ Ari. β Ari=Pr.

Wei : 35, 39, 41 Ari. 35 Ari=Pr.

Mao : Plejades. 17 Tau=Pr.

Pi : α, θ, 71, γ, δ^1, δ^3, ε, λ Tau. ε Tau=Pr. Fu Êr, δ Tau. In Yao Lu, Pr is given as "the first star of the left thigh", and N.P.D.=76 degrees.

Tsui : λ, ϕ^1, ϕ^2 Ori. ϕ^1 Ori=Pr.

Shên : α, β, γ, δ, ε, ζ, $\varkappa$, 42, θ, ι Ori. δ Ori=Pr. In Yao Lu. N.P.D. =94 degrees.

Tsing : μ, ν, γ, ξ, λ, ζ, 36, ε Gem. Yüeh, η Gem. Generally, μ Gem is taken for Pr, but from the investigation of Hour Angles it follows that ν Gem should be Pr. This is in agreement with that shown in the Hung Wu Celestial Chart.

Kuei : γ, δ, η, θ, M 44 Cnc. θ Cnc=Pr.

Liu : ρ, η, σ, δ, ε, ζ, ω, θ Hya. δ Hya=Pr.

Sing : ι, τ^2, τ^1, 28, α, 26, 121 G Hya. α Hya=Pr. In Yao Lu, N.P.D.=91 degrees.

Chang : $\varkappa$, υ^1, μ, λ, ϕ^3, 192 G Hya. The principal star was not unique for different ages. 唐書 T'ang Shu mentions it. Here, υ Hya is taken as Pr.

I : ν, 225 G, 240 G, 44, χ, ξ, β, 315 G Hya ; α, β, γ, δ, ζ, Boss 2937 ε, ι, θ, Boss 3137 Crt.

Chên : γ, ε, β, δ Crv. γ Crv=Pr. Ch'ang Sha, ζ Crv. Right Hsia, η Crv. Left Hsia, α Crv.

Shih Shen's Chung Kuan Stars

In should be understood that the first named star in the following descriptions is the principal star, unless otherwise stated.

1. η, τ, ν; o, π, ζ Boo. Though there is no description given of Pr, η Boo was picked out.
2. α Boo.
3. ρ, σ, ε Boo. N.P.D. was read 10 degrees greater. And it is interpreted as belonging to K'ang Siu instead of to Vei.
4. γ Boo.
5. λ Boo. N.P.D. was read 10 degrees greater.
6. κ, ι, θ Boo. N.P.D. was read as 26 degrees instead of 18 degrees This is referred to, again later.
7. ι Her; ξ, ν, β, γ Dra. N.P.D. was read 10 degrees greater.
8. π, 69, ρ Her.
9. β, ν^1 Boo; χ, ϕ, τ, σ, η Her.
10. π, θ, β, α, γ, δ, ε, ι, ρ CrB. π Ser corresponds well to the observed values, but it lies entirely outside the crown. Hence π CrB was taken as Pr. for which N.P.D. was read smaller 10 degrees, and Vei Siu replaced by Sin Siu.
11. ξ CrB; ζ, ε Her and others. It is difficult to restore all the stars. Pr is said to be "fourth" star, but not "the" fourth star. And as there is no mention of the direction, "fourth" 四 should be understood as a degenerated form of "west" 西.
12. α, ε, ζ Lyr.
13. ζ, υ, ε, δ Oph; ε, α, δ, β, γ Ser; κ, γ, β Her; η Oph, ξ Ser, ν Oph; η, θ Ser; ζ Aql, 110, o, μ, δ Her.
14. α Her.
15. α Oph.
16. 60 Her; 33, 32 Oph; Σ 2115. As Pr 33 Oph was taken instead of the Southernmost star 60 Her.
17. It is most difficult to pick five stars in a Bushel type. The following five just satisfy a Bushel type.

    Piazzi 125, ω, 29,—Her, Σ 2106,

    but the first star Piazzi 125 does not satisfy the observations. Stars are named with numbers only in Bushels. Moreover K'ang should be read as Sin.
18. γ, β Oph.
19. 66, 67, 68, 70 Oph. The south-west star 67=Pr.

20. 72, 71 Oph. In Ch'in Ting I Shiang K,ao Ch'êg and also in Uranographie Chinoise, 110, 111 Oph are taken as the asterism. But the former two more nearly satisfy the values of observations.
21. ϕ, χ, Ψ, ω Oph and ξ Sco; 48, θ, η Lib. Pr.=ψ Oph.
22. 36, θ, 44, 51 Oph. It seems there is an error in the Hour Angle.
23. υ, ρ, 43, π, o, ν Sgr. π Sgr=Pr. π Sgr. does not correspond to the description "west" star, but it is almost meaningless to retain the original description "fourth".
24. It is difficult to find the asterism corresponding to the observations. But if the Hung Wu Celestial Chart is consulted, the following stars must be taken.

    15, λ, 12, 9, 6, Piazzi 197,—, 2, 12 Aql.

    But the 9 stars; 14, 15, λ, 12, 9, 6, 3, 2, 1 Aql resemble a crown in shape. There is no Pr. star to fit to the observations.
25. α, β, γ Aql.
26. 1 Aqr. Pi 116,—, 69, 71 Aql. N.P.D. seems larger. Although it is a little difficult to explain the process of the interchanges between "four and two", many cases of this are found in later treatment. If N.P.D.=92 instead of 94, 1 Aqr is to be taken as Pr.
27. ζ, α, β, γ, δ Del. N.P D. was read greater by 10 degrees.
28. δ, o, α, ν, τ, υ, ζ, ε, γ Cyg. Tou should be Niu.
29. α, 9, β, —Lac; and others.
30. β, υ, η, α, ζ Cas. The description of the asterism should be read as follows: Wang Liang lies north of K'uei (奎), in the Galaxy and Pr is West star.
31. γ Cam, ι, ε, δ, ϕ, θ Cas probably. The principal star should be South star, but δ was taken. N.P.D. war read larger by 10 degrees. If the original N.P.D. is retained, a much more northerly star must be sought.
32. γ Cas.
33. γ, ν^2, ξ^1, ω, υ, Piazzi 104 And;—, ε, η, γ, δ Tri after the fashion of the Hung Wu Chart.
34. 9, τ, ι, $\varkappa$, β, ρ, 16, 12 Per. The principal star is "eighth" star, but it was interpreted as North.
35. η, γ, α, ψ, δ, Piazzi 186, 48, μ b^1 Per.
36. ν, ε, ξ, ζ 38 Per. The principal star is shown by "second star". Also it must be interpreted as "North" star. The transition is rather easily comprehensible. In the original record, there is:

卷舌六星在鼻北二星入胃十度云々.

And the character "二" came from the symbol "〻" which means a repetition, hence, it signifies the foregoing character 北 "north"

37. ι, α, β, θ Aur; β Tan. Here, also "fourth" must be replaced by "West".

38. ζ Tau.

39. ρ, α, β Gem; ε, β, α CMi. Pr=β CMi. In the original description, Pr is the Centre of Both rivers. But "Both" 兩 must be "South" 南.

40. θ, τ, ι, υ, $\varkappa$ Gem.

41. ϕ Gem.

42. o Gem. N.P.D. recorded in T'ien Ti Shui Shiang Chih is 55 degrees. It justifies o Gem as Pr, without doubt.

43. 74, 81, 85 Gem; μ Cnc. The recorded Hour Angle is too small by nearly 10 degrees, and it is justified by the record in Shui Shiang Chih.

44. 35 Lyn, 10 UMj; 38, α Lyn, 59, ι, ξ Cnc; λ, ε, μ, ζ, γ, η, α, o, 31, ρ Leo. Pr=α Leo.

45. 53, 52, 51 Leo; 41 LMi.

46. δ, θ, ι, σ Leo; β, η, γ, δ, ε, Vir; α Com. Pr=β Vir.

47. β Leo.

48. Four stars of moderate magnitude are not found near "Emperor Huang".

49. ω, ν, π, o Vir.

50. No descriptions are given.

51. α CVn.

52. ——

53. ι, $\varkappa$, λ μ, ν, ξ UMj. In the original, Pr. is given as North star of Both Excellencies, but the character "Both" 兩 should be read as West 西.

54. Shui Shiang Chih shows that the observed values of Hour Angle and N.P.D. are interchanged.

55. ψ UMj.

56. 36, 37, 39, 43, 44, 60 UMj, Pr=44 UMj.

57. o, 23, υ, ϕ, θ, 15 UMj.

58. α, β, γ, δ, ε, ζ, η UMj. Fu, g UMj.

59. 6, λ Dra; Piazzi 126, 27 UMj; Piazzi 187 Σ 634, β 1176 and α, ι, η, ζ, δ, ε Dra; β, γ Cep.

60. Polar Stars γ, β, 5, 4 UMi; Piazzi 133. Kou Ch'en ζ, ε, δ, α UMi; 2,—Cep.
61. $\varkappa$ Dra.
62. 4 Dra. N.P.D. was read as 11 degrees.

Wai Kuan Stars

1. Treasury: ζ Cen; α Lup; η, θ, ι, γ, σ, δ, ρ,—Cen.
   Five Columns: τ, ι,—Lup; A, 4,—Cen; k, 1, 2 Cen; ν^1, ν^2,—Cen.
   Balance χ, ϕ, μ, ν Cen.
   Pr=δ Cen.
   N.P.D. in Shui Shiang Chih is 130 degrees.
2. β Cru, β Cen.
3. γ, R Hya.
4. C_L,—, —Cen; $\varkappa$ Cen; β, o Lup; ε, λ, π; $\varkappa$, μ ν Lup and others.
5. 144 G Lup; —, λ; —, —, μ; γ, 413$^{\triangle}$, ε Nor; —Lup, η, δ Nor.
6. 181 G Sco, σ, α, μ, θ Ara.
7. G Sco.
8. Boss 4513 (Cluster).
9. 12 G CrA, δ, ζ Tel.
10. η, —, ζ, δ, β, α, γ, ε, —, λ, $\varkappa$, —, θ, —CrA. Pr=CrA.
11. The asterism can not be identified.
12. ι, θ, $\varkappa$ PsA, γ Scl.
13. Yü- Lin Army is composed of very many stars and only υ Aqr is mentioned as Pr. "Fourth" star in K'ai Yüan Chang Ching, but "West" star in Shui Shiang Chih.
    Line of Ramparts are:
    27, 29, 30, 33 Psc; φ, λ, σ, ι Aqr; δ, γ, ε, $\varkappa$ Cap.
14. Formalhaut.
15. β Cet.
16. υ, τ, ζ, θ, η, ι Cet. For the principal star, the south star of the two bright ones i. e. η Cet was taken. N.P.D. given in Shui Shiang Chih is 112 degrees.
17. α, g, λ, μ, ξ^1, ξ^2, ν, γ, δ, 75, 70, 63, o Cet.
18. o, g, f, e, ξ Tau. South star is taken for Pr, in spite of the record as "Second" star.
19. Boss 956, γ, π, δ, ε, ζ, η Eri; π Cet; τ^1, τ^2, τ^3, τ^4, τ^5, τ^6, τ^7, τ^8 τ^9 Eri.
20. π^5, π^4, π^3, π^2, π^1, g, o^2, 11, 15 Ori.

21. ψ, β, λ Eri ; τ Ori.

The three values of observations are nearly consistent, but can not be satisfied by any of the above four stars.

22. ε, μ Lep.

ε Lep was taken as Pr.

23. α, β, γ, δ Lep. β Lep was taken as Pr.

24. Entirely different stars are adopted as Celestial Foeces in the Ch'un You Star Chart and the Hung Wu Celestial Chart respectively.

It seems as if ν Col should be taken, but it is not justified by observations.

25, 26 are later referred to.

27. α CMj.

28. 10, ε, σ, 27, 30, o^2, η CMj ; ξ Pup.

29. α Car.

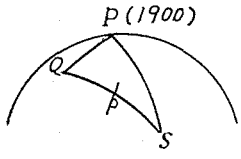
30. *H.* δ, $\varkappa$, N Vel.

The North Pole at the Age of the Observations

Let a star position be represented with the right ascension (α) and the declination (δ) referred to the mean equator and equinox at the beginning of 1900. These co-ordinates can be derived from the *Boss-Preliminary General Catalogue of 6188 stars.*

Refering to the same co-ordinate axes, the position of the North Pole at the age of the observations may be represented with the right ascension (A) and the declination (D).

Fig. 2



Since the north pole shifts incessantly in one direction among the stars by the effect of precession, the North Pole at the age of the observations, denoted by Q in the Fig. 2, lies to one side of the present north pole P (1900.0). Connect Q to a star position S, then QS is the North Polar distance observed. Denote it by p.

By the fundamental formulae of Spherical Trigonometry, the following relations are given ;

$$(1)\quad \cos p = \sin\delta \sin D + \cos\delta \cos D \cos(\alpha - A)$$
$$\text{or} \quad = \sin\delta \sin D + \cos\delta \cos\alpha \cos D \cos A + \cos\delta \sin\alpha \cos D \sin A.$$

And may be put briefly

$$(2)\quad a = \cos\delta \sin\alpha, \quad b = \cos\delta \cos\alpha, \quad c = \sin\delta,$$
$$x = \cos D \sin A, \quad y = \cos D \cos A, \quad z = \sin D,$$

it follows that

$$(3)\quad \cos p = ax+by+cz$$

In the above equation, the following relations must be necessarily satisfied

$$(4)\quad x^2+y^2+z^2=1.$$

Consequently when the north polar distance is given for a star, and a, b, c are calculated by formula (2), a linear equation of three unknowns similar to (3) will be obtained. And then if, for three stars, the observations of polar distances are given, simultaneous linear equations of three unknowns are formed and a unique solution for x, y, z can be got.

The right ascension and the declination of the North Pole at the age of the observations are easily derived from formula (2).

On the one hand, the position of the North Pole at any date can be precisely calculated from Newcomb's fosmula, and hence by comparing the position of the Pole solved as above with this position from the formulae, the epoch of the observations can be known. Since the observed values of polar distances are probably affected by observation errors, it is necessary to have more than three observations to reduce the effect of the observation errors as much as possible and to get a reasonable position of the North Pole. For the solution of many observation equations, the method of Least Squares will serve. Here it shall be questioned whether the values of the Right Ascensions and the Declination of the North pole derived from the observations be consistent with the position calculated from Newcomb's formulae. Or in other words, the question occurs whether the North Pole derived from observations lies on the path of the North Pole drawn on the Celestial Sphere according to Newcomb's formulae. When the derived Pole does not lie on the path of the North Pole, if the observations are reliable, it is necessary to correct, either the annual or the secular coefficients or both in Newcomb's formulae of precession. But in that case, the epoch of the observation should be known, and consequently trying to solve the problem under consideration is shown to be a case of working in a circle.

Moreover, it wil be seen from the facts considered below that the above analytical method to get x, y, z should be applied at least in the secondary process, and the actual situation shows that the frontal attack can not succeed in solving such an entangled problem.

1) Although there are several stars which are evident from the descriptions, Shih Shên's stars are now very obscure, and the identi-

fication of them with the stars given in modern catalogues composes the main part of the problem.

2) Even if the stars are identified correctly, there may exist a doubt about the mistakes in the copying of the observed values of North Polar distance. If there is a mistake of ten degrees in an observation, it will spoil fatally the result of other good observations.

3) Even if it be granted that the above two conditions are satisfied perfectly, it can not be asserted, a priori, that all the observations were made in the same epoch. The observations might have been carried out over a rather wide range of years, or it might be supposed that the greater part of the observations was transmitted from the ancients without any change, while the rest of them were improved in later ages.

4) As the data, which satisfy the first and the second conditions mentioned above, are extremely restricted, the in accuracy of each observation will have considerable effect on the result.

5) Above all, such an analytical method entirely reveals its inability to manipulate properly "specially bad material". Hence the following process was taken to get the position of the North Pole.

With the star as centre, draw a circle the radius of which is equal to the observed polar distance, then the North Pole at the age of the observations must lie somewhere on the circle. Then the interesting point of these circles drawn for all the stars is nothing other than the required North Pole.

The co-ordinates A, D of a point on the locus, will satisfy the equation

$$\cos p = \text{sifi}\,\delta \sin D + \cos\delta \cos D \cos(\alpha - A)$$

It is unnecessary to draw the entire circle but only a part near the north pole, hence three points are required:

one: at the point where the circle cuts the hour circle of the star, the co-ordinates are: $A = \alpha$

$$\cos p = \sin\delta \sin D_\alpha + \cos\delta \cos D_\alpha = \cos(D_\alpha - \delta)$$
$$D_\alpha = p + \delta$$

two: at the intersections with the parallel of 77° Declination.

The 77° parallel was arbitrarily taken under the assumption that the required North Pole lies inside the circle.

And the co-ordinates will be given by the following formula.

$$\cos(\alpha - A_{77}) = (\cos p - \sin\delta \sin 77^0)/\cos\delta \cos 77^0$$

Since the above relation holds for the spherical surface, the curve,

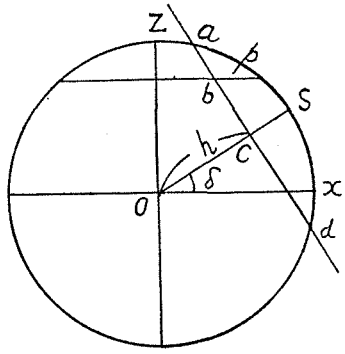
strictly speaking, can not be plotted on a plane as it is. But since in the original drawing, the curves were drawn to a scale such that 1 degree was equal to 1 centimeter, the spherical surface may be regarded as a plane in the polar region inside the 77° parallel. To tell the truth, the Pole in 1900 is elevated by 1 44 centimeters in this scale, above the plane of the 77° parallel, but in the orthogonal projection the Pole is situated just in the centre of the Declination circle. It must be tested whether other relations are maintained or not in the projection to the plane of the 77° parallel.

Let the equation of a sphere be

$$x^2+y^2+z^2 = a^2$$

that is, the origin of the co-ordinates lies in the centre of the sphere and the radius is equal to a. Now draw z axis towards the Pole at 1900, and let x axis be taken in the plane and in the side of the star.

Fig. 3



Since the circle of 77° Parallel lies above the centre as high as $a \sin 77°$, the equation of the circle will be given by the following two.

$$x^2+y^2+z^2 = a^2 \qquad Z = a \sin 77°$$

Consequently, the equation of the projected circle will be given by

$$x^2+y^2 = a^2 \cos^2 77°$$

then it is seen that the radius of the projected circle is equal to $a \cos 77°$. In the drawing, this radius was taken as 13 centimeters, hence

$$a \cos 77° = 13° = 13^{cm}$$

Denote the position of the star with S, and having the centre at S draw a circle of a radius equal to the North Polar distance p. Then the small circle must lie in a plane $a\ b\ c\ d$ in Fig. 3.

The plane of the circle is represented by the following equation,

$$lx+my+nz = h$$

where l, m, n, are the direction consines of the normal to the plane from the centre or Oc, and h is its length. And it is clear from the figure that there exist the following relations,

$$h = a \cos p$$

$$l = \cos \delta, \qquad m = o, \qquad n = \sin \delta$$

Then the equation of the plane is reduced to the form

$$x \cos \delta + z \sin \delta = a \cos p.$$

And the intersection where this plane cuts the spherical surface is nothing but the circle in which the North Pole at the age of observations is to be found.

$$\begin{cases} x^2+y^2+z^2 = a^2 \\ x\cos\delta + z\sin\delta = a\cos p \end{cases}$$

The above two equations determine the circle.

The equation of the projected curve of this circle will be given by elimination of z from these two equations, i. e.,

$$x^2+y^2\sin^2\delta - 2a\cos p\cos\delta\cdot x + a^2(\cos^2 p - \sin^2\delta) = 0$$

From this equation it will be seen that it generally represents an ellipse, and it becomes a parabola for a star on the equator, and a circle for the pole star. The co-ordinates of the point of intersection where the curve passes through the great circle of the star's right ascension will be given in the following way :—

let $y = 0$

then the equation becomes

$$x^2 - 2a\cos p\cos\delta\cdot x + a^2(\cos^2 p - \sin^2\delta) = 0$$

and it gives the solution of x thus :—

$$\begin{aligned} x &= a\cos p\cos\delta \pm a\sqrt{\cos^2 p\cos^2\delta - (\cos^2 p - \sin^2\delta)} \\ &= a(\cos p\cos\delta \pm \sin p\sin\delta) \\ &= a\cos(p\mp\delta) \end{aligned}$$

For the northern point of intersection $x = a\cos(p+\delta)$, and for the southern point of intersection $x = a\cos(p-\delta)$, to which it is now unnecessary to refer.

In the drawing, the northern point of intersection was traversed in the radius, measuring a length of $\{90-(p+\delta)\}^{cm}$ from the North pole, where p and δ are expressed in degrees and fraction, but now it has been shown that this distance is $a\cos(p+\delta)$ in rigorous expression, or $13\sec 77^\circ\cos(p+\delta)$, since $a\cos 77^\circ = 13^{cm}$.

Consequently the inaccuracy of the drawing will be measured by the magnitude of the difference :

$$13\sec 77^\circ\cos(p+\delta) - \{90-(p+\delta)\}$$

The following small table shows the order of inaccuracy at a glance.

$90-(p+\delta)$	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°
$13\sec 77^\circ\cos(p+\delta)$	1.01	2.02	3.02	4.03	5.04	6.04	7.04	8.05	9.04	10.03	11.02	12.00	13.00

The maximum error is only 0.5^{mm}, and hence the errors in the drawing may not have any serious effect on the result.

Next the co-ordinates of the points at which the circle intersects with the 77° parallel will be given by two equations :

$$\begin{cases} x^2+y^2\sin^2\delta - 2a\cos p\cos\delta\cdot x + a^2(\cos^2 p - \mathrm{sid}^2\delta) = 0 \\ x^2+y^2 = a^2\cos^2 77^\circ \end{cases}$$

From these 2 equation, it follows that

$$x^2\cos^2\delta - 2a\cos p\cos\delta\cdot x + a^2(\cos^2 p - \sin^2\delta + \cos^2 77^\circ\sin^2\delta) = 0$$

$$x = a\frac{\cos p \pm \sin 77^\circ\sin\delta}{\cos\delta}$$

Of these double signs, the negative sign should be taken, and the positive sign need not be considered.

Pass a radius through the intersection, and denote the angle between this radius and x axis by θ, then the value of θ will be given as follows :

$$\cos\theta = \frac{x}{a\cos 77^\circ} \text{ or } \frac{\cos p - \sin 77^\circ\sin\delta}{\cos 77^\circ\cos\delta}$$

This value entirely coincides with that which was required formerly for the drawing. In fine, the method adopted in the drawing is justified now within the limit of permissible errors.

The Epoch of the Observations

Following the above process, curves were laid for three divisions separately, and they are shown in the accompanying figures (p.62). In each of the figures, the centre being the north pole in 1900.0, the large circle represents the 77° parallel itself, and the central cross stands for the equinoxial and solstitial colures, the arrow showing the direction of the vernal equinox.

The line passing through several dots represents the path of the North Pole and each dot corresponds to the age written beside it.

As for the convergency of the curves, although it is not so good as expected from the minuteness of the observations, it may be said to show moderate convergency, so that the epoch or epochs of the observations can be read from the figures rather easily.

Firstly, for the 28 Sius (Fig. 4, p. 62), the converging point is rather acute, and the epoch of the observations should be considered as 200 A.D. Of all the 28 stars two are defective in observations of North Polar Distance and the following 18 stars can be counted as belonging to the converging point.

房 Fang, 尾 Vei, 牛 Niu, 女 Nü. 虛 Hsü, 危 Wei,
室 Shih, 壁 Pi, 奎 K'uei, 婁 Lou, 胃 Wei, 昴 Mao,
畢 Pi, 觜 Tsui, 井 Tsing, 鬼 Kuei, 翼 I, 軫 Chên.

Moreover, a special feature of the figure can not be overlooked, that the curves of the following Sius seem to assemble to a point corresponding to the year about −300.

角 Chio, 心 Sin, 箕 Chi, 張 Chang.

As for 斗宿 Tou Siu, there is a suspicion about the principal star. In the drawing, φ Sgr was teken as the principal star to keep an accordance in the equatorial widths, but if it is replaced by σ Sgr, the curve will pass nearer to the earlier converging point.

Next, in the figure of Shih Shên's Chung Kuan (Fig. 5, p. 62), it can not be denied that there are two converging points—one about the year −360, and the other about 180 A.D. To the earlier epoch belong the following 27 asterisms,

1−5, 7, 9−16, 18−23, 27−29, 32, 46, 47, 58II

and to the later epoch, the following 13 asterisms pertain :—

34−38, 40, 42, 44, 49, 59−62

This fact may be interpreted as meaning that all of the Shih Shên's stars were observed early in −360 or there about and later a part of the observations were revised after re-observations.

Now an inspection of the stars in respective groups shows that the stars of the first group are contained nearly in the hemisphere with Winter Solstice, and those of the second group are in the hemisphere with Summer Solstice. This condition may induce a suspicion of some underlying defects in the observations themselves,—say, the ill-adjustment of the polar axis of the astronomical instrument,—but if that be the case, the curves must envelope a circle around a true Pole, and moreover the converging points are so well situated on the path of the North Pole, that it can not be considered as a mere accidental coincidence.

No. of Astsm.	North Polar Distance (in Chinese degrees)
8	50
24	90 much
33	60 little strong
39	80
45	70 & a half
53	30 little

a group.

But there are also rather many stars remaining which do not belong to either of the groups, and thorough examination is necessary for these stars.

i) Of the remaining asterisms, the tebulated six are counted in

For these asterisms, the recorded values of the North Polar Distance are all defective in unit places, and consequently it may be suspected that there might have been some figures there in the original catalogue.

ii) For the 6th asterism, the recorded distance is 18 Chinese degrees, but the value is too small by nearly ten degrees, and then if the Chinese figures「一十八度」for 18 degrees are considered to have degenerated from「二十六度」or 26 degrees, then the value will accord with others and the curve will pass nearby the earlier converging point.

The same holds good for the 25th asterism, if the recorded value 八十三度 or 83 degree be considered as the degeneratered form of 八十五度 or 85 degrees.

iii) The asterisms of the numbers 31, 54, 55, 58 seem to belong to another epoch near about −150, but the convergence is not so certain as with the other two groups, since the stars are few in number.

Then there are left few asterisms for which no regular relations are found.

In short, it seems that there is scarcely room for doubt about the existence of two converging points.

Finally, Shih Shên's Wai Kuan stars were also investigated. From the figure (Fig. 6, p. 62), it is conceivable that there are also two converging points. And the first ten asterisms, except the 3rd, show a convergence about a point, corresponding just to the earlier epoch shown by the Chung Kuan stars.

The remaining twenty asterisms, except the 11th, 21st, 24th and 29 th give an epoch 200 A.D. or a little earlier, that is to say, the conclusion as to the Wai Kuan stars does not conflict with that derived from the investigations of the Chung Kuan stars.

The following remarks may be given as to special asterisms.

南門 Nan Mên. In 欽定儀象考成 "Ch'in Ting I Shang K'ao Ch'êng", α, ε Cen are adopted, and in Uranographie Chinoise, the following three, β Cir, α, β Cen are taken. But here β Cen and β Cru are adopted as the two stars of Nan Mên, to accord with a description by Shih Shên quoted in K'ai Yüan Chan Ching, as fellows.

> 石氏曰南門中有三星芒者則兵車出
>
> Shih Shên says, there are three small stars within the South Gate (Nan Mên), etc.

But the recorded polar distance is too short by nearly ten degrees for the principal star β Cru, and also for β Cen, the principal star taken in Uranographic Chinoise, to be reconciled with the others.

Hence the recorded value 130 degrees was read as 139 degrees instead of 140 degrees, a similar record in 天地瑞祥志 "T'ien Ti, Shui Shiang Chih" being taken into consideration.

Such a liberal adjustment may be accepted from the following consideration. When the North Polar distances of Shih Shên's Wai Kuan stars are investigated through out, there are found eleven records which are defective in unit places, but there is a fair number of records with other digits, as shown below:—

Figure in unit place . . .	0	1	2	3	4	5	6	7	8	9
Number of the records . .	11	3	4	2	2	2	3	0	2	1

Hence the following revisions may be made:—

No. of Asts'n	Asts'n	North Polar Distance		Remark
		Record	Revised Value	
2	南門 Nan M'n	130	139	
3	平星 P'ing Sing	100	102	
7	傅說 Fu Shuo	120 a half	124 a half	
16	天倉 T'ien Ts'ang	120 a half	112 a half	According to Tien Ti Shui Shiang Chih
21	玉井 Yü Tsing	120 much	—	

軍市 Chün Shih. The number of the stars contained in the asterism is not given in K'ai Yüan Chan Ching, but they are counted as thirteen in T'ien Ti Shui Shiang Chih and also in 步天歌 "Pu T'ien Ko",—a well-known poem composed of star names.

But in Ch'in Ting I Shiang K'ao Ch'êng, only six stars are given —β, ν^3, π^1, π^3, o, ξ CMj. And although in Uranographic Chinoise the following are mentioned:—

ν^3, β CMj; θ, η, ζ, —, —, —, —Lep; ξ^1, ξ^2, —CMj;

the five stars in Lepus unnominated are very doubtful, and morever the outline of the asterism does not accord with a phrase quoted there from 星經 "Canon of Stars"

軍市十三星在參井之南如錢狀.

The Military City of 13 stars, lies on the south of the constellations 參井 Shên and Tsing, and looks like a coin in shape.

Then the following 13 stars should be adopted to form the asterism.

θ, ρ (17), 19 Lep ; $-22^{\circ}.1327$, $-22^{\circ}.1330$, ξ^1, ξ^2, ν^2, ν^3,
$-14^{\circ}.1525$, $-12^{\circ}.1518$, $-12^{\circ}.1470$, $-13^{\circ}.1411$ CMa,

and the west star ρ Lep is taken as the principal star.

野雞 Yeh Chi. β CMj is taken as this asterism, just in the centre of the *Military City*. However, in Ch'in Ting I Shiang K'ao Ch'êng and also in Uranographie Chinoise this star has been taken for a constituent of the City, and then it is replaced by ν^2 CMj and 17 Lep respectively.

Shih Shên's Catalogue compared with Modern Observations

The observations of the stars in Shih Shên's Catalogue were compared with the positions derived from modern observations.

I. Observations in the Epoch -350

Twenty-eight Sius

No.	of Ast.	Star	N.P. Dist. Obs.	N.P. Dist. Comp.(−360)	N.P. Dist. O.−C.	Latitude Obs.	Latitude Comp.(1900)	Latitude O.−C.
1	Chio	α Vir	88°.71	88°.17	°.54	—	−2°.02	—
2	K'ang	κ Vir	—	87.93	—	+5°.42	+2°.85	+2°.57
4	Fang	π Sco	106.45	106.50	−.05	−0.86	−5.48	+4.62
5	Sin	σ Sco	106.94	106.86	.08	−3.45	−3.97	+0.52
7	Chi	γ Sgr	116.30	116.47	−.17	−5.17	−6.87	+1.70
26	Chang	υ Hya	95.61	95.80	−.19	−26.12	−26.58	+0.46
					M.E.±°.27			

Shin Shên's Chung Kuan Stars

1	η Boo	58°.64	58°.71	−°.07	36°.22	28°.32	7°.90
2	α Boo	57.17	57.37	−.20	33.76	32.20	1.56
3	ρ Boo	47.31	47.86	−.55	48.30	42.42	5.88
4	γ Boo	40.16	40.00	.16	56.55	49.52	7.03
5	λ Boo	32.03	31.93	−.10	52.24	56.30	−4.06
6	κ Boo	26.38	26.04	.34	69.98	60.77	—
7	ι Her	41.40	40.98	.42	70.97	69.27	1.70
9	β Boo	38.69	38.66	.03	58.77	54.20	4.57
10	π CrB	48.54	48.10	.44	36.47	50.50	—
11	ξ CrB	50.76	51.47	−.71	55.93	51.38	4.55
12	α Lyr	51.25	51.19	.06	61.85	61.60	0.25
13	ζ Oph	92.90	92.81	.09	11.09	11.38	−0.29

Shih Shên's Chung Kuan Stars (continued)

14	α Her	°	70.17	.06	28.58	37.28	—
15	α Oph	72.69	72.84	—.15	37.45	36.00	1.45
16	33 Oph	70.47	70.34	.13	37.45	36.25	1.20
18	γ Oph	82.79	83.27	—.48	27.10	26.17	0.93
19	67 Oph	83.78	83.79	—.01	27.60	26.40	1.20
20	72 Oph	77.86	77.72	.14	23.41	32.94	—
21	ψ Oph	101.52	101.51	.01	2.22	1.62	0.60
22	36 Oph	109.40	109.68	—.28	—1.97	—2.80	0.83
23	π Sgr	111.62	110.94	.68	0.99	1.47	—0.48
27	ζ Del	80.33	80.85	—.52	32.53	32.17	0.36
28	δ Cyg	48.30	48.74	—.44	48.54	64.42	—
29	α Lac	50.27	50.59	—.32	52.48	53.34	—0.86
32	γ Cas	42.38	42.36	.02	56.18	48.82	—
46	β Vir	75.20	75.65	—.25	2.71	—2.03	4.74
47	β Leo	62.59	62.94	—.35	10.60	12.47	—1.87
58	α UMa	17.99	17.89	.10	—	49.73	—
				M.E.±.33			

Shih Shen's Wai Kuan Stars

1	δ Cen	128.18	128.06	.12	—21.44	—44.48	
2	β Cru	137.00	136.83	—.17	—21.44	—48.62	
3	γ Hya	100.53	100.28	.25	—11.58	—13.72	2.14
4	c^1 Cen	113.84	113.25	.59	—19.22	—18.25	— .97
5	144 G Lup	122.46	122.08	.38	—20.94	—20.72	— .22
6	181 G Sco	129.12	129.65	—.53	—20.70	—20.88	.18
7	G Sco	122.71	122.26	.46	—13.55	—13.62	.07
8	Boss 4513	120.25	120.28	—.03	—11.83	—11.83	— .53
9	12 G CrA	130.60	130.67	.07	—21.44	—20.22	—1.22
10	α CrA	127.64	127.19	.45	—13.80	—15.52	1.72
				M.E.±.36			

II. Observations in the Epoch 200 A.D.

Twenty-eight Sius

	Star	N.P. Dist Obs.	Comp. (200)	O.−C.	Latitude Obs.	Comp.(900)	O.−C.
		°	°	°	°	°	°
19	Niu β Cap	108.42	108.59	−.17	4.68	4.60	.08
0	Nü ε Aqr	104.48	104.40	.08	7.89	8.12	− .23
11	Hsü β Aqr	102.51	102.10	.41	7.89	8.63	− .74
12	Wei α Aqr	97.58	97.94	−.36	9.61	10.67	−1.06
13	Shih α Peg	83.78	83.84	−.07	18.23	19.45	−1.22
14	Pi γ Peg	84.76	84.70	.06	12.32	12.60	− .28
15	K'uei δ And	68.99	69.08	−.09	23.90	24.43	− .53
16	Lou β Ari	78.85	78.71	.14	11.83	8.33	3.50
17	Wei 35 Tau	70.97	71.09	.12	11.83	11.32	.51
18	Mao 17 Tau	72.94	73.13	−.19	4.19	4.22	− .03
19	Pi ε Tau	76.88	76.65	.23	− 6.65	− 2.56	− 4.0
20	Tsui φ Ori	82.79	83.68	−.89	−12.57	−13.82	1.25
21	Shên δ Ori	—	93.45	—	−22.18	−23.57	1.39
22	Tsing μ Gem	68.99	68.80	.19	− 2.46	− 0.77	−1.69
23	Kuei θ Cnc	67.02	67.69	−.67	0.74	− 0.73	1.47
27	I ν Hya	97.58	97.52	.06	−20.21	−21.93	1.72
28	Ch'n γ Crv	97.58	97.64	−.06	−15.03	−14.47	− .56
				° M.E.±.33			

Shih Shên's Chung Kuan Stars

		°	°	°	°	°	°
34	9 Per	43.61	43.48	.13	39.67	38.08	.69
35	η Per	42.87	43.02	.15	42.63	37.47	5.16
36	ν Per	55.20	55.02	.18	11.58	22.13	—
37	ι Aur	62.09	62.01	.08	10.60	10.45	.15
38	ε Tau	72.44	72.36	.08	− 2.71	− 2.18	− .53
40	θ Gem	56.18	56.30	−.12	3.20	11.05	—
42	ο Gem	54.21	54.07	.14	12.57	12.98	− .41
44	α Leo	69.98	70.28	−.30	1.23	0.52	.71
49	ω Vir	71.46	72.31	−.85	—	5.33	--
59	6 Dra	10.35	10.00	.35	55.93	62.00	−6.07
60	α UMi	11.33	10.69	.64	63.08	66.03	−2.95
61	χ Dra	10.35	10.24	.11	73.43	61.79	
62	4 Dra	10.84	10.81	.03	73.43	61.24	
				° M.E.±.35			

Shih Shên's Wai Kuan Stars

		°	°	°	°	°	°
12	ι PsA	129.36	129.65	−.29	−18.73	−18.29	− .44
13	υ Aqr	118.52	118.88	−.36	−13.06	−10.75	−2.31
14	α PsA	128.87	128.26	.61	−23.16	−20.93	−2.23
15	β Cet	118.52	118.00	.52	−23.90	−20.75	−3.15
16	η Cet	110.39	110.05	.34	−17.74	−16.00	−1.74
17	α Cet	95.11	94.15	(.96)	−14.05	−12.55	−1.50
18	ο Tau	88.71	88.65	.06	− 9.61	− 9.31	− .30
19	Boss 956	112.36	112.53	−.17	−47.56	−35.45	—
20	δ Ori	91.66	92.25	−.59	−13.31	−20.58	—
22	ε Lep	116.30	116.26	.04	−46.08	−44.93	−1.15
23	β Lep	113.35	113.72	−.37	−43.61	−21.24	—
25	17 Lep	108.42	108.01	.41	−40.41	−39.94	− .47
26	β CMa	109.40	108.69	.71	−42.14	−41.27	− .87
27	α CMa	105.22	105.66	−.44	−41.64	−38.80	−2.84
28	67 G CMa	120.49	120.62	−.13	−51.75	−53.90	2.15
30	H Vel	136.02	136.64	−.62	−66.78	−64.57	−2.21
				° M.F.±.43			

Eqatorial Widths of Twenty-eight Sius

No. of Siu	Principal	Right Ascension (200A.D.)	Right Ascension (−360)	Equatorial Width (200A.D.)	Equatorial Width (−360)	Equatorial Width obs.	O.−C. (200)	O.−C. (−360)
		°	°	°	°	°	°	°
1	α Vir	8.97	5.44	11.74	11.71	11.83	.09	.12
2	κ Vir	20.71	17.15	8.84	8.76	8.871	.03	.11
3	α Lib	29.55	25.91	14.96	14.56	14.78	− .18	.22
4	π Sco	44.51	40.47	5.35	5.24	4.93	.42	− .31
5	σ Sco	49.86	45.71	4.99	4.36	4.93	− .06	.57
6	μ Sco	54.85	50.07	19.02	18.87	17.74	−1.28	−1.13
7	μ Sgr	73.87	68.94	10.29	10.22	10.84	.55	.62
8	φ Sgr	84.16	79.16	26.13	25.12	25.87	− .26	.75
9	β Cap	110.29	105.65	7.61	7.91	7.80	.19	− .11
10	ε Aqr	117.90	113.56	11.63	11.78	11.83	.20	.05
11	β Aqr	129.53	125.34	9.27	9.52	9.86	.59	.34
12	α Aqr	138.80	134.86	15.99	16.56	16.76	.77	.20
13	α Peg	154.79	151.42	16.61	16.52	15.77	− .84	− .75
14	γ Peg	171.40	167.94	6.33	6.551	8.87	2.54	2.32
15	δ And	177.73	174.49	17.88	17.581	15.77	−2.11	−1.81
16	β Ari	195.61	192.07	11.04	10.82	11.83	.79	1.01
17	35 Ari	206.65	202.89	14.82	14.63	13.80	−1.02	− .83
18	17 Tau	221.47	217.52	11.07	11.07	10.84	− .23	− .23
19	ε Tau	232.54	228.59	17.68	17.84	15.77	−1.91	−2.07
20	φ Ori	250.22	246.43	0.93	1.38	1.97	1.04	.59
21	δ Ori	251.15	247.81	8.39	7.13	8.87	.48	1.74
22	μ Gem	259.54	254.94	32.96	32.63	32.53	− .43	− .10
23	θ Cnc	292.50	287.57	3.53	4.36	3.94	.41	− .42
24	δ Hya	296.03	291.93	14.43	15.07	14.78	.35	− .29
25	α Hay	310.46	307.00	6.58	6.58	6.90	.32	.32
26	υ Hya	317.04	313.58	14.17	14.33	17.74	3.57	3.41
27	ν Hya	331 21	327.91	20.94	20.87	17.74	−3.20	−3.13
28	γ Crv	352.15	348.78	16.82	16.66	16.76	− .06	− .10

In this Table, Right Ascensions are counted from the Hour Circle opposite to the North Pole in 1900.0, for the sake of convenience. The discordance between the observed and the computed equatorial widths is rather conspicuous, but there seems no preference for either of the epochs.

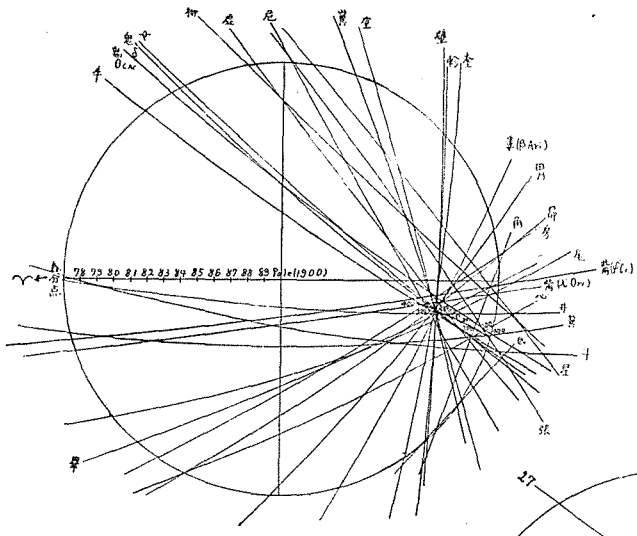
And if a few of the principal stars are replaced, namely δ And by ζ And, ν Hya by α Crt, the specially large deviations are very much reduced.

This alteration may be approved of from the fact that authorities of later dynasties variously assigned these stars as the principal stars.

As to the observations of Hour Angles of Chung Kuan and Wai Kuan Stars, another work by the present author in Japanese, mentioned above, "Study of Shih Shên's Star Catalogue" may be consulted.

The author expresses his heartfelt thanks to Prof. S. Shinjo who has taken great interest in the problem and given valuable advice in the course of the investigation.

Kyoto University Observatory, 1929.



← Fig. 4

Twenty-eight Sius

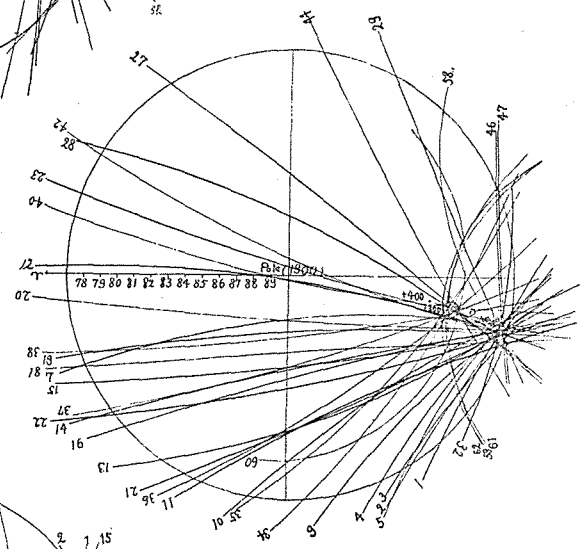
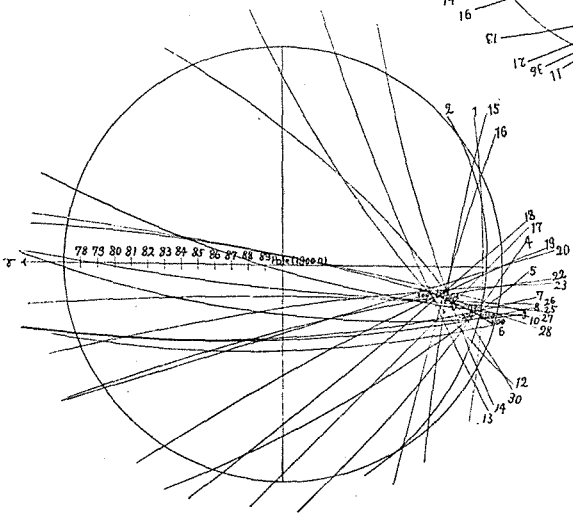


Fig. 5 →

Shih Shên's Chung Kuan Stars

Epoch					
+200		−300			
34	49	1	11	20	46
35	59	2	12	21	47
36	60	3	13	22	58
37	61	4	14	23	
38	62	5	15	27	
40		7	16	28	
42		9	18	29	
44		10	19	32	



← Fig. 6

Shin Shên's Wai Kuan Stars

Epoch		
Later		Earlier
12	23	1
13	24	2
14	25	3
15	26	4
16	27	5
17	28	6
18	30	7
19		8
20		9
22		10

m stands for much 太
lt a little 少
st strong 強
wk weak 弱

I. The Twenty-eight Sius or Zodiacs

	Name of Asterism	No. of *	Additional Asterism and No. of stars	Principal star	Eqatoreal Width		N.P. Dist	Latitude
						Early obs. (	In chinese	degree)
1	角 chio	2		Left Horn	12	—	91	—
2	亢 K'ang	4		——	9	—	—	+ 5.5
3	氐 Ti	4		South west star	16	17	94	+ 1
4	房 Fang	4	鈐鈐 Kou Ling 2	The second * from South west	5	7	108	—1 wk
5	心 Sin	3		The sceond star beforehand	5	12	108.5	3.5
6	尾 Vei	9		The second star from East	18	9	134	—15 lt
7	箕 Chi	4		North west star	11	10, 11¼	118	— 5 lt
8	斗 Tou	6		The forth star in the Square	26¾	—	116	— 2.5
9	牛 Niu	6		Central large star	8	9	110	+ 4 m
10	女 Nü	4		The first form South west	12	10	106	+ 8
11	虛 Hsü	2		South star	10	14	104	+ 8
12	危 Wei	3	墳墓 Fên Mu 4	South west star	17	9	99	+ 9 m
13	室 Shih	2	離宮 Li Kung 6	South star	16	20	85	+18.5
14	壁 Pi	2		South star	9	15	86	+12.5
15	奎 K'ue	16		South western large star	16	12	70	+14 lt
16	婁 Lou	3		Central star	12	15	80	+12
17	胃 Wei	3		South west star	14	11	82	12
18	昴 Mao	7		The first * from South west	11	15	74	— 4 lt
19	畢 Pi	8	附耳 Fu Êr 1	The first star of Right thigh	16	15	78	— 6 m
20	觜 Tsui	3		South west star	2	6	84	—12 m
21	參 Shên	10		—— ⌈shaft	9	—	—	—22.5
22	井 Tsing	8	鉞 Yüeh 1	The first star, west top of south	33	29	70	— 2.5
23	魂 Kuei	5		South west star	4	5	68	+ m
24	柳 Liu	8		The third star from West top	15	18	77	—12
25	星 Sing	7		Central large star	7	13	90	+21 lt
26	張 Chang	6		The first star beforehand	18	13	97	—26.5
27	翼 I	22	⌈Hsia 2	West star of the centre	18	13	99	—20.5
28	軫 Chên	4	長沙 Ch'ang sha 1, 蛇	North west star	17	16	99	—15 lt

II. Shih Shên's Chung Kuan Stars or Northern Stars

	Name of Asterism		Position of Asterism	No. of*	Principal Star	Hour Angle mzd in Sin	(in	N.P. Dist. chinese de	Latitude gree)
1	攝提 Sheh T'i	Regulator	Embracing Grand Horn	6	——	Chio(角)	8lt	59.5	+36 m
2	大角 Ta Chio	Grand Horn	in Regulator	1	——	K'ang(亢)	2.5	58	+34 lt
3	梗河 Kêng Ho	Branch of Elm	North of Grand Horn	3	West star	Vei(尾)	8	38	+49
4	招搖 Chao Yao	Swinging ⌈berd	North of Branch of Elm	1	——	Ti(氐)	2.5	40	+57 m
5	玄戈 Hsüan Ko	Miraculous Hal-	North of Swinging	1	——	Ti(氐)	1	22.5	+53
6	天槍 T'ien T'siang	Celestial Lance	East of the Handle of North	3	West star	Ti(氐)	0m	18 m	+71
7	天棓 T'ien P'êi	Celestial Flail	North east of Berth ⌊Bushel	5	Handle star	Chi(箕)	8	32	+72
8	女牀 Nü Ch'uang	Feminine Berth	North of Celest. Disicpline	3	West star	Chi(箕)	1	50	+56
9	七公 Ts'i Kung	Seven Lords	East of Swinging	7	West star	Ti(氐)	4.5	39 lt	+59.5m
10	貫索 Kuan So	Ligature	Before of Seven Lords	9	Upper Right star	Vei(尾)	.5	59 lt	+37
11	天紀 T'ien Chi	Celestial Discipline	Eeast of Ligature	9	West star[1]	Vei(尾)	5	51.5	+56 m
12	織女 Chih Nü	Weaver	East End of Discipline	3	Large star	Tou(斗)		52	+62 m
13	天市垣 T'ien Shih	Enclosure of Celes-	North east of Fang & Sin (房心)	22	Right Gate Keeper	Vei(尾)	—	94 lt	+ 1 lt
14	帝座 Ti Tso ⌊Yüan	Throne ⌊tial City	In Celestial City, West of	1	——	Vei(尾)	15.5	71 lt	+29
15	侯星 Hou Sing	Attendant ⌈Harem	East of Throne ⌊Atteddant	1	——	Chi(箕)	10.5	73 m	+38
16	宦者 Huan Cheh	Officials in Imperial	West of Throne	4	South star	Vei(尾)	12	71.5	+38
17	斗 Tou	Bushel	South west of Officials	5	The first star	K'ang(亢)	10lt	71	+25
18	宗正 Tsung Chêng	Imperial Parents	South east of Throne	2	South star	Chi(箕)	2	84	+27.5
19	宗人 Tsung Jên	Imperial Relatives	East of Imperial Parents	4	South west star	Chi(箕)	7.5	85	+28
20	宗星 Tsung Sing	Imperial Scions	North of Imperial Relatives	2	South star	Chi(箕)	9	79	+23 m
21	東咸 Tung Hsien	East Harmony	North east of Fang(房)	4	South star	Sin(心)	2	103	+ 2 lt
	西咸 Si Hsien	West Harmony	North of Fang(房)	4	——	——	—	—	—
22	大江 T'in Chiang	Celestial River	North of Vei (尾)	4	South star	Vei(尾)	6lt	111	− 2
23	建 Chien	Establishment	North of Tou(斗)	—	West star[2]	Tou(斗)	7lt	113 lt	+ 1
24	天弁 T'ien Pien	Celestial Crown	North of Establishment	9	South west star	Tou(斗)	6m	90 m	+17 m
25	河鼓 Ko Ku	Tambourine of the	North of Niu(手)	3	Large star	Tou(斗)	22m	83	+28 m
	旗 Ch'i	Flag ⌊River		9	——	——	—	—	—
26	離珠 Li Cha	Linked Jewels	North of Nü(女)	5	North star	Nü(女)	0	94	+30
27	匏瓜 P'ao Kua	Gourd	North of Linked Jewels	5	Wset star	Nü(女)	−1t	71.5	+33
28	天津 T'ien Tsin	Celestial Ford	In the Galaxy, north of Nü(女)	9	North west star	Tou(斗)	2	49	+49 lt
29	螣蛇 T'eng Sheh	Sacred Serpent	North of Shih(室)	22	Beak star ⌈laxy[3]	Shih(堂)	1.5	51	+53 lt
30	王良 Wang Liang	Celebrated Driver	North of K'uei(奎)	5	West* in the Ga-	Pi'(壁)	.5	42.5	+57

II. Shih shên's Chung Kuan Stars or Northern Stars-continued

	Name of Asterism		Position of Asterism	No. of ✻	Principal Star	Hour Angle mzd in Siu	(in	N.P. Dist. Chinese de	Latitude gree)
31	閣道 Ko Tao	Arched Corridor	North East of Driver	6	South star	K'uei(奎)	5	42 lt	+58 lt
32	附路 Fu Lu [Chin	Lateral Avenue	South Side of Corridor	1	——	K'uei(奎)	3	43	+57
33	天將軍 T'ien Tsiang	Celestial General	North of Lou(婁)	11	Large star	K'uei(奎)	15.5	60 lt st	+29 lt
34	大陵 Ta Ling	Grand Maosoleum	North of Wei(胃)	8	North star[4]	Lou(婁)	6lt	44 lt	+40 lt
35	天船 T'ien Ch'uan	Celestial Vessel	In the Galxy, North of Maosoleum	9	North star	Lou(婁)	9	43.5	+43 lt
36	卷舌 Chüan Sheh	Rolled Tongue	North of Mao(昴)	6	North star[5]	Wei(畢)	10lt	56	+11 m
37	五車 Wu Chü	Five Waggons	North east of Pi(畢)	5	West star[6]	Pi(畢)	3	63	+10 m
38	天關 T'ien Kuan	Celestial Barrier	South of Waggons, NW of Shên	—	—— [River[7]	Tsui(觜)	0	73.5	− 2 m
39	南北河 Nan Pê Ho	North and South	Interposing Tsing(井) [River	6	Centre of South	Tsing(井)	17lt	80	−14
40	五諸侯 Wū Chu Hou	Five Nobles [River	North of Tsing(井), Near to N.	5	West star	Tsing(井)	2	57	+ 3 lt
41	積薪 Tsi Sin	Heaped Fagot	South east of Water	1	——	Tsing(井)	21.5	61.5	+10 m
42	積水 Tsi Shui	Accumulated Water	North west of North River[8]	1	——	Tsing(井)	12	50	+12 m
43	水位 Shui Wei	Water site	East of Tsing(井), in a line	4	South star	Tsing(井)	9.5	72.5	− 3 m
44	軒轅 Hsien Yüan	Chariot	North of Sing(星)	17	Large star	Chang(張)	—m	71	+ 1 lt
45	少微 Shao Vei	Small Profundity	In a line, west of Large Prof.	4	South star	Chang(張)	10.5	70.5	+ 3.5wk
46	太微 T'ai Vei	Large Profundity	North. of 1 & Chên(翼軫)	10	Right Gate Keeper	I(翼)	9	76.5	+ 2 m
47	黃帝 Huang Ti	Emperor Huang	In Large Profundity	5	Central star	I(翼)	9.5	63.5	+10 m
48	四帝 Szü Ti	Fore Fmperors							
49	屏 P'ing	Interior Sereen	South of Emperors	4	West star	I(翼)	7	72.5	—
50	郎位 Lang Wei	Officiers	——	—	——	——	—	—	—
51	郎將 Lang Tsiang	Conrmander	Northeast of Officiers [Pi(畢)	1	——	Chên)軫)	8	39 lt	+36 wk
52	常陣 Ch'ang Ch'ên	Regular Troops	North of Emperors, in form of	7	West star	I(翼)	5	35	+33
53	三台 San T'ai	Three Excellencies	Extended fr. Civil to Large Prof.	6	North ✻ of Ex-	Tsing 井)	36m	30 lt	+38 lt
54	相 Siang	Minister	South of North Bushel	1	—— [cellency[9]	I(翼)	5	31.5	+37
55	太陽守 T'ai Yang Shou	Solar Regarder	South west of Minister	1	——	Chang(張)	13lt	35 flat	+39
56	天牢 T'ien Lao	Celestial Prison	Under the Square of N. Bushel	6	East star	Chang(張)	11lt	26.5	+44 m
57	文昌 Wen Ch'ang	Civilisation	——	6	West star	Tsing(井)	15m	25 m	+43.5
58	北斗 Pê Tou	North Bushel	North of Large Profundity	7	The fifth star	Ton(斗)	13	12 m	—
	輔 Fu	Supplement		1	Pole star	Chang(張)	0	18 lt	+98
59	紫微垣 Tsü Vei Yüan	Enclosure of Profundity fo Purple	North of North Bushel	15	Right star	Chên(軫)	10	90.5	+56 m
	北極 Pê Chi	Polar Stars		5	——	——	—	—	—
60	鉤陳 Kou Ch'en	Curverd Snoops	In Palace of Purple Profundity	6	Large star	Pi(壁)	8	11.5	+64
61	天一 T'ien I	Celestial Unity	South of Right Gate Keeper of Pr.	1	South star	Chên(軫)	10	10.5	+74.5
62	太一 T'ai I	Grand Unity	Near te South Cel. Unity	1	——	Chên(軫)	10	10	+74.5

III. Shih Shên's Wai Kuan Stars or Southern Stars

	Name of Asterism (Translation)		Position of Asterism	No. of*	Principal Star	Hour Angle in Siu	mzd (in	N.P. Dist. chinese de	Latitude grce)
1	庫樓 K'u Lou	Treasury		10	North west star	Chên(軫)	—lt	140	—21 m
	五柱 Wu Chu	Five Columns	South of chio (角)	15	——	——	—	—	—
	衡 Hêng	Balance		4	——	——	—	—	—
2	南門 Nan Mên	South Gate	South of Treasury	2	Right star	Chên(軫)	14	130	—21 m
3	平星 P'ing Sing	Equality	North of Treasury	2	West star	Chên(軫)	14	100	—11 m
4	騎官 Ch'i Kuan	Cavalry	South of Ti (氐)	27	North* in West-	K'ang(亢)	4m	115.5	—19.5
5	積卒 Tsi Tsu	Valets	South of Fang & Sin (房心)	12	West ward Branch	Ti(氐)	13m	124 lt	—21 lt
6	龜 Kuei	Tortoise	South of Vei (尾)	5	Head star	Vei(尾)	12	131	—21
7	傅說 Fu Shuo	Premier in Dream	Behind of Vei (尾)	1	——	Vei(尾)	12m	120.5	—13 m
8	魚 Yü	Fish	n the Galaxy behind of Vei(尾)	1	——	Vei(尾)	14	122	—12
9	杵 Ch'u	Pestal	South of Chi (箕)	3	North star	Chi1(箕)	1m	132.5	—21 m
10	鼈 Pieh	Turtle	South of Tou (斗)[1]	14	Right star	Tou(斗)	1	129.5	—14
11	九坎 Chiu K'an	Nine Caves	South of Niu (牛)	9	South west *	Tou(斗)	14.5	136	—19 m
12	敗臼 Pai chiu	Damaged Mortar	South of Hsü & Wei (虛危)	4	South west *	Nü(女)	10	132 lt	—19
13	羽林 Yü Lin	Yü Lin Army	South of Shih (室)	45	West star[2]	Vei(尾)	4m	120 m	—13 m
	壘壁陣 Lui Pi Chên	Line of Ramparts		12	——	——	—	—	—
14	北落 Pê Lo	North Country	South west of Yü Lin	1	——	Wei(危)[6]	9	120 m	—23.5
15	土司空 T'u Szu K'ung	Civil Engineer	South of K'uei (奎)	1	——	Pi(壁)	7m	120 lt	—24 lt
16	天倉 T'ien Ts'ang	Celestial Granary	South of Lou (婁)	6	South star	K'uei(奎)	4m	120	—18
17	天困 T'ien Chün	Celestial Warehouse	South of wei (胃)	12	North east *	Wei(胃)	lt	96.5	—14 lt
18	天廩 T'ien Lin	Celestial Archive	South of Mao (昴)	4	South star[4]	Wei(胃)	13lt	90	— 9 m
19	天苑 T'ien Yüan	Celestial Garden	South of Mao & Pi (昴畢)	16	North east star	Pi(畢)	1m	114	—48 lt
20	參旗 Shên Ch'i	Standard of Shên	West of shên (參)	9	South star	Pi(畢)	9.5	93	—13.5
21	玉井 Yü Tsing	Well of Jewels	Under Left Leg of Shên (參)	4	South west star	Pi(畢)	12lt	120 m	—50 lt
22	屏 P'ing	Screen	South of Well	—	North star	Tsui(觜)	—m	118	—46 m[5]
23	厠 T'zu	Celestial Lavatory	East of Screen	4	North west *	Shên(參)	3lt	115	—44.5
24	天矢 T'ien Shih	Celestial Fœces	South of Lavatory	1	——	Shên(參)	7	122	—53
25	軍市 Chün Shih	Military City	South east of Shên (參)	—	West star	Tsing(井)	3lt	110	—31
26	野雞 Yeh Chi	Wild Cock	In the midst of City	1	——	Tsing(井)	8	121	—42 m
27	狼 Lang	Celestial Wolf	South east of Shên (參)	1	——	Tsing(井)	13	106 m	—42 lt
28	弧 Hu	Bow	South east of Wolf	9	West star	Tsing(井)	16	122 lt	—52.5
29	老人 Lao Jên	Old Man	South of Bow	—	——	Tsing(井)	19	133.5	—75 m
30	稷 Tsi	Millet	South of Sing (星)	5	West star	Liu(柳)	14lt	148	—68 lt