THE K'ANG-HSI EMPEROR'S ABSORPTION IN WESTERN MATHEMATICS AND ASTRONOMY AND HIS EXTENSIVE APPLICATIONS OF SCIENTIFIC KNOWLEDGE

BY

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INTRODUCTION

The introduction of Western science into China by the Jesuit missionaries during the late Ming and the early Ch'ing dynasties came to a climax in the middle of the K'ang-hsi reign (1662-1722). The enthusiastic approval and acceptance of scientfic knowledge and techniques from the West by the second Ch'ing emperor, K'ang-hsi, had encouraged the Jesuits serving in his court and surprised contemporary Europeans as well as his Chinese subjects. For this reason, K'ang-hsi became famous in the West as "a devotee of the European civilization". His scientific attainments, among many other things, have been eulogized in Chinese history. Works concerning K'ang-hsi's interest in Western science are available, but none of them provides a full explanation.

Almost all special articles on this topic are based solely on sources in Western languages, mainly on Jesuit letters and works in French. For the lack of a sufficient understanding of the Emperor's background and political intentions, writers portray K'ang-hsi as such a fan of science that he indulged in this intellectual pursuit without thinking much about the practical side of his scientific studies. Also, in the absence of an investigation of K'ang-hsi's enthusiasm for Chinese learning they tend to exaggerate the Emperor's fervor for Western learning. Thus, they lose sight of K'ang-hsi's real standpoint and attitude in dealing with Western scientific knowledge and techniques. As a result, writers tell amusing stories of an Oriental emperor studying Occidental civilization, and fail to offer a case study in the history of the introduction of Western science into China. Ts'ai Mao-t'ang's "K'ang-hsi-ti te Yang ch'u-wei" (The K'ang-hsi Emperor's interests in Western civilization) and Gōto Sueo's "Le Gôut Scientifique de K'ang-hsi Empereur de Chine" are typical examples.

All the books on the history of the communication between the East and the West—such as Father Fang Hao's works, records of the Catholic missionaries in China, and Favier Alphonse's *Yen-ching kai-chiao lueh*, for instance; as well as articles on China's response to Western science and culture, like George Wong's essays—do furnish pieces of information relevant to the topic under consideration. However, this kind of fragmentary information is far from being ample to satisfy a desire to understand fully K'ang-hsi's interest in Western science.

There are works devoted to the K'ang-hsi Emperor, such as *koki tai tei* by Nishimoto Shirakawa; "Lun K'ang-hsi" by Liu Ta-nien and Johathan D. Spence's "The Seven Ages of K'ang-hsi (1654-1722)" and *Tsao Yin and the Chinese Bondservants: Imperial Bureaucracy in the Early Ch'ing Period*, but none of them attempts what this paper proposes to do.

This paper strives to construct as integrated a picture as possible of the K'ang-hsi Emperor's appreciation and application of Western scientific knowledge and techniques in the fields of mathematics and astronomy. Hopefully, this picture can provide an adequate background and indicate the depth and extent of K'ang-hsi's attainments in these fields. The focus of the picture-taking, however, is centered on searching after K'ang-hsi's genuine attitude towards Western science, his real intention of employing the Jesuits and of absorbing their scientific teachings, and the efficacy of the application of modern techniques. Finally, comes a discussion of the influence resulting from these attitudes and circumstances as a whole upon the introduction of Western science into China during his raign and the subsequent reigns.

To achieve these goals, emphasis is placed on associating K'ang-hsi's scientific interests with his administrative purposes and his point of view in Western science with his background in Chinese learning. Since both the K'ang-hsi Emperor's status and scholarly propensity are involved, this paper bears inevitably a political-intellectual tone.

As far as material is concerned, this paper is based largely on Chinese and French sources and partially on Japanese and English references. It is true that Chinese primary sources supply no detailed and complete information relevant to this topic. In the authorized sources about the K'ang-hsi Emperor like the *K'ang-hsi ch'ao tung-hua lu*, the *Sheng-tsu sheng-hsün* and the *T'ing-hsün ke-yen*, one can hardly find any mention of K'ang-hsi's study of Western science under the instruction of Jesuits. Even in K'ang-hsi's own anthology which amounts to more than two thousand pages, the portion regarding the Jesuits' service is surprisingly small. However, there are many miscellaneous narrations existing in scattered works or records presenting K'ang-hsi's earnest concern with and intensive applications of science of either Chinese or Western derivation.

Owing to deficiencies in the Chinese original sources, works in French, especially those by the Jesuits who served in K'ang-hsi's court, become indispensable. But it must be remembered that most of them left nearly factitious impressions of Jesuits' relationship with the Ch'ing Court or gave overstatements of the K'ang-hsi Emperor's attainments, for these works were in general written for the purpose of displaying the merits of Jesuit missionaries in China to win the favour and support of their sponsors in Europe. Among them, the *Histoire de L'Empereur de la Chine* by Joachim Bouvet and works or letters by other Jesuits have been consulted but with great care in this paper.

Individually, none of the works mentioned above fully cover the topic. However, collectively these works along with those which dealing with Chinese science of philosophy have made considerable information available for this study.

I. THE K'ANG-HSI EMPEROR'S ABSORPTION IN WESTERN MATHEMATICS AND ASTRONOMY

Three factors might account for K'ang-hsi's resolving to adopt and to study Western mathematics and astronomy: his reverence for his heritage, his resentment at the disputes between Chinese and Western stronomers at the dawn of his reign, and his naive fascination. Being instilled with the Chinese traditional view of heaven, the K'ang-hsi Emperor esteemed astronomy, and especially mathematics on which calendarmaking and other astronomical practices essentially depend. He, as did his predecessors, employed Jesuits to manage the affairs of the Imperial Astronomical Bureau when domestic astronomers and their methods proved to be ineffective. Furthermore, urged on by his enthusiasm for learning, he devoted himself to the acquisition of Western mathematical and astronomical knowledge under the instruction of these Jesuit scientists.

1. His Heritage

A. Chinese traditional cosmology and K'ang-hsi's view of astronomy

T'ien (天 Heaven), according to traditional Chinese cosmology, was regarded as the source of the controlling power over the earth; the will of Heaven, thus, becomes the unique law of human affairs. This source is above the collective will of people and the will of Heaven is manifested in political and social life.[1] All heavenly phenomena are useful for giving lessons to the people.[2] "The Chinese cosmogony characterized by augury is essentially a practical guide to human life," pointed out Chang Tung-sun, a philosopher.[3] In order to seek good fortune and to avoid misfortune, Chinese people crave to know the will of Heaven. Accordingly, they and especially their emperor, regard astronomy very highly as a science dealing with heavenly affairs.[4] The Emperor in China was considered the person who was entrusted by Heaven with the care of the human affairs of all under heaven. It was for this reason, that the Emperor was generally called T'ien-tzu (天子 the Son of Heaven).

Numerous examples in works by and about K'ang-hsi reveal to us that he shared these principles of traditional Chinese cosmology, or at least he supported and followed sincerely what a Chinese emperor was supposed to think and to do. "Heaven and man are closely related." said the Emperor once to his officials. "Whenever there is something wrong with human affairs on the earth, reproofs will be instantly given by Heaven. Heaven's response to the earth is as prompt as a shadow to its form; an echo to its sound."[5] He also considered the "emperor" as the one who acted for Heaven. In carrying out the charges received from Heaven, the emperor alloted national rewards and punishments thus manifesting the will of Heaven and refining the custom of the people.[6] In this connection, an emperor who intended to pacify his people in order to gain the blessings of Heaven had to be diligent in his administration and, most important, had to follow the will of Heaven.[7] In addition, he had to give due weight to warnings from Heaven. All the unusual changes of nature such as flood, drought, frost, earthquake, eclipses and irregular appearances of stars were interpretad by him as warnings from Heaven. He was convinced that these were portents notifying the emperor that something had been done against the will of Heaven, such as negligence of duties either by the Emperor himself or by his mandarins, or unjust sentences.

For this reason, it was of great importance to establish a special office to take note of the observation and the prognostication of omens. Thus the K'ang-hsi Emperor instructed the Imperial Astronomical Bureau: "All kinds of meteorological phenomena, good or evil have to be prophesied carefully and reported immediately." If evil omens appeared, following his precedessor's examples, the K'ang-hsi Emperor examined himself and confessed his sin; then he reformed his faults, if any. Sometimes, he even reduced his food or shunned entertainments in order to show his repentance. At the same time, he asked his mandarins to do the same. Also, like all the Chinese sovereigns of the previous dynasties, the K'ang-hsi Emperor regarded the esteeming of agriculture, the life-pulse of the Chinese people, as a way of showing reverence to Heaven. He prayed earnestly for rain and for good harvests for the people whenever there was a drought or a year of scarcity.[8] All these practices were designed to bring back the favour of Heaven.

B. Developments of astronomy and mathematics in China before the K'ang-hsi reign

Among various astronomical matters, Imperial China focused its attentions upon calendar-making which had long enjoyed a vital role in politics. In Imperial China whose foundation was based on agriculture, an orderly arrangement of civil life in the country required that it be in perfect harmony with natural changes which had a close effect on farming. Only with the aid of a correct calendar could the Son of Heaven be expected to achieve the orderly arrangement of human affairs. Therefore, the publication of a calendar was considered an indispensable function of the government. The promulgation of an authoritative astronomical system (*pan-cheng-shuo* 頒正朔) was always listed first in the agenda made for the inauguration of a new emperor. That the people followed the calendar issued by their emperor was regarded as an indication of their loyalty to the throne and their approval of the ruler's legitimacy.[9] In a sense, the calendar served as a symbol of sovereignty. The accuracy of the imperial calendar was vital to the imperial prestige. In other words, an inaccurate calendar might cause disorder or uprisings among the people. When this happened, the emperor had to give orders to retify or to reconstruct the current calendar system.[10]

However, accurate calendar-making depends upon accurate astronomical observations and calculations. These in turn depend upon accurate mathematics. For through mathematical reckonings, people can figure out the changings of the seasons, the solars terms and other celestial phenomena. Relying on these results people make calendars for the guidance of farming affairs. At the same time, by means of astronomical calculations based on certain premises astronomers can predicate calamities or other irregular changes in heaven, and thus warn the emperor to examine his administrations.[11] Even before foreign influence, Chinese experts in both astronomy and mathematics had sporadically since the Western Han Dynasty (206 B.C.-A.D. 23) thrown new light on their fields. Later on, following countries the expansion of the Fmpire, the cultural interchange with foreign countries as well as the decline of traditional science, alien knowledge about calendar-making gradually entered China. Accord ingly, the calendar system changed from time to time.[12] By the late Ming and early Ch'ing dynasties, the Western astronomical system held almost in complete domination. It is beyond the scope of this paper to narrate the whole story in any detail; but a few important points should be noted.

According to the "Yao-tien" (堯典 Documents of the Emperor Yao), one of the chapters in the *Shang-shu* (尙書, the Book of History), the legendary emperor Yao (approx. 2356-2256 B.C.) ordered Hsi and Ho, two of his officials, to fix the seasons of one year by figuring out an intercalary month (*jun-yueh* 閏月).[13] Thus began the long story of calendar-making in China. And it is for this reason that the "Yao-tien" became a code for traditional astronomers of China. The reliability of this legend has not yet been attested, but that the authority of the "Yao-tien" can not be contested. During the K'ang-hsi reign, its authority still stood firm and received even more respect than in previous dynasties.[14]

As in other ancient countries, Chinese astronomy and even mathematics were derived or related to astrology. These two fields were always associated with *Liang-i* (兩儀 the Two Fundamental Forces: Yin 陰 and Yang 陽), *Wu-hsing* (五行 the Five Elements), *Chan-kua* (占卦 the protoscientific use of elaborate symbolic structure)[15] as well as the *Ho-tu* and the *Lo-shu* (河圖洛書 the plan of the Yellow River and the Book of the River Lo, mystic diagrams said to have been supernaturally revealed). All of these are discussed in the *I-ching* (易經 the *Book of Change*), and have a direct connection with Chinese cosmology. According to traditional belief, it is because of some antique sages' explorations that the signs indicating the will of Heaven became manifest. In order to search after the significance of these signs, sages had arranged diagrams serving the purpose of divination Only through these divinations could the gap between Heaven and people be bridged. Pao-hsi (庖犧 around 2852 B.C.) was said to be the one who had invented the diagrams. Sages after him like Chou Wen-wang (周文王 around 1154 B.C.) had modified and developed the application of these diagrams thus producing all the theories and deductive methods atated in the *I-ching.* As a result of these divinations, Chinese mathematics and astronomy were born. The K'ang-hsi Emperor inherited these convictions wholesale and combined them with his mathematical and astronomical knowledge as will be shown on later pages.[16]

Chinese began to compute *yüan-chou-lü* (圓周率 i. e. π, Ludolphian number or the ratio of the circumference of a circle to its diameter) in the ancient time.The *Chou-pei suan-ching* (周髀算經 The arithmetical Classic of the Gnomon and the Circular Pathes),the first work on mathematics in China brought up a value of the ratio as approximately 3. Liu Hsin (劉歆47 B.C.—A.D. 23,), a scholar of the Western Han Dynasty, gave a value of π as 3.1547. Chang Heng (張衡 A.D.78-139), a bright scholar of the Eastern Han Dynasty, gave a value of the ratio as $\sqrt{10}$ Liu Hui (劉徽 A.D. 200-280) gained a value of π as 3.14 by successively doubling the number of polygones inscribed in a circle. Down to the fifth century, the great mathematician and astronomer Tsu Ch'ung-chih (祖冲之 A.D. 429 -500) presented more a detailed value; "*Yüeh-lü*" (約率 the approximate value of π) as 22/7; and "*Mi-lü*" (密率 the accurate value of π) to be 335/113. According to this the value of the ratio should be between 3.1415926 and 3.1415927. He applied the same method as Liu Hui but with more deliberations.[17] These computations of *yüan-chou -lü* were discussed by K'ang-hsi while evaluating Western mathematics. *Tien-yüan shu* (天元術 Chinese algebra), another accomplishment in the field of traditional mathematics, became much more famous in the Ch'ing Dynasty than it had ever been before, since *Tien-yüan shu* was held to be the origin of Western algebra in the K'ang-hsi reign. *Tien-yüan shu* was first introduced by Ch'in Chiu-shao(秦九韶A. D.?-1260), a Yüan scholar, in the *Shu-shu chiu-chang* (數書九章 The Nine Sections of Mathematics, in 1274). It was also found in Li Yeh's (李冶 A.D. 1192-1279) work, the *Ts'e-yuan hai-ching* (測圓海鏡 Sea-mirror of Circle Measurement, in 1248).[18] However, the records of this method were lost in the Ming Dynasty.[19]

Both Chinese mathematics and astronomy in the Ming Dynasty experienced a period of abeyance which left the doors of these fields open to Western science when the Jesuits arrived in China. No

Chinese mathematician succeeded in carrying on the tradition or in throwing new light on the field. Astronomers who resorted to either the *Ta-t'üng li* (大統曆 Ming calendar-making) or the *Hui-hui li* (回回曆 Muslim calendar-making) frequently gave inaccurate calculations and predictions. On the other hand, the newly introduced scientific knowledge and technique from the West attracted some enlightened Chinese scholars through whose recommendation Jesuits were employed in the Imperial Astronomical Bureau. The Jesuits did make progress in readjusting current calendars as well as in other services and thus found favour in the Ming court.[20] However, their superiority over the Chinese in this field aroused the jealousy and resentment of traditional astronomers and conservative scholars. The attack of the latter was so bitter that the Court was forced to dismiss the Jesuits, and helped to create the anti-Western sentiment prevailing in the late Ming and early Ch'ing dynasty. This sentiment did nothing for the improvement of the existing astronomical systems nor could it reduce the Imperial concern for calendar-making. The craving for a correct calendar and exact predications of heavenly portents resulted in the Court using the Jesuits again. Simultaneously, anti-Western sentiment reappeared and once more forced the Jesuits out of the Imperial Astronomical Buaeau.[21]

In spite of being alternately favoured and persecuted by the Ming court, the Jesuits received steady and constant support and assistance from Hsü Kuang-ch'i (徐光啓) and Li Chih-tsao (李之藻), two Chinese scholars and Catholic converts, and were thus able to carry out their scientific-missionary activities rather smoothly. Besides their merits in correcting the calendar, they also had constructed astronomical instruments such as the a rmillary sphere, zodiac theodolite, sextant, sun dial and quadrant instrument.[22] Most important, they had translated and compiled works on astronomy and mathematics, the most significant ones being: [23]

Titles	Authors	Year(A.D.)
Ch'ien-kun t'i-i (乾坤體義)	Matteo Ricci (comp.)	1601-1610
Chi-ho yuan-pen (幾何原本)	Ricci & Hsü Kuang-ch'i (trans.)	1607

Yuan-jung chiao-i (圜容較義)	Ricci & Li Chih-tsao (comp.)	1608-1609
T'ung-wen suan-chih (同文算指)	Ricci & Li Chih-tsao (comp.)	1614
T'ien-hsiang lüeh (天象略)	Manoel Diaz (comp.)	1615
Piao-t'u shuo (表圖說)	Sabbatinus de Ursis (comp.)	1615
Ch'ung-chen li-shu (崇禎曆書)	Joannos Terrens, de Ursis, Nicolaus Longobardi, Joaunes Adam Schall von Bell, Jocobus Pho (trans. and comp.) Hsu Kuan-ch'i and Li Tien-ching (supervised)	1629-1634

Among these works, the *Ch'ien-kun t'i-i* explains celestial phenomena and introduces some basic mathematical concepts. The *Chi-ho yuan-pen*, that is a Chinese version of the *Euclidis Elementorum Libri*, XV (1517) by P. Christophus Clavius (A.D. 1537-1612), presents essential geometric theorems in its main parts and indicates in detail, in its preface by Ricci, the relationship between geometry and other sciences and the practical value of geometry. These two books later became the major source of the *Shu-li ching-yun*,[24] the famous mathematic work compiled by K'ang-hsi's order. The *Yuan-jung chiao-i* is a work specially dealing with theorems of circles. The *T'ung-wen suan-chih* introduces general principles and calculations of Western arithmetics. These two works have also been consulted by the authors of the *Shu-li ching-yün*. The *T'ien-hsiang lueh* and the *Piao-t'u shuo* are works interpreting all kinds of meteorological phenomena, with the aid of attached illustrations.[25] The *Ch'ung-chen li-shu* was the only authoritative and comprehensive work on Western science in the Ming Dynasty. It is a combination of articles on astronomical observations, tables of surveying references and maps of stars.[26] Through this work, European astronomical theories and technique were presented and the application of trigonometry as well as of geometry were introduced.[27] All of this knowledge was unprecedented in China and caused opposition from some contemporary scholars. However, the Jesuits had introduced new ideas in these fields in the Ming Dynasty, whether they were believed or not, thus providing reference in the field of mathematics and astronomy for the people in the Ch'ing Dynasty.

When the Manchus conquered China and came to the throne, the Jesuits by virtue of their accurate astronomical demonstration, together with other scientific knowledge, won favour from the court. Father Joannes Adam Schall von Bell was invited to direct the Imperial Astronomical Bureau. He made a new calendar for Ch'ing court which the throne entitled "*Shih-hsien li*" (時憲曆 Current calendar) with a sub-line saying "*I Hsi-yang hsin-fa*" (依西洋新法 Being based on new Western method). Furthermore, schall introduced his work, the *Hsin-fa piao-i* (新法表異) indicating the differences between the Chinese and the Western astronomical syatems with forty-two examples, and thus disclosiny the defects in the Chinese system. All of Schall's works irritated the traditional astronomers.[28]

2. Disputes between Chinese and Western Astronomers in the K'ang-hsi Reign

At the time when K'ang-hsi came to the throne, anti-Western sentiment in the field of astronomy was again aroused by Yang Kuang-hsien, an astronomer. In 1664, Yang composed the "Che miü-lun" (摘謬論) pointing out ten errors in the astronomical calculations of Adam Schall von Bell. By means of another work, the "hsüan-che-i" (選擇議) mixing the concepts of astronomy with astrology he accused Schall of having fixed an inauspicious date in 1688 for the burial of the infant Prince-Jung (榮親王).[29] In 1665, Imperial councillors heard and decided this case. In the course of the official inquiry, Yang and Schall defended themselves. None of the councillors, however, could give a just judgement for, in addition to knowing nothing about astronomy, they strongly disliked foreigners. As a result of repeated imperial deliberation, Schall was removed from office and soon died from disease. Other Jesuits who were involved in this case were ordered to return to Macao, while some others were imprisoned.[30] Yang, the winner, was appointed head of the Imperial Astronomical Bureau.

As a matter of fact, Yang Kuang-hsien knew little about astronomy.[31] In fear of his inabilities to fulfil this charge, Yang memorialized again and again declining the appointment. In his six "Pu-kan shou-chih chih wei shu" (不敢受職之畏疏 memorialising in the fear of assuming the position); two "Pu-kan shou-chih chih hsiu shu" (不敢受職之羞疏 memorialising in the shame of assuming the position) and five "kou-hun shu" (叩閽疏 petitions), Yang first made excuses of ill-health, and then emphasized that he knew something about astronomical principles but nothing about calculations. Therefore, he dared not to serve in the Bureau, or he preferred to work there without bearing an official title. But all his petitions were denied by the Board of Civil Office.[32] In fact, at this time there were no outstanding astronomers in the country. Yang's actions reflected the Chinese dilemma: to reject Jesuit merits on the one hand, and to be conscious of their own disability on the other. His chauvinism had temporarily defeated the Westener but his reluctant service in the Bureau led in the long run to failure.

After Yang assumed the post, he and his followers failed to make accurate astronomical observations and calendar calculations owing to their insufficient scientific knowledge.[33] In order to rectify this situation, Yang was eager to search for some learned experts as his assistants. And, stubbornly enough, he hoped to adopt some long obsolete method recorded in the history of the Han Dynasty as his remedy. In 1666, Yang represented his desires to the throne and asked the Board of Rites for the preparation of the following materials: *chu-kuan* (竹管 bamboo tube), *chia-fu* (葭莩 reed stems) and *chu-shu* (秬黍 black millet).[34] Two years later, the K'ang-hsi Emperor declared that all these materials were ready and the tests which he had made through these materials, according to old methods, gave useless results, Then he asked Yang to check these methods or to have others examine it. Yang failed to achieve both and again gave ill-health as his excuse for resigning.[35]

In calendar-making Yang and his followers resorted to the system of *ta-t'ung-li*. Again, their inability led to emberrassment. Yang made a calendar of 1668 including an intercalary month after the twelfth month. But he discovered a miscalculation after the issue of the calendar. After receiving his report, the Emperor gave orders to cancel the intercalary month. This offended the throne so badly that Yang was almost in danger of being beheaded.[36] In spite of his failure Yang still acted as s strong spokesman for the anti-Western movement. In 1667 when the K'ang-hsi Emperor was considering the employmant of Ferdinandus Verbiest, Yang Kuang-hsien promptly warned the throne with stubborn ethnocentrism:

> It is better to have no good astronomy than to have Westerners in China. If there is no good astronomy, this is no worse than the Han situation when astronomers did not know the principle of apposition between the sun and the moon and consequently claimed that the solar eclipses often appeared on the last day of the month; still the Han dynasty enjoyed dignity and prosperity for four hundred years. With Westerners in China, I am afraid that they would use money to win the hearts of our people; it is like the setting of fire to a bunndle of firewood, and troubles will not be too far off . . . .[37]

Before Yang's assertions could convince the emperor, another event inthe field of astronomy soon occured in the following year. Verbiest pointed out all the errors in the calendar which was made for the year of 1669 by Wu Ming-hsüan(吳明烜), Yang's assistant. The emperor considered this case of great importance and ordered all the councillors, princes, and nine ministers to deliberate the matter earnestly. They found that Verbiest's arguments were too abstruse to judge so they asked the Imperial Astronomical Bureau to investigate before they made any decision. At the same time, they suggested to the emperor that he appoint some other officials to join their investigation. Twenty persons, both Manchu and Chinese, were dispatched.[38]

After comparing the Wu's calendar and Verbiest's predicates with the actual celestial happenings of 1669, (the time of *Li-ch'un* 〔立春 Spring begins or Aquarius〕 and *Yü-shui* 〔雨水 Rain water or Pisces〕; the locations of the moon, Mars and Jupiter) Ma Hu (馬祜), head of the Bureau, with the twent additional officials gave a judgement favouring Verbiest. Then the councillors recommended Verbiest to the throne to take charge of making a calendar for the year of 1670, for "what Verbiest argued has all been verified while what Wu Ming-hsüan suggested has not been fulfilled." But K'ang-hsi ordered them to consult Ma, Yang, Wu and Verbiest on the case of 1665 (disputs between Yang and Schall) for reference before he made any decision.[39] This time Yang, in the hope of playing down his failure, petitioned to the throne with ridiculous orthodoxy:

> ....the astronomy of the Imperial Astronomical Bureau is the hereditaty method of she Emperor Yao and the Emperor Shun. Since the throne Your Majesty holds is the throne inherited from Yao and Shun, and since the authority Your Majesty enjoys is the authority handed down by Yao and Shun, then the astronomy promugated by Your Majesty should be the astronomy of Yao and Shun. Everything that Your Majesty decrees is in accord ance with Yao and Shun, how can it be that only astronomy is not? With regard to Ferdinand Verbiest, he destroys the hereditary astronomical instruments of Yao and Shun, replacing them with European instruments....[40]

However, Ma and his followers all accused Yang of having faulted the astronomical system which Schall had suggested and supported Verbiest for all his calculations proved in accordance with observed celestial phenomena. Faced with this situation, the councillors made their final decision completely opposed to that of 1665: 1) "From 1670 on, the calendar system suggested by Verbiest will be adopted and the application of all the useless traditional ways of calculations will be stopped." 2) "Yang Kuang-hsien, on the charges of delinquency, of giving improper protection to Wu Ming-hsüan, and of maligning Western astronomical methods, must be severely punished." The Emperor approved their decisions but treated Yang in a rather kind way—removing him from office only.[41] Following this, Verbiest was made assistant of the Imperial Astronomical Bureau. Through his advice, the emperor gave orders to move an extra month from the calendar of 1699 to 1670, and to do all the astronomical observations according to Verbiest's suggestions from then on.[42] Five months later, the Emperor approved Prince K'ang's (康親王,Giyesu) suggestion to honour Schall posthumously by reconferring his title "Tung-wei chiao-shih" (通微教士) as well as his official rank, and to pardon all these still in prison as a result of his case. Some of the latter were also reinstated in office.[43] The disputes between Chinese and Western astronomers thus ended. Afterwards Jesuit scientists enjoyed a better time at the court serving the throne in various duties.

It must be noted that during this period of disputes, all the decrees given by the K'ang-hsi Emperor were decisions based on his officials' judgements rather than on K'ang-hsi's own opinions.[44] As in the late Ming period, when stubborn astronomers attacked the Jesuits, there were also officials who protected them. K'anghsi did not pay any special attention to either group but let his councillors do the judging. He requested thorough investigations and accepted what the majority favored. In the case of 1668-69, the councillors followed a practical and objective approach and brought about a reasonable result. If these councillors had been as prejudiced as their predecessors in the case of 1665, and if there had been no strong supporters for Verbiest in the Imperial Astronomical Bureau, it is doubtful whether K'ang-hsi would have accepted the Western astronomical system so promptly, although he esteemed calendar-making highly. He certainly would not have approved the Western sytem exclusively if his officials had not generally favored the Jesuits. Again, he would not have approved it so quickly without his officials' recommendation for he had no real understood of it.

As a matter of fact, K'ang-hsi at this time was not yet versed in Western mathematics or astronomy. In the following statement he reveals that it was these very disputes which gave rise to his determination to learn mathematics:

> You all know that I am good at mathematics but none of you know the reason why I study it. When I was young, there were disputes between Han officials and Westerners in the Imperial Astronomical Bureau. They blamed each other so badly that they almost brought on themselves the

> danger of being beheaded. Yang Kuang-hsien made a bet with T'ang Jou-Wan [Schall] in predicating a sun shadow in front of Wu-men [午門 the Wu Gate], in the presence of the nine chief ministers. However, none of them knew what the astronomers were doing. In my opinion, a person who lacks knowledge in certain field is in no position to judge others in that field. Since then I have put forth my efforts to learn it [mathematics].[45]

K'ang-hsi really felt ashamed of his officials' ignorance. As vital as astronomical affairs were to his country and as enterprising as his mind was for learning, how could he stand a situation like this? So when Yang made a serious mistake in his calendar for the year of 1668, K'ang-hsi's dissatisfaction became intense and was transformed into an force urging him to study matters dealing with heavenly affairs. Here is his own statement:

> .....[in this] case, people wrangled and disagreed over the inserting of the extra intercalary month [which Yang had made] for it sounded odd to put two intercalary months in a single year. All the nobles and ministers were ordered to think over this case again and again, but none of them knew anything about calendar-making. I was pained in my heart when I witnessed this event. Therefore. I devoted myself to the study of astronomy and mathematics.[46]

3. K'ang-hsi's Study of Western Mathematics and Astronomy

Under the instruction of the Jesuits, the K'ang-hsi Emperor began studying Western mathematics and astronomy at sixteen and became fairly competent in geometry and instrumental surveying by middle age.

A. Prelude

During the period from 1670 to 1674, Fathers Ferdinandus

Verbiest, Christianus Herdtricht, Philippus Grimaldi and Thomas Pereyra served as imperial tutors and taught K'ang-hsi in turn.[47] In spite of some officials' warning,[48] the Emperor studied geometry very hard at intervals. At the same time, he learned how to use some major astronomical instruments.[49] In order to provide a text book for the teaching of geometry, Verbiest completed a Manchu version of Clavius' *Euclidis Elementorum Libri XV* (Chapter I-VI) based on Matteo Ricci and Hsü Kuang-ch'i's Chinese translation of this work.[50] The astronomical instruments which were cast by the Jesuits in the last years of the Ming Dynasty were all destroyed by the rebels (李自成Li Tzu-ch'eng's followers). When K'ang-hsi began to learn about astronomical observations, he had the instruments which were sent to his father, the Shun-chih Emperor, by the Jesuits all brought out. Then, he tried to operate them one by one according to the Jesuits' demonstrations. He also ordered Verbiest to cast some new ones. In 1674, Verbiest completed six pieces of astronomical instruments.(See Table I) These pleased the Emperor to the extent that he conferred on Verbiest the official title of "T'ung-cheng shih" (通政使 an imperial official in charge of receiving memorials from inside or outside the Imperial city).[51]

The Rebellion of the Three Feudatories (1673-1681) interrupted K'ang-hsi's scientific studying. During warfare, he studied geometry only once in a while. Later the Emperor was busy with his tours to Shengking (盛京, ie. Liaoning 遼寧, in 1682) and to Tartary (in 1683). Attending the Imperial Tours, Verbiest, as a member of his retinue, was ordered to carry astronomical instruments and make observations along the way.[52]

It was not until 1685 that K'ang-hsi was able to continue his course of mathematics and astronomy. Another Jesuit, Thomas Antonius, was recommended by Verbiest to give lectures.[53] Unfortunately, the Emperor was soon forced to stop his study because of the Sino-Russia conflict (1685-1687).

B. Climax

Again in 1689, K'ang-hsi resumed his studying of Western

TABLE I

ASTRONOMICAL INSTRUMENTS CAST IN THE K'ANG-HSI REIGN

Year (A.D.)	Caster	Instruments	English Equivalents
		T'ien-t'i-i (天體儀)	The Armillary Sphere
		Huang-tao ching-wei i (黃道經緯儀)	The Zodiac Theodolite
1674	Ferdinandus Verbiest	Ch'ih-tao ching-wei i (赤道經緯儀)	The Equatorial Theodolite
		Ti-p'ing ching i (地平經儀)	The Azimuth Instrument
		Ti-p'ing wei i (地平緯儀)	The Transit Instrument
		Chi-hsien i (紀限儀)	The Sextent
1681		Ti-p'ing p'ing-mien jih-kuei i (地平平面日晷儀)	The Horizontal Sun Dial
	Thomas Pereyra	Chien-p'ing i (簡平儀)	The Equinoctial Instrument
1693		San-ch'en chien-p'ing ti-p'ing ho-i (三辰簡平地平合儀)	The Horizontal-equinoctial Instrument
1713-1714	Beryardus Kiliamus Stumpf	Ti-p'ing ching-wei i (地平經緯儀)	The Horizontal Theodolite
		Hsing-kuei i (星晷儀)	The Star Dial
1714		Ssu-yu-piao pan-yüan i (四游表半圓儀)	Season Revolving Simicircle Instrument
		Fang-chü hsiang-hsien i (方矩象限儀)	The Rectangular Quadrant Instrument

science. From then on, Fathers Joachim Bouvet, Jean-Francois Gerbillon and Antonius associating with Pereya and Suares took turns delivering daily lectures in the Yang-hsin tien (養心殿 Hall of cultivating the mind).[54] Both the scope and content of the subjects which K'ang-hsi explored in the field of Western science broadened as time went on. To geometry and astronomical observations were added trigonometry, surveyings, algebra and later anatomy. Simultaneously, more works were translated as teaching materials. It was during this period that K'ang-hsi's enthusiasm for Western learning reached its climax.

i. *Intensive mathematical studies.* In the process of daily lectures, K'ang-hsi listened with attention to the Jesuit tutors doing their best to give particulars of geometric theorums. Applying a compass and Western methods, the Emperor learned to draw geometrical figures to verify theorems.[55] K'ang-hsi's enthusiasm for learning provided him with a source of patience which enabled him to stand the Jesuits' broken Manchu language and even their abrupt manners.[56] It also sustained him in pursuing practical aspects in his learning and in asking questions.

As we can imagine, in the course of a cultural introduction of this nature, his questions mostly resulted from barriers in both language and ways of thinking. As far as language was concerned, both the Emperor and the Jesuits preferred Manchu to Chinese. For K'ang-hsi, it meant he could comprehend new concepts more clearly when lectures were carried on in his mother tongue. "Manchu, in terms of its spelling and grammar, is much easier to learn than Chinese," said Bouvet; and he also revealed, "We, Jesuits, can study Chinese books by means of their Manchu version only after a short period of learning Manchu; on the contrary, we were unable to put Chinese into practice even after having studied it for several years."[57] However, hindrances still remained. Rendering scientific concepts into the Manchu language was not an easy task, especially to those who were not quite familiar with Manchu intellectual and practical experiences. Some European scientific terminology and some complex ideas found no adequate counterparts in the Chinese or Manchu languages. Therefore, the Jesuits had difficulty at times in giving K'ang-hsi a thoroughly comprehensive explanation. In many cases, the Jesuits could only integrate original European terminology into the Manchu context.[58]

K'ang-hsi, whenever in doubt, inquired of the Jesuits in detail over and over again. If Jesuit answers failed to satisfy him, K'ang-hsi, himself would think over the question all day long, and ask the Jesuits the same question again until his doubt was solved.[59] Owing to K'ang-hsi's inquisitive mind, one single lecture usually lasted for several hours. At times when the Jesuits failed to finish explaining the daily lessons, K'ang-hsi would take home the lecture sheets. Under the lamp-light in the Imperial bed-chamber, the Emperor-student reviewed what he had learned during the daytime and tried to figure out what was new to him. He studied so hard that he always went over a single piece of theorem with its methods at least twelve times before he thought himself fully versed in it.[60]

Simultaneously, burning the midnight oil in their apartment in the Ch'ang-ch'un yüan (暢春園),[61] Bouvet, Gerbillon, Antonius and the others, with the assistance of their editors and their scribes, prepared new lectures for the next day.[62]

There are many descriptions found in works based largely on French sources dealing with the Emperor's study of Western mathematics. They might be too farfetched to be trusted as exact facts, but they at least could be regarded as the partial truth of the story which reflects K'ang-hsi's favor and the Jesuits' efforts in this case.

According to Jesuit descriptions, the diligent Emperor-student indeed kept his Jesuit tutors busy. Among them Bouvet and Gerbillon seemed to be the busiest. As a routine, they left their house early in the morning, escorted by imperial grooms, and got back late in the evening.[63] At a time when K'ang-hsi's zeal for learning Western science grew intensive, both of them spent four hours a day at the court, two hours before noon and another two afterwards to deliver lectures.[64] Occasionally, Bouvet was called to K'ang-hsi's palace even late in the night to answer questions which suddenly occurred to the Emperor during his "homework"; or to correct calculation papers which K'ang-hsi had done by himself.[65] When K'ang-hsi stayed at his summer palace in Jehol Bouvet was obliged to get up at four o'clock in the morning in order to arrive at the palace in time for the Emperor's morning lessons. He was kept staying there to prepare lessons and give lectures again until K'ang-hsi's evening class was over. After that, Bouvet returned to his residence "where he spent a large portion of the night answering the questions raised that day andpreparing lessons for the next morning." [66]

Following Verbiest's example and the Imperial order as well, the Jesuits resorted to using Western works as their teaching materials. As a result of accumulating daily translations and compositions, the Jesuits produced some works on mathematics, mainly on geometry; Bouvet completed a Manchu and a Chinese version of the *Elementa Geometriae*; Gerbillon finished translating the *Elements de Géométrie tires d'Euclide et d'Archimede* and the *Géométrie Practique et Théorique, tirée en partie du Paredie* into both Manchu and Chinese.[67] Antonius compiled a collection of problems of calculations in arithmetics and geometry.[68] Besides their editors' help, they reportedly had to resort to a dictionary by Ricci to overcome their language difficulties.[69] Most of the above mentioned works were later modified and embodied in the *Shu-li ching-yü*.[70]

For his part, the K'ang-hsi Emperor did make progress in his geometrical studies. As one of his teachers, Bouvet, tells us, that only five or six months after they began to teach K'ang-hsi, the Emperor had mastered most essential geometric theorems. He became so adept that whenever he glanced at a geometric diagram he could tell immediately the method as well as the theorem which was supposed to be applied to verify the diagram.[71] Later on, he further learned about cubes, cylinders, cones, pyramids and spheroids. He became versed in some of the European terms for these objects as well as with the methods of drawing the symbols and diagrams for demonstrating them.[72]

As to K'ang-hsi's study of trigonometry, special information has not yet appeared. According to Father Hsu Tsung-tse's record, Jesuits had translated works on trigonometry into both Manchu and Chinese for their teaching in that subject,[73] but both the names of the translators and the date of delivering lectures remain unknown. However, from K'ang-hsi's remarks on the computation of π, we know that he explored this subject. Once in 1692, he pointed out to his officials the ingenuity of the device to compute π through trigonometric progressive extraction while criticizing the defect lying in traditional solutions to the same question which used geometry by successively doubling thd number of sides of a regular polygon inscribed in a circle. He at the same time revealed to them that he found this device, translated as *Kou-ku pan-chin fa* (勾股半徑法), in trigonometric works; and that it was this device from which the method of extraction was derived. Also he demonstrated to his officials some calculations.[74] From this we can believe that K'ang-hsi at least had a chance to read works concerning trigonometry, whether they were special texts on the subject or just references in texts used for other related subjects, such as geometry or surveying.

Similarly in the case of K'ang-hsi's study of algebra, both the names of his teachers and the time of his learning this subject are obscure. Fortunately, a few pieces of information found in Chinese sources are available. According to these records, K'ang-hsi had a hard time in learning algebra in the beginning. He studied it diligently, but found it not so easy as what he had already learned. "I study algebra with A-ko (阿哥 princes) and others everyday after I get up," said the Emperor. "This new method is the hardest one. In reality, it is easier than those old solutions; but it looks more difficult." [75] Therefore, he felt, "There is something wrong and also something contradictory." [76] He was really confused. So he ordered Wang Tao-hua (王道化), an official, to examine with Westerners the book he read, to expunge whatever was ungrammatical, and to ask the Westerners questions. These questions revealed that K'ang-hsi at this time was utterly a stranger to algebra. For example, he inquired:

> According to what they said, [in such examples] 'x multiply by x; y multiply y; and z multiply by z', there are no numerals; the quantity of the products are also unknown. . . .[77]

Owing to this kind of uncertainty, the Emperor even doubted his Western tutor's mathematical attainment by saying, "It seem from this that what this man learns about calculation is nothing better than average level." [78] Nevertheless, K'ang-hsi finally became skilled in algebra, for he could apply it to figure out an unknown location in a survey, an unknown number in daily life or an unknown root in music. By this time, he had changed his viewpoint completely. "Western calculation is good," remarked the Emperor and then concluded, "This method 【 algebra 】 originated from China. They call it '*a-erh-chu-pa-erh*'; this means a method from the East." [79] K'ang-hsi himself gave this method a Chinese name, "*Chieh-Ken-fang*" (借根方 to borrow root and power ie. algebra).[80] Later he taught this method to Mei Ku-cheng (梅轂成), a mathematician in his court, with far-reaching results as will be shown on later pages.

This scene helps us to revise the amusing impressions which we receive from Jesuit descriptions. Here we know that K'ang-hsi was really not a "tame student". Besides his inquisitive habit, a sort of subjective passion emerged in the course of his learning Western science, which would result in certain kinds of misunderstanding. Also, the Emperor-student showed less respect to his Jesuit tutors than students in China were supposed to in dealing with their teachers. It is true that K'ang-hsi had treated the Jesuits in his court with great favor which always heartened them. However, this is nothing more than the Emperor's customary practice to encourage those who had offered him satisfying services. As a matter of fact, he did not consider the Jesuit tutors as teachers but learned servants. Accordingly, he did not show much respect for their scholarship. It is true that K'ang-hsi had even displayed his admiration for what he had learned from the Jesuits after he became versed in it. But before this, when he was still perplexed about a new subject, his skepticism and even bias arose from time to time. In view of this, the Jesuits' teaching work was really hard. However, their efforts as well as K'ang-hsi's own enthusiasm for learning cleared the air to a large extent and confirmed the Emperor's confidence in Western mathematics. But, it must be noted that, according to K'ang-hsi, these Western methods were something "new" rather than something "Western." In this connection, the admiration which he had paid to these "new" methods is admiration for the ingenuity of the methods rather admiration for either Jesuit scholarship or European civilization. Furthermore, owing to his constant reverence for the Chinese heritage, he dogmatically believed that these admirable methods derived from China. This point will become more clear as our discussion goes on.

As to mathematics itself, K'ang-hsi did show genuine interest in this subject. "Mathematics is an exact science. Even the daily volume of flowing water through the lock gate of a river can be figured out," said the Emperor. He explained, "The calculation is to measure the width and the volume of flowing water per second, and then [the answer] is easy to know".[81] Although this calculation is merely a simple example in the application of multiplication, it seemed to K'ang-hsi a sort of magic which transformed things unmanageable into things manageable. It is this practical side of mathematics which attracted K'ang-hsi to the study of this subject, and also which led the Emperor to the intensive application of mathematics and his adoration in instrumental surveys.

ii. *Practical astronomical surveying exercises.* In the position of a Chinese emperor, K'ang-hsi's concern about the practical side of mathematics was inevitably focused on calendar-making. He realized the vital fact that after a calendar was issued, it would serve as a manual for agriculture and be verified by actual natural happenings. "How can it escape people's notice?" constantly troubled him.[82] Also, he recognized that calendar-making is a work based on surveys and completed by calculations. K'ang-hsi indicated: "As to all the celestial phenomena, without surveying we can never know them in particular; while without calculations we can in no way make any surveys of these phenomena."[83] For this reason, K'ang-hsi was eager to study surveying in addition to mathematics. From Antonius, Gerbillon or the other Jesuits, he learned how to make land surveys and astronomical observations.[84] Part of his Imperial Tours served as his "field work" for surveying. Accordingly, K'ang-hsi highly esteemed astronomical instruments on which surveying work depends.

As a matter of fact, the Emperor exhibited an adoration of Western astronomical instruments. He claimed: "In an imperial stock like mine, I can find almost everything. But I have an eye particularly for the astronomical instruments stored in it."[85] This was because of his conviction that celestial phenomena were great mysteries; only through these instruments which were based on eternal principles, could this mystery be observed.[86] The eternal principles here referred to mathematical theorems. Again, he realized the magic of mathematics. So, he cherished these astronomical instruments which Verbiest had cast for him.[87] He even composed a poem entitled "Yün kuan-t'ien i-ch'i" (詠觀天儀器) to eulogize them. Besides describing their luminous appearances and elaborate structures, he praised, "The eternal principles which make a thorough search into the mystery of Heaven and Earth."[88] To this point, K'ang-hsi thought only of science. However, he did not forget to reverence his heritage, for he noted that these astronomical instruments "find their origin in the time of Ancient Sages."[89] Later, he asked Father Pereyra and Father Stumpf to construct more surveying instruments.[90] (See Table I) In addition to these, the Emperor received various kinds of instruments made in Europe, large and small, from the Jesuits.

As soon as Bouvet and other Jesuits arrived in Peking in 1688, they presented an armillary sphere and a quadrant together with a telescope, a sextant and some books on astronomy to the throne.[91] The first two were recent products of the French Academie des Sciences. Through them eclipses and comets could be observed. K'ang-hsi appreciated them and had them set in the main palace.[92] Father Jean de Fontaney and Father Claude de Visdelou also offered the Emperor several astronomical timers and a couple of levels, and explained their usage to him. At the same time, they taught K'ang-hsi how to observe eclipses.[93] Then the Emperor sent out orders to the mandarins in the coastal cities ordering that all scientific instruments should be forwarded immediately to Peking upon their arrival from Europe. When Fontaney and Visdelou went to the southern provinces, they and Father Louis Le Comte, as well as Suarez, sent instruments and other Western scientific products to Peking. K'ang-hsi received from them a transit instrument, a quadrant and a huge compass together with some dry and some liquid phosphorous. K'ang-hsi used the transit instrument and the quadrant inctrument very often.[94] The Emperor had most of these instruments housed in the Peking Observatory located in the south-eastern Seition of the Imperial City.[95]

When the Emperor stayed in Peking he went to this observatory once in a while to investigate some heavenly phenomenon, the locations of a star, the changing of an eclipse or the time of a solar term. Besides he liked to measure a shadow of the sun in front of the main palace; or to make other tests to compare his calculations with the measurements resulting from his practical surveys. Through these exercises, he went over what he had learned from the Jesuits and became fairly versed in some surveying methods by means of the instruments.[96] K'ang-hsi also had instruments carried with him on most of his journeys.

On his frequent Imperial Tours to the North or to the South, K'ang-hsi usually stopped to make calculations or surveys. He always had Gerbillon carry out the surveys. After he became familiar with the operations of the several kinds of instruments, he tried personally to make some surveys too: to measure the length of a road, the height of a mountain, the width of a river, the size of a piece of land or the distance between places. Whenever he found that his calculations were completely accurate or that his own measurements coincided with those of Cerbillon his enthusiasm for learning Western science increased. The praises and shouts of joy coming from his surprised retainers and other witnesses also added to this encouragement.[97] On the Imperial Tours to the South, K'ang-hsi always visited the Observatory in Nanking.[98] The Jesuits staying there attended the Emperor and usually offered him some Western products. Among these contributions, K'ang-hsi accepted scientific instruments but returned religious articles.[99] He was not interested in Western religions at all in spite of his curiosity for new things.

After numerous observations and surveys K'ang-hsi's confidence in Western calendar-making was becoming firmer. This does not mean that he had never found anything wrong in calendars the Jesuits made. Rather he recognized that Western calendar-making as a whole was available. Several times he discovered slight divergencies in current calendars, but he thought these small faults were technically inevitable because from his practical surveying exercises, he realized the fact there were elements which always caused deviations in surveys, such as geocentric parallax (the effects of rugged surface of the earth);[100] magnetic deflections;[101] or effects of a drizzling atmosphere 【Meng-ch'i 蒙【濛】氣】.[102] These deviations, even though trivial would result in divergencies between actual celestial happenings and the predications in the calendar based surveys which involved these elements.[103] It is evident from this that the K'ang-hsi Emperor's trust in Western calendar-making was not the result of a blind favoritism but rather of a sober mind.

In surveying, K'ang-hsi put emphasis on measurements of the degree of the equator and latitudes, for they are essential to calendar-making.[104] He told his officials that the variety of temperatures and the length of seasons from north to south depends upon the different local distances from the sun. In this connection, the measurement of the equatorial degrees was a matter of primary importance which required examining in detail. If a person wants to figure out a direction, south or north, the best method is to take the sun's location at noon as a basis for comparison.[105] He recommended this method because no other proved more accurate, even compasses, owing to their magnetic deflections, sometimes failed to show exact directions. Talking about latitudes, he at first pointed out the relation between the measurement of the celestial body and that of the earth by saying:

> .... The celestial body measures three hundred and sixty degrees; the earth has the same measurement. One degree of the measurement on the earth is equal to two hundred and fifty *Chou-ch'ih* (周尺 a linear measure, as a foot used in the Chou Dynasty, 1122-255 B.C.), but equal to two hundred current *ch'ih* (a Chinese foot around 1.41 English measure). Therefore, we know the celestial bodies and the earth have the same measurements ....[106]

Then, based on this recognition, he recommended that one could figure out the degree of latitude of a spot by measuring the sun's location on that spot at certain times.[107] This is in fact a common application of the method of trigonometrical survey but to K'ang-hsi, it was a sort of "master key" to astronomical mysteries:

> . . . . No matter what size a place is, large or small; no matter what distance it is, far or nearby, through the calculation [according to] this method, we can gain an exact predication. To a large extent, this method of *San-chiao kou-ku* [trigonometrical survey] can be applied to the reckoning of the revolving of the celestial bodies; of the occurrence of an irregular star; of the eclipse of sun or moon. Even those which had occurred hundreds and thousands years before or will happen after us, can become known to us.[108]

Once again he was attracted by the magic of mathematics. And once again he reverenced his heritage. He was convinced that people in the Age of Ancient Sages had already carried out rather accurate surveys and used a similar method. Chinese people after them forgot such surveying. But Western people happened to learn this method and kept improving on it all the time.[109]

From his discussions, it is obvious that the Emperor was not merely a fan of science or a simple follower. He tried to associate his mathematical book-learning with practical surveying; his land surveying with his astronomical observation; and most important, his scientific studies with his political concerns; and his modern knowledge with the traditional heritage. Also, K'ang-hsi tried to make use of what he had learned from the Jesuits in both mathematics and astronomy. On the following pages, we will see how he applied his scientific knowledge to meet his purposes, namely, to guide administration to win scholars, and to reinforce his prestige.

II. EXTENSIVE APPLICATIONS OF SCIENTIFIC KNOWLEDCE

Solely receiving knowledge from the Jesuits was not K'ang-hsi's final goal. Furthermore, he desired to introduce and sometimes "show-off" what he had learned in Western mathematics and astronomy. K'ang-hsi, by using his scientific knowledge as well as his attainments in other fields, not only taught the children of the imperial house hold, officials and even Chinese scholars in the same fields, but also set about solving problems which he encountered.

The Emperor was said to have composed a text on geometry for teaching his children once he had became thoroughly versed in the subject. Gathering the children in a hall, K'ang-hsi would explain to them some geometric theorems and at the same time verify them in detail with a compass. At times such as these, he acted more like a school teacher than as a majestic ruler.[110] Finding that his third son had an aptitude for science, K'ang-hsi gave him special instructions in geometry, and later in surveying.[111] Also, the Emperor had his sons study under the Jesuits' instructions. For example, he asked Bouvet to teach his second son; he ordered his third son to go with Thomas on a surveying mission in 1702;[112] and in 1711, he had Tillich teach his fourth son science.[113] These actions reflect K'ang-hsi's determination to furnish his children with a background in Western science which could be applied during their future administration as well as during K'ang-hsi's own.

As far as K'ang-hsi's own administrative purposes were concerned, he at times applied his Western scientific knowledge to imperial affairs, especially in river conservancy works, in territorial control, in regulating weights and measures, as well as in calendar making. All of these were closely related to the national life-pulses, namely agriculture and revenue.

1. Administrative Instructions and Self-Display

In 1711, the Emperor visited Chili to inspect water conservancy works. He told Chao Hung-hsieh (趙宏燮), the governor of the province, "Since you, hold the post of governor, you are supposed to know something about surveying. Let me give a demonstration for you."[114] First, he cut off a piece of rope, two *chang* (丈) long.[115] Next, he made from this piece of rope a rectangle with each side five Chinese feet long, and soon fixed each vertex of its four angles. "Look at the area within the rope: each side of this area has an epual length to that of this rectangle. But the measurements of their size are not necessarily exactly the same owing to the unevenness existing in the physical feature of the land," K'ang-hsi pointed out and then remarked, "So, in practical survey work, the method we just used is obviously unsuitable."[116] Furthermore, he warned Chao, "People usually take advantage of this [defective method] and report false measurements in order to cheat their governor and thus to evade their duty." Then, the Emperor suggested, "There is a way to stop this kind of illegal practice. By measuring only the diagonal line of a field we can figure out immediately its acreage. Then people will be unable to play tricks. In this instance, surveying is of great importance."[117] Although, the method which K'ang-hsi suggested to Chao is just one of the preliminary calculations in surveying, it was important to the K'ang-hsi Emperor. On the one hand, he taught the governor a simple way to resolve a troublesome problem involving both territorial control and revenue. On the other, he indirectly prevented his officials from being negligent of their duty. His instructions indicated to his officials that the emperor was a knowledgeable man, so capable that he could discover any fault.

As his predecessors Shih Huang Ti in the Ch'in Dynasty and Emperor Wu in the Han Dynasty. K'ang-hsi took the system of weights and measures as one means for regulating social order. In other words, without a standarized system of weights and measures, an reasonable price of commodities, and a reasonable marketing administration, fair judgement in civil affairs and a powerful system of law could hardly be expected. In order to consolidate, to centralize the country, and to check or to take precautions against malpractices, the standardization of weights and measures formed one of the important planks in the government platform.[118] For this reason, the K'ang-hsi Emperor occasionally examined in person samples of weights and measures offered by the Board of Revenue. In this matter, K'ang-hsi again made use of his mathematical ability.

For instance, in 1704 he told his officials that he had tested samples of *hu* (斛), *tou* (斗) and *sheng* (升), (three levels of cubic measres), offered by the Board of Revenue. By pouring water in these cubic measures and then checking their volumes through calculations, he found that all the measurements of the angles were uneven. So he had a new model *tou* and a new model *sheng* made according to the standard which he had fixed; and ordered the Board of Revenue to recast new cubic measures based on these models.[119]

To value weights and measures was a customary concern of a Chinese emperor. But to have a standard measure set by the emperor himself was unprecedented in Chinese history.

Another example which showed K'ang-hsi's earnest attitude in administration supported by his scientific interest and knowledge was calendar-making. In order to examine the accuracy of the current calendar, the Emperor usually observed in person, by means of astronomical instruments, the time and the course of eclipses or heavenly phenomena at the time when they took place.[120] By doing so K'ang-hsi checked the actual phenomena with predications made by his astronomical officals. In case he found any differences, he would search for the factors which had caused these divergencies.[121] In this respect, K'ang-hsi relied almost wholly on what he had learned from the Jesuits in the fields of mathematics and astronomy. At the same time, he displayed a mind which was much more receptive than that which he had displayed when he first began to learn algebra

In addition to applying this knowledge to practical political purposes, K'ang-hsi sometimes revealed a strong desire to show-off his attainment in Western science because of his vanity. It was said that once in the middle of K'ang-hsi's daily mathematics class, Tillich was presented. At that time Tillich had not yet learned the Manchu language since he had just recently arrived in China. K'ang-hsi handed a geometric figure to Tillich giving it the European name. The Emperor boasted to his officials on the spot that he was able to converse with Tillich through a mathematical language.[122]

K'ang-hsi also liked to exhibit his ability in calculation to his subjects. Cha Shen-hsing (查愼行), one of his courtiers, tells us, "Our Emperor is well versed in mathematics. Once he showed us the "On Triangle," one of his own essays; but none of us could understand its contant." [123] Another time, K'ang-hsi made a demonstration in their presence. He arranged a pile of rice into a cylinder and measured with a soft rule its height and its circumference.

Then the Emperor used the method of mensuration (*Tuei-to fa* 堆垜法) tocalculate the volume of this cylinder. After this, K'ang-hsi used a copper peck to measure all the rice. "The measurement was exactly the same as he just reckoned. . . ." [124] The Emperor thus surprised those of courtiers who were ignorant of geometry.

One day in 1692, he asked for a sundial and marked a sign on it. "At noon, the sun-shadow coming to our palace will reach this sign," K'ang-hsi pointed out to his courtiers. Then, he had some of them put the sundial in the center of the Ch'ien-ch'ing Gate (乾清門 the gate in front of the main palace, Ch'ien-ch'ing Kung) and watch it. At noon, the sunshadow came to the exact point the Emperor had marked. "Today because of Your Majesty's demonstration, we learn what we have never known before. This really overcomes us with joy," eulogized his courtiers.[125]

It appears from these examples that the K'ang-hsi Emperor, being proud of his own attainments in both mathematics and astronomy, wished others to share his intellectual pleasures, or rather longed for praise and admiration from others, to reinforce his prestige among his subjects.

In addition, K'ang-hsi took pleasure in communicating with those Chinese scholars, inside or outside the Court, who were versed in mathematics and astronomy. In the course of discussions and interviews with them, K'ang-hsi enjoyed sharing knowledge, traditional and Western, in these fields. Also he enjoyed displaying what he had learned from the Jesults while giving instructions to such scholars. Accordingly, he treated them with great favor.

2. Academic Communications and Directives

Mathematics and astronomy, in imperial China, had a close connection with classical learning. The *Shang-shu* (The Book of History) began with a chapter dealing with calendar-making. The *Yu-hsüeh* (The book of elementary studies for beginners in classical learning) put emphasis on arithmetical learning. These works naturally made it essential for traditional scholars to acquire some knowledge, in these two fields. Thus through, studying the classics, those who had a natural aptitude for these subjects became mathematicians and astronomers. During the Ch'ing Dynasty, mathematicians and astronomers, as did some of their predecessors in the late Ming dynasty, absorbed Western knowledge in the same fields.[126] In 1700 scholars of the Anhui School dominated these two fields.[127] Accordingly a chief scholar of this school, Mei Wen-ting (梅文鼎), his grandson, Mei Ku-ch'en, and one of his students, Ch'en Hou-yao (陳厚耀), were recommended to the K'ang-hsi Emperor by their friend, Li Kuang-ti (李光地).[128]

Li Kuang-ti was a famous courtiers of the K'ang-hsi reign. He found favor with the Emperor due to his attainments in metaphysics, especially in the study of the *I-ching*, a source of traditional mathematics and astronomy. Appointed imperial expositor and Hanlin compiler in metaphysics Li sometimes also attended the Emperor on Imperial Tours. Li was said to have picked up Western knowledge in mathematics and astronomy but to such a limited extent that he usually failed to answer the Emperor's questions about celestial phenomena. Instead, K'ang-hsi would informed him of new concepts in these fields. In their dialogues dealing with astronomical affairs, we can see clearly K'ang-hsi's interest as well as his attitude toward both traditional and Western calendar-making.

An encounter occuring in 1689 (K'ang-hsi 28/2/27) reflects this clearly. On that day the Emperor visited the Nanking Obervatory while on an Imperial Tour to the South. K'ang-hsi summoned his retinue and asked if there were any Chinese officials among them who were versed in astronomy, but he got a negative answer. Then, the Emperor asked Li Kuang-ti, "How many stars do you know?" "I could not even identify all the twenty-eight Hsiu (宿 the Chinese Zodiacal Constellations)," answered Li. "Do you know the reason why the two constellations, Ts'an (參) and Tsuei (觜) were recorded as 'Tsuei-ts'an' in old calendars but now as 'Ts'an-Tsuei' in new calendars?" questioned K'ang-hsi. Li replied to the Emperor, "I really don't know." "According to the results of astronomical surveys using the instruments in our observatory, the constellation Ts'an actually comes before the Tsuei," explained K'ang-hsi. He further remarked: "In view of this, we can believe the accuracy of the current calendar." [129] This seems to show that K'ang-hsi did place his confidence in new calendars, products of Western calendar-making, on practical observations.

Again, the Emperor tested Li, "Are the fixed stars moving?" "I am not quite sure," said Li; but straight away he gave an answer satisfying the Emperor, for he added; "According to modern astronomers' words, the fixed stars are moving, but slightly." Then, K'ang-hsi noted, "Because of his unawareness that fixed stars are actually moving, Kuo Shou-ching's (郭守敬) astronomical instruments have now become out-dated."[130] Here, K'ang-hsi criticized the old astronomical system on the basis of modern discoveries. Furthermors, K'ang-hsi asserted that most astronomical records found in the historical works of the successive dynasties after the ancient period were unreliable, for when one judged them through eternal principles they became worthy of nothing but empty words. "For example, it has been said that the planet Mars is retreating," mentioned the Emperor and pointed out the following differences; "In terms of heavenly warning signs, this saying means it. In terms of reality, however, it is doubtful. If the planet Mars were actually retreating, I wonder on what basis the astronomers in the successive dynasties would gain their accumulating measurements."[131] It is obvious from this that K'ang-hsi had a comprehension which enabled him to tell a scientific natural law from an ethical natural law. A scientific natural law indicates what the physical universe really is; it manifests reality, while an ethical matural law implies what the spiritual heaven is. The former is a source of science controlling the material world, while the latter is a source of politics regulating human sociery.

They ended their discussion with a short survey. The Emperor opened a map of constellations, looked at the South and pointed out a big star close to the Earth, then told the officials, "This is *Lao-jen hsing* (老人星 Canopus)." Li Kuang-ti commented, "According to historical books, when the *Lao-jen hsing* appears, it symbolizes the presence of long-lived virtuous people on the earth." "But, in examining the latitudes, we find it is always seen in Chiang-ning (江寧 Nanking)," argued K'ang-hsi and asked: "How can it be so, emerging for a while and hiding for a while?"[132] Examining the conversation here, we find that K'ang-hsi based his argument about *Lao-jen hsing* on a scientific inference, while Li introduced a traditional interpretation of the star from an ethical point of view. In other words, traditional scholars were convinced that the appearance of the *Lao-jen hsing* represented an auspicious sign in human society; whereas K'ang-hsi believed that it was a constantly existing star in the celestial regions.

On the same day, K'ang-hsi consulted the Jesuits about *Lao-jen hsing*. On this tour, Fathers Jean D. Gabiani and Fontaney attended on the Emperor. That morning K'ang-hsi gave them silver. That afternoon these two Jesuits went to the emperor's lodging to express thanks for the Imperial favor and presented twelve items of Western products. The Emperor took half of them and asked for two themometers.[133] After they left, K'ang-hsi sent Chao Ch'ang (趙昌), an imperial body-guard and one other retainer to their church. They asked the Jesuits whether they could see *Lao-jen hsing* in Chiang-ning and what its location was in degrees of latitude in Chiang-ning and in Twangtung. Gabiani and Fontaney answered these questions one by one. The two Imperial retainers rode at a gallop to report to the throne. Still, Gabiani and Fontaney, for fear of having made a mistakes in their hurried snswers, made an observation, that evening, to examine the location and revolution of the *Lao-jen hsing*. Then they wrote a memorial recording these results in detail and sent it to K'ang-hsi the next morning. . . .[134]

It appears from this episode that the encounter at the Nanking Observatory was pre-arranged, so to speak. Here the K'ang-hsi Emperor once more cut a brilliant figure in the presence of his courtiers. Using Western scientific knowledge, previously acquired or hastily picked up from the Jesuits, as well as personal experiences from practical surveys, the emperor examined some traditional concepts in astronomy and praised modern calendar-making. Although his knowledge and experience might mean nothing to experts in astronomy, they were complex enough to impress his subjects who seemed more conservative and less learned in science than their emperor. However, it is not safe to draw a conclusion from this scene that K'ang-hsi had become a devotee of Western science exclusively or that he had received no influence from Li Kuang-ti. For, in fact, the emperor preferred a syncretic way in adopting Western science, as we will see in the later pages. And K'ang-hsi's belief in all the theories stated in the *I-Ching* bears a similarity to that of Li Kuang-ti. In the study of the *I-Ching* as well as of metaphysics, the emperor trusted Li, as far as ethical natural law was concerned.[135] It must be noted also that K'ang-hsi's criticism of the old astronomical system was in no way an indication that he had lost his reverence for the Chinese cultural heritage, as we mentioned before. The heritage which K'ang-hsi revered refers to the ages of or before the Legendary Sages rather than the ages after them.[136] To believe in the Legendary Sages was by no means superstition, for K'ang-hsi did so out of a desire to act more like a Chinese emperor.

Mei Wen-ting (1633-1721), a celebrated scholar in the early Ch'ing Dynasty, had dedicated his life to developing Chinese traditional mathematics and astronomy. In his comprehensive studies, he attempted to reconcile Chinese and Western learning in these two fields.[137] He had become well known by 1702 when K'ang-hsi asked for his works.[138]

Li Kuang-ti provided one of Mei's works, the T'ian-hsüeh i-wen, (天學疑問 Queries on astronomy).[139] This time the Emperor wanted to be the commentator. He said, "Since I have studied mathematics for many years, I think I can critically evaluate this work." After a short survey, he found that this book was a thoughtful product with fair arguments and that the author's attainments in the field were high. K'ang-hsi decided to carefully read it. Li encouraged the Emperor to write down his critical notes on the pages of the book.[140]

One year later, on an Imperial Tour to the South, the emperor sent back Mei's work with punctuation marks, comment circles, erasures and attached notes all written in his own hand. Li inquired about faults in the work. "There is nothing wrong in this work," said the Emperor, "but the calculations in his discussion do not seem perfect enough."[141] Had the emperor possessed no genuine interest nor proper background, he would not have bothered to do this commentary on Mei's work in spite of his desire to show off. Viewed from this angle, one may say that he fulfilled his own vanity through intellectual efforts rather than empty gestures. His vanity in this respect seems to have come after rather than before he was taught about Western mathematics and astronomy. Once he became self-contented with his own achievements, no matter how great or little, in a certain field, he was inclined to challenge and also to learn more from others in the same field. In addition, he sometimes bested of his ability to outsiders. At the same time, he paid sincere respect to those who were superior in the same field.

On another imperial tour to the South in 1705, the Emperor asked Li Kuang-ti to summon Mei Wen-ting. On the Imperial boat, in a three-day interview, the Emperor consulted, in an informal manner, this aged scholar about mathematics and calendar-making. After that K'ang-hsi told Li, "I have long been applying myself to the study of astronomy and mathematics in which few people are well versed. Talented people like Wen-ting are rare; he is gentle, too, but very old. What a pity!" Then the emperor wrote four characters in large size: "Chi-hsüeh ts'an-ts'e" (積學參徹 erudite and thorough) as a gift to be bestowed on Mei wen-ting.[142]

In recognition of Mei Wen-ting's merits, K'ang-hsi in 1706 granted to Mei's grandson, Mei Ku-ch'eng (1681-1763), the privilege of studying at Court.[143] In 1712, the Emperor appointed Mei Ku-ch'eng compiler and then chief compiler in the *Meng-yang chai* (蒙養齋), placing him in charge of the compilation then in progress of two cardinal works the *Shu-li ching-yün* (數理精蘊 Essential meanings of mathematics) and the *Li-hsiang k'ao-ch'eng* (曆象考成 Verifications on astronomy). K'ang-hsi also conferred on him a "*ch*ü-*jen*" degree in 1713, and the "*chin-shih*" degree one year later because of his excellent efforts.[144] In addition, the Emperor encouraged him to carry on his family learning. As a result of this, Mei Ku-ch'eng revised and edited a collection of his grandfather's works entitled "*Mei-shih l*ü*-suan ts'ung-shu*". He also composed several works presenting his own arguments.[145]

Most important of all, K'ang-hsi frequently taught Mei Ku-ch'eng something about Western mathematics.[156] In this respect, Mei shared K'ang-hsi's inclination to revere the Chinese heritage. As a matter of fact, Mei Ku-ch'eng revealed a strong ethnocentric sentiment throughout his writings.[147] After learning algebra from the K'ang-hsi Emperor, Mei's ethnoentric sentiment became so articulate that it reinforced the popular conviction rising in the late Ming period and prevailing until the late Ch'ing Dynasty, that "All Western learning was derived from China." We are not going to deal with this popular conviction in this paper, for it has already been discussed in great detail by others.[148] We only stress here Mei-Ku-ch'eng's own arguments and examine the extent of his understanding of algebra in order to find out K'ang-hsi's opinion and influence on the same field.

Mei Ku-ch'eng emphasized the superiority of the Chinese cultural heritage, on the one hand, and degraded Jesuit scientific achievements as opportunistic on the other.[149] As to Western science itself, he shared his grandfather's syncretic approach: to use new meteods to supplement the incompleteness of the old, but not to seek the complete abolition of old methods in order to follow the new.[150] He blamed those devotees of Western science who criticized traditional cultre. At the same time he disagreed with those conservative people who totally refused to accept alien learning. Therefore, Mei Ku-ch'eng himself while promoting traditional mathematics, accepted those Western methods which he considered to be worthwhile.

When he was studying at Court, Mei Ku-ch'eng had a chance to learn three mathematical formulas introduced by Father Petru Jartoux who arrived in Peking in 1701. The three formulas had to do with the computations of Ludilphian number (i.e., π); sine and versed sine, through the calculation of trigonometric progressive extraction.[151] These thsee methods were all novel to Chinese mathematicians at that time who could compute three of these subjects only with the aid of geometric calculations. When compared with their counterparts in geometry, these three trigonometric methods were found much more convenient and time-saving. Viewing these advantages, Mei Ku-ch'eng translated and incorporated these newest methods into one of his works, the *Ch'ih-shui i-chen* (赤水遺珍) in order to introduce them to his Chinese readers. Furthermore, he proved them by using the law of proportion.[152] However, his hostile feeling towards the Jesuits, in the long run, diminished his enthusiasm for Western mathematics. Accordingly, to reconcile this dilemma; or rather to compensate for the injured self-esteem, in an ethnocentric sense, he adopted an attitude of cultural "condescension" towards the foreigners.[153] It was in this psychological state that Mei Ku-ch'eng dabbled in algebra.

Having attended upon his learned grandfather for many years, Mei Ku-ch'eng was imbued with Mei Wen-ting's academic work. He was already familiar with mathematics before he studied at Court. Nevertheless, he had had grave doubts about *t'ien-yüan shu*, Chinese algebra, since he found both its terms and methods very confusingly transmitted in the existing works of his age.[154] His doubts remained unresolved until he had learned algebra from the K'ang-hsi emperor.

According to Mei Ku-ch'eng's biography, the emperor seems not really to have taught Mei algebra, but rather to have explained its terms. He was said one day to have given Mei a book on *chieh-ken-fang* (algebra) and noted: "Westerners named this method 'A-erh-je-pa-ta' which can be translated into Chinese as 'Tung-lai fa', (東來法) a method from the East". After reading this book, Mei found the method introduced very conducive and similar to *t'ien-yüan shu*. Then he reexamined the *Shou-shih suan-ts'ao* (Calculation drafts of the Shou-shih system, a work of the Yüan Dynasty) in great detail, and declared that the two systems of algebra were of the same method although their terminology was different.[155] Furthermore, in the hope of restoring Chinese algebra, he asserted:

> During the Yüan Dynasty, scholars, whether they were composing books on mathematics, or whether they were regulating mathematics, were all dealing with this subject, algebra. Somehow, for reasons unknown, [the history of] its development has been lost. Fortunately, from the distant people, the Jesuits, we have rediscovered this old subject. Still, they have not forgotten where the term "*tung lai-fa*" comes from. [156]

Most of the Ch'ing scholars believed Mei Ku-ch'eng's assertion, and considered it as a great rediscovery of a lost treasure in the field of traditional mathematics. Even Meng Shen (孟森), a famous historian of the early republican period, took for granted that *chieh-ken-fang* and *t'ien-yüan shu* were the same thing.[157] From the following investigation, we will find whether Mei's words were true or false.

As regards method, these two systems of algebra are similar, for they both assume a root for an unknown quantity as well as for the process of extraction.[158] However, they are different in their method of calculation. As Li Jui (李銳 1768-1817), a mid-Ch'ing mathematician, pointed out: *t'ien-yüan shu* resorts to a calculation of cancelling in which only the operation of subtraction is applied. As to *chieh-ken-fang*, it reckons upon fluctuation, that is another kind of cancellation employing both subtraction and addiion.[159]

As far as the terminology and the symbols of 'a-erh-je-pa-la' (阿爾熱巴拉) are conceaned, *chieh-ken-fang* and the *t'ien-yüan shu* are not identical nor is there any relationship. An article entitled 'A-erh-je-pa-la k'ao' (阿爾熱巴拉考 An investigation of *A-erh-je-pa-la*) found in the *Chung-Hsi wen-chien lu* (中西聞見錄 Memoir of Visiting the East and the West), provides the following information:

> In the nation of Arabia, we found one kind of mathematical book entitled 'A-la je-pa-erh i-a-la mo-chia-pa-la, (阿拉熱巴爾愛阿喇莫加吧喇). (Aljabrwal Muquabalah) 'A-la' means 'this'; 'je-pa-erh' means 'can' . . . . these two words combined together point to a calculation which can transform fractions into integers; 'mo-chia-pa-la' means 'corresponding' or 'being equal to' . . . . that is 'computing through interchanging one with another . . . .'[160]

It is evident from this that there is nothing in the meaning of the term "*A-erh-je-pa-la*" indicating its origin. It might have been the European Jesuits in China who invented the free translation "Tung-lai fa" (method from the East) to mame algebra, denoting that this method was borrowed from the Oriental country, Arabia.

Although its symbols have been changed several times since

Arabian algebra was invented, all the applied symbols bear no relation to that of *t'ien-yüan shu.* Central Asian mathematicians in the fifteenth century like Al-Kashi (?-1456), in his work entitled "Key to Mathematics," expessed the unknown quantities in algebraic equations root, square, cube, square-square, square-cube, cube-cube, etc. Italian and French mathematicians in the sixteenth century signified them as cosa, censo, cubo, censo d: censo, censo d: cubo, cubo d: cubo, etc. From the seventeenth century, European mathematicians symbolized them as x, x^2, x^3, x^4, x^5, x^6 .... The compiler of the *Shu-li ching yün* adopted the latest symbols and stated them as x^4-x^2. x^2; x^6-x^3, x^3 or x^6-x^2. x^2. x^2.[161] Ch'ing mathematicians did apply algebraic formulations to the resolution of some questions in *t'ien-yüan shu*, but these in no way signify that algebra was the original method of *t'ien-yüan shu.*[162] In the original *t'ien-yüan shu*, its roots were called, "*t'ien yüan-i*" (天元一) and marked in Chinese characters; and its calculations were registered in columns.[163] All these are different from algebra in either the Arabian or European style.

From these facts we can conclude that Mei Ku-ch'eng's deduction, that *chieh-ken-fang* originated from the *t'ien-yüan shu* in the Yüan Dynasty in China is a misapprehension resulting from his ethnocentrism as well as his ignorance of the differences between them. However, it is because of this association that *t'ien-yüan shu* attracted the attention of scholars and thus became more well-known than ever before.[164] In spite of the unreliability of Mei's deduction, his views drew immediate support from the K'ang-hsi Emperor as well as other contemporaries.

Ch'en Hou-yao, one of Mei Wen-Ting's students, being good at mathematics and astronomy was recommended to the throne by Li Kuang-ti in 1706. As soon as Ch'en came into the presence of the emperor, he was given a quiz. K'ang-hsi drew a triangle and asked him to figure out the center line of this triangle, then questioned him on how to reckon the size of an arc. Ch'en Hou-yao responded to the Emperor promptly with accurate answers. The emperor was satisfied with him and two years later appointed Ch'en compiler to join forces with Mei Ku-ch'eng and others in compiling imperial works. Also, once in a while, the emperor summoned him to talk about geometry and surveying.

Their discussions even covered some practical aspects involving astronomical surveys, such as the measurement of latitudes, the effects of moist air, and the application of the formula for computing the circumference of a circle.[165] Their talks disclosed that the emperor shared with Ch'en reverence for the Chinese heritage and at the same time reliance on Western scientific knowledge. For K'ang-hsi always agreed with Ch'en who in the process of discussions usually showed respect for traditional works yet drew his conclusions from Western science. For instance. one day K'ang-hsi asked Ch'en "What is the source of the theory: 'the Earth is round in shape'?" "The *Chou-pai suan-ching* had already mentioned it," answered Ch'en. "Why do you believe that it is round?" asked the Emperor. According to the *Chih-fang wai-chi* (職方外紀 a book on world geography by Father Julius Aleni in 1632), the Westrners say that they saw people everywhere on the road while taking a tour round the earth; so we know it is round," Ch'en replied. Ch'en produced other evidence. "There are always divergencies in time between the East and the West when we measure sun-shadows; there are always divergencies in distance between the North and the South when we survey the stars. These all tally with the charactistics of a sphere; so I am sure that it is round." "Good points," praised the emperor.[166]

In this dialogue, Ch'en attributed the origin of the theory that the Earth is round to an ancient Chinese work, on the one hand, and supported his convictions entirely by Western sources of facts based on actual physical surveys. It appears from this that Ch'en's attitude toward Western science was totally in accordance with that of the K'ang-hsi emperor when the latter deat with Western calendar-making, as mentioned above.

Because of this harmony in their intellectual inclinations, K'ang-hsi was willing to share more scientific knowledge with Ch'en. He showed Ch'en the imperial stock of astronomical instruments on another day. Furthermore, K'ang-hsi tutored Ch'en in some algebraic methods dealing with determinants, extraction, and supposition. Later, he bestowed on Ch'en a hend-copied rare book, the Chinese version of

Clavius' Euclidis Elementorum libri I-VI by Matteo Ricci, and taught him some geometric calculations.[167] In order to encourage Ch'en Hou-yao, K'ang-hsi also gave him stationery of excellent quality and even a precious desk made of luminous wood.[168]

The great kindness which the emperor had conferred on Mei Wen-ting, Mei Ku-ch'eng and Ch'en Hou-yao was unprecedented. There were no other people in Chinese history who had received such impressive imperial favors by virtue of talent in mathematics and astronomy, even though calendar-making had long attracted imperial attention. All these accounts which show the emperor enjoying himself by communicating with his subjects about scientific knowledge make it hard for us to deny the emperor's sincerity in his devotion to science and mathematics and his respect for talented people in these fields.

At least, these accounts reflect that the emperor, unlike those jealous or unlearned emperors among his predecassors actually encouraged scholars in science as well as in other fields.[169] It is true that this encouragement, in a political sense, was a sort of device to win over Chinese scholars. This device was more effective in practice than any othar methods used during his reign. However, this encouragement, in an intellectual sense, is indication that K'ang-hsi also cherished authentic academic zeal for sharing knowledge with others as well as for pursuing knowledge, in addition to his political intentions.

As far as K'ang-hsi's attitudes toward Western science were concerned, he more or less shared the same opinions as Mei, Ch'en and Li : a syncretic way of accepting Western science, a grave concern for preserving China's prestige, and a tendency to associate science with the theory of the *I Ching*.

The K'ang-hsi emeperor was not exclusively devoted to Western science although he could recognize its superiority to Chinese science. Throughout his reign he adopted calendars made by using Western methods for their evident accuracy. However, in the course of his application of Western science, he revealed from time to time an appreciation of the superstitious use of Western mathematics. On the other hand, sometimes he frankly pointed out defects lying in traditional science. In spite of this, K'ang-hsi never advocated the wholesale discarding of traditional science; rather, he preferred a synthesis. According to him, the pattern of the traditional calendars was good but their calculating results were all out of date. So he thought that the way of producing imperial calendars used in his reign was the best: "following traditional patterns yet using the latest calculations." [170] K'ang-hsi's method of synthesis, in other words, was a selective acceptance of both the traditional heritage and alien knowledge.

Having a practical mind, K'ang-hsi advocated employing ideas and techniques that were valuable and discarding those that were not irrespective of their background. The only thing he was concerned about was how to make a perfect combination by integrating, if possible, whatever was considered the most helpful and efficient with respect to his administration. Another example demonstrates this point clearly. Once he read a Western book and found that it contained calculations similar to those in the *I-ching*, yet the explanation in Western language was beyond his linguistic ability. He put some notes and figures among those calculations which seemed to him to be most useful. Then the Emperor handed this book to his officials and ordered: "Translate those parts which seem worth using and memorialize me; ask about which you cannot make decisions and expurge those which are not useful." [171] It appears from this that the emperor's approach in accepting Western science bears a similarity to that which Mei Wen-ting and Mei Ku-ch'eng followed. They, as has been mentioned above, were inclined to inte- grate into their works that Western scientiffc knowledge which they considered valuable while dealing with Chinese astronomy or mathematics.

Like Mei or other Chinese scholars in his age, the emperor also applied his scientific knowledge to check the textual accuracy of astronomical records in Chinese books. For instance, he once used his knowledge of *Lao-jen hsing* (Canopus) to check the astronomical record in the *Liao-shih* (a history of the Liao Dynasty, A.D. 907-1119). K'ang-hsi recognized the fact that stars revolve about a celestial body. They are, in fact, always in existence, and their appearance or disappearance depends upon the observer's location on the earth. On this basis, he criticized part of the astronomical record in the *Liao-shih* as false because it recorded that in the second month of the twelfth year of the Mo-tsung reign (A.D. 936) *Lao-jen hsing* was seen in their capital. K'ang-hsi exposed the error by saying: "The capital of the Liao Dynasty, Lin-huang Fu [臨潢府 a place in Lin-tung Hsien, Jehol Province] is located in the extreme northeast part [of China]. How could they see *Lao-jen hsing*?" [172]

In the long run, the emperor could not dispense with the prevailing influence of ethnocentric sentiment in China. Instead, he shared Mei Ku-ch'eng's convictions and became one of the spokesmen, a powerful one because of his superior status, of the theory "that all Western learning was derived from Chinese origins."

Talking about calendar-making, K'ang-hsi asserted that those people were ignorant of the source of calendar-making who believed that modern calendar-making was basically different from traditional ways. In his opinion, calendar-making sprang from China and was then introduced to the West. The Westerners had long persevered it; Kept on making surveys and thus revised it from year to year. It was because of this that they had more accurate calendars rather than because they used other methods. Although their terms and symbols were different, these had nothing to do with the source of calendar-making. The point was that if the Chinese had kept accurate surveys and made yearly modifications, Chinese calendar-making would never have been out of date and could have proceeded without outside influences for thousands of years.[173]

The emperor believed that the ancient Chinese were very familiar with surveying and mathematical calculations. Furthermore, he inferred that calculations by trigonometry already had been applied by the ancient Chinese for they knew the annual variation, monthly variation diurnal variation, and the like.[174] They recorded the waxings and wanings of the stars, and the natural inclinations of animals and plants. They reckoned summer and winter solstices indicating the revolving of the sun, the vernal and autumn equinoxes marking the changing of the seasons, the appearances of the stars, and the eclipses of the sun and the moon. They also had the *hsüan-chi* (璿璣)[175], a kind of ancient astronomical instrument of the time of Shun (舜) 2255-2205 B. C.). Therefore, they made calendars. By following these calendars all the people could fully perform their daily functions. All of these celestial phenomena could not be observed in complete detail or recorded with accuracy without surveying, nor could these achievements have been accomplished without mathematical calculations. It was impossible that the ancient Chinese made calendars without applying the method of trigonometry, an essential method to surveying and astronomical calculations.[176] Here the emperor attributed the invention of calendar-making to the ancient Chinese and gave evidence by associating their achievements with modern scientific knowledge.

According to the emperor's inferences, the ways which Western astronomers followed had already been used by the ancient Chinese. In other words, the Western astronomers just followed exactly what the ancient Chinese astronomers did. Westerners owed the accuracy of their calendars to their improvements based on the Chinese heritage rather than to the invention of new methods. In this connection, to adopt calendars basing on Western methods was in fact to fulfill the Chinese tradition rather than merely to learn from foreigners. This is also true of the emperor's attitude towards Western mathematics. "Western mathematics is good. It originated from China," said he.[177] Thus, he implied that his appreciation of Western mathematics was actually an appreciation of Chinese science. On the other hand, K'ang-hsi blamed those who failed to carry on the Chinese heritage or who cared nothing for Chinese science.

K'ang-hsi indicated that scholars living in or before the time of the three ancient dynasties, Hsia (夏), Shang (商), Chou (周), 2205-255 B. C., thought highly of practical learning. This was the reason why they could achieve great things in science. Scholars after them, however, thought highly of official rank and devoted themselves to the literary arts. Most of the astronomers did not bother with complicated calculating processes and adopted slovenly ways. After many dynasties, they knew nothing about the source of calendar-making but kept on using short-cuts. And over a number of years they never realized their own errors. Famous Chinese astronomers like I-hsing (一行) and Kuo Shou-ching (郭守敬) in the Yüan Dynasty modified slightly Chinese calendar-making merely by borrowing the Arabian astronomical system. These calendars were adequate for the time being, not forever, owing to "the fact that these calendars were not grounded on mathematics." [178] As to mathematics, most scholars in China after the ancient period chose to ignore it completely. This resulted from the fact that they thought some principles of mathematics were too abstruse to understand while some were so easy as not to merit study. As a result, they almost lost sight of the tradition of Chinese mathematics. Worse still, this caused disputes about calendar making in the early years of the K'ang-hsi reign.[179]

It appears from here that the Chinese heritage which the emperor revered referred to what was handed down before the most ancient period rather than from all the dynasties preceding his reign. Those traits which emerged during or before the ancient time, he respected, whereas those which came afterwards he looked down upon. In criticizing traditional science, he emphasized the unfavorable Ming atmosphere, but attributed similar unfavorable conditions to all dynasties succeeding the ancient period. Accordingly, achievements of the astronomers and mathematicians of later dynasties were ignored of degraded. In this respect, the Kang-hsi emperor's standpoint was not exactly in accordance with that of Mei Ku-ch'eng and his grandfather or some others, for they esteemed scientific geniuses of the Han, T'ang, Sung and Yüan Dynasties as highly as the legendary sages. Mei and others attributed the sources of Western scientific theories to different works by Chinese scholars not necessarily within the category of the sagely classics. The emperor, however, associated the sources of Western scientific theories exclusively with the classics. On this point, K'ang-hsi shared the convictions of Li Kuang-ti who believed that calendar-making found its origin in the "Yao-tien," a chapter in the *Classic of History* and that all kinds of calculations sprang from the *I-ching.*[180]

On this basis, while talking about algebra, the emperor, like Mei ku-ch'eng, believed that Western algebra was derived from China; but K'ang-hsi attributed its source specifically to the *I-ching*[181] while Mei Ku-ch'eng associated it with *t'ien-yüan shu* used by the scholars in the Yüan Dynasty. As to the *I-ching,* the emperor and Mei, as well as the average Chinese scholars of their age, were in agreement in regard to this classic book as a genercl source of science but differed in the degree to which they trusted its individual theories. K'ang-hsi, like Li Kuang-ti, accepted wholesale the theories stated in the *I-ching*, as we have mentioned before. However, Mei Ku-ch'eng and some of his contemporaries doubted the reliability of the theories of the Ho-t'u (the diagram of the Yellow River) and the Lo-shu (the book of the River Lo).[182] In spite of these differences among them, they were all in harmony in their desire to seek a reasonable excuse for their acceptance of Western science. They thought that they were learning from the Chinese heritage rather than from Western culture, for all Western learning was derived, supposedly, from Chinese origin. The lag in Chinese scientific advancement was the fault of those Chinese scholars who failed to carry on what their great ancestors had begun. Their failure obligated the scholars of the K'ang-hsi reign to rediscover the lost Chinese tradition from Westerners who succeeded in improving on the Chinese heritage. Their failure would impede the development of science in China. But this stagnancy was merely a reflection of the indifference and laziness of those scholars who failed to carry on the Chinese heritage, it was by no means an indication that Chinese culture was basically inferior to Western culture. In other words, when scholars applied themselves to the study of Western science it meant that they applied themselves to the restoration of Chinese culture. By saying so, the emperor and his fellow scholars strove not only to preserve Chinese prestige, but also to manifest their own achievements in carrying on the Chinese heritage.

It is true that since he was a Manchu, K'ang-hsi might not have held the Chinese heritage in as much reverence as did Chinese scholars. But, since he was in the position of the ruler of China and had a desire to rule his people successfully, he hed to follow the contemporary trends of Chinese thought. In Rome do as the Romans do, so to speak. Moreover, the emperor, as a Manchu ruler, who was eager to show to the Chinese people his superiority over his predecessors of the previous dynasties, spoke as proudly as any Chinese scholar of his reverence for China's ancient sages, and emphasized more heavily than most Chinese scholars the faults of the previous dynasties.

3. The Compilation of Works on Astronomy and Mathematics

In addition to his own study and application of Western astronomy and mathematics, the K'ang-hsi emperor also ordered the Jesuits, and Chinese and Manchu scholars to record astronomical and mathematical knowledge in works under the imprial name.

Works on astronomy produced under the patronage of the emperor are shown on Table II.[183] Among them, the *Ling-t'ai i-hsiang chih* is a byproduct of Verbiest's casting of six pieces of astronomical instruments in 1674. It is an explanatory work concerning these instruments, their manufacture, operation, and arrangement. Tables of survey results are attached.[184] The *Shengching tui-suan piao* is a table of measurements of the degree of latitude of Shengching (Liaoning), a result of the survey made by Verbiest in 1682. Likewise, the *Tseng-yen Meng-ku chu-ch'u tui-suan piao* is a table of survey results concerning the degrees of latitude made in Mongolia and its vicinity.[185] This indicates that the K'ang-hsi Emperor cared for the recording of whatever knowledge was new to him. When new Instruments were manufactured or surveys made, records were compiled. The *K'ang-hsi yüng-nien li-fa* is a chronicle (1644-1721) of the predications of the twenty-four solar signs (*chien-ch'i* 節氣), eclipses of the sun and the moon, and locations of planets. Because this work was compiled in order to set a model for succeeding calendar-makers, it was given another name "Yü-ting ch'i-cheng wan-nien shu" (a permanent calendar made by Imperial order).[186] This work exemplified K'ang-hsi's syncretism: to have Western methods predicate Chinese farming and government schedules so as to provide a guide for the maintenance of the social order.

The *Li-hsiang k'ao-ch'eng* is the only work which was entirely the labor of Chinese and the Manchu scholars without the assistance of the Jesuits. However, the compilers of this work resorted largely to the *Ch'ung-chen li-shu* made by the Jesuits during the late Ming period and revised some old astronomical records with more recent surveying results offered by the Jesuits at Court. Compared with the contemporary development of science in Europe, the *Li-hsiang k'ao-ch'eng*

TABLE II

WORKS ON ASTRONOMY PRODUCED UNDER ORDER OF THE K'ANG-HSI EMPEROR AND SUPPLEMENTS TO THEM

Titles	Compilers	(A.D.) Years	Chüan
Ling-t'ai i-hsiang chih (靈臺儀象志)	Ferdinandus Verbiest	1674	13
Shengching tui-suan piao (盛京推算表)	〃	1682	
Tseng-yen Meng-ku chu-ch'u tui-suan piao (增衍蒙古諸處推算表)	Thomas Pereyra Antoius Thomas Joachim Bouvet Jean-Francois Gerbillon	1703	
K'ang-hsi yüng-nien li-fa (康熙永年曆法 or under an other title "Yü-ting ssuyü ch'i-cheng wan-nien shu" 御定四餘七政萬年書)	Verbiest Ludovicus Buglio	1682-1718	33
Li-hsiang k'ao-ch'eng (曆象考成 or entitled "Li-hsiang k'ao-cheng ch'ienpien" 曆象考成前編)	Mei Ku-ch'eng, Ch'en Hou-yao, Ming An-t'u, Ho Kuo-tsung, Ku Ch'en-hsü, Yüng-chih (Supervisor)	1713-1722	42
Jih-ch'an piao chi yüeh-li piao (日躔表及月離表)	Ignatius Köler Andreas Pereyra	1730	39pp.
Li-hsiang k'ao-ch'eng hou-pien (曆象考成後編)	Köler, Pereyra, Mei Ku-ch'eng, Ho Kuo-tsung	1737-1742	10
I-hsiang k'ao-ch'eng (儀象考成)	Augustinus von Haller-stein, Antonuis Gegeisl, Köler	1744-1750	30

was behind its age. For one thing, the source of this work, the *Ch'ung-cheng li-shu* introduced mainly the theories of Brahe Tycho (1473-1543) and Galilei Galieo (1546-1642).[187] For another, the compilers of this work had not yet been informed of those epochmaking' principles discovered by Sir Isaac Newton (1642-1727).[188] These omissions reflect the slowness of scientific introductions into China due to the effect of the Rites Controversy which was raging at the time. This work may also reflect an imperial intention to have Chinese and Manchu scholars, under the supervision of a Manchu prince, Ch'eng Yüng-chih (允祉), investigate a scientific work produced during the Ming dyasty rather than to have them compile a scientific work up date.[189] At any rate, this work was improved by the Jesuits in the Yung-cheng and the Ch'ien-lung reigns.

In 1730, the Jesuits Köler and Andreas Pereyra predicted eclipses of the sun and the moon. In 1737, at the recommendation of Ku Tsung (顧琮), an official, and in association with Mei and Ho, Köler and Pereyra began working on illustrations and interpretations of these tables. Their work was finished five years later and given the title "Li-hsiang k'ao-ch'eng hou-pien" (the latter part of the *Li-hsiang k'ao-ch'eng* by the Ch'ien-lung Emperor.[190] As a supplement to the *Li-hsiang k'ao-ch'eng*, the significance of this work lies in four points:

1. The introduction of the calculation of the distances between the Earth and the Sun and Moon according to Newton's theory.
2. The introduction of the theory: "The planet describes an ellipse; the sun being in one focus." This is one of the three theories developed by Johann Keller (1671-1630).
3. The calculation of misty variations.
4. The measurement of the radius of the sun.[191]

Besides, Verbiest's *Lin-t'ai i-hsiang chih* was also revised by Köler and other Jesuits with an emphasis on the corrections of the number, order and measurements of the degrees of latitude of the stars, and the measurements of the equator and the zodiac. This work was entitled "I-hsiang k'ao-ch'eng." [192]

Owing to K'ang-hsi's patronage, works on astronomy by his order and by his successors relied heavily on theories from the West. The old astronomical systems like the *ta-t'ung* or the *hui-hui* systems traditionally applied by the Chinese, no longer were influential.[193]

Paralleling the compilation of the *Li-hsiang k'ao-ch'eng*, the same compilers completed, by the order of the K'ang-hsi Emperor and under the supervision of Yüng-chih a work on mathematics entitled *Shu-li ching-yün* (1713-122). [194] This work was highly valued in its age and always has been mentioned by those who deal with the history of the introduction of Western mathematics into China. For it is a work providing detailed interpretations, together with clear diagrams and tables, some primary mathematical principles and their applications. The four operations of arithmetic; addition, subtraction, multiplication, and division; arithmetical, geometrical and harmonic progression; laws of proportion, evolution and equations; calulations concerning a triangle or a circle; measurements of length, capacity and weight; the computation of profit or loss, of assets and liabilities are all illustrated. A mathematical work of comprehensive nature like the *Shu-li ching-yün* was unprecedented in China.[195] More important, it is the best collection of Western mathematics for that age. Almost all the calcuations of arithmetic, geometry, algebra and trigonometry which had been introduced into China by the Jesuits since the late Ming period were included.[196] However, it still contained two defects. For one thing, the three formulae which were introduced by Father Jartoux to Mei Ku-ch'eng and other scholars at Court were not mentioned in the *Shu-li ching-yün*, They dealt with the three ways to calculate π, sine and versed sine through the trigonometric method.[197] For another, the algebraic calculations introduced in the *Shu-li-ching-yün* are limited. In this work the application of algebraic calculations were not yet beyond the use of cubic equations while four dimensional equations had already been applied by mathematicians in Europe.[198]

Most important of all, the *Shu-li ching-yün* mirrors K'ang-hsi's and his fellow scholars' attitudes toward Western science. First, it is a product of syncretism, for the compilers of this work combined

Western learning with Chinese ancient ideas. On the one hand, they grounded this work primarily on those works of Western origin which had been translated by the Jesuits as shown in Table III.[199] Most of them were produced originally for use in teaching the K'ang-hsi Emperor. On the other hand, these compilers integrated ancient

TABLE III

WORKS OF WESTERN ORIGIN CONSULTED IN THE *SHU-LI CHING-YÜN*

Bouvet, Joachim trans., *Chi-ho yüan-pen* 幾何原本 (Elementa Geometriae). Peking, 1689. 7 *chüan.*

Chieh-ken-fang suan-fa 借根方算法 (Calculations of algebra).

Chieh-ken-fang suan-fa chieh-yao 借根方算法節要 (A. summary of the calculations of algebra). 2 *chüan.*

Gerbillon, Jean-Francois trans., *Chi-ho yüan-pen* 幾何原本 (*Geometrie Practique et Theorique, tiree en partie du Paredies*). Peking, 1690. 7 *chüan.*

Hsi-ching lu 西鏡錄 (A record of the Western telescope).

kou-ku hsiang-piao fa 勾股相表法 (Calculations of trigonometry), 1 *ts'e.*

Pa-hsien piao ken 八線表根 (Tables of the roots of trigonometry), 1 *ts'e.*

Pi-li kuei chieh 比例規解 (Explanations of the proportions), 1 *ts,e.*

Ricci, Matteo trans. and comp., *Ch'ien-kun t'i-i* 乾坤體義 (Meanings of the universe), 1610. 2 *chüan.*

Thomas, Antonius comp., *suan-fa ts'uan-yao tsung-kang* 算法纂要總綱 (A comprehensive outline of essential calculations). 15 *chüan.*

. *Suan-fa ts'uan-yao tsung-kang* (A comprehensive outline of essential calculations). 2 vols. app. 1. *Shu-piao* 數表 (numerical tables) 1 *chüan.* 2. *Shu-piao yüng-fa* 數表用法 (the usage of the numerical tables), 1 *chüan.*

. *Ts'e-liang kao-yüan i-ch'i yüng-fa* 測量高遠儀器用法 (The operations of some instruments in surveying). 1 *ts'e.*

Chinese works concerning mathematics, into the *Shu-li ching-yün*. the *Ho-t'u*, the *Lo-shu* and the *Chou-pai suan-ching.* Its table of contents, exhibited in Table IV discloses its syncretic nature.

TABLE IV

A TRANSLATION OF THE TABLE OF CONTENTS OF THE *SHU-LI CHING YÜN*

Secondly, this work echoes reverence of the emperor and others for the ancient sages and their works. Although they borrowed sources from the Jesuits, the compilers in dealing with the origin of mathematics tell their readers that it was because the ancient sages lived that the *Ho-tu* and the *Lo-shu* appeared. From the diagrams of the *Ho-t'u* addition and subtraction originated; from the diagrams of the *Lo-shu* multiplication and division were originated. Through the variations and development of these calculations, mathematics was thus given birth.[200] These compilers also claim that the first mathematical work was composed by Li-shou (隸首) by order of Huang-ti (黃帝 The Yellow Emperor, a legendary emperor in China, ca. 2698-2598

B. C.) and the first calendar was made by Hsi and Ho on order of Yao (堯 a legendary emperor in China, ca. 2356-2256 B.C.). Moreover. they indicate that mathematics had been taught in official institutes in China since as carly as the the Chou Dynasty (1122-255 B.C.) according to the *Chov-pal suan-ching.*[201]

Thirdly, this work give the views and emphasis of the emperor and others on the practical value of mathematics. The compilers say, "... mathematics seeks after the principle of everything ... It is a practical subject on which surveying, astronomy, music, measures and weights, currency and business depend."[202]

Fourthly, this work reveals the resentment of the emperor and others over the underdevelopment of science during the Ming Dynasty. The compilers point out that rulers after the Chou Dynasty in general followed earlier examples and thought highly of mathematics Therefore, knowledgeable scientists appeared sporatically from dynasty to dynasty. However, Ming scholars were indifferent to practical learning, indulged in empty talk, and consequently lost sight of the tradition. This left the field of science in China open to the Westerners. "One may say that Ming scholars were inferior to the Westerners but one should not say that all the ancient Chinese were inferior to Westerners."[203]

Finally, this work served as an instrument for the emperor and others to promote the theory "all Western learning was derived from Chinese origins." The following passage found in the introductory chapter of thls work contains the assumption that Chinese learning was introduced to the West:

> ... During the prosperous San Tai (the Hsia, Shang and Chou dynasties, 2205-255 B.C.) the fame of our teachings spread everywhere ... and [Chinese] books circulated abroad. .. At the end of the Chou dynasty, disciples of mathematicians were scattered everywhere. As the result of the burning of books in the Ch'in dynasty (221-207 B.C.), most of the classics in China were lost. But the branches abroad still preserved the originals. Itis from this that Western learning has its origin.[204]

Works dealing with Western science which immediately followed the *Shu-li chiug-yuu* contained characteristics similar to those of the *Shu-li ching-yün* and examplified the intellectual vogue of the K'ang-hsi reign. In general, succeeding scholars supported vigorously the theory "all Western learing was derived from Chinese origins," but discarded the belief in the *Ho-t'u* and *Lo-shu*. The authors of the *Ming-shih*, the *Ssu-Ku ch'üan-shu* and the *Ch'ou-jen chuan* are representative.[205] In fact, the *Li-hsiang k'ao-ch'eng* and the *Shu-li ching-yün* are collections of known works on science, rather than collections introducing newly developed scientific knowledge or techniques.

CONCLUSION

Bending his mind to adequately prepare himself to cope with complicated imperial affairs, the K'ang-hsi Emperor strove to study in various fields. Accordingly, he became deeply concerned with the study of mathematics and astronomy which were closely related to his political interests. As a devotee of principle-seeking, the emperor showed a great interest in mathematics based on reasoning. As a person of practical mind, he indulged in astronomical observations and land surveying. In his study of the Chinese classics he paid special attention to the *I-ching*, a major source of Chinese traditional mathematics. He also was attentive to the *Shang-shu* from which Chinese calendar-making and map-making were said to be derived.[206] Therefore, it should not surprise us that he proved zealous in his efforts to master Western science. It is also evident that he was inclined to associate Western science with the Chinese classics.

Through his constant and intensive studies and practice. the K'ang-hsi Emperor did learn something from the Jesuits in the fields of Western mathematics, astronomy, and surveying. No matter whether his attainments in these fields were sufficient to qualify him as a mathematician, an astronomer, or a surveyor, they were ample enough to fulfill his administrative purposes and at the same time to satisfy his intellectual curiosity. He even sought to apply Western scientific knowledge and technology himself and to transmit such information and skills to various Chinese scholars whom he favored.

Paralleling his own studies of Western science. he also ordered the Jesuits to make calendars and maps to assist him in ruling his empire. In addition, the emperor had scholars in China collect and integrate Western scientific knowledge into works under the imperlal name.

In the course of his study of Western science, K'ang-hsi did sometimes meet difficulties but in spite of this he showed great perseverance. From his experience in studying and applying Western scientific knowledge and technology, he discerned the magical power of mathematics in transforming mystery into reality. He also acknowledged the accuracy of modern calendar-making, and at the same time, recognized defects in traditional Chinese astronomical surveying methods. However, in the long run, the K'ang-hsi emperor attributed all the merits of Western science to ancient Chinese works: mathematics to the *1-ching*, and calendar-making to the "Yao-tien." Thereby, K'ang-hsi became one of the strong advodates of the theory that all Western learning was derived from Chinese origins. On the other hand, K'ang-hsi laid the blame upon those scholars in previous dynasties who were indifferent to practical learning for the low ebb of scientific development in China.

As a matter of fact, both K'ang-hsi's reverence for the Chinese heritage and his stress on practical learning were in accordance with the contemporary intellectual tide. He echoed the voices of scholars in the late Ming and the early Ch'ing period, like Ku Yen-wu (顧炎武) and Huang Tsung-hsi (黃宗羲), who stressed the practical use of learning (*ching-shih chih-yung* 經世致用). As for the concern of the emperor and contemporary scholars for preserving China's prestige while adopting Western science, they implicitly assumed at least a partial anti-Western stance similar to sentiment in the late Ming period, and hence paved the way for the theory of the "Chinese origin of Western learning" which blossomed in late Ch'ing times.

In the process of his applying Western scientific knowledge and skills, the emperor revealed vanity in showing off his learning. However, this was not a kind of silly showing-off or of making empty gestures. Behind his showing-off, there were serious political intentions. By making displays of his own learning, the emperor could accomplish his ends of winning respect and obedience form his subjects. On the one hand, he could keep his officials from being negligent by giving them an impression that their emperor was a wise person who knew everything. On the other hand, he could attract talent and good will among scholars in the field of science as well as in other fields. This scheme bears a similarity to that of the Jesuits who in order to win converts among the Chincse scholars, went among the Chinese scholars-studied the Chiness language and the Chinese classics, and followed the rules of Chinese etiquette. When it became necessary to win favor from the Ch'ing court, the Jesuits made efforts to study the Manchu language and assist in imperial affairs. There was yet another similarities between the Jesuits and the K'ang-hsi emperor: both parties stressed the practical side of learning and manifested a sincere interest in human affairs.

Jesuit activities during the K'ang-hsi reign marked the climax of the introduction of Western science into China. This achievement resulted largely from the K'ang-hsi emperor's enthusiastic approval and acceptance which were reinforced by his intellectual interests as well as his political intentions. The policy of focusing attention on an imperial court distinguished the Jesuit activities of the Ch'ing period from those of late Ming times. It is because of this that the Jesuits received unprecedented favor from the throne. It is also because of this that the Jesuits during the Ch'ing dynasty, unlike their predecessors of the late Ming period, kept more aloof from scholars in China and adhered more to a single person, the emperor himself. Under these circumstances Jesuit learning had less direct influence upon intellectual circles in China. One could not find such scholar-converts during the Ch'ing dynasty like Hsü Kuang-ch'i or Li Chih-tsao of the Ming period who enjoyed intimate friendship with the Jesuits and supported them from beginning to end in spite of changes in imperial attitudes.

The K'ang-hsi emperor, who considered political advantage above all else, accepted the Jesuits because of their reverence for Chinese traditional customs and their obedience to the Ch'ing court as well as their efficient service. When these factors no longer applied, the emperor's attitude towards the Jesuit missions changed accordingly. For K'ang-hsi was a Manchu ruler over the Chinese people and at the same time a Chinese sovereign and sponsor of Chinese culture to the Westerners. When the Jesuits offered loyal services like his subjects, K'ang-hsi treated them like his subjects and adhered to religious tolerance. In cases of controversy rising among the Catholic orders and violations of Chinese traditions, K'ang-hsi stood firmly for Chinese culture and the state, and restricted the Catholic missions.

In short, K'ang-hsi's study and application of Western science arose from his political intentions and were fortified by his enthusiasm for learning. His attitudes toward Western science admittedly followed the contemporary intellectual tide in China. Meanwhile, his policies toward the Jesuits in China depended entirely on his political concerns. K'ang-hsi successfully applied Western scientific knowledge and skill to achieve political goals and at the same time offered a case for the theory that "all Western learning was derived from Chinese origins". This explains his role in the introduction or Western science into China.

Footnotes

1. Chang Tung-sun, "A Chinese philosopher's Theory of Knowledge," The *Yen-Ching Journal of Social Studies*. 1, 2 (January, 1939), 178, "When we speak of Heaven we have in mind only Providence which is merely a manifestation of Heaven. In other words, the Chinese sre concerned with the will of Heaven without being too particular about Heaven as Heaven itself, because according to the Chinesc point of view the will of Heaven is Heaven itself, and to inquire into Heaven without paying attention to its will is logically inconceivable in China. Heaven and the will of Heaven are the same thing . . . the Chinese have never considered Heaven as an entity . . . a substance."

2. Yabuuchi Kiyoshi. *Chu goku no temmon rekiho* (Chinese Astronomy and Calendar-making). (Tokyo: Heibon sha, 1969), p. 6.

3. Chang Tung-sun, 174. He also noted, "Chinese cosmology may be called 'significism or omenis'. The Chinese character *Hsiang* which we have translated as 'sign' has all the meanings of the English words phenomenon, symbol and omen, but it must be noted that behind the *Hsiang* no concrete things are implied. Its signification is only concerned with human affairs."

4. Arthur de C. Sowerby, "Astronomy in Ancient China," The *China Journal*. XX, 6, 307.

5. "K'ang-hsi ch'ao sheng-tsu nen-huang-ti sheng-hsün," (Sacred Instruc-

tions of the K'ang-hsi reign) *Ta-Ch'ing shih-ch'ao sheng hsün* (Sacred Instructions of the Ten Reigns of the Ch'ing dynasty)(n.p., 1879), ch. 10, 36. Hereafter cited as STSH.

6. *T'ing-hsün ke-yen* (A collection of the K'ang-hsi Emperor's mexims and instructions), *Liu-yü ts'ao-t'ang ts'ung-shu* (Wu-hsing, 1909), revised by Liu Ch'eng-kan, 33b. Hereafter cited as THKY.

7. STSH, ch. 10, 3b. K'ang-hsi Emperor. *K'ang-hsi-ti yü chih wen-chi* (An anthology of the K'ang-hsi Emperor) (Taipei: Hsüeh-sheng shu-chü, 1966), I, 306. Hereafter cited as YCWC. "Heaven produced all people and chose a ruler among them. This is not because Heaven wanted to honour the one whom he chose. Rather, he wanted to hold him responsible for pacifying the people everywhere in the country. Thus, an emperor has to obey the will of Heaven; to set up government; to direct farming affairs; to regulate people and to solve their problems . . ."

8. THKY, 52b, 53b, 68b; STSH, ch. 10, la-lla. YCWC, II, 1227, pp. 1229-1230. Ch'en K'ang-ch'i. *Yen-hsia hsiang-chung-lu* (A record of the Ch'ing court) (Shanghai: Wen-ming shu-chü, 1936), I, ch 4, 4a.

Chin Liang comp. *Ch'ing-ti wai-chi* (Unauthorized biographies of the Emperors of the Ch'ing dynasty) (Peiping, 1934), pp. 74-75. Wang Jung-pao. *Ch'ing shih chiang-i* (Lectures on the history of the Ch'ing dynasty) (Shanghai, Commercial Press, 1913), P. 68, P. 72.

9. Wang Ping. *Hsi-fang li-suan-hsüeh chih shu-ju* (The introduction of Western calendar and mathematics into China). (Nankang, Taipei: Institute of Modern History, Academia Sinica, August, 1966). p. 1.

10. George H. C. Wong, "Some Aspects of Chinese Science Before the Arrival of the Jesuits." The *Ch'ung Chi Journal.* II, 2 (May, 1963), 169. Hereafter cited as Wong, SACSBAJ.

11. Yabuuchi, pp. 5-6.

12. Chang T'ing-yü and others comp. *Ming Shih* (A history of the Ming dynasty) (n.p. 1739). ch. 31, 1b, the section of "Li" (Calendar-making). ". . .the calendar had been changed six times from Huang-ti to the Ch'in Dynasty; four times during the Han dynasty; fifteen times from the Wei to the Sui dynasty; fifteen times from the T'ang to the Five Dynasties; seven times during the Sung dynasty; five times from the Chin to the Yüan dynasty. However, the *Ta-t'ung li* of the Ming dynasty, an imitation of the *Shou-shih li* of the Yüan dynasty, has been used For more than two hundred and seventy years . . ."

13. Wong, SACSBAJ, 170. "The Chinese traditional calendar was soli-lunar, for it was based on the movements of both the sun and the moon. Such a combination was complicated, in order to make the lunar year correspond with the solar year, traditional Chinese astronomers inserted seven intercalary

months every nineteen years." And they believed that this practice originated from the Age of Yao.

14. *Shu-li ching-yün.* (Essential meanings of Mathematics), comp. by the order of the K'ang-hsi Emperor. (Nanking, 1882). Double leaves, lb. Hereafter cited as SLCY.

15. Sowerby, 307-310; Wong, SACSBAJ, 196; SLCY, Preface. Chang Tung-sun, 173, "In the *I-ching* most probably words were originally coined as token-symbols. . .but there must have been previously arranged limits of possible combinations for the purpose of divination. Each combination is a possible sign. It may be said that the signs do not merely symbolize something external but also indicate possible changes."

16. YCWC, I, 308, "I have studied very hard the Chinese classics, especially the *I-ching*. . .In general, the merits of the creative energies of Heaven and Earth is nothing other than the combined forces of Ying and Yang. The happenings of the human affairs all could be seen in the calculations of those broken and unbroken straight lines . . ." other exemples are found in YCWC, II, 1075-1076; IV, 2292.

17. Wong, SACSBAJ, 172-173. Li Yen. *Chung-kuo suan-hsüeh shih* (A history of mathematics in China) (Shanghai; Commercial Press, 1937). p. 14, p. 20, pp. 28-29. Hereafter cited as Li, CSS.

18. Wong, SACSBAJ, 172; Li, CCS, p. 84, p. 108. Hsü Ch'un-fang. *Chung-suan-chia te tai-shu-hsüeh yen-chiu* (Chinese mathematicians' studying algebra) (Peking: Kai-ming shu-tien, 1952), p. 112.

19. Wong, SACSBAJ, 174. Being ignorant of the principle *t'ien-yüan,* Ku Ying-hsiang cast aside Li's addenda in the *Ts'e yüan hai-ching* when he republished Li's work in 1550. Hence, the true meaning of Li's work was lost sight of.

20. Favier Alphonse. *Yen-ching K'ai-chiao lüeh* (A history of Catholic missionary activities in Peking). (Chiu-shih T'ang, 1905), II, 17b-18a. Hereafter cited as YCKCL. Hsü Tsung-tse. *Chung-kuo T'ien-chu-chiao ch'uan-chiao shih kai-lun* (An introduction to the history of the Catholic missionaries in China). (Shanghai: Tu-shan-wan Press, 1938), pp. 220-222. Hereafter cited as Hsü, CCSKL.

21. George H. C. Wong, "China's Opposition to Western Science during the Late Ming and Early Ch'ing, "*Isis,* LIV, I (1963), 29-33. Hereafter cited as Wong, COWS.

22. YCKCL, 17b-18a. Yao Pao-yü, "Chi-tu-chiao chiao-shih shu-ju Hsi -yang wen-hua k'ao," (The introduction of Western civilization into China: A study of the activities of the Christian missionaries) *Shih-hsüeh chuan-k'an.* I, 2 (February, 1936), 4.

23. Chin K'ang-feng, "Hsi-yang hsüeh-shu te shu-ju chih meng-ya shih-ch'i" (The beginning of the introduction of Western culture into China), *K'e-hsüeh.* XVIII, 9 (September, 1934), 1139-1140. Yao, 3-5, 17-21.

24. *Ssu-k'u ch'üan-shu tsung-mu t'i-yao* (An annotated bibliography of books in the *Ssu-k'u ch'üan-shu*) comp. by Chi Yün and others in 1782. (Shanghai: Commercial Press, 1931), ch. 106, 66, 96. Hereafter cited as SKCSTMTY.

25. *Ibid.*, 66-67.

26. Yao, 4.

27. SKCSTMTY, ch. 106, 69.

28. YCKCL, 22a-25b. Juan Yüan. *Ch'ou-jen chuan.* (Biographies of astronomers and mathematicians in China) (Shanghai: Commercial Press, 1935), ch. 45, 581-582. Hereafter cited as CJC.

29. Yang Kuang-hsien. *Pu-te-i* (I could not keep silent) in *T'ien-chuchiao tung-ch'uan wen-hsien hsü-pien* (Supplementary documents of the Catholic missionaries in the East) (Taipei: Hsüeh-sheng shu-chü, 1965). III, 1163, 1169, 1309-1910, Hereafter citedas PTI. Although these disputes aroused by Yang form a well-known case, most historians seldom have really consulted Yang's own work, and therefore have given unclear impressions. For example George H. C. Wong in his COWS took "Hsin-fa shih-miu" as the title of one of Yang's articles. Actually that article is entitled "Che miu-lun" and we find no article entitled "Hsin-fa shih-miu." Again, most historians such as Meng Shen in his *Ch'ing-tai shih* (Taipei: Cheng-chung shu-chü, 1962, p. 172), concluded that the final decision of 1669 to adopt Western systems resulted from K'ang-hsi's wise judgement. In fact, K'ang-hsi at that time knew nothing about astronomy.

30. *Ibid.*, 1311-1312. Wang Hsien-ch'ien, comp., "K'ang-hsi ch'ao tung-hua lu" (A record of the K'ang-hsi reign), *Chiu-ch'ao tung-hua lu* (Records of the nine reigns of the Ch'ing dynasty) (Shanghai, 1908), ch. 1, 30a, 30b. Hereafter cited as THL.

31. Wang Shih-chen, *Ch'ih-pei ou-t'an* (Chatter in the north of the lake) (Shanghai: Chin-pu shu-chü, n. d.), lst. ed. in 1690, ch. 4, 8a.

32. PTI, 1255-1300. CJC, 451.

33. THL, ch. 2, 19a.

34. Ibid., ch. 2, 2a. All those are materials for meteorological observations through those traditional methods which had already been lost for one thousand and two hundred years. Hsin Tu-fang in the North Ch'i dynasty was said to be the last one who succeeded in applying them. Also see PTI, 1313-1314.

35. THL, 20b, 21a.

36. Wang Shih-chen, ch. 4, 8a. Then Yang was dismissed and Ma Hu replaced him.

37. PTI, 1249. Wong, COWS, 34. The K'ang-hsi Emperor assumed personal control of the country in this year, 1667, although he had come to the throne in 1662.

38. THL, ch. 2, 21b.

39. THL, ch. 2, 22b. Arthur W. Hummel, ed., *Eminent Chinese o, the Ch'ing Period (1644-1912)*. (Washington, D. C., 1943-1944), p. 891. "... At this time the Emperor had just condemned the fomer Regent, Oboi as a traitor and a tyrant. Verbiest seized the opportunity to rectify the injustice that had been done to [shall] von Bell and the astronomers in 1665 by claiming that Oboi had misjudged the case in favor of yang Kuang-hsien."

40. PTI, 1187-1190, an article entitled "Ch'ung sheng-hsüeh shu" (A memorial advising the throne to respect Sages' learning." English translation of this quotation was made after consulting George Wong's translation. Wong, COWS, 34; Inaba Iwakichi, *shinchō zenshi* (A complete history of the Ch'ing dynasty), Tan T'ao trans. under the title *ch'ing-ch'ao ch'üan-shih* (Taipei: Chung-hua shu-chü, 1960), pp. 166-167.

41. THL, ch. 2, 22b; PTI, 1131.

42. THL, ch. 2, 23a.

33. THL, ch. 2, 30b; PTI, 1139; CJC, ch. 45, 582.

44. Kenneth Scott Latourette, *A History of Christian Missions in China.* (London: Society for Promoting Christian Knowledge, 1929, lst. ed., Taipei: Ch'eng-wen Publishing Company, 1968), pp. 120-121, 158, 199. YCKCL, 38a-39a.

45. THKY, 55. It is obvious that this piece of information refers to the case of 1665. But Wang Ping pointed out, in her *Hsi-fang li-suan-hsüeh chih shu-ju* (note 6 on page 103), that K'ang-hsi had made a mistake in recalling this statement by taking Verbiest for shall von Bell. Actually, Wang herself made a mistake owing to the fact that she did not consult the original source, THKY.

46. YCWC, III, 1624.

47. Fang Hao. *Chung-Hsi chiao-t'ung shih* (A History of the Communication between China and the West) (Taipei: Chinese Culture Publication Committee, 1954). IV, 27. Hereafter cited as Fang, CHCTS. Hsü Tsung-tse, *Ming-mo Ch'ing-ch'u kuan-shu Hsi-hsüeh chih wei-jen,* (Great persons who introduced Western learning into China during the period of the late Ming and early Ch'ing) (Kiangsu: T'u-shan-wan Press, 1926), pp. 39-40. Hereaftar cited as Hsü, KHCWJ.

48. YCKCL, 33a. "...officials were astounded by K'ang-hsi resolving to learn Western science in person. Some of them warned him that Verbiest and his followers were nothing more than monks..."

49. YCKCL., 33a. Feng Tso-min trans., and comp., *Ch'ing K'ang-Ch'ien liang-ti yü T'ien-chu-chiao ch'uan chiao shih.* (A history of the Catholic missionaries in the K'ang-hsi and the Ch'ien-lung reigns) (Taichung: Kuang-ch'i Publishing House, 1966), p. 56.

50. Feng, p. 56; Li, CSS, p. 209; Chin K'ang-feng, 1139.

51. YCKCL, II, 34a. These instruments were made of copper, fixed on marble stands with bronze trays covered by carved dragon designs. "Golden glitter are their polished surfaces; pearl ripples are their ornaments," so described the Emperor. (YCWC, I, 477). They were all housed in the Peking Observatory belonging to the Imperial Astronomical Bureau. As a witness told us, "Peking Observatory is located in the south-east side of the Imperial city. By the Survey-calculation Room, there is a stair leading to the Observatory of the Imperial Astronomical Bureau. This Observatory was built by T'ang Jo-wang [Shall von Bell]. I have been there once accompanied by staff members of the Bureau. All the instruments are highly elaborate... and easy to handle, too..." (Man-shu chen-chun, *T'ien-chih ou-wen* [Hearings from the throne], [Kan-t'ang chuan-she, 1895]). For the names of these six instruments as well as some others cast after them see Table I. This table is compiled from the following sources:

Huang-ch'ao t'ung-chih (An imperial encyclopedia on geographical and topographical affairs of the early Ch'ing dynasty) (Chekiang shu-chü, 1822) comp. by the order of the Ch'ien-lung Emperor. Double leaves. ch. 23, la-12b. Hereafter cited as HCTC.

Huang-ch'ao wen-hsien t'ung-k'ao (An imperial encyclopedia dealing with the biographical sources of the early Ch'ing dynasty) (Chekiang shu-chü, 1882). ch. 258, Section "Wei-hsiang k'ao" (astronomical instruments). Hereafter cited as HCTK.

Li Huang-chang and others comp. *Ta-Ch'ing hui-tien shih-li* (A collection of statutes and precedents of the Ch'ing dynasty) (Shanghai: Commercial Press, 1909), ch. 830. Hereafter cited as CHTSL.

Ch'en Tsun-kuei. *Ch'ing-ch'ao t'ien-wen i-ch'i chieh-shuo* (An explanation of the astronomical instruments in the Ch'ing dynasty) (Peking: Astronomy Institute, 1956), p. 6, pp. 15-45, deals with the six instruments cast by Verbiest and one piece by Stumpf in great detail; but with an absence of explanations on other instruments made in the K'ang-hsi reign.

Chang En-lung. "Ming-Ch'ing liang-tai lai-Hua wai-jen k'ao-lüeh," (Foreigners coming to China during the Ming and the Ch'ing dynasties) *Library Science Quarterly,* IV, 3-4 (December, 1930), 470. Hsü Hsi-lin. *Hsi-ch'ao hisn-yü* (New anecdotes of the early Ch'ing period) (Shanghai: Wen-ming shu-chü , 1832), ch. 7, 9a. Li, CSS, p. 214; Yao, 6; YCKCL, 34a;

52. Chang En-lung, 469; THL, ch. 7, 22a. Chang Ying-lin., "Ming Ch'ing chih-chi Hsi-hsüeh shu-ju Chung-kuo k'ao-lüeh," (An investigation of the introduction of Western learning into China during the period of the Ming and the Ch'ing dynasties), *The Tsing-Hua Journal,* I, 1 (June, 1924), 49.

53. Chang En-lung, 464. Joachim Bouvet. *Histoire de L'Empereur de la Chine, présentée au Roy,* (La Haye: Meyndert Uytwerf, 1699). p. 89. Unlike other Jesuits, Antonius taught in Chinese instead of Manchu, for he was not familiar with Manchu.

54. Bouvet, p. 84; Chang En-lung, 463, 466, 471, 472; Li, CSS, p. 218; Feng, p. 64, 65. Lan-lin nü-shih. *Ch'ing-kung mi-shih* (A secret history of the Ch'ing court) (Shanghai: Hung-wen t'u-shu-kuan, 1924), I, 10. Hereafter cited as CKMS.

55. Gōto Sueo. "Kōki tai tei to Rō-i jūyon," (K'ang-hsi the Great and Louis XIV) *Shigaku zashi,* XLII, 3 (March, 1935), 19. Chou Ching-lien trans., "K'ang-hsi ta-ti yü Lu-i shih-ssu," *Jen-wen yüeh-k'an,* VII, 5 (Shanghai, July, 1947),5, Yan Wei-yü and P'an Kung-chao, "K'ang-hsi-ti yü Hsi-yang wen-hua," (The K'ang-hsi Emperor and Western culture) *Tu-shu t'ung-hsün.* No. 121 (November, 1964), 9. Gōto Sueo. "Le Goût Scientifique de K'ang-hsi, Empereur de Chine," *Bulletin de la Maison France-Japonaise,* 4 (1933), 123.

56. Bouvet, p. 88; Chou Ching-lien, 5; Yang and P'an, 9. Ts'ai Mao-t'ang, "K'ang-hsi-ti te Yang ch'ü-wei," (The K'ang-hsi Emperor's interest in Western civilization). *Fan-kung Tsa-chih,* No. 234 (Taipei, September, 1961), 11, were all based on Bouvet's work. As to the expedient manner, in regular lessons with K'ang-hsi, the Jesuit tutors were permitted to mount the Dragon throne and sit on either side of the Emperor to explain more easily the figures. These manners astounded the mandarins who knew of no procedents for this behavior.

57. Bouvet, p. 78. YCKCL, II, 38a. For these reasons, Jesuits were in general ordered to learn Manchu before teaching. As soon as Bouvet and Gerbillon arrived in China, they received intensive Manchu Language training. After eight months or so, both of them were able to explain Western science to the throne. While teaching in the court, they still took language courses. The Emperor assigned teachers to drill them not only in Manchu but also in Chinese.

58. *Lettres Édifiantes et Curieuses Ecrites des Missions Étrangers.* (Paris, 1718), X, 446.

59. Bouvet, p. 88.

60. *Ibid.,* pp. 82-89; Feng, p. 28.

61. YCWC, II, 1114, "Ch'ang-ch'un Yüan is located in a place twenty *Li*

[Chinese miles] west of the Gate Hsi-chih. . . ." Bouvet, p. 85. These apartments in the Garden Ch'ang-ch'un was part of the former Palace of K'ang-hsi's father's and was denoted to the Jesuit tutors when they began their teaching work. These apartments were not very far from K'ang-hsi's usual residence. Many times, K'ang-hsi attended his mathematics class right there. Also see CKMS, I, 10.

62. Bouvet, p. 86; Li, CSS, p. 218. These editors were well versed in both Chinese and Manchu. These scribes, usually just one or two, who knew bow to use a Western pen, helped to copy or write down the Jesuits' lectures in writing or dictation form.

63. Bouvet, p. 86.

64. CKMS, I, 10; Marcia Beth Reynders. *Father Joachim Bouvet and His Contribution East and West,* unpublished M. A. thesis (Honolulu, 1965). p. 29.

65. Reynders, p. 32.

66. *Ibid.*, p. 30.

67. Li, CSS, p. 219, 221; Bouvet, pp. 87-88.

68. Bouvet, pp. 89-90.

69. Reynders, p. 37. A comprehensive dictionary which contained most of the new scientific terminology renderd into Chinese characters was compiled by Ricci with the aid of Chinese scholars. p. 38. Bouvet also did a small French-Chinese dictionary entitled *Petit Vocabulaire* which was very helpful to Jesuit newcomers in China who were struggling to master Chinese.

70. Li, CSS, p. 222.

71. Bouvet, p. 87.

72. Gōto, 124; Reynders, p. 37. Feng, 28.

73. Hsü Tsung-tse. *Ming Ch'ing chien Yeh-su hui-shih i-chu ti-yao* (An Annotated bibliography of the works written or translated during the Ming and the Ch'ing dynasties) (Shanghai: Chung-hua shu-chü, 1949). p. 400. Hereafter cited as Hsü, ICTY.

74. STSH, ch. 5, 7b. Also see Hsü Hsi-lin, ch. 5, la-b.

75. "K'ang-hsi chu-pi yü-chih," (Vemilion Endorsements of the K'ang-hsi Emperor) *Wen-hsien ts'ung-pien* (Miscellaneous Ching Historical Documents) (Peiping: Palace Museum, 1931) (Taipei, 1964), p. 42. Hereafter cited as WHTP.

76. *Ibid.*

77. *Ibid.*

78. *Ibid.*

79. Wang Sung-ju. *Chang-ku Lin-shih* (A collection of historical records) Taipei: Wen-hsi shu-chü, 1964), ch. 1, 102.

80. Nishimoto Shirakawa. *Kōki tai-tei* (K'ang-hsi the Great) (Shanghai:

Shunshin sha, 1925), p. 154.

81. THL, ch. II, 28a; STSH, ch. 5, 8a.

82. YCWC, III, 1625.

83. *Ibid.*, 1624.

84. Bouvet, p. 85, Feng, p. 65.

85. YCWC, III, 1626.

86. YCWC, I, 477.

87. Table I.

88. YCWC, I, 477.

89. *Ibid.*

90. Bouvet, p. 91; Chang En-lung, 470; Table I.

91. Huang Po-lu. *Cheng-chiao feng-pao* (Catholic missionaries receiving Imperial praise) (Shanghai: Ts'u-mu t'ang, 1904). II, 19. Bouvet, p. 93.

92. Bouvet, p. 93.

93. *Ibid.*, pp. 129-130. Soon after this they were sent to other provinces.

94. Chang En-lung, 466; Bouvet, pp. 91-92, pp. 94-95.

95. Man-shu-chen-chün, ch. 2, 22b.

96. K'ang-hsi Emperor, *K'ang-hsi chi-hsia ke-wu pien* (Notes on the science studied during intervals of Imperial affairs)[n. p.], 1899, III, 1, 7a-b. Hereafter cited as CHKWP. STSH, ch. 5, 8a, 14b-15b; ch. 30, 5b; THL, ch. 11, 28a; Chin liang, p. 67; Feng, p. 28; Gōto, 124.

97. Bouvet, P. 92, pp. 128-129. *Lettres Édfiantes* t, VII, 202-204. "Ta-ch'ing Sheng-tsu Jen-huang-ti shih-lu" (A veritable record of the K'ang-hsi Reign), *Ta-Ch'ing li-ch'ao shih-lu* (Veritable records of the successive reigns of the Ch'ing dynasty) (Taipei: Wen-hai shu-chü 1965), ch. 245. Hereafter cited as CSL. YCWC, III, 1626-1627. For an example: If he wanted to test the gradient of a spot on a certain mountain, he first fixed two basic points. Then calculated their distance by means of a compass and geometric theorem. Next he had the Jesuit survey the spot. When the Jesuit's report tallied with his calculation, K'ang-hsi rejoiced. See Chou Ching-lien, 6.

As to surveying, in 1711, the Emperor sailed to T'ung-chou. Mooring on the west bank and walking two miles. the Emperor arranged in person the instruments and fixed the direction. Then, he measured and drove in stakes as length marks..." see Chin Liang, p. 71.

98. YCWC, I, 320.

99. Huang Po-lu, II, 82, 95-98; Fang Hao. "Hung-lou-meng hsin-k'ao" (A new study of the *Dream of the Red Chamber*), Fang Hao, *Chung-wai wen-hua chiao-t'ung shih lun-ts'ung* (An anthology of the history of the cultural interchange between China and foreign countries) (Chnugking: Tu-li ch'u-pan she, 1944), I, pp. 105-106. Hereafter cited as Fang, WHCTS.

100. STSH, ch. 5, 10b, 13b; CHKWP, III, 1, 7b-8a.

101. STSH, ch. 30, 5b; CHKWP, III, 1, 7a.

102. CHKWP, I, 1, 1b.

103. STSH, ch. 5, 13b-14a.

104. *Ibid.*, 14b.

105. *Ibid.*, ch. 30, 5b; CHKWP, III, 1, 7b.

106. YCWC, III, 1626.

107. *Ibid.*

108. *Ibid.*

109. *Ibid.*

110. Le Come, *Noveaux Mémoires sur l'Etat présent de la Chine.* (Paris, 1902), t. II, 195-196. Feng, p. 28.

111. Bouvet, p. 98, Reynders, 32.

112. Bouvet, p. 145, Reynders, 33.

113. YCKCL, II. 58. This son later became the Yüng-cheng Emperor. He told us. "...I have received father's instructions in mathematics and calendar-making since I was a child..." see his "Yü-chih *Lü-li yüan-yüan* hsü" (Preface to the *Lü-li yüan-yüan*), *Lü-li yüan-yüan* (Compendium on calendar-making, music and mathematics) (1724), Preface.

114. Wang Sung-ju, p. 101.

115. *Chang*(丈), a Chincse linear measure, 1 *chang* is equal to ten Chinese feet, and around 141 English inches.

116. Wang Sung-ju, p. 101.

117. *Ibid.* Still numerous examples are found in STSH, ch. 33-34.

118. THKY, 65a.

119. Hsü Hsi-lin, ch. 5, 1b. *Hu*(斛), a corn measure, equals to five *tou*(斗); *tou,* a Chinese peck, contains 316 cubic inches. *Sheng*(升), a Chinese pint, measures equivalent to 3.16 cubic inches. 10 *sheng* equal to one *tou.*

120. STSH, ch. 5. 10b, 13b.

121. *Ibid,* ch. 5. 13b-14a.

122. Reynders, p. 37, based on Letter from Father Tillich dated July, 1711.

123. Cha Shen-hsing, *Jen-hai chi* (Memoirs during thirty years residence at the court of Peking in the K'ang-hsi reign). Double leaves. II, 81a In *Cheng-chüeh-lou ts'ung-shu* (Ch'angsha, 1851).

124. *Ibid.*

125. THL, ch. II, 28. Also see STSH, ch, 5; Chin Liang, p. 67.

126. Li, CSS, pp. 225-227; Wang Ping, p. 4. But it must be noted that there was no such close relation between these scholars in the Ch'ing Dynasty and the Jesuits, as that in the Ming dynasty.

127. Yen Tun-chieh. "Ch'ing-tai shu-hsüeh-chia Mei Ku-ch'eng tsai shu-hsüeh-shih shang te kung-hsien," (A mathematician of the Ch'ing dynasty, Mei Ku-ch'eng's contribution to the history of mathematics) *Anhui Shixue Tongxun*, No. 11 (1959), 5.

128, Hsu ke. *Ch'ing-pai lei-ch'ao* (A collection of the anecdotes of the Ch'ing dynasty) (Shanghai; Commercial Press, 1920), *ts'e* 28, 69.

Besides, Li had even recommended Li Yü and Chang Hu, but available records concerning their relations to the Emperor have not yet been found.

129. THL, ch. 10, 23a. Also see CSL, ch. 139. The approximate constellation of Ts'an in α, β, γ, ς, ϵ, ξ, η, κ, Orion. The approximate constellation of Tsuei is λ, ϕ, (2) Orion.

130. THL, ch. 10, 23a. Also see CSL, ch. 139; STSH, ch. 5, 7a.

131. THL, ch. 10, 23a. Also see STSH, ch. 5, 7a.

132. *Ibid.*

133. Huang Po-lu, II, 82. Fang Hao, WHCTS, I, 105.

134. Fang Hao, CHCTS, IV, 32; Huang Po-lu, II, 82. In view of the dates, the reference on which K'ang-hsi based his argument on Lao-jen Hsing is the information gained by Chao Chang from the Jesuits on the day (K'ang-hsi 28/2/27) rather than the report offered by the Jesuits in the next morning of the next day (K'ang-hsi 28/2/28). For both THL and CSL record that this encounnter took place on the day (K'ang-hsi 28/2/27).

135. K'ang-hsi Emperor. "Yü-chih *Chou-i che-chung* hsü," (Preface to the *Chou-i che-chung*), *Chou-i che-chung* (A comprehensive study of the I-ching) compiled by Li Kuang-ti under the order of the K'ang-hsi Emperor. 2a-b. [n. p., 1867]. K'ang-hsi Emperor, "Yü-chih *Hsi Hsin-li ching-i* hsü", "(Preface to the *Hsin-li ching-i*) *Hsin-li ching-i* (Essential meanings of metaphysics) (n.p., n.d.) 3a-b. Hereafter cited as HLCI. Needham, Joseph, *Some Thoughts About China.* (London, 1946), pp. 1-4.

136. HLCI, Preface, la.

137. Ch'ien Pao-tsung. *Chung-kuo shu-hsüeh shih* (A history of Chinese Mathematics) (Peking: Ke-hsüeh ch'u-pan she, 1964), p. 264. Ch'ien Lin and Wang Tsao. *Wen-hsien chen-ts'un lu* (A collection of biographies of eminent Chinese of the Ch'ing dynasty) (Yu-chia-shu Hsüan, 1858). Double leaves, ch. 3, 59a-b, 60a-62b. Mei Ku-ch'eng, "Tseng-shan suan-fa t'ung-tsung fan-li" (Direction to the Tseng-shan suan-fa t'ung-tsung). *Tseng-shan suan-fa t'ung-tsung.* (An Emendation to the *Suan-fa t'ung-tsung*) (Shanghai: Chin-chang Press, 1914), p. 1. Mei Wen-ting's work amounted to 88 *pu* (sets). The scope of his works on mathematics and astronomy covers: supplementary explanations commentary notes and textual verifications. Historical statement and creative critiques had been made in traditional astronomy with an emphasis on the

successive changes in astronomy, especially those of the Yüan and Ming dynasties. At the same time, he tried to integrate almost all contemporary western scientific knowledge into his existing knowledge. In this aspect, he had made some just comparisons and stimulating arguments.

138. Li Yen, "Mei wen-ting nien-p'u," (A chronological biography of Mei Wen-ting) *Chung suan-shih lun-ts'ung* (Essays on the history of mathematics in China) (Peking: Science Publication House, 1955), ser. IV, p. 669. Hereafter cited as Li, CSSLT. When K'ang-hsi stayed in Teh-chou (in Shangtung Province) on an Imperial Tour to the South.

139. Ch'ien Lin and Wang Tsao, ch. 3, 59b. In fact, this work was completed by Li Kuang-ti's request. "Viewing that astronomy was hard to understand, few people were actually skilled in this field, but it was promoted by the Emperor. I.i asked Mei Wen-ting to write a clear and comprehensive book on astronomy. The result, the *T'ien hsüeh i-wen* in three volumes satisfied Li to such an extent that he chose this book to submit to the throne when K.ang-hsi asked for Mei's work."

140. Ch'ien I-chi comp. *Pei-Chuan chi* (Biographies and epitaphs of eminent Chinese of the Ch'ing period, 1644-1795) (Kiangsu, 1893), lst. ed. in 1826. ch. 132, 5a, 16a. Hereafter cited as PCC. Li, CSSLT, ser, IV, 571. STSH, ch 5, 9a.

Chang Ch'in, comp., *K'ang-hsi cheng-yao* (A classified collection of instructions of the K'ang-hsi Emperor) (n.p. 1910), ch. 18, 21a. Hereafter cited as KHCY.

141. *Ibid.*

142. KHCY, 21b; PCC, ch. 132, 5b, 18b. Li, CSSLT, ser. IV, 571. Mei Wen-ting also presented one of his works, the *San-chiao-fa chü yao* (Essential meanings of trigonometry). At this time, he was seventy-three years old.

143. KHCY, ch. 18, 21b; Yen Tun-chieh, 1.

144. CHTSL, ch. 829. "The Meng-yang chai is an institute located in the Ch'ang-ch'un Garden. There the compilers under the leadership of the Prince Chuang, compose books on mathematics, music and astronomy. They had to submit their drafts to the throne everyday..." Yen Tun-chieh, 1; Mei Ku-ch'eng, p. 2. Nishimoto, p. 155.

145. Mei Ku-ch'eng, p. 2. Ch'ien Lin and Wang Tsao, 63a.

146. Hsü Ke, *ts'e* 28, 71.

147. Like his own works, the *Ch'ih-shui i-chen* (赤水遺珍), the *Ts'so-man chien-yen* (操縵卮言) and the *Tseng-shan suan-fa tung-tsung*. Ch'ien Lin and Wang Tsao, 63a.

148. For example, Ch'üan Han-sheng, "Ch'ing-mo te Hsi-hsüeh yüan-ch'u Chung-kuo shuo," (The theory of the Chinese origin of Western learning in the late Ch'ing, *Ling-nan hsüeh-pao*, IV, 2 (June, 1935), 57-102. Ch'en Teng-yüan,

"Hsi-hsüeh lai-Hua shih huo-jen chih wu-tuen t'ai-tu," (The Chinese dogmatic attitude toward Western knowledge when it was first introduced into China), *Tung-fang tsa-chih,* XXVII, 8 (April, 1930). 61-74. Wong, COWS, 30, 31, 35, 39, 43, 45.

149. George H. C. Wong, "The Anti-Christian Movement in China; Late Ming and Early Ch'ing." *Tsing Hua Journal of Chinese Studies,* New Series III, I (May, 1962), 187, Hereafter cited as Wong, ACMC. Wong, COWS, 41.

150. CJC, ch. 58, 473.

151. *Ibid.*, ch. 46, 600; Ch'ien Pao-tsung, p. 301.

152. *Ibid.*

153. Ch'en Teng-yüan, 62. Wong, COWS, 31.

154. Ch'ien Lin and Wang Tsao, ch. 3, 62b-63a. "It was said that Li Yeh applied, in his *Ts'e-yüan hai-ching,* the method *t'ien-yüan i-li*" T'ang Shun-chih in the Ming dynasty said, "*t'ien-yüan i-li* is similar to the method *chiu ch'eng-ching*: assuming the radius of *t'ien-yüan* as 240 and *t'ien-yüan* as 120." "These are really confusing."

155. *Ibid.*, CJC, ch. 39, 486; Wong, COWS, 39.

156. CJC, ch. 39, 486; Wong, COWS, 39.

157. Meng Shen, p. 172. "...The oriental *t'ien-yüan-i shu* had been transformed into Western *Chieh-ken-fang Chieh-ken-fang* means to assume a root as an unknown quantity. This is just the same as *li-t'ien yüan-i.* After that, we compute the formulas and get forms of equations. Then, calculating by means of extraction, we gain the answer. To begin with borrowing roots and to end with borrowing powers like this method is in no way different from the method of *t'ien-yüan shu...*" Wang Jung-pao, p. 32. "... *t'ien-yüan-i shu* was brought to light because of the reintroduction of its method into China by the Westerners, but bore a different name-*ch'ieh-ken-fang.*"

158. Ch'ien Pao-tsung, pp. 167-172.

159. Wang Ping, p. 85; Ch'ien Pao-tsung, pp. 167-172.

160. *Chung Hsi wen-chien lu,* series 8 (1873), see Yen Tun-chieh, p. 5. This quotation is translated from the quotation in Yen's essay.

161. Yen Tun-chieh, p. 5.

162. Hsü Ch'un-feng, p. 116, p. 121-129; Li, CSS, pp. 87-95.

163. Li, CSS, pp. 87-95. Ch'ien Pao-tsung, pp. 167-172.

164. Hsü Ch'un-fang, p. 115, scholars like Li Jui, Juan Yüan, Lo Shih-lin (羅士琳), I Chih-han (易之翰), Chiao Hsün (焦循), Chang Tun-jen (張敦仁) and Wu Chia-shan (吳嘉善) all had paid special attention to the study of *t'ien-yüan shu.*

165. KHCY, ch. 18, 22a-b; Ch'ien Lin and Wang Tsao, ch. 3, 52a-b.

166. *Ibid.*

167. Hsü Ke, *ts'e* 28, 70–71; Ch'ien Lin and Wang Tsao, ch. 3, 53a.

168. Hsü Ke, *ts'e* 28, 71; Hsiao-heng-hsiang-shih chu-jen. *Ch'ing-chao yeh-shih ta-kuan.* (A classified collection of the anecdotes of the Ch'ing dynasty), (Taipei: Chung-hua shu-chü, 1959), I, 14.

169. That is, jealous emperors like Shih Huang-ti in the Ch'in dynasty 오 the Emperor Wen (Ts'ao P'i) in the Wei dynasty; and different and unlearned ones as most of the emperors in the Southern Sung dynasty, the Yüan dynasty and the Ming dynasty. K'ang-hsi did heve to use force to surpress or to eliminate anti-Manchu sentiments among the Chinese scholars or in Chinese books. But in general, he preferred conciliating mearures.

170. STSH, ch. 5. 14b.

171. WHTP, p. 40.

172. CHKWP, III, 1, 2a–b.

173. YCWC, III, 1624–1625.

174. *Ibid.*, 1626.

175. Chen Tsun-kuei, p. 8. The "*hsüan-chi*" is described as: " 'a rotating instrument; some have thought that it was an armiliary sphere but there is no certainty.' "

176. YCWC, III, 1623–1625.

177. THL, ch. 18, 1b.

178. YCWC, III, 1624, 1625, 1626.

179. *Ibid.*, 1624.

180. CJC, 498–499, Ch'en Teng-yüan, 66. YCWC, I, 447.

181. THL, ch. 18, 1b.

182. Mei Ku-ch'eng, p. 1. The *Ho-t'u* and the *Lo-shu* was said to be mystic diagrams having been supernaturally revealed in the Yellow River and the River Lo. Neo-Confucian scholars considered them as the iliustrations of the origin of numbers.

183. Table ll is based on the following sources: Yü Ming-chung and others comp. *Kuo-ch'ao kung-shih* (A classified collection of the rocords of the early Ch'ing courts and courtiers) (T'ientsin, 1759). Section "Books," No. 8 "Astronomy," ch. 29, 3a–ab. Hsiang Ta. *Chung-Hsi chiao-t'ung shih* (A History of the Communication between China and the West) (Shanghai: Chung-hua shu-chü, 1934), p. 84. HCTK, ch. 256, 9b–10b, 13b, 17a. YCKCL, II, 34a. PCC, ch. 132, 5a. CJC, 485. KHCY, ch. 18, 22a. Chang Ying-lin, 48–50. Fang, CHCTS, IV, 12–13, 21. Yao, 6–7. Chang En-lung, 464, 466, 469, 470.

184. Table 1. HCTC, ch. 23, 1a, 12b.

185. HCTK, ch. 256, 9a–10b.

186. YCKCL, II, 34a; Yao, 6–7; Chang Ying-lin, 49.

187. Chang Ying-lin, 48–49; Yao, 6; Fang, WHCTS, I, 41, 45.

188. Yao, 7.

189. Kuei Ching-hsien. *Ch'ing-tai wen-hsien chi-lüeh* (A record of the cases of literary inquiry in the Ch'ing dynasty) (Chungking: Jen-wen shu-chü, 1944), pp. 1-2.

190. HCTK, ch. 256, 17a; Yao. 7. Yü Min-chung, 4a.

191. Chang Ying-lin, 50.

192. Fang, CHCTS, IV, 13. Yü Ming-chung, 3b-4a.

193. Hsiang Ta, 84. Chang Chin. *Chung-hua t'ung-shih* (A general history of China) (Taipei: Commercial Press, 1959). V, 1469.

194. The *Shu-li ching-yün* and the *Li-hsiang k'ao-ch'eng* were combined with another work on music entitled "*Lü-lü cheng-i*." The three together were entitled "*Lü-li yüan-yüan,*" and published in 1723.

195. SKCSTMTY, ch. 59, 12.

196. Wang Ping, p. 73. Chang Chin, V, 1496. Li, CSS, p. 222, p. 227.

197. Yen Tun-chieh, 4. Fang, CHCTS, IV, 52.

198. *Ibid.*

199. Table III is based on the following sources; Li, CSS, pp. 219-222; Hsiang Ta, p. 87; Fang, CHCTS, IV, 48; Yao, 19, 29-30; Bouvet, p. 85, pp. 87-90.

200. SLCY, ch. 1, 1b-2a.

201. *Ibid.*, ch. 1, 10b.

202. *Ibid.*, ch. 1, 1b-2a.

203. *Ibid.*, ch. 1, 10.

204. *Ibid.* The Englisn translation of this passage was made after consulting George Wong's translation. Wong, COWS, 39.

205. The attitude of these authors has already been discussed in detail. Wong, COWS, 36, 38, 40, 43. CJC, "Preface."

206. Peng Hsiao-fu, "A Study of the Production of the Huang-Yü Ch'üan-lan T'u," *Historical Research.* No. 1 (January, 1973), The Graduate Institute of History and the Department of History, National Taiwan Normal University. 314-289.

FOOTNOTE ABBREVIATIONS

CHKWP	*K'ang-hsi chi-hsia ke-wu pien.*
CHTSL	Li Huang-chang and others, comp., *Ta-Ch'ing hui-tien shih-li.*
CJC	Juan Yüan, *Ch'ou Jen chuan.*
CKMS	Lan-lin nü-shih, *Ch'ing-kung mi-shih.*
CSL	*Ta-Ch'ihg li-ch'ao shih-lu.*
Fang, CHCTS	Fang Hao, *Chung-Hsi chiao-t'ung-shih.*

Fang, WHCTS	Fang Hao, *Chung-wai wen-hua chiao-t'ung shih lun-ts'ung.*
HCTC	*Huang-ch'ao t'ung-chih.*
HCTK	*Huang-ch'ao wen-hsien t'ung-kao.*
HLCI	*Hsing-li ching-i.*
Hsü, CCSKL	Hsü Tsung-tse, *Chung-kuo T'ien-chu-chiao ch'uan-chiao shih kai-lun.*
Hsü, ICTY	Hsü Tsung-tse, *Ming-Ch'ing chien Yeh-su-hui-shih i-chu ti-yao.*
Hsü, KHCWJ	Hsü Tsung-tse, *Ming-mo Ch'ing-ch'u kuan-shu Hsi-hsüeh chih wei-jen.*
KHCY	Chang Chin, *K'ang-hsi cheng-yao.*
Li, CSS	Li Yen, *Chung-kuo suan-hsüeh shih.*
Li, CSSLT	Li Yen, *Chung-suan-shih lun-ts'ung.*
Li, HJCN	Li Yen, "Ming-Ch'ing chih-chi Hsi-suan shu-ju Chung-kuo nien-piao."
PCC	Ch'ien I-chi, *Pei-chuan chi.*
PTI	Yang Kuang-hsien, *Pu-te-i.*
SKCSTMTY	*Ssu-k'u ch'üan-shu tsung-mu ti-yao.*
SLCY	*Shu-li ching-yün.*
STSH	"K'ang-hsi ch'ao Sheng-tsu Jen-huang-ti sheng-hsün.
THKY	*T'ing-hsün ke-yen.*
THL	Wang Hsien-ch'ien, *Chiu-ch'ao tung-hua-lu.*
WHTP	*Wen-hsien ts'ung-pien.*
Wong, ACMC	Wong, George H. C., "The Anti-Christian Movement in China: Late Ming and Early Ching."
Wong, COWS	Wong, George H. C., "China's Opposition to Western Science during the Late Ming and Early Ch'ing."
Wong, SACSBAJ	Wong, George H. C., "Some Aspects of Chinese Science Before the Arrival of the Jesuits,"
YCKCL	Favier Alphonse, *Yen-ching k'ai-chiao lüeh.*
YCWC	*K'ang-hsi ti yü-chih wen-chi.*