The Journey of Euclid's *Elements* to China

Chuanming Zong

In 1582, the Italian priest Matteo Ricci arrived in China with a copy of Euclid's *Elements* in his luggage. In 1606, he and the Chinese scholar Xu Guangqi started to translate it into Chinese. Unfortunately, Ricci died in 1610 in Beijing. At that time they had only finished the first six Books. The remaining seven Books were not translated into Chinese until 250 years later, in 1857, by the British missionary Alexander Wylie and the Chinese mathematician Li Shanlan. This paper tells the dramatic story.

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Communicated by Notices *Associate Editor Laura Turner.*

DOI: https://doi.org/10.1090/noti2719

1. Introduction

About 2,300 years ago, Euclid (330 BC–275 BC) completed his Στοιχεία, commonly known in English as *Elements*, one of the most important mathematical works to

date. It contained thirteen Books (see [4, p. 79]):[1] I. Foundations of plane geometry. II. The geometry of rectangles. III. The geometry of circles. IV. Regular polygons in circles. V. Magnitudes in proportion. VI. Geometry of similar figures. VII. Basic arithmetic. VIII. Numbers in continued proportion. IX. Prime numbers. X. Incommensurable line segments. XI. Foundations of solid geometry. XII. Areas and volumes. XIII. The Platonic solids. In particular, it established the mathematical system of definitions, axioms, and propositions, which has served as a model of rigorous mathematical reasoning for more than two thousand years, and perhaps will last forever.

In the following centuries, Euclid's original copy was nowhere to be found. Instead, its contents were scattered in different manuscripts. At the end of the fourth century AD, Theon of Alexandria collected the manuscripts and edited a complete Greek copy. As one of the most important books in human civilization, Euclid's *Elements* has a complicated and dramatic history (see [3, 17]). It has been translated into almost every language, in more than one thousand different editions.

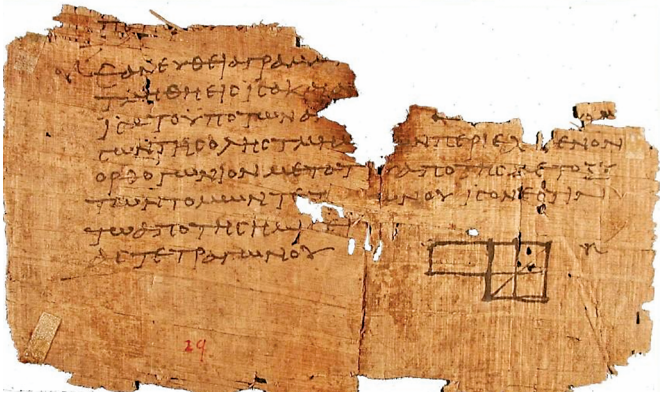

Figure 1. The earliest discovered *Elements* on papyrus.

In ancient times, China had few connections with other civilizations. More or less at the time of Euclid, the Chinese developed their own arithmetic and elementary geometry. Their earliest mathematical achievements were collected in *Jiu Zhang Suan Shu* (*Nine Chapters on the Mathematical Art*,[2]) which was compiled during the early Han Dynasty (202 BC–220 AD). No author or editor is known (Zhang Cang (256 BC–152 BC) and Geng Shouchang in Han Dynasty were the earliest recorded compilers). The book discussed 246 practical problems, such as how to do basic arithmetic, how to compute the area of a rectangle, an isosceles triangle, or a circle, how to calculate the volume of a pyramid, a cylinder, or a ball, and how to solve linear equations, in nine chapters (see [7, 13, 14]). Of course, there were mistakes and inaccuracies in the early versions. In fact, many important later Chinese contributions to mathematics were achieved as commentaries to revisions of the *Nine Chapters*. Needless to say, it is the founding work of the Chinese mathematical tradition.

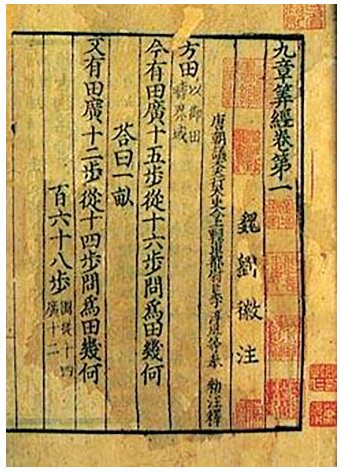

Figure 2. The title page of the *Nine Chapters*, commented by Liu Hui (c. 225–295).

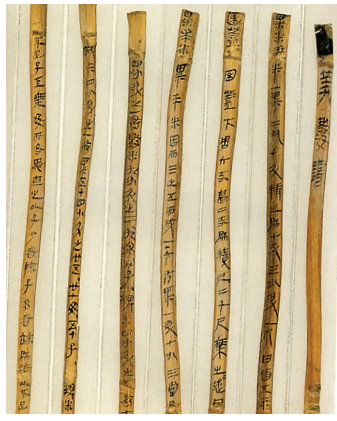

Figure 3. Bamboo strips of the *Suanshu Shu*.

In 1983–1984, Chinese archaeologists excavated an ancient tomb at Zhangjiashan in Hubei Province, which can be dated to around 186 BC in the Han Dynasty, and discovered a mathematics book, *Suanshu Shu* (*Book of Numbers and Computations*), written on some 200 bamboo strips. It dealt with 68 practical problems: 9 about multiplication and manipulating fractions, 44 on mercantile arithmetic such as collecting taxes and dividing coins, and 15 on geometric issues such as areas and volumes (see [4, 6, 7]). For example, it presented a method to determine the volumes of a cone and a frustum, under the assumption that $\pi = 3$. It is interesting to see that some problems of the *Suanshu Shu* are similar to those of the *Nine Chapters*, since the first is an original source and the second has been reedited many times.

In 221 BC, a little later than Euclid, the Qin Emperor (259 BC–210 BC) unified China. From 221 BC to 1912, China was ruled by more than four hundred emperors and Chinese society was rather closed. The earliest foreign influences to China were recorded in the Han Dynasty (202 BC–220 AD), Tang Dynasty (618–907), and Yuan Dynasty (1271–1368). Buddhism was introduced to China in the Han Dynasty from India. Islam was introduced to China in the Tang Dynasty from West Asia. Along with culture and religion, foreign knowledge such as astronomy and mathematics was also introduced to China. For example, the Persian astronomer Jamal ad-Din Bukhari worked

[1] *In some later editions, it was extended to fifteen Books, but Books XIV and XV are spurious.*

[2] *In some literature it was translated as Nine Chapters on Mathematical Procedures.*

in the Imperial Astronomical Bureau of the Yuan Dynasty and introduced Islamic astronomy into China. Marco Polo (1254–1324) also visited China in the Yuan Dynasty. However, at that time, there was no printed *Elements* yet.[3]

In 1552, the first European missionary St. Francis Xavier (1506–1552) arrived in China. In fact, he did not set foot on the Chinese mainland, but rather an island off the south coast. He died there. The early missionaries mainly engaged in religion dissemination. The Chinese did not know the systematic work of the ancient Greeks until Matteo Ricci's visit at the end of the 16th century.

For more about ancient Chinese mathematics, we refer to [4, 6, 7, 13, 14, 20].

2. Rome

In 1552, Matteo Ricci was born into a wealthy family in Macerata, Italy. He first attended a school run by the Jesuit priests in Macerata for seven years. Afterward, according to his father's wishes, he went to Rome to study law at Sapienza University. At that time, his father was the governor of his home province. However, Matteo had no interest in law, but was attracted to religious life. In 1571, he joined the Society of Jesus and went to the Jesuit College in Rome (Collegio Romano).

The college (today the Gregorian University), founded in 1551, was one of the first and most important Jesuit colleges. It offered courses not only in theology and religion, but also in mathematics, astronomy, and other subjects. When Ricci entered the college, Christopher Clavius (1537–1612) was a professor of mathematics there. In fact, it was Clavius who initiated an important tradition of Jesuit research by emphasizing applied mathematics and insisting on the need for the serious study of mathematics in the humanities.

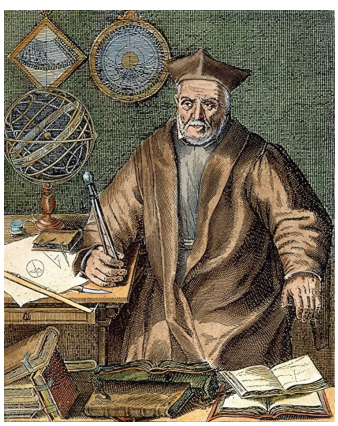

Figure 4. A portrait of Christopher Clavius.

Clavius was born near Bamberg, Germany. He entered the Jesuit order at Rome in 1555. The next year, he was admitted to the University of Coimbra in Portugal, where he learned mathematics and astronomy. In 1561, Clavius returned to Rome and studied theology at the Jesuit College. He graduated in 1564 and began teaching mathematics there. In fact, apart from a two-year stay in Naples, he remained in Rome as professor of mathematics at the Jesuit College for the rest of his life (see [9]).

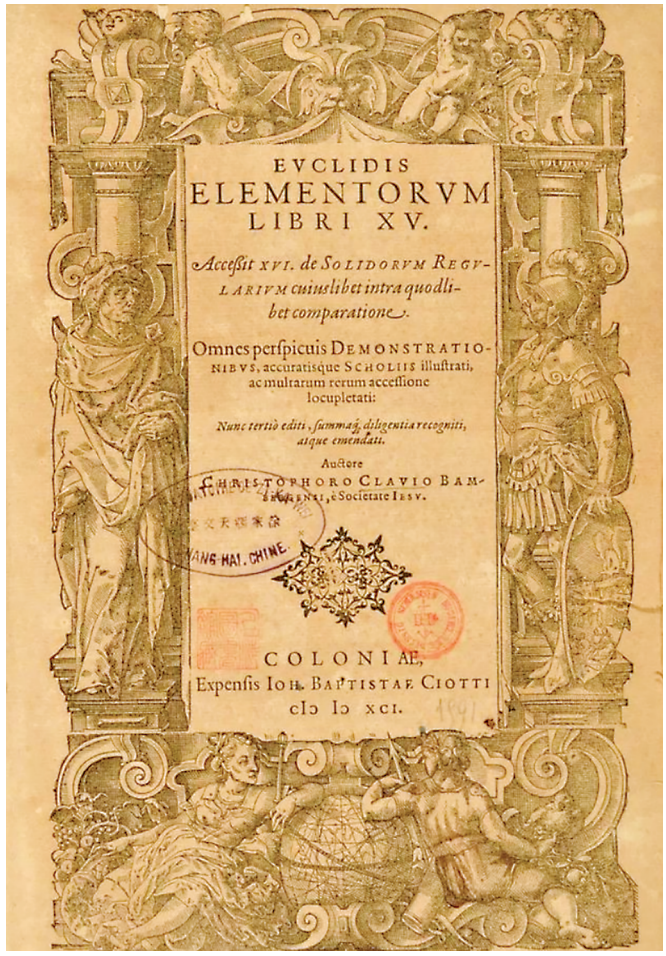

Figure 5. The cover of Euclid's *Elements*, reedited by Christopher Clavius.

In 1570, Clavius published an astronomy textbook, *Commentarius in Sphaeram Joannis de Sacro Bosco*, which influenced astronomers including Tycho Brahe, Johannes Kepler, and Galileo Galilei. His astronomical work made him highly instrumental in the calendar reform of 1582 that resulted in the introduction of the Gregorian Calendar (see [1, 9]).

At the Jesuit College in Rome, Ricci studied Latin, Greek, theology, mathematics, and astronomy. He attended Clavius's classes in mathematics and astronomy, where he learned Euclid's *Elements*, Apollonius's *Conics*, Archimedes's *Measurement of a Circle*, and Sacrobosco's *On the Sphere of the World* (see [8]). In particular, when Clavius published a Latin version of the *Elements* with his commentaries in 1574, Ricci got a copy and brought it to China later. The master and the pupil kept up a good friendship. When Ricci was in India and China, they corresponded by letters.

[3] *The Elements was first printed by the Italian publisher Erhard Ratbolt in 1482, based on the Latin version of Campanus of Novara (c. 1220–1296).*

In 1577, Ricci and three other students of the Jesuit College offered themselves for the East Indian missions. Before their departure, they were received by Pope Gregory XIII. They first went to Portugal, where Jesuit missionaries received formal instruction before going to the East, then took a six-month voyage from Lisbon to Goa, a Portuguese colony on the west coast of India. At that time, Portugal had colonies on the coasts of Africa and India and dominated this sea route. In fact, it was the only route for the European missionaries to the East. Ricci continued his studies for the priesthood in Goa and was ordained priest in 1580.

3. Peking (Beijing)

In 1557, Macao became a Portuguese colony on the south coast of China. In 1571, a house of the Jesuits had been set up at Macao. In 1582, to extend the China mission, Matteo Ricci was called from Goa to Macao by Alessandro Valignano (1539–1606), the superior of all Jesuits in the Far East and a former teacher of Ricci when he studied at the Jesuit College in Rome.

When Ricci arrived at Macao, China was at the end of the Ming Dynasty (1368–1644). The dominant hierarchy was conservative and corrupt, and establishing the Jesuit mission was very difficult. In particular, obtaining residence permissions for foreign priests was very hard. Thus, Ricci quickly learned Chinese language and culture, dressed as a Chinese scholar, presented himself as a Buddhist monk rather than as an European priest, and tried to make friends with every Chinese person he met. There are many books about Matteo Ricci (see [10, 19], for examples). For more on Ricci and Chinese mathematics, we refer to [11].

Figure 6. A portrait of Matteo Ricci.

In 1583, priests Michele Ruggieri (1543–1607) and Ricci visited the governor of Zhaoqing, a Chinese state close to Macao. The governor was deeply impressed by their demonstrations: a mechanical clock which can ring the hours, a prism which can produce colorful lights in sunshine, and a harpsichord which can make music. In particular, the governor was suffering with some disease and the priests were able to cure him quickly. This made them good friends of the governor and they obtained permission to live in Zhaoqing. In twenty years, Ricci moved from Macao in the deep south to the Chinese capital Peking step by step, from Macao (1582–1583) to Zhaoqing (1583–1589), Shaozhou (1589–1595), Nanchang (1595–1598), Nanking (1598–1600), and finally, Peking (1601–1610). Of course, he traveled with his precious books, including Euclid's *Elements*.

While Ricci was in Shaozhou, he met Qu Rukui (1548–1610), a bright young scholar and son of a top official of the Ming government. Ricci taught Qu mathematics and astronomy, and Qu introduced many important friends to Ricci. In fact, they once had the idea to translate the *Elements* into Chinese together and even finished part of the first Book. Unfortunately, the project was terminated at an early stage without known reason (see [13, p. 21]).

Having been prepared for almost twenty years, with the help of his important Chinese friends including princes, ministers, governors, and scholars, Ricci arrived in Peking in 1601 with his assistant Diego de Pantoja (1571–1618). Upon arriving in Peking, they presented the Emperor a set of well-prepared European gifts, including two magnificent mechanical clocks, a decorated harpsichord, a portrait of the Virgin Mary, and a beautiful world map in Chinese which was made by Ricci himself. They were invited to the Forbidden City, but were not received by the Emperor. Nevertheless, for his knowledge of science and technology, Ricci was appointed a royal position maintaining the clocks and other mechanisms in the Forbidden City. In this way, he obtained not only permission to reside in Peking, but also a royal salary.

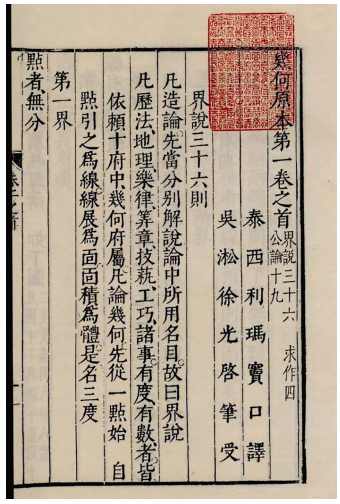
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Figure 7. The title page of the Chinese version of Euclid's *Elements*, translated by Matteo Ricci and Xu Guangqi.

In 1604, Xu Guangqi (1562–1633) succeeded in the Imperial Examination and was assigned a position in the Hanlin Academy.[4] From that point, he often visited Ricci and they became close friends. In fact, Xu first met Ricci in 1600 in Nanking, where he was baptized by Jean de Rocha (1566–1623) in 1603. Through this friendship Xu learned a lot from Ricci, not only in theology and religion, but also in astronomy and mathematics. In 1606, Ricci and Xu started to translate Euclid's *Elements* from

[4] *In the Ming Dynasty, the Hanlin Academy was somehow a secretariat of the court, where the emperor and the government could obtain advice about agriculture, astronomy, weather, natural phenomena, etc.*

Clavius's Latin version into Chinese: Ricci translated it from Latin to oral Chinese, after which Xu formulated it into classical Chinese. In 1607, they finished the first six Books and published them under the Chinese name *Jihe Yuanben* in Peking (see [13], for example). Perhaps, they planned to translate the remaining Books of the *Elements* later. Unfortunately, Xu's father died in 1607. In ancient China, a ranked official was expected to stay at home for three years if his father or mother died. Even more regrettably, when Xu returned to Peking three years later, Ricci had died.

The Chinese version of the *Elements* formally introduced "logical thinking" into Chinese mathematics. The traditional Chinese induction was mainly based on concrete examples, instead of logic and assumptions. Euclid's mathematics is different from the ancient Chinese mathematics in nature. Unfortunately, at that time the Chinese education system paid no attention to mathematics and therefore only a handful of people knew *Jihe Yuanben*. Nevertheless, many Chinese mathematical terms (such as *jihe* for geometry, *pingmian* for plane, *sanjiaoxing* for triangle, *lifangti* for cube, and *tiji* for volume) created by Ricci and Xu are still in usage today (see [8]).

Besides Euclid's *Elements*, Ricci and his collaborators also introduced several other Western books into China (see [13, p. 22]). For example, in 1607 he and Xu translated *Explanations of the Methods of Measurement* (the author is unknown) into Chinese which was published in 1617 in Beijing; in 1608 he and Li Zhizao (1564–1630) translated Clavius's *Epitome Arithmeticae Practicae* into Chinese which was recompiled and published in 1613 in Beijing.

Xu Guangqi was a very important politician and scholar in Chinese history. He made great contributions in agriculture, astronomy, and mathematics. At the end of the Ming Dynasty, the court was dominated by factions. Xu had a difficult political career in which he was dismissed or resigned several times. Nevertheless, he was appointed the minister of rites in 1630 and a grand secretary (more or less a vice prime minister) in 1632. He died at the height of his political career. There are many Chinese books about Xu (see [15], for example). In China, few historical figures have museums. There is one in Shanghai devoted to Xu Guangqi, which has an original copy of Clavius's *Elements*.

Marco Polo is often regarded as the first foreign person who introduced China to the West. Matteo Ricci certainly is the most important person who introduced the West (its religion, science and culture) into China. He drew the first world map in China, which created sensational interest among the learned Chinese. Even the Emperor ordered ten copies from him. For his great contribution to China, when Ricci died in 1610, his body was permitted by the

Figure 8. An oil painting of Matteo Ricci and Xu Guangqi.

Figure 9. The tomb of Matteo Ricci in Beijing.

Emperor himself to be buried in Peking. Before him, no foreign person was allowed to be buried on Chinese soil.

There was one emperor who was enthusiastic about Euclid's *Elements*. Emperor Kangxi of the Qing Dynasty ascended the throne in 1661 when he was seven and reigned for 61 years. In 1689, he decided to learn mathematics and astronomy (see [11]). For this purpose, two Frenchmen, Joachim Bouvet (1656–1730) and Jean-Francois Gerbillon (1654–1707), were appointed royal teachers. They were missionaries sent to China by King Louis XIV of France in 1687. Since the court language in the Qing Dynasty was Manchu rather than Chinese, the teachers had to learn Manchu first and then translate the selected *Elements* into Manchu. Of course, they taught the emperor in the Forbidden City.

4. London

The first English translation of Euclid's *Elements* was published by Sir Henry Billingsley in 1570. Billingsley was born in London and attended both Oxford University and Cambridge University. He was a successful merchant. In

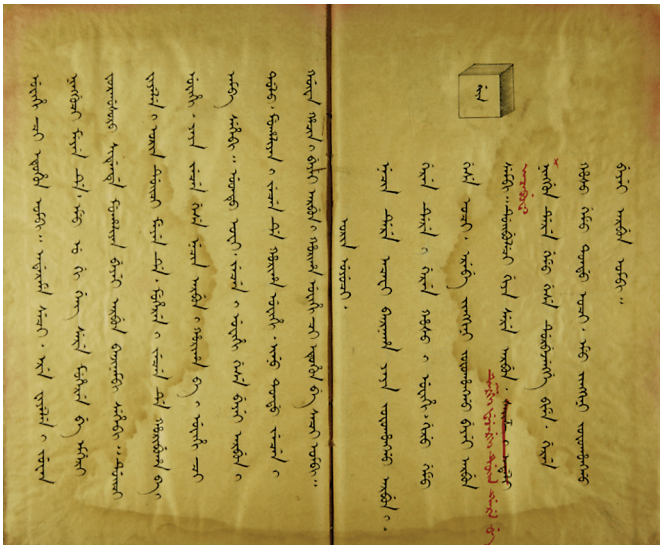

Figure 10. The Manchu translation of the *Elements* used by Emperor Kangxi. The red notes were made by the emperor.

1596, he became Lord Mayor of London. In fact, the history of the English version of *Elements* is also dramatic (see [3]).

For many years, Billingsley's translation was celebrated for its exquisite cover. However, it mistakenly wrote "EVCLIDE of Megara" instead of "EVCLIDE of Alexandria." In fact, many editions of the *Elements* had this mistake (see [2]). As indicated on the cover, this edition contained a preface by John Dee, an advisor to Queen Elizabeth I.

In the 16th, 17th, and 18th centuries, the *Elements* were translated into English editions by many scholars. In particular, Isaac Barrow (1630–1677) produced one in 1660. He completed his education at Trinity College, Cambridge, in 1648. Afterward, he was a fellow of the college and a visitor to Europe for some years. In 1660, he was appointed to the professorship of Greek at Cambridge. In 1662 he was made professor of geometry at Gresham College, and in 1663 became the first Lucasian Professor of Mathematics at Cambridge. He resigned the latter to his pupil Isaac Newton in 1669. He was appointed master of Trinity College in 1672, and held the post until his death.

When more and more English editions appeared, the *Elements* gradually entered high school classes in the UK. In 1815, Alexander Wylie was born in London. He attended a grammar school in Chelsea, where he studied Latin and mathematics including Barrow's *Elements*. After school, he became a carpenter working in Covent Garden and joined the London Missionary Society. In 1845, he started to learn Chinese by reading the Chinese Bible translated by the British and Foreign Bible Society. These preparations coincidentally created conditions for completing the Chinese translation of the *Elements*.

Figure 11. The cover of Billingsley's English translation of Euclid's *Elements*.

5. Shanghai

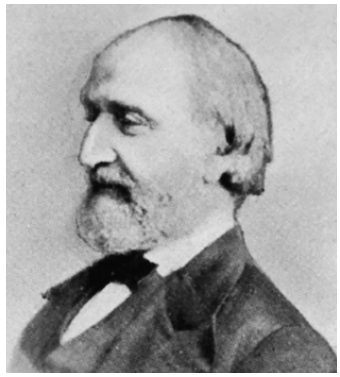

Figure 12. A portrait of Alexander Wylie.

In 1843, for the purpose of printing Chinese Bibles and other religious materials, the British missionary Walter Henry Medhurst (1796–1857) created a publishing house in Shanghai, the London Missionary Society Press. It was one of the earliest modern publishers in China. In 1847, for his Chinese language knowledge and religious background, Wylie was chosen to be an assistant manager of the publishing house. He arrived in Shanghai in August of 1847.

In the early years, the publisher indeed focused on Bibles and other religious books. Gradually, it also started

to introduce culture and science. In 1852, Li Shanlan (1811–1882) joined the publishing house. At that time, he had already made a name as a mathematician. Wylie was impressed by his achievements and his mathematics knowledge.

Figure 13. A portrait of Li Shanlan.

When Wylie and Li discussed Matteo Ricci, Xu Guangqi, and their Chinese translation of the *Elements*, they decided to complete the mission of translating Euclid's *Elements* into Chinese. Unlike Ricci, Wylie did not bring the *Elements* with him when he arrived in Shanghai. In fact, they were not able to find such a book anywhere in Shanghai. So, Wylie had to ask his London colleagues to buy a copy for them. For years, it was believed that they obtained a Barrow edition. However, Yibao Xu [18] provided strong evidence in 2005 that it was a Billingsley translation.

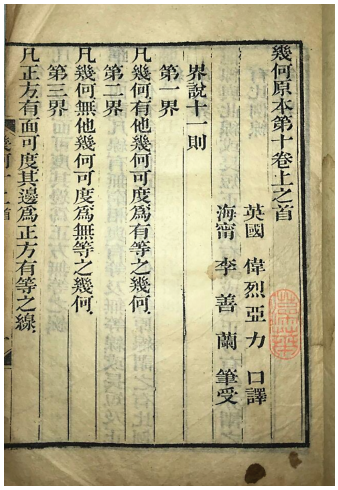
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Figure 14. The title page of the Wylie–Li translation of the *Elements*.

Wylie was not as knowledgable as Ricci in geometry, though he did learn some arithmetic and geometry in school. Luckily, Li was an established mathematician and the two complemented each other. Wylie did the oral translation and discussed with Li until the latter understood the mathematics. Then Li formulated it in standard Chinese. In 1857, Book VII to Book XV[5] of the *Elements* were completely translated into Chinese and were printed under the patronage of Han Yingbi.

Besides the *Elements*, Wylie and Li translated several other important volumes as well. In 1859, they translated Augustus De Morgan's *Algebra* and Elias Loomis' *Calculus* into Chinese. It was the first time that calculus was formally introduced into China. They started a project to translate Newton's *Philosophiae Naturalis Principia Mathematica* into Chinese. Unfortunately, it was interrupted by the Taiping Rebellion[6] and was never finished. Newton's *Principia* was translated into Chinese in 1931, by Taipu Zheng.

Like Ricci, Wylie made great contributions to the China-West exchange. Besides translating classics, he published many books and papers introducing the West to China and China to the West. In 1852, he introduced the Sun Tsu theorem and related results to Europe. In 1874, L. Mathiesen discovered the similarity between the Sun Tsu theorem and Gauss's theorem on linear congruences. Thereafter it is usually referred as the Chinese remainder theorem. For more about Wylie, we refer to [5, 13].

In 1848, Wylie married Mary Hanson in Shanghai. Unfortunately, the next year his wife died in childbirth, although their daughter survived. Wylie returned to the UK in 1877. At that time, he was weak and almost blind. He died on February 6, 1887, in London.

6. Nanking (Nanjing)

In 1860, when the Taiping rebels attacked Shanghai, Alexander Wylie returned to the UK for a short time. Li Shanlan also left the publishing house. During the next years, most of Li's property including books and papers was destroyed by the rebels.

In 1862, Zeng Guofan (1811–1872) invited Li to be one of his aides, in charge of books and references. Zeng was one of the most important figures in the later Qing Dynasty. He was a key politician, a great general, and a leader of the Westernization Movement.[7] At that time, Zeng was the Liangjiang governor in charge of Jiangsu, Anhui, and Jiangxi provinces. On this occasion, Li suggested that Zeng print some important books including the Chinese version of the *Elements*. In 1864, Zeng's army suppressed the Taiping Uprising and took over Nanking again as the residence city of the Liangjiang governor.

As a leader of the Westernization Movement, Zeng strongly supported the effort to introduce Western knowledge into China. In 1865, financially supported by governor Zeng, the complete Chinese translation of Euclid's *Elements* (Book I to Book VI by Ricci and Xu, Book VII to Book XV by Wylie and Li) was published for the first time by Jinling Publishing House in Nanking. Since then, more than two thousand years after it was written by Euclid, China has had the complete *Elements*. During the past one-and-a-half centuries, more than ten different Chinese

[5] *Both Clavius's Latin version and Billingsley's English version contain the two spurious Books XIV and XV. Therefore, Wylie and Li's Chinese translation also contains the two spurious Books.*

[6] *The Taiping Rebellion (1851–1864) was a well-known peasant uprising against the rule of the Qing Dynasty led by Hong Xiuquan (1814–1864). They once took over more than half of China and built a government.*

[7] *From 1861 to 1894, for the purpose of saving the Qing empire, the ruling class pushed hard to learn science and technology from the West.*

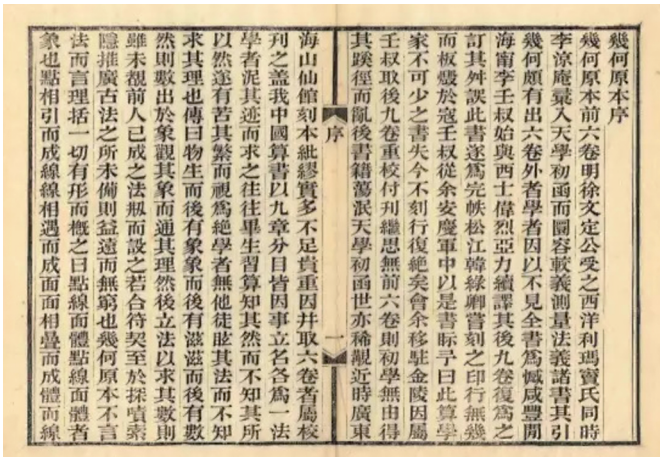
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Figure 15. The preface of the complete Chinese translation of the *Elements*.

translations of the *Elements* (based on different editions) have been published.

Li Shanlan was the most important Chinese mathematician in the Qing Dynasty (1636–1912). In 1862, as a result of the Westernization Movement and for the purpose of training foreign language experts, the Qing government founded the School of Combined Learning in Peking. It was the most advanced institute in China at that time. Four years later, the school created a chair for astronomy and mathematics and Li was recommended. In 1868, he took the chair and held it until his death in 1882. During this time, he taught mathematics, in particular Euclid's *Elements*. For more about Li Shanlan, we refer to [12, 13, 16]. In mathematics, among other things, he is remembered for the Li Shanlan identity: *If* $n \geq m \geq 0$, *then*

$$\sum_{j=0}^{m} \binom{m}{j}^2 \binom{n+2m-j}{2m} = \binom{n+m}{m}^2.$$

Note. In Western literature, the names of ancient Chinese are often written as family name before given name. In this paper, to avoid confusion with literature, the names of Geng Shouchang, Han Yingbi, Hong Xiuqan, Li Shanlan, Li Zhizao, Liu Hui, Qu Rukui, Xu Guangqi, Zeng Guofan, and Zhang Cang follow this rule.

ACKNOWLEDGMENTS. This work is supported by the National Natural Science Foundation of China (NSFC12226006, NSFC11921001) and the National Key Research and Development Program of China (2018YFA0704701). The author is grateful to Leoni Dalla, Joseph Dauben, Richard J. Gardner, the referees, and the handling editor Laura Turner for their comments and suggestions, which essentially improved the quality of this paper. All photos in this paper are in the public domain. The map in the heading image is a copy of the first world map in China, which was created by Matteo Ricci in 1584.

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