

Li Shanlan's Achievements in Scientific Translation and His Contributions to the Modernization of Chinese Sciences

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Abstract

Li Shanlan is a well-known translator, scientist and educator in the late Qing Dynasty of China. He published 8 great translation works in his lifetime, totaling 104 volumes. Li's translation works encompass many important fields of modern western sciences -- mathematics, astronomy, mechanics and botany. His erudite knowledge, profound research, and far-sighted vista mark the translator somebody in the Chinese history. This paper firstly discusses Li Shanlan's specific scientific translations, and then analyzes and points out that his great contributions to the modernization of Chinese sciences. The pioneer Li has not only disseminated western scientific knowledge and laid the foundation for the disciplinary knowledge system in China, but has also cultivated a large number of talents to meet the development and construction in modern Chinese sciences. Moreover, many scientific terms he translated and created are still in use today, consistently yielding a positive effect on the contemporary Chinese sciences and education.

Key words: Li Shanlan; Scientific translation; Modernization of Chinese sciences

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INTRODUCTION

Li Shanlan (1811-1882), also known as Li Renshu, is an outstanding Chinese translator, scientist and educator in the late Qing Dynasty, who was born in Zhejiang Province and died in Beijing. Li Shanlan grew up from a literary family and had received private education since childhood. Endowed with gift and flanked by diligence as well as patience, Li gradually excelled at mathematics and astronomy that he can recite the articles he once read. The preface to the translation of Euclid's *The Elements* (1857) reads: "When I was fifteen years old, I grasped the meaning and principle in the six volumes of the old translation before thinking about the latter nine volumes which, I think, must be more recondite. It is such a pity that former translators didn't finish the whole work." Sporadic descriptions show that Li Shanlan was eager to learn advanced knowledge and stand as the proof of his determination to begin translating western books in the future. Li Shanlan translated a host of scientific masterworks throughout his life including the last nine volumes of *Jihe Yuanben* (几何原本), eighteen volumes of *Daiweiji Sheji* (代微积拾级), thirteen volumes of *Daishuxue* (代数学), eighteen volumes of *Tantian* (谈天), twenty volumes of *Zhongxue* (重学), three volumes of *Yuanzhui Quxianshuo* (圆锥曲线说) and eight volumes of *Zhiwuxue* (植物学). It is worth mentioning that his translations, especially those over mathematics and astronomy, were widely recognized in the late Qing Dynasty. Except for one unfinished translation *Naiduan Shuli* (奈端数理), all the other translations were published in Shanghai Mohai Library and Jinling Publishing House, exerting influence widely in China and even overseas.

Since the end of the 1970s, most studies on Li Shanlan in the domestic academia have shed light on the following three aspects: (1) Studies on Li Shanlan and his co-translators. Yu Yingji (2007) introduced Li Shanlan and his co-translator's scientific translation works, holding that they could not be underestimated in terms of translation

methods and the translation of modern scientific nouns; Wang Yusheng (1983) discussed Li Shanlan's activities in turn with sufficient historical materials in various periods, and highly evaluated his translations as a contribution to the development of modern sciences and technology in China; Du Xuefeng (2012) explored the co-translation of Li Shanlan and his closest collaborator Alexander Wylie, and pointed out that if without Li's pioneering translations, the development of modern Chinese sciences would be incomplete; Zhang Bisheng, Qu Anjing and Yao Yuan (2017) also summarized Li Shanlan's academic translation achievements, highlighting that translators have their translation features such as scientific selection and collation, and emphasizing that Li is a master of both western studies and academic research; Wang Xiaojin (1999) elaborated on the situation of Li Shanlan's co-translator Wylie who stayed in China for more than 30 years and his translation of western scientific works in chronological order. Wang Liqun (2004) indicated that Li Shanlan and Wylie kept reversing western prejudice towards Chinese mathematics and served as a bridge between Chinese and western cultures. (2) Studies on Li Shanlan's translation background and the influence of his translation works. Li Guofa and Jiang Xian (2005) held that Li Shanlan's translation achievements in mathematics once again led the trend of translation and introduction of western mathematics and other sciences; Zhang Bisheng (2019) focused on analyzing the originality of Li Shanlan in translating scientific terms and their impact on education in the late Qing Dynasty, and as such affirmed Li's educational achievements; Yan Chunyu and Li Weiwei (2015) explored the breakthrough of the concept of traditional Chinese mathematics in *Daiweiji Sheji*, and also pointed out the trait of mathematics in the late Qing Dynasty: underlining practicality whereas overlooking theories; Zhao Shuanlin (2017) introduced the translation background of *Daishuxue* and its terms, stressing that many mathematical terms still in use today had been shaped early in the late Qing Dynasty; Yu Xingyue (2015) demonstrated the translation *Tantian* on the basis of its reception in China in order to exemplify that the book played a decisive role in the modernization of China's astronomy; Guo Jianfu, Yongmei and Shao Wen (2017) analyzed the positive effects of experimental applications in *Zhongxue* while pointing out that the localization of western sciences by the late Qing scholars was not conducive to the long-term scientific development in China to a certain extent; Zhang He (2019) dissected the positive impact of *Zhiwuxue* on modern China and Japan as well as its significant role in the modernization of Japanese botany. (3) Studies on the contents of Li Shanlan's translation works and their source texts. Zhang Bisheng (2013; 2016) carried out a detailed analysis of *Daiweiji Sheji* and *Daishuxue* respectively, and those studies on the source texts of Li's translation works were made about *Jihe Yuanben* (Li & Guo, 2013), *Daiweiji*

Sheji (Gao, 2014), *Zhongxue* (Nie, 2010) and *Yuanzhuo Quxianshuo* (Gao, 2018), all of which discussed in detail the times, features and publications of their translated versions, and their impact on later generations. Although the scholars have made in-depth researches on the above three respects, the research on Li Shanlan's achievements in scientific translation and his contributions to the modernization of Chinese sciences is still insufficient and relatively fragmented. For this reason, this paper attempts to analyze Li Shanlan's contributions to the scientific modernization of China by probing into his scientific translation achievements.

1. LI SHANLAN'S ACHIEVEMENTS IN SCIENTIFIC TRANSLATION

Li Shanlan devoted his whole life to scientific research, translation, writing and teaching. In terms of translating western books, he had a long-term and unique vision concerning the selection of original texts. Almost all the translated western books, in their respective domains, are masterpieces, among which he introduced unremittingly the classics of western mathematics, astronomy, mechanics and botany to the lingering China. Not only that, Li Shanlan's many translations were the debuts in the Chinese translation field at that time, laying a solid foundation for people in the late Qing Dynasty to acquaint modern western sciences, and also blazing a bright trail for future generations to further domestic sciences.

1.1 The Only Translation Sequel to the Euclidean Geometry Two Hundred Years Later

The Elements is a mathematical monograph of the ancient Greek mathematician Euclid (330 BC-275 BC). It is also viewed as a "melting pot" integrated with plane geometry, solid geometry, theory of proportion and number theory as well as the most widely circulated book in the West besides the *Bible*. *The Elements* enjoys a high reputation because the book first established a deductive system using axiomatic methods, and has always been regarded as a model of rigorous thinking that must be followed. The book's introduction into China was not an easy story, and some theses (Zhang, 2000; Lan and Zhu, 2003) showed that Euclid's *The Elements* had been brought in the oriental country since the middle of the 13th century through the communication with Arabic arithmetic and culture. During the Mongolian period, there were also Arabic translations of Euclid's *The Elements* in Yuan Dynasty (Li & Jiang, 2005, pp.52-55). More than three centuries later, the scientist of Ming Dynasty Xu Guangqi (1562-1633) and Italian missionary Matteo Ricci (1552-1610) co-translated the first six volumes of *The Elements*. Xu Guangqi spoke highly of the book, saying "this book is beneficial", and believed that "everyone in the world should study this book", "one who can master this book can master anything else, and one who enjoys studying

it can acquire anything else” (Xu, 1865). However, due to various reasons, the translation of the last nine volumes did not proceed smoothly. In addition, China had implemented a self-fettered policy and banned the missionary work since the middle of the Qing Dynasty, resulting in the fact that academic and trade exchanges with foreign countries were almost completely interrupted, and no wonder Li Shanlan sighed about the lagging-behind of translation. Until 1852, Alexander Wylie (1815-1887) of the Mohai Library encountered Li Shanlan who was just visiting Shanghai, and was deeply convinced by his mathematical prowess. Since then, Li Shanlan had been invited to the library by Wylie and began his career of translating western books together with the foreign missionary. The first book to be co-translated was Euclid's *The Elements*.

After a lapse of 249 years, the translation of Euclidean geometry left by the last dynasty became alive again owing to Li Shanlan's endeavors. In the light of Xu Guangqi's attitude of “communication and transcendence”, Li Shanlan spent continually four years in translating nine volumes by correcting errors arising out of dictation and Wylie's interpretation. In the preface, Wylie fully affirmed Li's mathematical and translation abilities by saying: “The English version of *The Elements* has many mistakes and errors with poor proofreading. I am compunctious that I cannot distinguish them from the original. Thanks to Li's good command of mathematics and geometry, and his dedication to its revision and proofreading, the version was corrected and made understandable” (Wylie, 1857: Preface). In 1856, Li Shanlan finally accomplished the first complete Chinese translation of Euclid's *The Elements* which was published by the Mohai Library. The translation work introduced the contents of the last nine volumes in detail, mainly including elementary geometric number theory, irrational numbers, solid geometry, three-dimensional measurement, normal polyhedrons, and calculation and proof of related volumes, lateral areas, and surface areas of solid geometry. The definitions of terms, axioms, and postulates, from shallow to deep, were described in simple and lucid ways, filling many mathematical gaps since the incipient translation of Euclidean geometry and allowing Chinese mathematicians to see the whole landscape. In addition, the complete Chinese translation of *The Elements* played a positive role in promoting the development of modern Chinese mathematics, especially for the deduction methods emphasizing the rigorousness and logicity of thinking, for the methods of geometric argumentation (such as analysis, synthesis, and reduction to absurdity), as well as for mathematical education approaches. The inner rational spirit and translation tactics reflected in this only translation sequel opened up a new world for the modern and even contemporary mathematics in China.

1.2 The First Translation Masterwork of Universal Gravitation and the Copernican Theory

The first translation of *Tantian* began in 1851 when the prestigious British astronomer John Herschel (1792-1871) published the fourth edition of the famous astronomy book *Outline of Astronomy*, and Li Shanlan immediately started translating this western book that had just been introduced into the country. The book's translation lasted eight years and was published in Shanghai Mohai Library in 1859. *Tantian* is the first comprehensive and systematic translation work of modern astronomy in China, greatly improving the cognitive level of astronomical knowledge for all walks in life in the late Qing Dynasty. After the publication, “men of letters who know nothing about the translation shall be ashamed.” (Xiong, 2011, p.403) Literati including Kang Youwei and Liang Qichao regarded *Tantian* as the crucial one among miscellaneous translations of western books. It can be seen that Li Shanlan's translation was widely concerned and valued by politicians and all parties in the society in the late Qing Dynasty. In the 1940s, *Tantian* was still listed as one of “Chinese Translation Masterpieces of World Writings” and continued to be published by the Commercial Press (Chen, 2007, p.159).

The translation work of *Tantian*, based on Copernicus's astronomical system, introduced in detail the heliocentric theory and the ellipse theory which were supported by Newton's laws of gravity and the three laws of Kepler. Also, the book demonstrated the correctness and objectivity of the three theories that were supplemented with accurate observation data and reports. Among them, Newton's law of universal gravity and the theoretical system of astronomical mechanics in this book were systematically unfolded to the Chinese people for the first time, regarding the knowledge of lunar eclipses, planetary quality determination and perturbation. Furthermore, the translation work of *Tantian* also established a scientific concept of the solar system, including the sun-centered eight planets, asteroids, comets, meteor stream, satellite system, etc., and their laws of motion and data changes of orbital elements. Beyond that, *Tantian* distinguished the structure of the stellar world, mapped out the factors that affect the astronomical position of celestial bodies as well as established a clear concept of the celestial sphere for readers by enlightening the physical state of the solar system (Yu, 2015, pp.56-57). Li Shanlan's *Tantian* not only promoted the dissemination and acceptance of a series of modern western astronomical knowledge and ideas in China, but also apparently subverted the traditional idealistic astronomy in feudal China, contributing to the transformation of classical astronomy into modern astronomy. Having shaped the cosmos and world outlooks of advanced members, Li's *Tantian*, in this sense, acts as a kind of “weapon” in the Westernization Movement and the Modernization Movement opposing against the feudal ideologies.

1.3 The First Groundbreaking Translation of Newton's Three Laws of Mechanics

Li Shanlan talked about his busy translation in his Preface to *Zhongxue* in 1866 like this: "I translate *Jihe Yuanben* in the morning while *Zhongxue* in the twilight". His translation of *Zhongxue* was accomplished at the invitation of the British missionary Joseph Edkins (1823-905) on the basis of *An Elementary Treatise on Mechanics* (hereinafter referred to as *Mechanics*), a textbook of physics at the University of Cambridge in the United Kingdom. Its author, William Whewell (1794-1866) (now translated as Sewell), was a major figure in the Victorian scientific community. There are several editions of *Zhongxue* and the different editions also vary slightly in the contents. As one of the most important and influential works in physics, *Zhongxue* is the first translation of mechanics including kinematics, geostatics and hydromechanics in the history of modern Chinese sciences. In the book, Newton's three laws of motion were also introduced into China for the first time. Compared with the book *Far Western Exotic Implements' Figure and Illustrated Records* translated by Deng Yuhan and Wang Zheng in the late Ming Dynasty, it contained more novel knowledge of mechanics, among which the knowledge of kinetics, hydromechanics and the principle of steam engine were quite new for the people of the late Qing Dynasty. Therefore, the translation of *Tiantian* facilitated, to some degree, the spread of western mechanical knowledge in China.

The 17-volume content of *Zhongxue* was derived from the original work *Mechanics* with the coverage of most modern western mechanics at that time, which can be mainly divided into static gravity and dynamic gravity. The rest of the book consisted of hydromechanics, conic curve theory, Li Shanlan's preface, Qian Xifu's postscript, Wylie's English preface and a table of English-Chinese vocabulary. It is particularly worth mentioning that the translation gave an introduction of the three laws of motion of Newton, the collision theory established by Warris, Rennes and Huygens in the 17th century, the balance of rigid bodies and the rotation and curvilinear motion of rigid bodies. It also adopted the methods of calculus to discuss the issues of speed, acceleration and rigid body inertia (Nie, 2010, p.54). Besides, in the contents of kinematics covering volumes 8-17 of *Zhongxue*, the principle of flat acceleration and mutual attraction, the principle of parabola, moving surface resistance and the principle of mutual resistance were all brand-new knowledge from the development of mechanics, which greatly broadened the horizons of the people in the late Qing Dynasty. Li Shanlan always had a unique perspective on the selection of original texts. Most of his translated western books aimed at saving the country and the people. His translation of *Mechanics* was to be in the hope that he could do his bit to salvage the country from oncoming perils, as was revealed in his saying: "Today, European countries are becoming increasingly powerful and invasive

due to their precise calculation and edgy devices... If every Chinese people can benefit from this translation, learn calculation and gradually be able to manufacture advanced equipment sometime, my translation pays off then." (Li, 1886: Preface) There is no doubt that in terms of absorbing scientific theories, *Zhongxue* achieved some delightful results. However, because the original readers of the book and the target readers of the translation had tremendous knowledge and cognitive gap, *Zhongxue* failed to widely enlighten the masses in the late Qing Dynasty. Nevertheless, *Zhongxue* was still the first renowned mechanical monograph translated after the Opium War (1840-1842), which was far more scientific, theoretical, systematic and axiomatic than any previous translations. It was also beyond comparison with other mechanical books in the late Qing Dynasty concerning the knowledge and the coverage.

1.4 The Initial Masterly Translation of Modern Western Plant Cytology

According to the historical records, the knowledge of western botany was sporadically introduced into China as early as the Ming Dynasty, yet didn't form a unitary system. Western botany only began to settle down in China systematically after the Opium War (?), during which Li Shanlan's translation of *Zhiwuxue* played an irreplaceable role in the scientific modernization. *Zhiwuxue* was translated from the fourth edition of *The Outline of the First Principles of Botany* written by the British botanist John Lindley (1799-1865) and was published in 1858 by Shanghai Mohai Library. *Zhiwuxue* can be divided into 8 volumes totaling about 35,000 words with 242 illustrations. The translation mainly introduced the basic theoretical knowledge of modern botany on the basis of experimental observation, including the geographical distribution of plants, classification methods, the internal tissue structure of plants, the morphological structure and functions of various organs of plants, and different shapes of cells. The theory that all plants are composed of cells and the role of pistil and stamen in the reproductive process were also illuminated in the translation (Yan, 1998, p.44). In addition, *Zhiwuxue* gave a brief introduction to the distribution of plants at different latitudes on the earth. Just Li Shanlan pointed out in the book: "To know about plants is being of great importance", "All animals and plants are made of cell bodies." (Li, 1857: Volume 1 of *Zhiwuxue*) In Volume 1, it tells that there are numerous cell bodies fraught with fluids in the whole plant. The descriptions of plant organisms and cells in Li Shanlan's translation work were ever unheard of by the Chinese botanists in the 19th century. Botany, as a momentous branch of modern western sciences, was particularly concerned by the scholars in the late Qing Dynasty who regarded it as an indispensable section in enlightening modern Chinese sciences.

When translating *Zhiwuxue*, Li Shanlan created many botanical terms on the foundation of inheriting the traditional Chinese herbal and agronomic sciences in order to enable the Chinese people to have a better understanding and, by interweaving their existing knowledge, to accept new information of modern western botany. As China's earliest translation in this domain, *Zhiwuxue* did not completely abandon traditional botany, but naturalized and developed the knowledge based upon the original, enriching the connotations and breadth of traditional Chinese botany as well as exerting a significant impact on the surrounding countries, especially Japan. In the history of Chinese botany, *Zhiwuxue* functioned as a smelter fusing ancient and modern Chinese wisdom as well as foreign ideas into one furnace, which took on an altogether new aspect of the entire Chinese botany and laid the foundation for further digestion of western botany. Li Shanlan's *Zhiwuxue* can surely be said to be the intersection of eastern and western botany, marking the sprout of modern Chinese botany (Liu Xueli, 1991: 47).

2. LI SHANLAN'S CONTRIBUTIONS TO THE MODERNIZATION OF CHINESE SCIENCES

2.1 Introduction of New Learning: Disseminating Western Scientific Knowledge

Since being engaged in translation, Li Shanlan had successively translated nine volumes of *Jihe Yuanben*, eighteen volumes of *Daiweiji Sheji*, thirteen volumes of *Daishuxue*, eighteen volumes of *Tantian*, three volumes of *Yuanzhui Quxianshuo* and eight volumes of *Zhiwuxue* in the partnership with western scholars Alexander Wylie, Joseph Edkins and Alexander Williamson (1829-1890). His translations covered four main fields of modern western sciences, namely, mathematics, astronomy, mechanics and botany.

In the case of mathematics, Li Shanlan explained Euclidean geometry, advanced mathematics, and symbolic algebra respectively in such three translations as *Jihe Yuanben*, *Daiweiji Sheji* and *Daishuxue* together with detailed examples. Celebrated for a masterpiece of Euclidean geometry, *The Elements* integrates a multitude of western mathematical knowledge, including plane geometry, solid geometry, fillet theorem, proportion, similarity, measurement and calculation. *Jihe Yuanben*, the first complete Chinese translation of *The Elements*, not only had a profound influence on the traditional Chinese mathematical theory system, encouraging all walks of life in the late Qing Dynasty to rethink about the similarities and differences between the oriental and occidental mathematics, but also brought an epoch-making change to the axiomatic research methods and then the Chinese

mathematical research. The rational spirit had been infused in China's mathematical education from then on. *Daiweiji Sheji* (hereinafter referred to as *Sheji*) stood as the first translation of western advanced mathematics in the Chinese history, incorporating algebraic geometry (namely, analytic geometry today), differential calculus, and integral calculus. The translation and publication undeniably laid a solid foundation for using and researching calculus independently by the Chinese people (Yan & Li, 2015, pp.20-24). Li Shanlan's translation work of *Sheji* was known for being abstruse to read in the late Qing Dynasty, but at the same time, it also aroused the interest of traditional Chinese calculators in calculus learning and research. Therefore, variable mathematical knowledge gradually spread in China. At that time, many government-run schools and academies, such as Hunan Current Affairs School, Lianghu Academy and Xihu Jingshe Academy, all included calculus in their curricula, which can be seen that *Sheji* had a far-reaching impact on education in the late Qing Dynasty. Since then, western books had gradually replaced the Chinese mathematical books, and the Chinese scholars had also come into close contact with western advanced mathematics. Hyperbole aside, this phenomenon narrowed the gap between Chinese and western mathematics, representing the completion of westernization of mathematics in the late Qing Dynasty and moving towards the international mathematical field (Song, 2013, p.40). *Daishuxue* was the first translation work of symbolic algebra in China. Li Shanlan mainly introduced and propagated western polynomial theory, unary quadratic equation theory and expansion issues of exponential functions and logarithmic functions. The spread of western algebra in China delivered a kind of symbolic notation and a sort of rigorous algebraic reasoning and logical calculation to traditional Chinese mathematics (Zhang, 2017, p.104), and *Daishuxue* was recognized as an authoritative translation work and a wind vane for China to imitate the systemic western symbolic theory. In summary, Li Shanlan's mathematical translations not only opened the academic window for the Chinese people to get a glimpse of western mathematics in the late Qing Dynasty, but also paved the way for independent research and development of traditional Chinese mathematics, undoubtedly serving as the catalyst in the process of westernization of traditional Chinese mathematics. In terms of the entire history of Chinese mathematics development, *Jihe Yuanben*, *Sheji* and *Daishuxue* assimilated and disseminated western mathematical knowledge to China. It had been witnessing that the modernization progress of Chinese mathematics took a big stride since the late Qing Dynasty and had moved forward with pioneering spirit.

In astronomy, taking *Tantian* for example, Li Shanlan's translation discussed the rules and theories about relevant operations of celestial bodies, such as naming, geosciences, the universe, the moon, perturbation,

longitude and latitude, planets and comets. Moreover, law of universal gravitation, light aberration, sunspot theory, planet perturbation theory and comet orbit theory were also introduced in the translation work (Wang, 2000, p.108). The translation of *Tantian* greatly enriched the traditional Chinese celestial concept and inspired the scholars in the late Qing Dynasty to be curious and avid for western astronomy, let alone the modern scientific methodology first proposed at the beginning of the translation. The above-mentioned merits provided a new and scientific view of the universe and the world for those people in the late Qing Dynasty. In terms of mechanics, Li's translation of *Zhongxue* involved static gravity, dynamic gravity and hydromechanics, and illustrated physical concepts and issues such as mechanical principles of objects, friction, motion, work and energy, buoyancy and velocity. Although *Zhongxue* was not put into use as a textbook, the translation of the book and its multiple reprints were the best evidence to display the book's significance, necessity as well as its widespread and enduring dissemination. Later, famous mechanical writings in the Late Qing Dynasty, like *Instructions on Mechanics*, *Introduction to Gewu* and *Calculation of Gewu*, generally adopted Li Shanlan's translation method in terms of mechanical terms, concepts, theorems and laws. Physics textbooks even after the 20th century still retained some Li's translation flavor, indicating that the book's imperishable contribution far exceeded the value of the translation itself. With respect to botany, Li Shanlan's translation of *Zhiwuxue* was the first systematic book concerning the geographical distribution of plants and cells, inner structure, organ morphology and function of plants in the late Qing Dynasty. The translation spread western-style botany and lifted Chinese botanists who have long been immersed in traditional herbals to be exposed to novel observation and research perspectives. Li Shanlan's *Zhiwuxue* not only inherited and carried forward China's traditional botany, but also imbibed and transmitted new and modern botanical research methods, and results from the West to the Chinese people, serving as the landmark of the beginning of modern botany in China as a true science (Yan, 1998, p.43).

From this point of view, Li Shanlan's translations on mathematics, astronomy, mechanics and botany played a leading role in the development of modern sciences in China. It was because Li Shanlan understood that little chips light great fires that he introduced and disseminated new knowledge with the hope of enlightening his compatriots. He continued to translate authoritative works selected from various major scientific fields and widely democratized advanced modern western knowledge of sciences for China so as to expel the feudal obscurantism lingering in the late Qing Dynasty and, vigorously create a new era of scientific development for modern China.

2.2 Exertion of Creativity: Pioneering the Translation of Scientific Terminology

In the process of translating western scientific works, Li Shanlan paid special attention to the translation of scientific terminology. He did not adopt westernized translation strategies, but carefully considered the connotations of traditional Chinese scientific terminology after thoroughly understanding the concepts of western sciences, and then established a translation system which synthesized both oriental and occidental merits. Although Li Shanlan did not explicitly put forward his translation principles, he showed obvious translation tendencies and choices in the course of co-translation with several western scholars, which can be confirmed by a passage in the second volume of *Daishuxue*.

It is not hard to see that, according to Li's description, the extension of existing names of arithmetic terms and the creation of new algebraic names were of great significance to the translation and dissemination of algebra, and thus guaranteed that mathematical translations can be animated in foreign countries. The British mathematician Augustus De Morgan once advocated two approaches to handle with algebraic names, while Li Shanlan called it "two paradigms in terminology translation": One is to make the meaning explicit. If the term is not about mathematics originally, a new name can be established. The other is to change and extend the term's meaning to make it widely available. When it comes to co-translation of western books, Li Shanlan and Wylie skillfully transplanted these two principles into the translation process of Chinese and English mathematical terms (Zhao, 2007, p.689). The above-mentioned text was the clearest and most complete opinion and expression over the translation of scientific terminology by Li Shanlan. In addition, Li Shanlan's translation methods of scientific terms can be summarized as follows:

(1) Use the relevant terminology already existing in traditional Chinese sciences as much as possible, and do not seek overall westernization and replacement.

(2) Follow the terminology used in previous translations, and keep the translation of scientific terms unified in China.

(3) Give or add new scientific meanings and scopes of application to the old Chinese terms, and enhance the continuity of term translations.

(4) Select or concatenate new translation expressions that can express the original terms, and actively introduce western scientific terms.

Among the translations of all scientific terms created by Li Shanlan and Wylie, the terms regarding algebra, analytic geometry and calculus accounted for the highest proportion. The scientific terms created as such were broadly used by the Chinese Academy of Sciences with different proportions: 44% of algebraic terms, 50% of analytic geometry terms and 65% of calculus terms (Fang

& Zhuang, 2018, p.527). Li Shanlan's initial scientific translation not only gave rise to imitations in the late Qing Dynasty, for example, almost 50% of the algebraic terms in subsequent *Daishushu* co-translated by Fryer and Hua Hengfang followed Li's translation pattern in the late 19th century (Zhang, 2013, pp.2-24), but also withstood the test of time and history. Besides, initially-translated terms and the mode were introduced to Japan and were put into effect for judging the translation of Japanese scientific terms. In addition to being a crucial part in guiding the scientific terminology translation in China and neighboring countries at that time, a considerable portion of translated terms are, far and wide, still in use today, thus continuing to be viewed as a positive driving force to contemporary science education. For instance, in the mathematical domain, there are "algebra", "logarithm", "polynomial", "constant", "unknown number", "solution", "cube root", "equation", "geometry", "vertical line", "right angle", "center", "diagonal line", "pyramid", "volume", "sine", "cosecant", "origin", "quadrant", "tangent point", "hyperbola", "ellipse", "asymptote", "parabola", "normal", "function", "infinity", "differential calculus", "integral calculus", "series", etc.; in the field of astronomy, they are "the Autumn Equinox", "Winter Solstice", "azimuth", "proper motion", "comet", "constellation", "zodiac", "equation of time", "first quarter", "frigid zone", "meteorite", "microscope", "optics", "perturbation", "planet", "nebula", "sidereal day", "solar day", "synodic month", "galaxy", "centrifugal force", etc.; in the field of mechanics, they are "component force", "resultant force", "particle", "vacuum", "axis", "hook face", "curved bar", "gear", etc.; in the domain of botany, there are "botany", "cell", "family", "calyx", "valve", "palpus", "ovary", "endosperm", "carpel", "rosaceae", "leguminosae", "compositae" and so on.

All in all, in the process of scientific translation, Li Shanlan and his co-translators usually had neither similar books to refer to, nor professional terms that could be applied for reference. Because of the novelty and pioneering content of original texts, the translators had to scrutinize them repeatedly sentence by sentence and give a full play to their ingenuity and consciousness of innovation. Li Shanlan's reasonable and scientific translation of terminology produced a groundbreaking effect on guiding and catalyzing both scientific translation practice and science dissemination. While conserving a certain degree of "localization", he did not forget to absorb the advanced western ideas and give traditional scientific terminology new connotations. All of these being said not only contributed to the development of sciences, but also a major contribution to the cause of translation studies. Li Shanlan's pioneering translation contribution to the scientific terminology will be part of the Chinese language and culture as well as Chinese scientific knowledge, never ever fading into history (Yu, 2007, p.59).

2.3 Translation-cum-Writing: Laying the Foundation for Scientific Knowledge System

Mathematics, astronomy, mechanics and botany are the four important areas of the modernization of Chinese sciences which were all involved in Li Shanlan's translations, especially mathematics. He not only actively translated western mathematical theories and systems for his countrymen, but also wrote two pragmatic books entitled *Zeguxizhai Suanxue* (则古昔斋算学) and *Kaogen Shufa* (考根数法), which left a colorful stroke in the academic history of the late Qing Dynasty. His tireless attitude toward translation and his widely-circulated scientific translations wielded vital influence over the formation and development of four scientific disciplines in China.

In the field of mathematics, as a great mathematician, Li Shanlan had three translations of *Jihe Yuanben*, *Daiweiji Sheji* and *Daishuxue*, inspired by which the traditional mathematical research and Chinese mathematics gradually embarked on the road of globalization (Li & Jiang, 2005, p.54), thus laying the foundation for the modernization of mathematics in China. Among three books, the Euclidean geometry theory and its axiomatic mathematical methods in *Jihe Yuanben* pointed out a clear direction for the establishment and development of the knowledge system in regard to modern geometric number theory, analytical geometry and solid geometry in China. Mathematical reasoning and evolution were added to complete the pragmatism-oriented traditional geometry. *Sheji* marked China's first exposure to western systematic mathematics and the beginning of modern Chinese mathematics (Zhang, 2016, p.931). The theory of calculus discussed in the book had begun to take root in China since then, and had fixed the form of ancient Chinese mathematical system, which paved the way for the spread of advanced western mathematical knowledge in the future, and thus depicted the outline of the modern advanced mathematical knowledge system in China. Li's *Daishuxue* stood as a semi-symbolized algebra communication activity with the West under the influence of traditional Chinese algebra thoughts, making the evolvement of traditional algebra more scientific and systematic, and contributing to the later westernization of traditional Chinese algebra (Zhang, 2017, p.301). From then on, Chinese algebra knowledge theory and symbolic algebraic calculus model had begun to, little by little, step out of the traditional mathematical framework, and gradually accept the symbol system originated from modern western mathematics. These three mathematical translations made by Li Shanlan introduced the knowledge structure, reasoning mode, and evolutionary system of modern western mathematics from the aspects of geometry, calculus and algebra respectively. They turned into necessary extensions and additions to the relatively fossilized traditional mathematics which was brought in line with the western and even global

mathematics in the knowledge system as a footstone of the further development of modern Chinese mathematics.

The translation of *Tantian* for the first time showed the whole picture of modern western astronomy that was beyond the reach of China at that time to the Chinese people, making people re-examine the heliocentric theory which played a decisive role in the establishment of ellipse theory and the theory of earth movement in China (Fan, 2007, p.54). The new astronomic concept introduced in the translation steered correctly the construction of the Chinese astronomic knowledge system in the late Qing Dynasty, and guided the promising development of traditional Chinese astronomy, no longer being limited within the scope of calendar and astro-observation. Instead, the translation gradually spread the knowledge of modern celestial bodies based upon accurate calculations and systematic theories, thereby incubating the maturity of astronomy both in the late Qing Dynasty and modern China. In the field of mechanics, the breadth and depth of translations in the late Qing dynasty far surpassed those of the late Ming dynasty, and the construction of the mechanical knowledge system made a qualitative leap during Li's translating period. With the continuous expansion of the knowledge covered in the translation *Zhongxue*, people had a much more profound understanding towards the discipline of mechanics. It stemmed from focusing merely on its practical value to the theoretical construction, and gradually moved from a subsidiary status to the independent one, evolving into a critical science to other scientific disciplines and laying a firm foundation for the formation and development of physics in China (Nie, 2010, p.162). In the late Qing Dynasty, there were few translations regarding botany, let alone far-reaching influential ones. *Zhiwuxue* translated by Li Shanlan was rich in novel botanical knowledge, lucid plant terms and rigorous scientific systems, making a converging effect on the traditional Chinese botany. Before the publication of *Zhiwuxue*, traditional botany relied more on practical experience for a long time. Although the translation had a few defects, its advent was a breakthrough for the development of modern botany in the late Qing Dynasty where the scientific level of this discipline was still in its infancy (Wang, 1981, p.29).

Li Shanlan not only made outstanding contributions to improving the knowledge system of Chinese mathematics by translating western scientific masterpieces, but also combed the discipline knowledge system and established theoretical frameworks for such three scientific fields as astronomy, mechanics and botany. It can be concluded that while the publication and dissemination of Li Shanlan's translation continued to amplify the connotations of China's traditional scientific field, they also narrowed the gap of knowledge systems concerning four major disciplines with the West, thereby exerting influence on the development of related disciplines in China.

2.4 Translation and Compilation of Textbooks: Fostering Young Scientific Talents

Li Shanlan's life can be roughly divided into four periods: the period of being a mathematician and poet (1811-1844), the period of being an astronomer (1845-1851), the period of being a translator (1852-1859) and the period of being a mentor (1869-1882) (Zhang, 2013, pp.9-12). In 1861, Westerners including Yixin advocated establishing Peking Tungwen College which was founded in 1862. The college set foreign language courses that were intended to train diplomats and translators dealing with foreign affairs. "As mathematics and astronomy are fundamental and necessary to develop manufacturing industry, it is essential to set up another academy in the college." (Chinese History Society, 1961, pp.22-23) Thus, the "Academy for Mathematics and Astronomy" was officially established in 1866. The governor of Guangdong Province Guo Songtao (1817-1891) recommended Li Shanlan to the emperor as the general instructor of the newly built academy due to his good command of both scientific fields. Li Shanlan went to office in 1868. Since then, Li Shanlan had devoted himself entirely to arithmetical education and research and had always been recognized as the pioneer of modern mathematical education in China.

During Li Shanlan's 14-year teaching career, he had not only instructed generations of students by himself, but had never stopped translating and writing books about western sciences, especially about mathematics. In other words, he dedicated himself without hesitation to the cultivation of young talents for thriving modern sciences in China by means of providing appropriate textbooks and bibliographies. On the one hand, he meticulously examined and reviewed mathematical textbooks like *Tungwen Mathematical Course* and *Tungwen Abacus Course* in order to guide the teaching and practice of mathematics in the college; on the other hand, he set about translating *Sheji* which was massively used in the mathematical education system of the late Qing Dynasty and was honored as the irreplaceable designated textbook of mathematics for government-run schools and academies across the country. The translation greatly promoted the development of Chinese mathematical education in the late Qing Dynasty and modern times, and even acted as a reference for contemporary mathematical education. In 1876, the eight-year new curriculum and the five-year new curriculum formulated by Ding Weiliang (Martin, 1827-1916) in Peking Tungwen College both set calculus as a subject and used *Sheji* as the textbook. In Hunan Current Affairs Academy, Liang Qichao, the General Teacher, stipulated two textbooks of mathematics, one of which was *Sheji*; In addition, Lin Chuanjia, a professor at Imperial University of Peking, had taught mathematics since 1898 in Xihu Jingshe Academy in Hengzhou, Qiushi Academy in Changning and Xiangxue Academy in Changsha respectively. *Sheji* was still one

of the textbooks and teaching materials for calculus education in three places. In modern China, schools and colleges in various places chose Li Shanlan's translations and compiled writings as the designated mathematical textbooks, externalizing the profound impact of Li Shanlan's scientific translations on China's modern education system. Li Shanlan contributed greatly to the undertaking of traditional Chinese arithmetical knowledge and the cultivation of a large number of potential scholars and scientists. He taught them to incorporate traditional mathematics into the torrent of the modern global astronomical system and comply with the historical trend of the modernization of Chinese sciences.

Coincidentally, with the boom of the Westernization Movement in the late Qing Dynasty, Li Shanlan's astronomical translation of *Tantian* was also widely circulated in new schools and academies. Since then, astronomy had become an independent discipline, and *Tantian* had no longer been deemed only as a reading material for the gentry class, but had been collected in dozens of libraries as one of the required readings for students (Fan, 2007, p.51). Furthermore, Gezhi Academy, founded in 1873, was a typical representative of modern Chinese education. In *Gezhi Academy Lessons* compiled from the outstanding students' papers of the college, *Tantian* was mentioned many times by students and won their appreciation and favor. In addition, a few of translation works of *Tiantian* that were printed with red (China's imperial and official color) characters like "Yunnan Wubei School Collection", "Army Academy Official Book" or sealed with Manchu Script (Qing Dynasty's official language) were discovered at Tsinghua University (Fan, 2007, p.52), which also witnessed the educational influence of *Tantian*. After the introduction of new western studies, Li Shanlan's translation works of astronomy then took schools and academies as a carrier to successfully achieve their teaching and educational goals that aimed at popularizing principles of the universe and implementing systematic construction of sciences among the new generations of Chinese intellectuals.

Regarding Li Shanlan's teaching career, Cui Jingchang (Wang, 1993, p.1213) described in *Biography of Li Renshu* that the students he taught "are more than one hundred people, some of which become officials or governors in other provinces and others may go overseas". The outstanding students including Xi Gan, Gui Rong, Xiong Fangbai, Chen Shoutian, Hu Yulin, Li Fengchun, Gao Lu, Zhang Yun and Zhu Wenxin played a key role in spreading and developing China's modern scientific knowledge and system, and greatly accelerating the pace of the modernization of Chinese sciences. In the late Qing period when Chinese and western cultures were blended as well as the old and the new alternated, both teachers and students contributed selflessly to the modernization of Chinese sciences. No wonder that Ding Weiliang spoke highly of Li Shanlan by saying: "Astronomy, geography,

firearm and measurement are of significance to a country. The excellent performance of those students was rooted in Li's diligent attitude and fruitful instruction. If we didn't get assistance from Li who revived the traditional Chinese mathematics, we won't find another one!" (Ding, 1880: Preface).

In summary, Li Shanlan was committed to translating western books, compiling and reviewing teaching materials to meet the need of training young Chinese talents of sciences. Through these methods, Li Shanlan devoted his lifetime efforts to teaching younger generations by imparting them the knowledge system and thinking mode through advanced modern western sciences, and to imperceptibly cultivating them to be the next generations who would stand as frontrunners in the modernization of Chinese sciences; Adhering to translation and teaching in his whole life, Li Shanlan delineated a rosy picture for the modernization of Chinese sciences, and simultaneously cultivated a mass of potential and promising talents to realize the long-term target, provident and respectable.

CONCLUSION

Cooperated with western scholars like Wylie, Edkins and Williamson, Li Shanlan's translation works extended to four major areas of western sciences -- mathematics, astronomy, mechanics and botany. Many of his scientific translation works were accomplished under the prevailing slogan "self-improvement" in the late Qing Dynasty. Li's translation works opened the window for the Chinese people to cognize modern sciences in the West and were designed to be in line with global sciences on the basis of inheriting traditional scientific knowledge. The extensive translation and dissemination of modern western sciences not only culminated the phenomenon of English-to-Chinese translation of scientific writings again, but also broadened the horizons of academic circles and the Chinese people in the late Qing Dynasty by learning from western sciences. Moreover, Li Shanlan's contributions functioned as a booster and a catalyst in terms of establishing and promoting the translation of Chinese scientific terminology, the construction and developing of knowledge system of scientific disciplines as well as the education and cultivation of scientific talents. By means of translation, education and writing, Li Shanlan provided comprehensive knowledge, complete system, scientific terminology and brilliant talents for the modernization of sciences in China. He was, is and will be a preeminent pioneer of modern Chinese sciences.

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