Early Twentieth-Century Visitors and the Development of Modern Mathematics in China

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Modern science, including mathematics, came late to China. The first Chinese university was founded only in 1895; its first university mathematics department formally opened only in 1913. Although at the beginning of the twentieth century, some Chinese went to Europe, to the United States, and to Japan for higher education in modern mathematics and returned to China as the pioneer generation, it still took time for modern mathematics to take root in Chinese soil. That growth, however, was enhanced by the visits in the 1910s, 1920s, and 1930s of a number of leading mathematicians from Europe and the United States. The Germans Konrad Knopp, Wilhelm Blaschke, and Emanuel Sperner; the Englishman Bertrand Russell; the Frenchmen Paul Painlevé and Jacques Hadamard; and the Americans George D. Birkhoff, William F. Osgood, and Norbert Wiener all came to China for extended periods, lectured on their work, and sparked the mathematical interest of Chinese mathematicians eager to understand the modern approach that their work embodied. In a sense, then, this is the one-hundredth anniversary of modern mathematics' arrival in China. In what follows, I lay out the social background of this introduction and sketch the contours of various of the visits that played key roles in this new development for mathematics in China.

Some Social Background

At the end of the nineteenth century, after the second Anglo-Chinese war, foreign missionaries were under particular protection in China. Gradually, their followers also benefited from that protection. In 1897, conflict erupted between some church followers and local villagers in Shandong Province. When the villagers thought that they had been treated unfairly, they asked a famous boxer, Sanduo Zhao, to administer justice. They got the expected justice! Afterward, organized boxer gangs for the purpose of fighting with the missionaries and their followers were quickly formed, and they spread from Shandong to neighboring provinces, and finally to Tianjin and Beijing. Many churches were destroyed, and more than 100 000 people from both sides were killed. Having adopted the slogan "supporting the Chinese rulers and opposing foreign powers," the rebels obtained tacit permission for their actions from the Empress Dowager Ci Xi (1835–1908), who was then in power. In June 1900, more than 100 000 boxer rebels gathered in Beijing. When thousands of missionaries and their followers fled to the foreign embassies, the boxer rebels laid siege to the embassy area in Beijing.

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On May 28, 1900, Britain, the United States, France, Germany, Russia, Japan, Italy, and Austria invaded China to suppress this so-called Boxer Rebellion. Three months later, on August 14, 1900, more than 20 000 soldiers of the allied force occupied the Chinese capital of Beijing, but not before the imperial family as well as some high-ranking officials and servants managed to escape to Xi'an. A year later, on August 8, 1901, when the Chinese government agreed to all of the requirements of the eight nations, including payment of a huge indemnity (the Boxer Indemnity), the allied forces withdrew from Beijing.

Seven years later and after four years of hard diplomatic negotiation, the American government acknowledged the unfairness of the indemnity by returning some $11.96 million to China. Both sides agreed to use the money to set up an educational foundation to support Chinese students to study in America. According to the agreement, from 1909 through 1912, China could send 100 students a year to the United States, and thereafter, fifty students a year until the fund was exhausted. Meanwhile, the Tsinghua School was founded in 1909 to oversee the selection and preparation of the students. Twenty years later, Tsinghua University emerged from this preparatory school.

The educational foundation set up thanks to the returned Boxer Indemnity was crucial for the early development of modern mathematics in China. It led to the earliest Chinese PhDs in mathematics: Tah Hu (Mingfu Hu, 1891–1927) in 1917, Yuen-Ren Chao (Yuanren Zhao, 1892–1982)[1] in 1918, and Li-Fu Chiang (Lifu Jiang, 1890–1978) in 1919.[2] All three of these mathematicians took their degrees from Harvard University and returned home to pass on their newly acquired mathematical knowledge.

In the meantime, however, the Qing Dynasty had been overthrown in 1911, and the Republic of China had emerged. Consequently, the modern education system in which these earliest PhDs taught was set up gradually [22]. The two decades of the 1910s and 1920s witnessed great turmoil in China, as warlords fought with each other and various political movements vied for control. Even more disastrous, the Japanese invaded China in 1937 (China had already lost the Sino-Japanese War in 1895) and occupied more than half of China's territory for eight years. These social events decisively influenced the early development of modern science in China.[3]

Some Institutional Background

In 1912, the first mathematics department in China was set up at Peking University with two professors: Zuxun Feng (1880–1940) and Junji Hu (1886–??).[4] The new department welcomed its first two students a year later. Feng taught the analysis courses, including calculus, function theory, and differential equations, while Hu taught the others, such as Euclidean geometry and elementary number theory. Feng had enrolled as an undergraduate in Peking University in 1902. He was chosen in 1904 to study mathematics in Japan, supported by his university. When he graduated, specializing in differential equations, from Kyoto Imperial University in 1909, he became the first Chinese to complete a university education in mathematics. Hu also went to Japan, in 1903, to study mining metallurgy. He graduated from Tokyo Imperial University in 1910, but his coursework also included some modern mathematics. On accepting the teaching position at Peking University, he returned to Tokyo Imperial University to improve his command of mathematics.

Two Harvard-trained professors joined the mathematics faculty in 1917. Fen Qin (1887–1973) had earned a master's degree in astronomy at the Cambridge institution in 1909, while Renfu Wang (1886–1959) had completed his bachelor's degree in mathematics there in 1913. With their addition, Peking University's mathematics department had seven faculty members, who gave instruction to more than twenty students in a dozen mathematics courses including Euclidean geometry, calculus, function theory, differential equations, harmonic functions, theoretical physics, abstract algebra, modern geometry, group theory, and number theory. Teaching in this first decade was the top priority for professors. Although they published a number of textbooks and some short research notes in Chinese, Feng, Hu, Qin, and Wang were not research mathematicians.

The second department of mathematics in China was set up at Nankai University in Tianjin in 1920, a year after the university's founding. Li-Fu Chiang, who, as noted, had earned his Harvard PhD in 1919, was appointed its first professor of mathematics.[5] For four years, Chiang was the only member of the new department, teaching various undergraduate courses in analysis, geometry, and algebra. It was thanks to the training he provided that several of his promising students, among them Chin-Nien Liu (Jinnian Liu, 1904–1968), Tsai-Han Kiang (Zehan Jiang, 1902–1994), and Yu-Cheng Shen (Youchang Shen, 1901–1978), proceeded to Harvard for their PhDs and returned to make distinguished contributions to the country's modern mathematical development. Liu received his PhD in 1930 for a thesis titled "Contribution to the Restricted Problem of Three Bodies" under the supervision of George Birkhoff. Kiang worked with Marston Morse, also graduating in 1930, with a thesis titled "Existence of Critical Points of Harmonic Functions of Three Variables." Shen studied with Joseph Walsh, earning his PhD in 1935 for a dissertation "On

[1]In both [24] and [26], Yuen-Ren Chao is not listed as a mathematics PhD. However, according to [20, p. 295], Chao studied mathematical logic under the supervision of Henry M. Sheffer.

[2]In Chinese culture, the surname is written before the given name. In this paper, however, we adopt the convention of writing the surname last. Regarding romanization—the transliteration from Chinese characters into the Latin alphabet—there was at first no official system, resulting in a variety of spellings. Since 1978, however, Chinese government regulations have mandated the use of the pinyin system, which has become the international standard. As a result, many older Chinese names have two romanized forms. For example, with the arrival of pinyin, the capital city Peking became Beijing, and the name Yuen-Ren Chao became Yuanren Zhao. In what follows, I use both traditional and pinyin names where applicable.

[3]For more social and institutional background, we refer to [16, 29].

[4]For what follows in this section, compare [7, 22].

[5]Chiang's Harvard thesis was titled "The Geometry of a Non-Euclidean Line–Sphere Transformation" and was written under the supervision of Julian Coolidge.

Interpolation and Approximation by Rational Functions with Preassigned Poles." Kiang and Shen were particularly important for the development of modern mathematics in China, with Kiang being the first to introduce the field of topology to the country and Shen playing a similar role for differential equations.

The founding of Nankai University was followed a year later by that of the National Southeast University in Nanjing. It began its mathematics department in 1921 with the appointment as founding chair of King-Lai Hiong (Qinglai Xiong, 1893–1969), who had taken his master's degree from the University of Montpellier in 1919. Hiong designed his department's courses, prepared lecture notes, and taught analytic geometry, spherical geometry, calculus, analytic functions, differential geometry, and differential equations. A pioneering mathematics educator, he also recognized the absence in China of courses in complex analysis and worked to fill that educational lacuna. A department of one for only one year, Hiong was joined on the mathematics faculty by French-trained Zi-Xie Duan (1890–1969) in 1922. Duan had journeyed to France in 1913 and had earned a master's degree in mathematics from the University of Lyon in 1920.

In 1927, Tsinghua University set up its mathematics department. Under Zhi-Fan Zheng (1887–1963) as chair, it attracted King-Lai Hiong from Nanjing to serve as its second member. Zheng had earned a BA in mathematics at Cornell University in 1910. Thereafter, he visited Harvard for a year to hone his mathematical skills. Hiong and Zheng were joined in 1930 by two more professors, Dan Sun (Guangyuan Sun, 1900–1979) and Ko-Chuen Yang (Wuzhi Yang, 1896–1973). Both had earned their PhDs from the University of Chicago in 1928, Sun for a thesis in differential geometry under Ernest Lane, and Yang for work in number theory directed by Leonard Dickson. Both were later instrumental in introducing the areas of their doctoral research to China.

By the 1930s, China already had more than forty universities and several competitive mathematics departments, for example at Peking University, Tsinghua University, Zhejiang University, Central University, Nankai University, Chiao Tung University, Kwang Hua University, and Wuhan University [24, pp. 103–105]. Moreover, as of 1930, nineteen Chinese had obtained PhDs in mathematics; see Table 1.

These mathematicians and others began to publish the fruits of their mathematical labors in research journals abroad. In fact, the first mathematical research paper published in an international journal by a Chinese author was "The Differentiation of Quaternion Functions," published by K. T. Wang (Jitong Wang, 1875–1948) in the *Proceedings of the Royal Irish Academy* in 1911. Wang had studied and taught mathematics at the College of Languages (*Tongwen Guan*) in Beijing, but from 1909 to 1914, he served as an administrator for Chinese students in Britain. He went on to become a pioneer in electrical engineering in China. It was, however, Tah Hu, the first Chinese to earn a PhD, who published the second such paper. In 1918, his doctoral thesis appeared as "Linear Integro-differential Equations with a Boundary Condition" in the *Transactions of the American Mathematical Society* [9]. By 1937, before the Japanese invasion, Chinese authors had published more than 250 mathematical papers in journals internationally [26, p. 12]. That output had, in part, been spurred by a number of foreign visitors to Chinese soil.

Table 1. The First Nineteen Mathematics PhDs in China. (List compiled from [24, p. 189], [26, pp. 16–29], and [20, p. 295].).

Name	University	Year	Field
Tah Hu (Mingfu Hu)	Harvard	1917	Analysis
Yuen-Ren Chao (Yuanren Zhao)	Harvard	1918	Mathematical Logic
Li-Fu Chiang (Lifu Jiang)	Harvard	1919	Geometry
Jung Sun (Rong Sun)	Syracuse	1921	Algebra
David Yule (Dawei Yu)	Harvard	1922	Mathematical Logic
Bing-Chin Wong (Bingquan Huang)	Berkeley	1922	Geometry
Shih-Luan Wei (Siluan Wei)	Göttingen	1925	Analysis
Zhao-An Zeng	Columbia	1925	Geometry
Kun-Ching Chu (Gongjin Zhu)	Göttingen	1927	Analysis
Ko-Chuen Yang (Wuzhi Yang)	Chicago	1928	Number Theory
Dan Sun (Guangyuan Sun)	Chicago	1928	Geometry
Chin-Yi Chao (Jinyi Zhao)	Lyon	1928	Analysis
Wei-Kwok Fan (Guohui Fan)	Lyon	1929	Analysis
Kien-Kwong Chen (Jiangong Chen)	Tohoku	1929	Analysis
Tsun-Shien Lian (Junxian Liu)	Lyon	1930	Analysis
Tsai-Han Kiang (Zehan Jiang)	Harvard	1930	Topology
Chin-Nien Liu (Jinnian Liu)	Harvard	1930	Analysis
Hung-Chi Chang (Hongji Zhang)	Michigan	1930	PDE
Shu-Ting Liu (Shuting Liu)	Michigan	1930	Analysis

Konrad Knopp, the First Foreign Mathematician to Teach in China

In 1909, the German colony of Qingdao (Tsingtao) was the site of the German–Chinese College (*Deutsch–Chinesische Hochschule*) established as a joint venture of the German and Chinese governments.[6] The German Konrad Knopp (1882–1957) was appointed its mathematical chair, making him the first foreign mathematician to teach in China.[7] Knopp had received his doctorate in 1907 at the University of Berlin under Friedrich Schottky and Georg Frobenius, teaching thereafter for two years in Nagasaki, Japan, before moving with his wife to Qingdao in 1910. On his arrival, Knopp tried to introduce advanced courses in mathematics for his Chinese students, but as he soon discovered, they were prepared for such work neither linguistically nor in terms of basic mathematical knowledge. As a result, his efforts proved largely unsuccessful.

[6]On November 1, 1897, two German missionaries, Franciscus Nies and Richard Henle, were murdered in Juye county in the Shandong Province of China. Thirteen days later, seven hundred German soldiers landed in the province's Jiaozhou Bay and occupied the area, which from 1898 to 1914 included the German colony of Qingdao.

[7]On Knopp in China, see [14, p. 109] and [27].

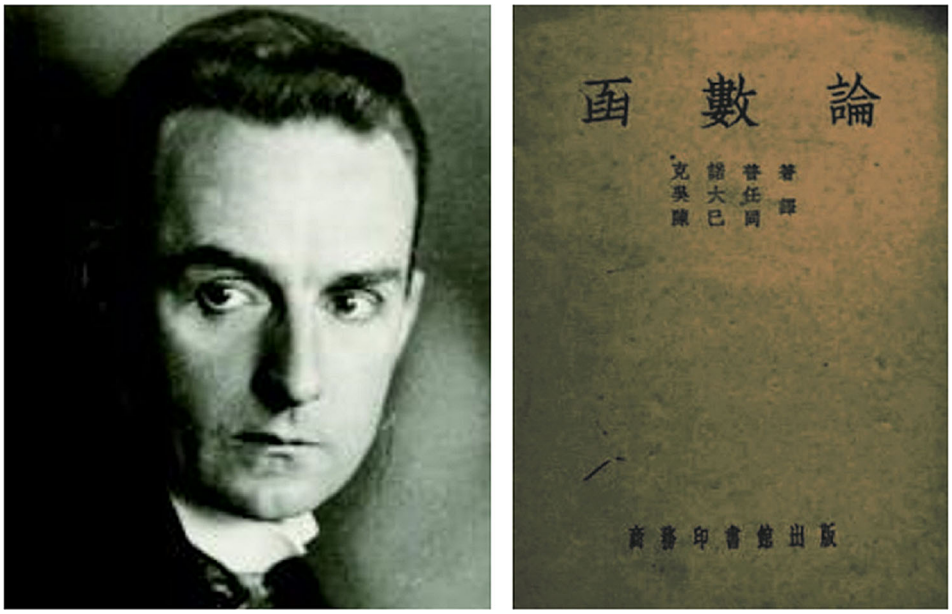

Figure 1. Konrad Knopp and his book *Funktionentheorie* in Chinese translation.

Knopp returned to Berlin in 1911, passing his habilitation at the University of Berlin and teaching there before moving on to the University of Königsberg. By 1926, he had taken a professorship at the University of Tübingen, where he would pursue his career in mathematics until his retirement in 1950. Among his mathematical contributions, Knopp is known as a cofounder and long-time editor of the *Mathematische Zeitschrift*.

If his classes at the German–Chinese College were underappreciated, Knopp nevertheless had a lasting impact on Chinese mathematics through his textbooks. In the 1930s, his books *Theorie und Anwendung der unendlichen Reihen* (1922) and *Funktionentheorie* (1936) were among the main mathematical references in Chinese universities, having been translated into Chinese in 1936 and 1947, respectively; see Figure 1. In fact, the Chinese version of the latter book was republished several times in the 1940s and 1950s.

Paul Painlevé and Bertrand Russell in China

Knopp's Chinese sojourn was followed in 1920 by the extended visits of the French analyst Paul Painlevé (1863–1933) and English logician, mathematician, philosopher, and peace activist Bertrand Russell (1872–1970). Painlevé, who actually visited China not as a mathematician but as a politician with fellow mathematician Émile Borel (1871–1956) as his secretary, was in the country from June 22 to September 12, 1920.[8] A professor at the Sorbonne and the École Polytechnique, Painlevé later taught at the Collège de France as well as at the École Normale Supérieure. His election to the French Academy of Sciences in 1900 preceded by six years his turn from mathematics to politics. Starting his political career as deputy for the fifth arrondissement in Paris, he served several times as a government minister and twice, in 1917 and 1925, as the French prime minister.

During his stay in China, Painlevé was awarded an honorary doctorate by Peking University, the first honorary doctorate in China. On that occasion, he gave a talk entitled "Mathematical Progress," another first: the first mathematical talk given in China by a foreign mathematician.[9] Then, just prior to his departure, Painlevé was invited, this time by the Chinese Society of Sciences, to gave another talk, but in Shanghai. Speaking on "Science and Education," he appealed to Chinese scholars to organize societies in their own specialized fields. Despite this entreaty, the Chinese Mathematical Society was established only in 1935, owing to the fact that the community was still too weak in the 1920s to sustain such a professional organization.

Both Painlevé and Borel proved to be lifelong friends of China [13]. In 1911–1912, when the Qing Dynasty was replaced by the Republic of China, Painlevé had been among the earliest Western politicians to support the diplomatic recognition of the new political entity. Then, in 1920, with Painlevé's support, the French Institute of Sinology (*Institut des Hautes Études Chinoises de Paris*) was founded jointly by the Chinese and French governments. Since then, it has played an important role in Sino-French relations, in particular in the area of cultural exchange. Painlevé served as its founding president until his death in 1933; Borel succeeded him in the presidency.

A month after the Frenchmen's departure, Bertrand Russell and Dora Black (they married in 1921) arrived in Shanghai at the invitation of the president of Peking University; see Figure 2. Thus began their nine-month stay

[8]For more on this visit, see [14, pp. 111–113] and [24, p. 62].
[9]Unfortunately, Borel gave no mathematical lectures during the visit.

Figure 2. Bertrand Russell and Dora Black in Shanghai.

in China.[10] To make the visit successful, Harvard-trained Yuen-Ren Chao was appointed Russell's interpreter and secretary. During his first three weeks in China, Russell delivered public lectures in Shanghai, Hangzhou, Wuhan, and Changsha on a variety of topics: social problems, education, Einstein's special theory of relativity, politics, philosophy, religion, and mathematical logic. His lectures attracted the attention of Chinese scholars and social activists alike and stimulated intense debates in the press. By early November, Russell had finally arrived at his ultimate destination, Peking University, in Beijing. He was to have lectured on philosophy there for six months.

At the beginning of March 1921, Russell agreed to give four lectures on mathematical logic, having been invited jointly by the Society for Mathematics and Physics at Peking University and the Society for Mathematics, Physics, and Chemistry at Beijing Normal University. The first of these lectures was delivered on March 8 to an audience of some 150 professors and college students. The second, announced for March 15, was, unfortunately, not given. Russell came down with pneumonia the day before. For nearly six weeks, and at times close to death, he was confined to his bed. Although he eventually recovered, he was still very weak when he finally left Beijing on July 10, 1921. Because of his sudden illness, Russell's subsequent lectures on mathematical logic were all canceled. Nevertheless, his visit and talks stimulated several Chinese to pursue research in mathematical logic. Russell's definition of mathematics even became popular and stimulated jokes in China: Mathematics may be defined as the subject where we never know what we are talking about, nor whether what we are saying is true.

Prior to Russell's visit, various Chinese magazines and newspapers had covered aspects of his life, persona, and work. For example, when his *Introduction to Mathematical Philosophy* was published in 1919, a Peking University magazine printed an introductory review. The book was translated into Chinese in 1922, the same year in which Russell published *The Problem of China*. Of course, afterward, many of his works, including *Principia Mathematica* (with Alfred North Whitehead) and *The Problem of China*, were translated into Chinese (Figure 3).

While the visits of Painlevé and Russell were not intended to be primarily mathematical in nature, they nevertheless resulted in the earliest modern mathematical talks given in China. Both men inspired the Chinese enthusiasts who heard them. Both ultimately made a lasting impression on the Chinese mathematical community.

Wilhelm Blaschke and Emanuel Sperner at Peking University

A decade later, in 1932, two German-speaking geometers, Wilhelm Blaschke (1885–1962) and Emanuel Sperner (1905–1980), visited Peking University; see Figures 4 and 5. Blaschke arrived first, in April, for a two-week stay that was part of his round-the-world mathematical tour to India, China, Japan, and the United States.[11] Born in Graz, Austria, he had earned his PhD from the University of Vienna in 1908 under Wilhelm Wirtinger. After teaching in Prague, Leipzig, Göttingen, Königsberg, and Tübingen, he became

[10]For these and other details of this visit, see [14, p. 110], [21], and [24, p. 63].

[11]For an account of the whole tour, see Blaschke's book *Reden und Reisen eines Geometers* [4, pp. 87–90].

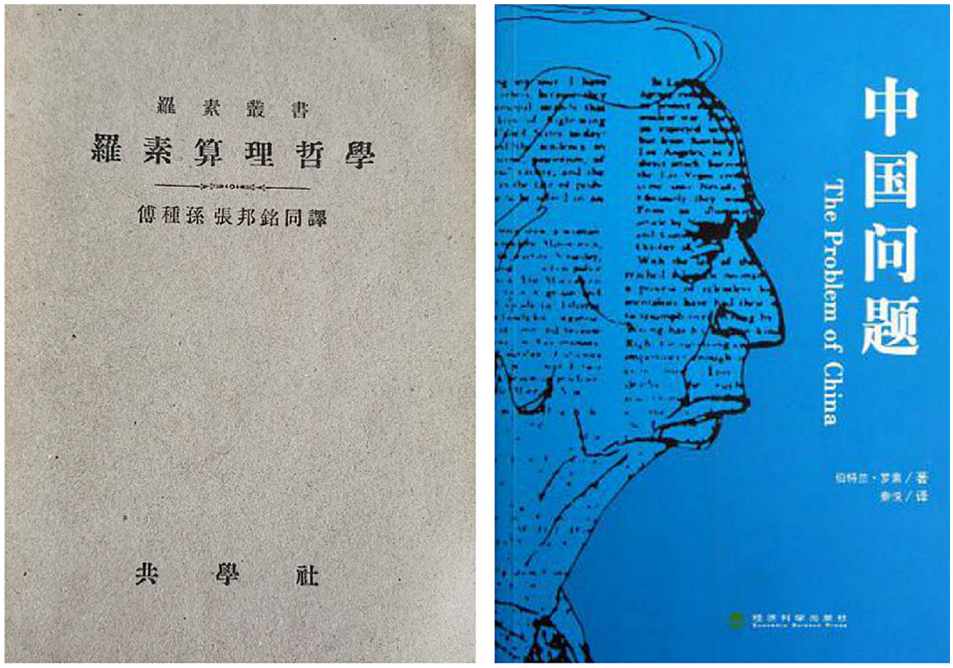

Figure 3. The Chinese translations of Russell's books *Introduction to Mathematical Philosophy* and *The Problem of China*.

a professor at the University of Hamburg in 1919, teaching there until his retirement in 1953.

During his visit to China, Blaschke gave a series of talks in Beijing on topological problems in differential geometry.[12] At that time, although very few in China understood differential geometry, one who did was Tsinghua's Dan Sun. Two others, Shiing-Shen Chern (Xingshen Chen, 1911–2004) and Dach-Rahn Wu (Da-Ren Wu, 1908–1997), were graduate students working on their master's degrees under Sun at Tsinghua.

Blaschke's visit, while not as nationally sensational as Russell's, was nevertheless a big event for the Chinese mathematical community. Many came from other cities to attend his talks, even though the majority could likely not understand a word of them. It was, however, in the context of these lectures that Chern first met Blaschke. The young Chinese mathematician attended all of Blaschke's lectures, took detailed notes, read Blaschke's related papers, and ultimately decided to study for his PhD with Blaschke in Hamburg [26, p. 70].

On completing his master's degree in Beijing, Chern took the selection examination for study abroad financed by the Boxer Indemnity and won one of the coveted scholarships. Usually, students so supported pursued their study and research in the United States, but surprisingly, Chern's application to study in Germany was approved by the Boxer Indemnity authorities. Chern arrived in Hamburg in 1934, enrolled as Blaschke's doctoral student, and obtained his doctorate in 1936 for the thesis "Eine Invariantentheorie der Dreigewebe aus r-dimensionalen Mannigfaltigkeiten im R^{2r}" [5]. From there, he gradually stepped onto the international mathematical stage. Chern's fellow graduate student under Sun, Dach-Rahn Wu, went to Hamburg a couple of years later and returned to introduce integral geometry to China.

After his brief visit, Blaschke recommended his 1928 doctoral student Emanuel Sperner as a visiting faculty member at Peking University.[13] Arriving in 1932, Sperner taught courses for two years based on his new books (with Otto Schreier) *Einführung in die analytische Geometrie und Algebra* and *Vorlesungen über Matrizen* [14, p. 106]. Besides his classes, he also ran advanced seminars and supervised graduate students, although at that time, the mathematics department had about seventy undergraduates and only four graduate students. Sperner's books with Schreier, both translated into Chinese by Ky Fan (Ji Fan, 1914–2010) in 1935 and widely used thereafter as textbooks, proved very influential for a number of young Chinese, as did his mathematical courses and talks. Among those so influenced were Shiing-Shen Chern, Dach-Rahn Wu, Ky Fan, and Ho-Gui Chang (Herui Zhang, 1911–1995). Fan pursued his doctoral studies under Maurice Fréchet in Paris, earning his degree there in 1941 and making his career in the United States, while Chang went to Hamburg for his PhD, taking it in 1941 with a thesis directed by Ernst Witt entitled "Über Wittsche Lie-Ringe." Chang returned to China, becoming one of the key figures in the introduction of modern algebra to the country.

George Birkhoff and William Osgood at Peking University

As Sperner was preparing for his return to Germany in 1934, two Americans from Harvard, George Birkhoff (1884–1944) and William Osgood (1864–1943), were making

[12]Blaschke's visit is treated in [14, pp. 114–115] and [24, p. 63].

[13]Emanuel Sperner obtained his PhD in 1928 under the supervision of Otto Schreier and Wilhelm Blaschke. For more on Sperner's life, see [1].

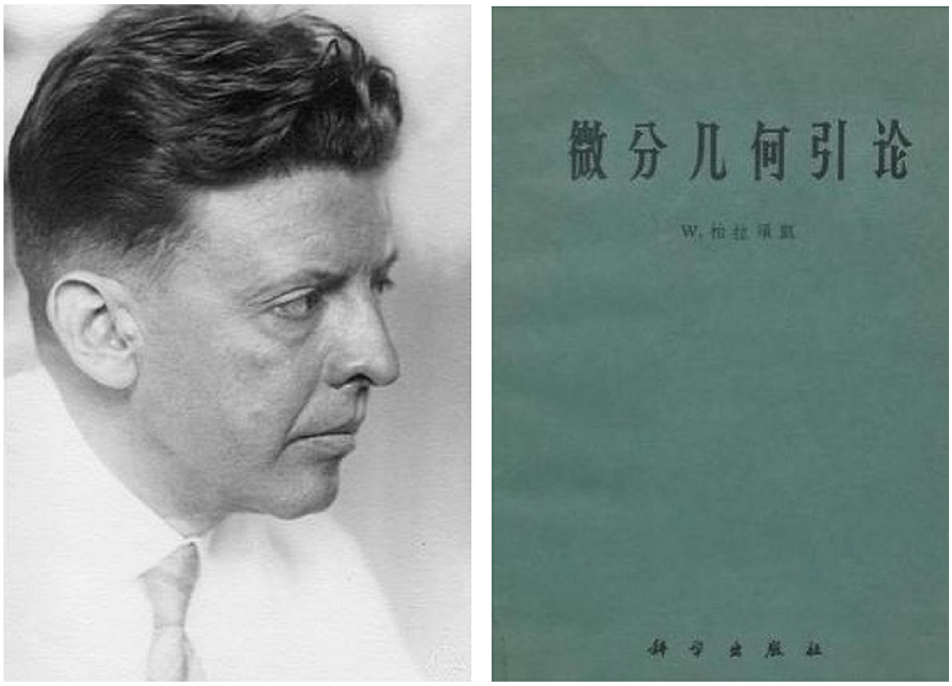

Figure 4. Wilhelm Blaschke and the Chinese translation of his book *Einführung in die Differentialgeometrie*.

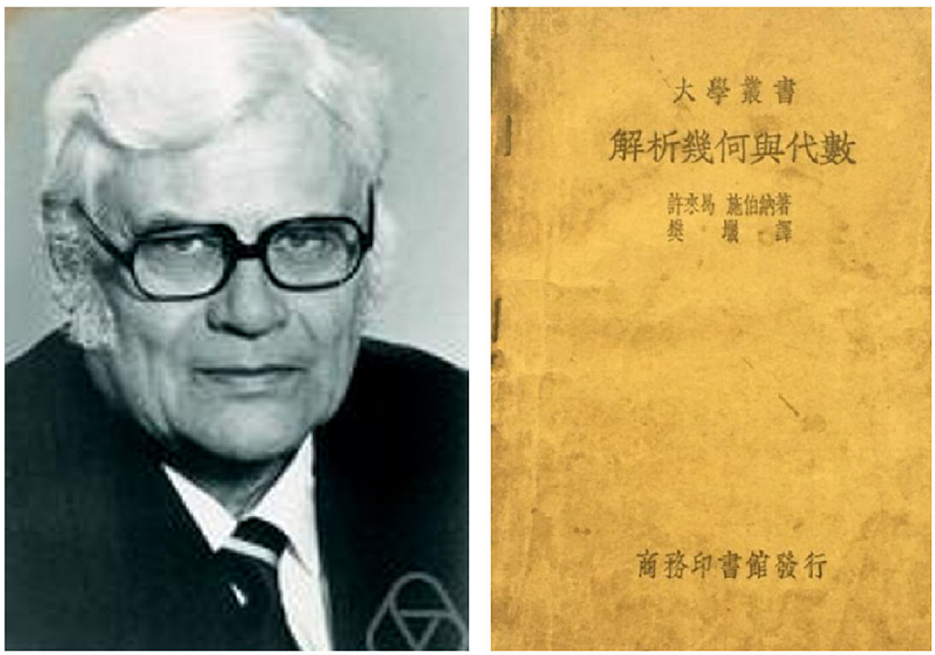

Figure 5. Emanuel Sperner and the Chinese translation of his book *Einführung in die analytische Geometrie und Algebra*.

plans to come to China. As noted, Tsai-Han Kiang, an early student in the Department of Mathematics at Nankai University under Li-Fu Chiang, had taken his PhD at Harvard under Morse in 1930. On his return to China, he took a position in the mathematics department at Peking University, becoming department chair three years later. Kiang was thus in a position to extend an invitation to the leader of the Harvard program—indeed, one of the leaders of American mathematics—George Birkhoff.

Birkhoff had earned his PhD at the University of Chicago in 1907 under Eliakim Hastings Moore and had gone on to make a huge research splash in 1913 with his proof of Poincaré's last geometric theorem [3]. On the Harvard faculty from 1912 until his untimely death in 1944, Birkhoff helped to guide the American mathematical research community as a member of the United States National Academy of Sciences beginning in 1918, as president of the American Mathematical Society for the two calendar years

Figure 6. Professors Wang, Feng, Osgood, Qin, and Kiang.

1925 and 1926, and as a vocal advocate for mathematics and its practitioners.[14] Over the course of the two months of April and May 1934, Birkhoff gave a series of talks: "Several Solutions in Quantum Mechanics," "Differential Equations of Dynamics," "The Four-Color Problem," and what he termed "Aesthetic Measure." So fashionable were these topics that they sparked great interest among professors and students alike, yet their advanced nature forced Birkhoff's audiences to struggle to understand them.

Three months after Birkhoff's visit, his Harvard colleague William Osgood arrived for a two-year stint as visiting research professor; see Figure 6. Osgood had been born in Boston, Massachusetts, and educated at Harvard, Göttingen, and Erlangen before taking his doctorate at the latter university in 1890 under Max Noether.[15] Appointed to the Harvard faculty in 1890, he was elected to the United States National Academy of Sciences in 1904 and served in the two calendar years 1905 and 1906 as president of the American Mathematical Society. It was thus a distinguished member of the American mathematical research community who was forced into retirement by the president of Harvard in 1933 after a career of more than forty years there. Osgood had caused a scandal by marrying the much younger wife of his Harvard mathematics colleague Marston Morse [17, p. 53].

During his stay in China, unlike Birkhoff, Osgood taught various basic courses on real functions, complex functions, and mechanics.[16] As his assistants, Pao Lu Hsü (Baolu Xu, 1910–1970) and Shu-Ben Sun made the careful notes that formed the texts of the books *Functions of Real Variables* and *Functions of a Complex Variable* (see Figure 7), published by Peking University in 1936 and used widely in China for many years. Since there were no textbooks on real- or complex-valued functions in China before that time, Osgood's lecture notes played a key role not only in modern mathematics education but also in introducing these subjects as active research topics.

Norbert Wiener and Jacques Hadamard at Tsinghua University

Just a year after Birkhoff had left China and while Osgood was still there, another famous American mathematician, Norbert Wiener (1894–1964), of the Massachusetts Institute of Technology (MIT), was invited to Tsinghua University, also in Beijing, for a long-term visit,[17] while one of the grand old men of French mathematics, Jacques Hadamard (1865–1963), came a year later, in 1936. Wiener had earned a Harvard PhD in 1913 at the tender age of eighteen and had followed his doctoral work in mathematical logic with a European study tour that took him, over the course of several years, to Russell and G. H. Hardy in England and to David Hilbert and Edmund Landau in Germany.[18] From 1919 to his retirement in 1959, Wiener served on the MIT faculty, being promoted to a professorship there in 1932.

One of the students at MIT in the 1920s was electrical engineer Yuk-Wing Lee (Yurong Li, 1904–1989); see Figure 8. Knowing well of Wiener's interest in various aspects of engineering mathematics, Lee's doctoral advisor, Vannevar Bush, counseled him to approach the mathematician. Lee became Wiener's assistant and later his close friend. After taking his MIT PhD in 1930, Lee returned to China in 1932 and was appointed professor in Tsinghua University's electrical engineering department. King-Lai Hiong was head of its mathematics department. It was on Lee and Hiong's recommendation that the university's president extended the invitation to Wiener.

The Wiener family arrived at Tsinghua on August 15, 1935, and with Lee's help, set up house on campus. Over

[14]For more on Birkhoff's life and work, see [2, 17, pp. 56–85], and [25].
[15]On Osgood's life, see [2, 10, 17, pp. 32–55], and [25].
[16]On Osgood's time in China, see [8] and [14, pp. 117–118].
[17]On Wiener's time in China and its import, see [14, pp. 118–129] and [24, pp. 125–130].
[18]On Wiener's life, see his autobiography [19].

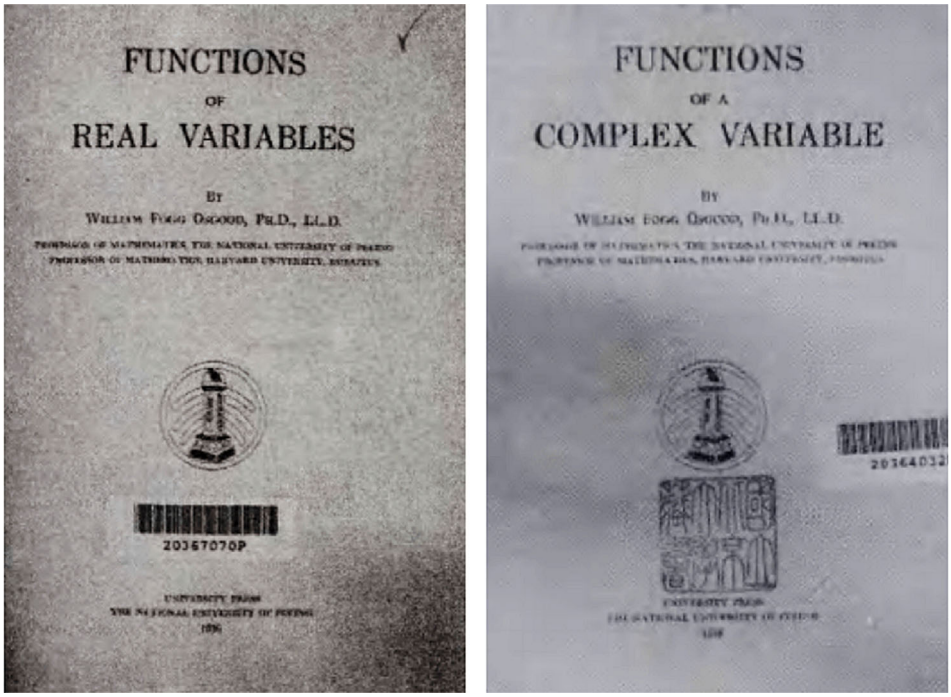

Figure 7. Osgood's books published at Peking University.

Figure 8. Norbert Wiener and Yuk-Wing Lee at MIT.

the next two semesters, Wiener taught courses on Fourier series, Fourier integrals, and Lebesgue integrals. He had paved the way for these courses' success by advising the university to acquire related reference books in advance. That gave his auditors the chance to bone up on the material before the courses actually began. Faculty members and students alike, not only from Tsinghua but also from other universities nearby, flocked to learn from him. One member of Wiener's audience was Loo-Keng Hua (Luogeng Hua, 1910–1985).

Hua, who had had no formal university education and was largely self-taught, was an assistant in Tsinghua's mathematics department at the time of Wiener's visit. He eagerly attended all of the American's courses, regularly discussed mathematics with him, and became his friend. Gradually, as a result of reading his work, Wiener became so impressed by Hua's mathematical talent that he recommended him for a Boxer Indemnity fellowship to study with Hardy in Cambridge. Hua spent the two years 1936–1938 there, which marked a turning point in a mathematical career that produced major contributions to number theory, abstract algebra, and complex variables [28].

Besides his lectures in the mathematics department, Wiener continued to work with Lee on electrical-circuit design. Later in life, Wiener gave detailed impressions of the Chinese people and their culture, beliefs, and daily life in his autobiography, *I Am a Mathematician*; see Figure 9. There, too, he spoke highly of his visit to China:

> If I were to take any specific boundary point in my career as a journeyman in science and as in some degree an independent master of the craft, I should pick out 1935, the year of my China trip, as that point [19, p. 207].

The Wiener family left China for the International Congress of Mathematicians in Oslo on May 19, 1936. Following his departure, Wiener maintained lasting friendships with his Tsinghua colleagues, in particular with Hua and Lee, and provided his support whenever it was needed.[19] In fact, Wiener had talked up China to the Institute for Advanced Study's John von Neumann and had piqued the latter's interest in an extended stay there. Unfortunately, the Japanese invasion in 1937 ultimately made such a trip an impossibility.

[19]That Wiener and Hua remained close is clearly evidenced in [11] and [23].

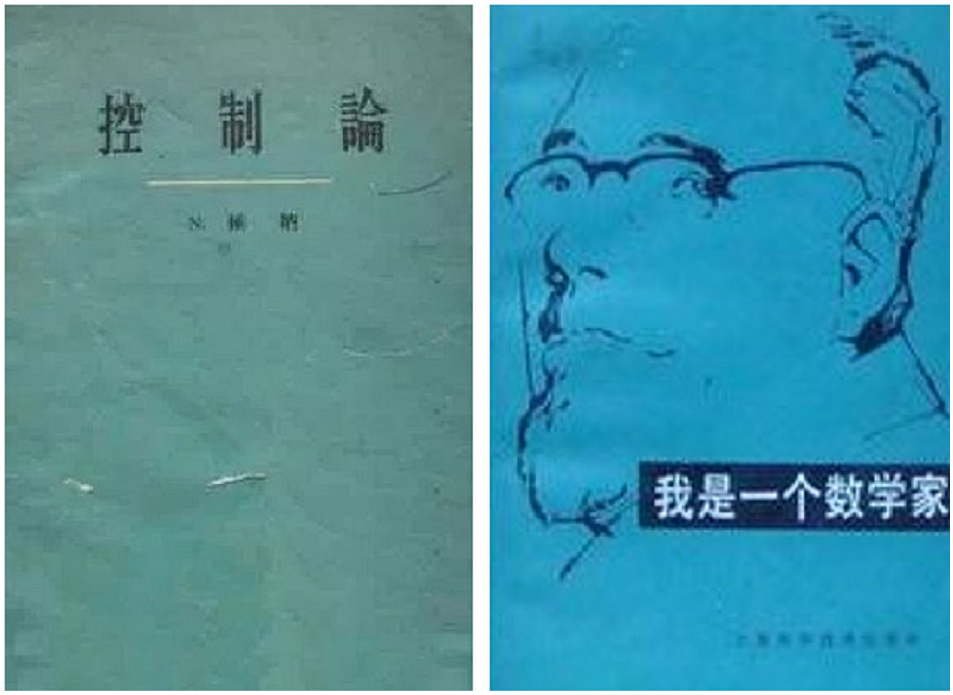

Figure 9. Wiener's books *Cybernetics* and *I Am a Mathematician* in Chinese translation.

One mathematician who did get to China, however, was the seventy-year-old Jacques Hadamard.[20] He and his wife arrived in Shanghai on the passenger ship *Queen of Asia* on March 22, 1936, three months before the Wieners' departure and having already corresponded with them about practical matters such as health and security concerns in Beijing. When their ship docked, they were warmly greeted by representatives of the Chinese Mathematical Society, the Chinese Physical Society, and the Sino-French Friendship Association. That evening, Yuan-Pei Cai, president of the Academia Sinica, hosted a banquet in their honor, at which many famous scientists and scholars in Shanghai were in attendance. In the days that followed, Hadamard gave public lectures at Chiao Tung University and the Sino-French Friendship Association.

The Hadamards finally made their way to Beijing by train, arriving on April 7, 1936. They were greeted at the station by the president of Tsinghua University, the university's dean of science, and Hiong, the chair of its mathematics department and the originator and organizer of the visit; see Figure 10. The Hadamards also enjoyed more than a month together with the Wieners before the latter returned to the United States. The two mathematicians engaged in lively mathematical discussions, while their families delighted in each other's company.[21]

As agreed, Hadamard gave twenty lectures under the heading "Definite Problems of Partial Differential Equations" [14, pp. 129–144]. This marked the first time that partial differential equations had received systematic treatment in China. Of course, Hadamard also gave public mathematical lectures on various occasions during his stay. For example, on the twenty-fifth anniversary of Tsinghua University, he spoke on "Some Reflections on the Role of Mathematics." His talks were a great inspiration to his audiences, in particular to young faculty members and students.

Although by the time of his China visit, Hadamard's mathematical interests had shifted from number theory to partial differential equations and other subjects, he remained a grand master of the former.[22] While at Tsinghua, Hadamard quickly got to know Loo-Keng Hua, whose interests lay in Hadamard's earlier area of research focus, and was impressed by both his persistence and his mathematical talent. Hadamard and Hua discussed a deep theorem in number theory, namely, Waring's problem: given an integer $k \geq 2$, is there an integer s such that every positive integer n can be written as $n = x_1^k + x_2^k + \cdots + x_s^k$, where the x_i are nonnegative integers? During the course of these discussions, Hadamard also introduced Hua to the analytic number-theoretic work of Ivan Vinogradov, and Hua later wrote to the Russian mathematician, becoming his lifelong friend. Along with Wiener, Hadamard persuaded Hiong, in his role as department chair, to support Hua's successful application for study abroad.

Hadamard also helped several other young Chinese mathematical aspirants. On his recommendation, both Singmo Ou (Xinmou Wu, 1910–1989) and Chi-Tai Chuang (Qitai Zhuang, 1909–1998) went to the University of Paris,

[20]For more on Hadamard's Chinese sojourn, see [12] and [18].

[21]Both Hadamard's biography [15, pp. 221–226] and Wiener's autobiography [19, Chapter 10] provide accounts of their Beijing experiences.

[22]Recall that in 1896, Hadamard had proved, independently of Charles-Jean de la Vallée Poussin, the prime number theorem, which describes the asymptotic distribution of the primes among the positive integers.

Figure 10. Front row (left to right): Professors Zheng, Yang, Hadamard, Wiener, Hiong, and Lee.

Figure 11. Two of Hadamard's books, *Essai sur la psychologie de l'invention dans le domaine mathématique* and *La théorie des équations aux dérivés partielles*, published in Chinese.

supported by the Boxer Indemnity. Wu studied partial differential equations there with Hadamard and Henri Villat, returning to China in 1951 to become a Chinese pioneer in the subject. Chuang worked with Georges Valiron in complex function theory, earned his PhD in 1938, and became a leading Chinese expert in that field.

Both Hadamard and Wiener participated in the nascent Chinese mathematical community. Just prior to their visits, in 1935, the Chinese Mathematical Society had been founded and had launched two journals, *Acta Mathematica Sinica* and the *Journal of Mathematics*. The first of these was devoted to original works, while the second was for introductory reports. Both foreign mathematicians supported the society by publishing their work in the *Acta*; Wiener's "A Tauberian Gap Theorem of Hardy and Littlewood" appeared in the journal's first issue, and Hadamard's "Le Problème de Dirichlet pour les équations hyperboliques" in the second. Owing to the Japanese invasion

and subsequent civil war, the first two volumes were the only ones published before 1951.[23]

The Hadamards left Beijing for Paris on the Trans-Siberian Railway on June 25, 1936. Hadamard's visit, like Wiener's, had a lasting impact on China's mathematical development. In 1964, delayed by the geopolitical events of the 1940s and 1950s, Hadamard's book *La théorie des équations aux dérivés partielles* was published in China and remained an important reference for work in partial differential equations for years thereafter; see Figure 11.

By Way of Conclusion

If the founding of the first mathematics department marks the birth of modern mathematics in China, it has been just slightly more than a hundred years since that way of looking at mathematics made its Chinese debut. In the opening decades of this new era, the Chinese mathematical community greatly benefited from the visits of the foreign mathematicians discussed in this paper. They brought mathematical knowledge and ideas, provided encouragement and inspiration, and sparked new exploration and research. Without their help, the development of modern mathematics in China would undoubtedly have been much slower. In particular, without the inspiration and support of Wiener, Hadamard, and Blaschke, the career trajectories of Loo-Keng Hua and Shiing-Shen Chern might have been significantly different.[24] Although this promising start for modern mathematics in China was interrupted by world events and civil upheaval, it nevertheless provided a firm foundation on which to build. In documenting the early history of modern mathematics in China, this paper commemorates its pioneers.

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