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THE HISTORY OF CHINESE MATHEMATICS: THE PAST 25 YEARS

ANDREA EBERHARD-BRÉARD
REHSEIS (CNRS), France • Ph. D. Program in History • The Graduate Center, CUNY

JOSEPH W. DAUBEN
Ph. D. Program in History • The Graduate Center, CUNY

XU YIBAO
Ph.D. Program in History • The Graduate Center, CUNY

RESUMEN

El presente artículo presenta los más importantes logros de la investigación sobre historia de las matemáticas chinas en el último cuarto del siglo XX. Comienza con una breve panorámica sobre el estado de conocimientos y las principales figuras que realizaron las primeras contribuciones fundamentales antes de 1975 para después examinar más detenidamente las aportaciones llevadas a cabo durante el último cuarto de siglo: autores europeos, publicaciones en inglés y, finalmente, la extraordinaria producción en chino, en su mayor parte tras la Revolución Cultural.

ABSTRACT

This paper presents the major accomplishments of research over the past quarter century in the field of Chinese mathematics and its history. We begin with a brief overview of the progress of our knowledge of that history, and the major figures who contributed the fundamental early works prior to 1975, and then examine more carefully the achievements of the past quarter century, beginning with a general overview of the subject before surveying in more detail the contributions made in the past twenty-five years, first by Europeans, then by scholars publishing in English, after which this survey turns to examine the extraordinary production of scholarship written in Chinese, most of it since the end of the Cultural Revolution.

Palabras Clave: Historiografía, Matemáticas, China, Siglo XX.

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The history of mathematics has experienced an unprecedented increase in levels of interest and exponential growth in the number of publications in the past twenty-five years, but nowhere has this been more dramatic and unexpected than in the amount of new material, including the discovery and editing of primary texts and a burgeoning secondary literature, all related to the history of Chinese mathematics. Whether one considers the collation and analysis of ancient texts, or the proliferating secondary literature covering virtually all periods of Chinese history, the number of publications and scholars working in China and the West on the history of Chinese mathematics is truly remarkable. It is thus particularly appropriate that in celebrating the past twenty-five years of *Llull* and its own contributions to the history of science, we reflect in what follows on the major accomplishments of research over the past quarter century in the field of Chinese mathematics and its history. We begin with a brief synopsis of the progress of our knowledge of that history, and the major figures who contributed the fundamental early works prior to 1975, and then examine more carefully the achievements of the past quarter century, beginning with a general overview of the subject before surveying in more detail the contributions made in the past twenty-five years, first by Europeans, then by scholars publishing in English, after which this survey turns to examine the extraordinary production of scholarship written in Chinese, most of it since the end of the Cultural Revolution.

History of Mathematics: East and West

It will come as no surprise that interest in the history of mathematics in China is of very long duration, and reaches back to antiquity itself, when scholars of the Han dynasty (206 BCE-220 CE) were already engaged in the retrieval, collation and study of even earlier works written in pre-Qin times (before 221 BCE), and went so far as to ascribe the beginnings of mathematics to mythological origins in Chinese prehistory. Later, systematic interest in history of mathematics was stimulated by the arrival of the Jesuits in China. Following the first translations of Western works into Chinese, beginning with the first six books of Euclid's *Elements* translated by Matteo Ricci and XU Guangqi in 1607, some scholars argued that this offered nothing new and they in turn began the search for early works of Chinese mathematics to prove their point[1]. MEI Wending (1633-1721) and the philological Qian-Jia School of scholars became the first serious historians of Chinese mathematics, followed in the last century by two scholars in particular, LI Yan (1892-1963) and QIAN

Baocong (1892-1974), to whom the origins of all modern work on the history of Chinese mathematics may be traced[2].

The history of Chinese mathematics as written by Western authors began in the nineteenth century, when French sinologists like Edouard Biot and missionaries like the British writer Alexander Wylie began to take an active interest in making the history of Chinese science and mathematics better known in the West. Wylie's accounts in «Jottings on the Science of Chinese Arithmetic» appeared as a series of articles in the *North China Herald* in 1852, and were included as part of Wylie's book, *Chinese Researches*, in 1897 (reprinted as recently as 1966) [4354][3]. Wylie was the first in English to give a reliable account, for the most part, of Chinese mathematics. Early in the twentieth century, MIKAMI Yoshio wrote the first book devoted to *The Development of Mathematics in China and Japan* (Leipzig: Teubner, 1913; repr. New York: Chelsea, 1974) [4224]), but more substantial treatments awaited the monumental work of Joseph Needham and the still on-going project he inspired following World War II to produce a series of volumes devoted to a thorough study of Chinese science and technology. This is discussed below in the section devoted to works on history of Chinese mathematics written in English, but we begin this survey of works devoted to the subject by European authors, before turning to those writing in English, including Chinese authors. The final section of this survey is devoted to the substantial literature on the subject produced in Chinese.

Continental European Contributions to History of Chinese Mathematics

Communist China, before opening up to the West in the 1980s, had closer contacts in fields of science and technology with the former Soviet Union than with any other part of the world. Due to the political climate, Russian scholars could easily access sources and arrange for scholarly exchanges with historians of mathematics inside China in the 1950s. The Marxist approach, comparable to that of Joseph Needham in England, assumes that modern science is essentially international and based on contributions from different civilizations and epochs—a view that links the development of mathematics in China closely to socio-political factors.

Consequently, the first non-Asian scholarly group interested in the history of mathematics in China was formed in Moscow around Professors Èl'vira Iranovna Berezkina and Adol'f Pavlovich Yushkevich (1906-1993) at the Russian Academy of Sciences. In the 1960s Berezkina discussed and translated

seven out of the *Ten Mathematical Classics* (*Suan jing shi shu*, compiled during the seventh century CE) [4274-4283], and published the first general survey of the history of Chinese mathematics in Russian in 1980 [4229]. Yushkevich published a more limited overview of medieval mathematics in China in his *Geschichte der Mathematik im Mittelalter* [1231], the major drawback of which was that he relied solely on secondary sources. Thus his treatment of the mathematical content in the Chinese classics did not include the important commentaries written by LIU Hui in 263 and by LI Chunfeng (602-670), both of which accompany all now extant editions. Only later, mainly through publications by Donald Wagner in the 1970s and Yushkevich's doctoral student Alexeï Volkov, currently the most active scholar of Russian origin, did Yushkevich learn more about the theoretical aspects of these commentaries written in early and medieval China on the mathematical classics. For a detailed evaluation of Yushkevich's contributions to the field of history of mathematics in China, see Karine Chemla, «Les travaux de A.P. Youschkevitch sur l'histoire des mathématiques en Chine,» in *Studies in History of Mathematics Dedicated to A.P. Youschkevitch*, Eberhard Knobloch, *et al.*, eds., *Proceedings of the XXth International Congress of History of Science, Liège (Belgium), 20-26 July 1997*, vol. 13 (Turnhout: Brepols, 2002), pp. 25-31. For Volkov's many publications in Russian on history of Chinese mathematics, see the CD-ROM version of *The History of Mathematics from Antiquity to the Present: A Selective Annotated Bibliography*, as described in note 3 above, items [4256-4259], [4300-4301], [4326], [4359], [4365-4366], [4401], [4431-4432], [4434], and [4544].

Yushkevitch also maintained a very active correspondence with the German historian of mathematics Kurt Vogel (1888-1985), who published a German translation of the *Nine Chapters on Mathematical Procedures* (*Jiu zhang suan shu*) in 1968: *Chiu chang suan shu: Neun Bücher arithmetischer Technik. Ein chinesisches Rechenbuch für den praktischen Gebrauch aus der frühen Hanzeit* (Braunschweig: Ostwalds Klassiker, Friedrich Vieweg Verlag, 1968) [4295].[4] One of their common interests was the transmission of problems between China and the Arabic world. Vogel's article on the circulation of a surveying problem («Ein Vermessungsproblem reist von China nach Paris,» *Historia Mathematica*, 10 (1983), pp. 360-367 [4381]) constituted the point of departure for a conference on the transmission of mathematical ideas recently held in Italy in May of 2000. Four contributions to that meeting concerned China, and sought to shed new light on possible routes of transmission, although a problem-oriented approach seems to be less fruitful than an analysis based on the comparison of algorithms. Volkov's paper on the «Hundred

Fowls Problem» and the solution of simultaneous indeterminate equations in different cultures reflects his recent investigations into hitherto unknown Vietnamese sources, i.e. an unpublished manuscript currently preserved in Hanoi and written around 1468. Volkov has recently suggested, based upon an examination paper in a Vietnamese treatise (the *Chi minh lap thanh toan phap*—Chinese: *Zhiming licheng suanfa*, preface dated 1822), that the suggested solution procedures cannot be interpreted merely as mathematical demonstrations aimed at «proving» certain statements and results of the mathematical problem to be solved. He argues that they must have also served as models for the state examination essays. Volkov presented a preliminary account of his work on this material in a lecture, «Demonstration in Chinese Mathematics: Argumentation for State Examinations,» at the Workshop on History and Historiography of Mathematical Proof in Ancient Traditions, 17-19 May 2002, a Joint Project with REHSEIS CNRS—University of Paris VII, the Maison des Sciences de l'Homme, and the Columbia University Institute for Scholars at Reid Hall, Paris.

In French, Volkov has also published a number of papers, including «Recherches sur les structures des textes chinois anciens en URSS,» in *Modèles et structures des textes chinois anciens*, Karine Chemla, Vera Dorofeeva-Lichtman, and Alexeï Volkov, eds., *Extrême-Orient, Extrême-Occident*, **13** (Saint-Denis: Presses Universitaires de Vincennes, 1991), pp. 11-30; «Structure d'un traité mathématique: l'exemple du *Hai dao suan jing*,» in *Modèles et structures des textes chinois anciens*, Karine Chemla, Vera Dorofeeva-Lichtman, and Alexeï Volkov, eds., *Extrême-Orient, Extrême-Occident*, **13** (Saint-Denis: Presses Universitaires de Vincennes, 1991), pp. 93-99; and «Nombres et nombres,» in *Sous les nombres, le monde: Matériaux pour l'histoire culturelle du nombre en Chine ancienne*, Alexeï Volkov, ed., *Extrême-Orient, Extrême-Occident*, **16** (Saint-Denis: Presses Universitaires de Vincennes, 1994), pp. 5-11.

In Germany, where Kurt Vogel was one of the first to institutionalize the history of science in the 1930s, there was no circle of historians of Chinese mathematics. But Vogel's special project, to revise for yet a fourth time the *Geschichte der Elementarmathematik* by Johannes Tropfke (1866-1939), which Vogel planned as early as the 1960s and pursued until 1987 at the *Lehrstuhl der Geschichte der Naturwissenschaften* (Institute for History of Science) in Munich at the Ludwig-Maximilians-Universität, did attract the interest of a sinologist, Hermann Kogelschatz. Kogelschatz worked on the sections of Tropfke's *History* concerning geometry in China and submitted contributions on LIU Hui's treat-

ment of circle measurements, stereometric proof methods in ancient China, and geometric definitions found in the Mohist canon. Publication of the volume on geometry was unfortunately abandoned after Vogel's death in 1985. Kogelschatz, mainly interested in critical textual studies, nevertheless published two important papers in German on editorial problems in the edition by DAI Zhen (1723-1777) of the *Nine Chapters* [4241 and 4242], and compiled bibliographic data for the *Ten Books of Mathematical Classics* [4270].

It was only at the end of the 1990s that another young German mathematician and sinologist, Andrea Bréard, published her Ph.D. thesis in the field of Chinese science: *Re-Kreation eines mathematischen Konzeptes im chinesischen Diskurs*, which appeared as volume 42 of *Boethius* (Stuttgart: Franz Steiner Verlag, 1999) [4557]. Bréard's analysis of the history of arithmetical series takes a diachronic approach to studying the development of this mathematical concept from the first to the nineteenth century. She discusses the treatment of series within the conceptual framework of piles of discrete objects that mathematically correspond to finite summations. Although written in German, some results of her book are also available to a larger public in English (see below), as well as in French: «La recomposition des mathématiques chez Zhu Shijie: la constitution d'un domaine autour du nombre 'quatre'», in *Oriens–Occidens,* 3 (2000), pp. 259-277. In German she has also written three articles, «Abakus,» «Chinesische Mathematik,» and «Japanische Mathematik,» as well as ten biographies of Chinese mathematicians ranging in time from antiquity to the twentieth century, for the *Lexikon der Mathematik*, Guido Walz, ed. (Heidelberg: Spektrum Akademischer Verlag, 2003, in 6 volumes or 1 CD). Subsequent to her Ph.D., she has investigated aspects of the introduction of Western symbolical algebra into Chinese discourse, and she is now the only scholar working on the history of probability and statistics in China.

Bréard owes much to one of her Ph.D. advisors, Karine Chemla in Paris, who can be considered one of the most active and innovative scholars studying the history of mathematical philosophy of ancient China. Her Ph.D. thesis, on LI Ye's *Ce yuan hai jing* (Sea Mirror of Circle Measurements) of 1248 [4437], analyzes the relationship between the description of method (*fa*) and the details of method (*cao*) in the context of polynomial algebra used to solve geometrical problems. Her subsequent studies have centered around translation of the *Nine Chapters* with their above-mentioned commentaries into French. She has also examined modes of expression of theoretical content in ancient Chinese mathematical writings, such as the specific conduct of proof, the meaning of

problem-structured texts, and the significance of diagrams found in Song-Yuan printings, as in «Les problèmes comme champ d'interprétation des algorithmes dans *Les neuf chapitres sur les procédures mathématiques* et leurs commentaires. De la résolution des systèmes d'équations linéares,» *Oriens–Occidens*, **3** (2000), pp. 189-234; and «Variété des modes d'utilisation des *tu* dans les textes mathématiques des Song et des Yuan,» *From Image to Action: The Function of Tu-Representations in East Asian Intellectual Culture* (Paris: September 3-5, 2001, in press). Her conclusions on interactions with the Indian and Arabic worlds are mainly based on internal textual characteristics, for example, as she explained in «Interactions mathématiques entre la Chine, l'Inde et le Monde Arabe: quelles perspectives?» at a conference, Leçons de l'histoire des sciences Arabes: Interaction scientifique des cultures, *Book of Abstracts* (Tripoli-Beyrouth, October 30-November 1, 2002), pp. 15-19.

In collaboration with Francesca Bray, FU Daiwie, HUANG Yilong, and Georges Métailié, Chemla serves as co-editor for the sections on China in *Storia della scienza*, Sandro Petruccioli, ed. (Roma: Enciclopedia Italiana, 2001, in eight volumes). Section I of volume II is devoted to «La scienza in Cina» (Science in China), pp. 1-608. A second section on the history of science in China after the seventeenth century is in preparation. A partial translation into Chinese of the volume already published has appeared as an issue of the journal of the Ecole Française d'Extrême-Orient: *Faguo hanxue* (French Sinology), **6** (2002), pp. 1-397.

Also working in Paris, at present the main geographic center for research on the history of Chinese mathematics and astronomy outside of China, are Catherine Jami and Jean-Claude Martzloff, among others. The latter is best-known for his synoptic *A History of Chinese Mathematics*, the most authoritative introduction in a Western language for a general readership (French 1988, English 1997). Martzloff's Ph.D. thesis was devoted to the greatest Chinese mathematician and astronomer of seventeenth-century China, MEI Wending (1633-1721). The last part of the published version [4526] analyzes the synthesis that MEI Wending forged between Euclidean geometry and ancient Chinese geometry, a topic that Martzloff elaborated in several articles [4484-4487] and extended into the modern period (see his article with LI Wenlin, «Aperçu sur les échanges mathématiques entre la Chine et la France (1880-1949),» *Archive for History of Exact Sciences*, **53**(3/4)(1998), pp. 181-200. Recently he has turned more towards the history of mathematical astronomy in China, a field hitherto little-dealt with by non-Chinese authors, and

has recently published «Le calendrier chinois: cadre historique général, structure, typologie et calcul,» in *Les Calendriers. Leurs enjeux dans l'espace et dans le temps*, Jacques Le Goff, Jean Lefort, and Perrine Mane, eds. (Paris: Somogy Editions d'Art, 2002), 3.XIV.

Catherine Jami is the main Western authority on the history of mathematics in China during the late Ming and early Qing dynasties (sixteenth to eighteenth centuries). Since her Ph.D. on MING Antu's development of trigonometric functions into power series: «Les méthodes rapides pour la trigonométrie et le rapport précis du cercle (1774). Tradition chinoise et apport occidental en mathématiques,» *Mémoires de l'Institut des Hautes Études Chinoises*, **32** (Paris: Collège de France, 1990) [4468], she has combined her skills as an historian of China with her mathematical knowledge to study the interaction of Western mathematics with Chinese tradition from an externalist point of view. Many of her articles are related to Jesuit activities at the court of the Emperor Kangxi (ruled 1662-1722), and to socio-political factors that played a crucial role in the circulation of scientific knowledge in China.

Jami recently co-edited a collection of articles on XU Guangqi (1562-1633), who in cooperation with Matteo Ricci translated the first six books of Euclid's *Elements* into Chinese (1607). Jami, in concert with Keizo HASHIMOTO, contributed a jointly-written article on XU's shaping of mathematics and astronomy in the early seventeenth century. One of the co-editors, Peter Engelfriet from the Netherlands, has also worked extensively on the Chinese translation of Euclid's *Elements*. His Ph.D. thesis, published in English, places this work into the proper intellectual and cultural context, and offers translations of all statements of the propositions of the first six books with the newly forged geometric terminology and their counterparts in modern Chinese.

To conclude this section on European works on the history of Chinese mathematics, two additional authors should be mentioned who have also made important contributions but are no longer actively working on the subject. The Belgian scholar, Ulrich Libbrecht, analyzed six mathematical manuscripts found by the sinologist Paul Pelliot and the archaeologist Sir Aurel Stein at the beginning of the twentieth century in the caves of Dunhuang (Gansu) and Turfan (Xinjiang). Libbrecht shows how the manuscripts provide important material related to metrology and decimal values, and to mathematical terminology in general [4407]. His major publication, *Chinese Mathematics in the Thirteenth Century* [4453], is a commentary and annotated translation of the *Mathematical Treatise in Nine Sections* by QIN Jiushao (1257 AD). One of the

most important advances made in this Song Dynasty work is a generalization of the method for extracting roots, applicable to quadratic equations with positive, negative, integral, or decimal coefficients. Jock HOE received his Ph.D. in Paris [4442] for his internalist study of the treatment of polynomial equations in ZHU Shijie's *Jade Mirror of Four Unknowns* (1303 AD). Unfortunately, the published version of HOE's thesis [4444] (under the name John HOE) does not include the extensive appendices, which include ZHU's Chinese text and translation of its 284 problems into modern symbolic terminology with a «semi-symbolic» language.

Contributions in English to the History of Chinese Mathematics

As already noted, it is easy to date the revolution in the general level of awareness of and appreciation for ancient Chinese mathematics in the English-speaking world: the appearance in 1959 of volume three of Joseph Needham's monumental series of books devoted to *Science and Civilisation in China*. The third volume, written by Needham and WANG Ling, is devoted specifically to *Mathematics and the Sciences of the Heavens and the Earth* (Cambridge: Cambridge University Press, 1959) [4225]. Earlier, WANG had written his doctoral thesis (unpublished) on *The «Chiu Chang Suan Shu» and the History of Chinese Mathematics During the Han Dynasty* (Trinity College, Cambridge, 1956) [4304].

Bibliographic guides

One measure of the growing interest in history of Chinese mathematics was the appearance in 1984 of «A Brief Chronological and Bibliographic Guide to the History of Chinese Mathematics,» published by ANG Tian-Se and Frank J. Swetz in *Historia Mathematica*, **11** (1984), pp. 39-56 [4217]. A.P. Yushkevich added another 23 titles to this list in a subsequent issue of the journal, *Historia Mathematica*, **13** (1986), pp. 36-38 [4221]. Meanwhile, LAM Lay Yong contributed the entries for history of Chinese mathematics as part of a comprehensive bibliography (a special project of the International Commission on History of Mathematics) devoted to the history of mathematics, *The History of Mathematics from Antiquity to the Present*, Joseph W. Dauben, ed. (New York: Garland Press, 1985), pp. 423-425. Also useful are the sections written by Christopher Cullen and devoted to mathematical texts (the *Zhou bi suan jing* and the *Jiu zhang suan shu*) in Michael Loewe's *Early Chinese Texts:*

Bibliographical Guide (Berkeley, CA: The Society for the Study of Early China and The Institute of East Asian Studies, University of California, 1993) [4218].

Special Encyclopedias, General Reference Works, and Collected Papers:

The classic encyclopedic reference work for historians of science is the *Dictionary of Scientific Biography*, published under the general editorship of Charles C. Gillispie and comprised of sixteen volumes issued between 1970 and 1980, to which two supplemental volumes were added in 1990. These include scholarly articles devoted to a number of major figures in the history of Chinese mathematics, as do articles in the more recent *Encyclopedia of the History of Science, Technology and Medicine in Non-Western Cultures*, edited by Helaine Selin (Dordrecht: Kluwer, 1997) [4220]. For a single very general overview of the history of Chinese mathematics, see the recent article by Jean-Claude Martzloff, «Chinese Mathematics,» in the *Companion Encyclopedia of the History and Philosophy of the Mathematical Sciences*, edited by Ivor Grattan-Guinness (London: Routledge, 1994, vol. 1, pp. 93-103) [4219].

There have also been several works published recently that offer collections of articles by various expert scholars on subjects dealing with the history of Chinese mathematics. These include two volumes published in the series of *Boston Studies in the Philosophy of Science* (under the editorship of Robert Cohen at Boston University), the first of which offers selected papers devoted to *Philosophy and Conceptual History of Science in Taiwan*, edited by LIN Cheng-Hung and FU Daiwie (Dordrecht: Kluwer Academic Publishers, 1993) [4504 and 4524]. Several years later, a similar volume appeared devoted to leading contributors to history of science in mainland China, edited by FAN Dainian and Robert S. Cohen, *Chinese Studies in the History and Philosophy of Science,* trans. Kathleen Dugan and JIANG Mingshan (Dordrecht: Kluwer Academic Publishers, 1996) [4243, 4337, 4391, 4529, 4533, and 4534]. There is also the somewhat earlier volume of essays written by many of the leading figures of history of science in mainland China, *Ancient China's Technology and Science* (Beijing: Foreign Languages Press, 1983) [4263].

Comprehensive general histories

The earliest comprehensive yet reliable history of Chinese mathematics in English was written by MIKAMI Yoshio and published as *The Development of Mathematics in China and Japan* (Leipzig: Teubner, 1913;

repr. New York: Chelsea, 1974) [4224]. But it was Needham and WANG's third volume in the series devoted to *Science and Civilisation in China* (Cambridge: Cambridge University Press, 1959) [4225], devoted in part to mathematics, that set the stage for the sudden proliferation of studies devoted to the subject over the past quarter century. Of the more recent books, LI Yan and DU Shiran's *Chinese Mathematics, A Concise History*, was translated into English by John N. Crossley and Anthony W.-C. LUN in 1987 (Oxford: Oxford University Press) [4222]. A decade later, Jean-Claude Martzloff's masterful survey, *A History of Chinese Mathematics*, was translated by Stephen S. Wilson (Berlin: Springer-Verlag, 1997) [4223]. This book is especially useful for the beginner, because it seeks to place the history of Chinese mathematics into its proper social and historical context. It is also a substantially revised version of the original published in French in 1987.

Continental European Contributions in English

There is no general survey in English specifically devoted to history of ancient Chinese mathematics, but B.L. van der Waerden devoted two sections of his *Geometry and Algebra in Ancient Civilizations* (Berlin: Springer-Verlag, 1983) [4255] exclusively to Chinese mathematics, including Liu Hui's measurement of the circle and his methods of finding the volumes of a pyramid and sphere.

Originally trained in Spain at the University of Zaragoza but now teaching in Mexico, José Antonio Cervera devoted his dissertation to Spanish missionaries in China, and focused in particular on mathematics and astronomy: *Los Misioneros Españoles como Vía para los Intercambios Científicos y Culturales entre el Extremo Oriente y Europa en los Siglos XVI y XVII* (Zaragoza: University of Zaragoza, Faculty of Sciences, 1999). This has now been published as *Ciencia Misionera en Oriente. Los misioneros españoles como vía para los intercambios científicos y culturales entre el Extremo Oriente y Europa en los siglos XVI y XVII* (Zaragoza: University of Zaragoza, «Cuadernos de Historia de la Ciencia,» no. 12, 2001). Among his publications in English are: «Spanish Friars in the Far East: Fray Juan Cobo and His Book *Shi Lu*,» *Historia Scientiarum*, 7(3)(1998), pp. 181-198; «Dominican Contributions to Science in the 16th and 17th Centuries: the Example of Fray Juan Cobo in East Asia,» in *The Spread of the Scientific Revolution in the European Periphery, Latin America and Asia*, A. Lertora, E. Nicolaidis, and J. Vandersmissen, eds. (Turnhout, Belgium: Brepols Publishers, 2000), pp. 183-192; and «Two Spanish Cosmographers in the Philippines: Andrés de Urdaneta and Martín de Rada,» in *Historical Perspectives*

on East Asian Science, Technology, and Medicine, Alan CHAN, Gregory Clancey, and Loy Hui CHIEH, eds. (Singapore: Singapore University Press and World Scientific Publishing, 2002), pp. 317-326.

Andrea Bréard, already mentioned above, currently resides in New York City and is a Visiting Professor in the Ph.D. Program in History at the Graduate Center of the City University of New York. In addition to her publications cited earlier in French and German, she has written in English as well about ZHU Shijie, SHEN Gua, and problems of mathematical terminology: «Shen Gua's Cuts,» *Taiwanese Journal for Philosophy and History of Science,* 10 (1998), pp. 141-162; «The Reading of Zhu Shijie,» in *Current Perspectives in the History of Science in East Asia,* selected papers from the 8th International Conference on the History of Science in East Asia held in Seoul, 26-31 August 1996, Yung Sik KIM and Francesca Bray, eds. (Seoul: Seoul National University Press, 1999), pp. 291-306 (Part V is devoted to Mathematical Sciences); «On Mathematical Terminology—Culture Crossing in 19th-Century China,» in *New Terms for New Ideas: Western Knowledge & Lexical Change in Late Imperial China,* Michael Lackner, Iwo Amelung, and Joachim Kurtz, eds. (*Sinica Leidensia*, vol. 52) (Leiden: Brill, 2001), pp. 305-326; and «Problems of Pursuit: Recreational Mathematics or Astronomy?» in *From China to Paris: 2000 Years of Mathematical Transmission*, Proceedings of a Conference Held at the Rockefeller Foundation Research and Conference Center, Bellagio, Italy, May, 2000, Yvonne Dold-Samplonius, Joseph W. Dauben, Menso Folkerts, and Benno van Dalen, eds., a special issue of *Boethius,* vol. 46 (Stuttgart: Steiner Verlag, 2002), pp. 57-86. Also soon to appear by Andrea Bréard are «Mediating Tradition and Innovation: The introduction of Probability Theory into Late Imperial Chinese Mathematical Culture,» *Historia Mathematica* (in press), and «Institutionalising Statistics in Early Modern Bureaucratic China: Sir Robert Hart and the Statistical Department of the Inspectorate General of Customs,» *Journal of Modern Asian Studies* (in press).

Karine Chemla, in addition to her many works in French, is also one of the most prolific authors writing in English on ancient Chinese mathematics. She has published extensively on aspects of proof and demonstration in the *Nine Chapters on Mathematical Procedures*, and on the mathematician LIU Hui in particular. See for example her articles: «Different Concepts of Equations in *The Nine Chapters on Mathematical Procedures* and in the Commentary on it by Liu Hui (3rd Century),» *Historia Scientiarum*, 4(1994), pp. 113-137 [4369];

«Relations between Procedure and Demonstration. Measuring the Circle in the *Nine Chapters on Mathematical Procedures* and the commentary by Liu Hui (3rd century),» in H.N. Jahnke, N. Knoche, and M. Otte, eds., *History of Mathematics and Education: Ideas and Experiences* (Göttingen: Vandenhoeck and Ruprecht, 1996), pp. 69-112 [4284]; and «What is at Stake in Mathematical Proofs from Third Century China?» *Science in Context*, 10 (2)(1997), pp. 227-251 [4424]. She has written as well about algorithmic methods in Chinese mathematics, and notably influential examples are the articles «Should they read FORTRAN as if it were English?» *Bulletin of Chinese Studies*, 1 (1987), pp. 301-316 [4356]; and «Theoretical Aspects of the Chinese Algorithmic Tradition (first to third century),» *Historia Scientiarum*, 42 (1991), pp. 75-98 [4358].

Chemla has also treated root extraction methods and the problem of irrational numbers in such studies as «Fractions and Irrationals Between Algorithm And Proof In Ancient China,» *Studies in History of Medicine and Science* (New Series), 15(1-2)(1997-98), pp. 31-54 [4361]; «Similarities between Chinese and Arabic Mathematical Documents (I): Root Extraction,» *Arabic Sciences and Philosophy* 2(4)(1994), pp. 207-266 [4362]; and with Agathe Keller, «The Sanskrit *karanis* and the Chinese *mian*,» in *From China to Paris: 2000 Years of Mathematical Transmission*, Proceedings of a Conference Held at the Rockefeller Foundation Research and Conference Center, Bellagio, Italy, May, 2000, Yvonne Dold-Samplonius, Joseph W. Dauben, Menso Folkerts, and Benno van Dalen, eds., a special issue of *Boethius*, vol. 46 (Stuttgart: Steiner Verlag, 2002), pp. 87-132. Her most recent publication was issued in conjunction with the International Congress of Mathematicians held in Beijing in August of 2002: «China and World Mathematics,» *Beijing Intelligencer* (Beijing: Higher Education Press, and Heidelberg: Springer Verlag, 2002), pp. 42-48.

Other subjects on which Chemla has written include «Reflections on the World-Wide History of the Rule of False Double Position, or: How a Loop was Closed,» *Centaurus*, 39 (1997), pp. 97-120 [4377]; and «History of Mathematics in China: A Factor in World History and a Source for New Questions,» (Proceedings of the International Congress of Mathematicians, Berlin, August 17-27, 1998), *Documenta Mathematica, Journal der Deutschen Mathematiker-Vereinigung*, Extra-Volume ICM 1998, Vol.III (Invited Lectures), pp. 789-798 [4285]. Finally, on historiographic matters Chemla has written about Joseph Needham in particular: «The Rivers and the Sea: Analyzing Needham's Metaphor for the World History of Science,» in *Situating the History of Science: Dialogues with Joseph Needham*, S. Irfan

Habib and Dhruv Raina, eds. (New Delhi: Oxford University Press, 1999), pp. 220-244 [4552].

Benno van Dalen is a member of the Institute for History of Science at the Johann Wolfgang Goethe University in Frankfurt, Germany. He has written primarily on the history of Chinese astronomy and astronomical tables, which are directly related to questions about the transmission of mathematical ideas between China and the Arabic and Persian speaking worlds. His most recent work on these matters is: «Islamic and Chinese Astronomy under the Mongols: a Little-Known Case of Transmission,» in *From China to Paris: 2000 Years of Mathematical Transmission*, Proceedings of a Conference Held at the Rockefeller Foundation Research and Conference Center, Bellagio, Italy, May, 2000, Yvonne Dold-Samplonius, Joseph W. Dauben, Menso Folkerts, and Benno van Dalen, eds., a special issue of *Boethius,* vol. 46 (Stuttgart: Steiner Verlag, 2002), pp. 327-356.

Peter M. Engelfriet received his Ph.D. in Chinese studies from the University of Leiden, and is the author of *Euclid in China: the Genesis of the First Chinese Translation of Euclid's Elements, Books I-VI (Jihe yuanben, Beijing, 1607) and its Reception up to 1723* (Leiden: Brill, 1998). Earlier he published a related article describing the historical background of medieval and Renaissance Euclidean texts: «The Chinese Euclid and its European Context,» in *L'Europe en Chine. Interactions scientifiques, religieuses et culturelles aux XVIIe et XVIIIe siècles*, C. Jami, and H. Delahaye, eds., *Mémoires de l'Institut des Hautes Études Chinoises*, vol. 34 (Paris: Collège de France, 1993), pp. 111-135 [4483].

Another of the Parisian circle of historians of Chinese mathematics is Catherine Jami, who concentrates as noted previously on the Ming and early Qing dynasties. Among others, she has written «Western Influence and Chinese Tradition in an Eighteenth-Century Chinese Mathematical Work,» *Historia Mathematica*, **15** (1988), pp. 311-331 [4466]; «Scholars and Mathematical Knowledge in the Late Ming and Early Qing,» *Historia Scientiarum*, **42** (1991), pp. 99-109 [4469]; «Learning the Mathematical Sciences in the Late Ming and Early Ch'ing,» in *Education and Society in Late Imperial China*, B. Elman and A. Woodside, eds. (Berkeley: University of California Press, 1994), pp. 223-256 [4473]; «From Louis XIV's Court to Kangxi's Court: A Institutional Analysis of the French Jesuit Mission to China (1662-1722),» in *East Asian Science: Tradition and Beyond,* Keizo HASHIMOTO, *et al.*, eds. (Osaka: Kansai University Press, 1995), pp. 493-499 [4476]; «Western Devices

for Measuring Time and Space: Clocks and Euclidean Geometry in Late Ming and Ch'ing China,» in *Time and Space in Chinese Culture*, Chun-Chieh HUANG and Erik Zürcher, eds. (Leiden: Brill, 1995), pp. 169-200 [4477]; and «Western Mathematics in China, Seventeenth Century and Nineteenth Century,» in *Science and Empires*, P. Petitjean, C. Jami, and A.-M. Moulin, eds. (Dordrecht: Kluwer Academic Publishers, 1992), pp. 79-88 [4495].

Jami has also focused some of her writing on specific individuals, including: «The French Mission and Verbiest's Scientific Legacy,» in *Ferdinand Verbiest. Jesuit Missionary, Scientist, Engineer and Diplomat*, John Witek S.J., ed. (Nettetal: Steyler Verlag, 1995), pp. 531-542 [4475]; «Aleni's Contribution to Geometry in China. A study of the *Jihe yaofa*,» in *Scholar from the West. Giulio Aleni S.J. (1582-1649) and the Dialogue between Christianity and China*, T. Lipiello and R.Malek, eds. (Nettetal: Steyler Verlag, 1997), pp. 555-572 [4497]; «Mathematical Knowledge in the *Chongzhen lishu*,» in *Western Learning and Christianity in China. The Contribution and Impact of Johann Adam Schall von Bell S.J. (1592-1666)*, Roman Malek, ed. (Nettetal: Steyler Verlag, 1998), pp. 661-674 [4498]; and «History of Mathematics in Mei Wending's (1633-1721) Work,» *Historia Scientiarum*, **4** (1994), pp. 159-174 [4518]. On historiographical topics, Jami has written: «In Memoriam. Joseph Needham (December 9, 1900–March 24,1995),» *Historia Mathematica*, **24** (1996), pp. 1-5 [4537]; and «Joseph Needham and the Historiography of Chinese Mathematics,» in *Situating the History of Science: Dialogues with Joseph Needham*, S. Irfan Habib and Dhruv Raina, eds. (New Delhi: Oxford University Press, 1999), pp. 260-278.

Also working in Paris, and leader of a team studying the famous Dun Huang manuscripts, is Jean-Claude Martzloff. In addition to his book on the history of Chinese mathematics already noted, he has written several articles in English, including a «Note on the Recent Chinese and Mongolian Translations of Euclid's *Elements*,» *Historia Mathematica*, **24** (1997), pp. 200-202 [4487]; and «Matteo Ricci's Mathematical Works and their Influence,» in *Proceedings of the International Symposium on Chinese-Western Cultural Interchange in Commemoration of the 400th Anniversary of the Arrival of Matteo Ricci S.J. in China* (Taipei, September 11-16 1983) (Taipei: Furen Daxue Chubanshe,1983), pp. 889-895 [4527]. He also contributed an article on «Chinese Mathematical Astronomy» to the volume *Mathematics Across Cultures. The History of Non-Western Mathematics*, Helaine Selin and Ubiratan D'Ambrosio, eds. (Dordrecht: Kluwer Academic Publishers, 2000), pp. 373-407.

The Belgian historian Ulrich Libbrecht has written several works in English, most notably his translation and commentary of the Song dynasty work by QIN Jiushao, *Mathematical Treatise in Nine Sections* (1257 AD), that includes among other things, an important generalization for the method of extracting roots: *Chinese Mathematics in the Thirteenth Century. The Shu-shu Chiu-chang of Ch'in Chiu-shao* (Cambridge, MA: MIT Press, 1973) [4453]. Libbrecht has also written about the Dunhuang manuscripts; see for example «Mathematical Manuscripts from the Tunhuang Caves,» in *Explorations in The History of Science and Technology in China,* LI Guohao, *et al.*, trans. (Shanghai: Chinese Classics Publishing House, 1982), pp. 203-229 [4407]. On historiographic matters, he too has written about Joseph Needham: «Joseph Needham's Work in the Area of Chinese Mathematics,» *Past and Present*, **87** (1980), pp. 30-39 [4538]. Libbrecht's «New Studies on Chinese Mathematics. A Review Essay,» *Chinese Science*, **4** (1980), pp. 65-68 [4454], surveys recent studies of the period from the Southern Song to the Yuan dynasties, including LAM Lay Yong's Critical Study of the *Yang Hui suan fa* [item 4449], and Jock HOE's doctoral thesis at the University of Paris [items 4442 and 4538].

Donald B. Wagner wrote his dissertation on *Proof in Ancient Chinese Mathematics: Liu Hui on the Volumes of Rectilinear Solids*, a thesis he presented at the University of Copenhagen in 1975 [4433]. Wagner has written a number of articles related to LIU Hui, especially on matters concerning the approximation of *pi* and derivations of the volume of the sphere. He has also questioned the authenticity of LIU Hui's commentary on the famous *Nine Chapters*: «Doubts Concerning the Attribution of Liu Hui's Commentary on the *Chiu-chang suan-shu*,» *Acta Orientalia*, **39** (1978), pp. 199-212 [4303]. Among his other works: «Liu Hui and Tsu Keng-chih on the Volume of a Sphere,» *Chinese Science*, **3** (1978), pp. 59-79 [4399] (which draws parallels with Cavalieri's method and procedures used by LIU Hui and ZU Gengzhi); «An Early Derivation of the Volume of a Pyramid: Liu Hui, Third Century AD,» *Historia Mathematica*, **6** (1979), pp. 164-188 [4400]; and «Proof of the Pythagorean Theorem by Liu Hui (Third Century A.D.),» *Historia Mathematica*, **12** (1985), pp. 71-73 [4387].

MA Li, who now teaches in Sweden, wrote her dissertation with Joran Friberg at the Chalmers University of Technology on *The Rule of False: Early Applications and Conjectured Transmissions* (Department of Mathematics, Chalmers University of Technology, The University of Göteborg, 1993) [4378].

British Contributions

Of historians of science in England, Christopher Cullen and G.E.R. Lloyd are noteworthy, the former for careful textual studies, including his recent translation with commentary of the early astronomical and mathematical classic, the *Zhou bi suan jing* [4286], and the latter for his comparative studies of ancient Greek and Chinese mathematics. Cullen, who is Director of the Needham Research Institute in Cambridge, England, for study of the history of East Asian science, technology, and medicine, has written on such subjects as Chinese tangent tables [4237], and recently published a general survey of the Chinese *gou-gu* (Pythagorean) theorem in which he considers the question of whether ancient Chinese mathematics included the notion of rigorous proof: «Learning from Liu Hui? A Different Way to Do Mathematics,» *Notices of the AMS*, 49(7)(August, 2002), pp. 783-790.

Cullen also considers historiographic issues in «How Can We Do the Comparative History of Mathematics? Proof in Liu Hui and the *Zhou Bi*,» *Philosophy and History of Science. A Taiwanese Journal*, 4 (1995), pp. 59-94. Here Cullen is critical of the use of the word «proof» by J.W. Crossley and A. W.-C. LUN in an article they devoted to «proof» in Chinese mathematics [4425]. Cullen argues that the word cannot be applied in the same sense to LIU Hui as to Euclid, and considers how best to understand LIU Hui's commentaries on the *Jiu zhang suan shu* (Nine Chapters on Mathematical Procedures) and the even earlier Han dynasty text, the *Zhou bi suan jing* (Mathematical Classic of the Zhou Gnomon).

Geoffrey Lloyd has written about Chinese mathematics in comparative terms as well, contrasting the content and methods of ancient Greek and Chinese mathematics in his *Adversaries and Authorities: Investigations into Ancient Greek and Chinese Science* (Cambridge: Cambridge University Press, 1996) [4247]. Chapter 7 in particular is devoted to the different conceptions of the infinite that arise in Greek as opposed to Chinese mathematics. He has also written about history of mathematics more generally, and in «Learning by Numbers,» *Extrême-Orient, Extrême-Occident*, **16** (1994), pp. 153-167 [4246], he emphasizes that historians should be primarily interested in the «problems investigated, in the styles of reasoning cultivated, in the relationships between 'mathematics' (however interpreted) and other types of inquiry, [and] in the roles and value of 'mathematics' in society,» (p.153). Lloyd also offers a comparative analysis in «Finite and Infinite in Greece and China,» *Chinese Science*, **13** (1996), pp. 11-34 [4418].

Studies of Chinese Mathematics in the United States and Canada

In the United States, after a four-month exchange under the auspices of the U.S. National Academy of Sciences and the Chinese *Academia Sinica* in 1988, Joseph W. Dauben undertook serious study of both the Chinese language and the history of Chinese mathematics. He has also worked with two graduate students in New York, HORNG Wann-Sheng and XU Yibao, in the Ph.D. Program in History at the Graduate Center of the City University of New York. Among other subjects, Dauben has written about aspects of argumentation and proof in ancient Chinese mathematics, «The 'Pythagorean Theorem' and Chinese Mathematics: Liu Hui's Commentary on the *Gou-Gu* Theorem in Chapter Nine of the *Jiu Zhang Suan Shu*,» in *Amphora: Festschrift in Honor of Hans Wussing* (Leipzig: B.G.Teubner, 1992), pp. 133-155 [4287]; and «Ancient Chinese Mathematics: The *Jiu Zhang Suan Shu* versus Euclid's *Elements*. Aspects of Proof and the Linguistic Limits of Knowledge,» *Chandrasekhar Memorial Issue, International Journal of Engineering Science*, **36** (1998), pp. 1339-1359 [4427]. He is currently working with colleagues in China, Singapore, and Taiwan to produce a critical edition in English with commentary of selections from the *Ten Classics* of ancient Chinese mathematics.

Dauben is also interested in the introduction of modern mathematics to China, and has written «Internationalizing Mathematics East and West: Individuals and Institutions in the Emergence of a Modern Mathematical Community in China,» in *Mathematics Unbound: The Evolution of an International Mathematical Research Community, 1800-1945*, Karen H. Parshall and Adrian C. Rice, eds. (Providence, R.I., and London, England: The American Mathematical Society and the London Mathematical Society, 2002), pp, 253-285. His contribution to a symposium at the University of Zaragoza, Spain, is due to appear shortly as an article in *Llull*: «Mathematics and Ideology: The Politics of Infinitesimals/Marx, Mao and Mathematics: Nonstandard Analysis and the Cultural Revolution,» to appear as well in *Proceedings of the III Simposio Internacional Galdeano* (Zaragoza: University of Zaragoza, Spain, September, 1996; in press) [4503].

Roger Hart is a member of the Departments of History and of Asian Studies at the University of Texas at Austin. His work has concentrated largely on Ming and early Qing dynasty mathematics. Among his publications are «Translating the Untranslatable: From Copula to Incommensurable Worlds,» in *Tokens of Exchange: The Problem of Translation in Global Circulations*, Lydia H. LIU, ed. (Durham, N.C.: Duke University Press, 2000), pp. 45-73,

which takes up, among other topics, the problem of translating Euclid's *Elements* from Latin into Chinese. He is currently working on a collection of essays, *Cultural Studies of Chinese Science, Technology and Medicine,* which he is editing and will include his own study of «Quantifying Ritual: Political Cosmology, Courtly Music, and Precision Mathematics in Seventeenth-Century China.»

Frank Swetz is Professor of Mathematics and Education at Pennsylvania State University, and has a special interest in the history of Chinese mathematics. He has published translations of several Chinese classical texts, including a translation with commentary of the *Hai dao suan jing* (The Sea Island Mathematical Classic) and Chapter 9 from the *Jiu zhang suan shu* (The Nine Chapters on Mathematical Procedures) on right triangles and the Chinese version of the Pythagorean theorem. The first he published with ANG Tianse, «A Chinese Mathematical Classic of the Third Century: The Sea Island Manual of Liu Hui,» *Historia Mathematica*, **13** (1986), pp. 99-117 [4273], which led to Swetz's *The Sea Island Mathematical Manual: Surveying and Mathematics in Ancient China* (University Park, PA: Pennsylvania State University Press, 1992) [4298]; the latter he published with T.I. KAO, *Was Pythagoras Chinese? An Examination of Right Triangle Theory in Ancient China* (University Park, PA: The Pennsylvania State University Press,1977) [4386]. Swetz followed this some years later with a further account, «Right Triangle Concepts in Ancient China: From Application to Theory,» *History of Science*, **31** (1993), pp. 421-439 [4385], and in collaboration with ANG Tianse, «A New Suggestion on Tzu Chu'ng-Chih's Method of Finding the Value of π and its Significance in the History of Mathematics,» *Papers on Far Eastern History,* **16** (1977), pp. 161-165 [4396].

Swetz has also published on topics of interest to classroom teaching, for example: «The Amazing *Chiu Chang Suan Shu*» and «The 'Piling Up of Squares' in Ancient China,» both in *Mathematics Teacher*, **65** (1972), pp. 425-430 [4297], and 70 (1977), pp. 72-79 [4251], respectively; and «The Evolution of Mathematics in Ancient China,» *Mathematics Magazine*, **52** (1979), pp. 10-19 [4252]. He has also studied the progress of mathematics since the late Qing, in «The Introduction of Mathematics in Higher Education in China, 1865-1887,» *Historia Mathematica*, 1 (1974), pp. 167-179 [4499]; and *Mathematics Education in China, its Growth and Development* (Cambridge, MA: The MIT Press, 1974) [4500].

XU Yibao is writing his doctoral dissertation on the subject of the infinite in Chinese mathematics at the Ph.D. Program in History at the Graduate Center of the City University of New York. Previously, in 1991 he completed his Master's degree in history of Chinese mathematics under LI Di at Inner Mongolia Normal University in Huhehot, China. In addition to his publications in Chinese, he has written a number of works in English, including «Chinese-U.S. Mathematical Relations: 1859-1949,» in *Mathematics Unbound: The Evolution of an International Mathematical Community, 1800-1945*, Karen H. Parshall and Adrian C. Rice, eds. (Providence, Rhode Island: American Mathematical Society & London: The London Mathematical Society, 2002,) pp. 287-309. «Bertrand Russell and the Introduction of Mathematical Logic in China,» *History and Philosophy of Logic* 24, no. 3 (2003), 181-196; and «The First Chinese Translation of the Last Nine Books of Euclid's *Elements* and Its Source,» *Historia Mathematica* (in press). Also in press is an historiographic study of Joseph Needham: «Joseph Needham and the Historiography of the History of Chinese Mathematics,» in *Proceedings of the Symposium on the History of Science in Commemoration of the Centennial of the Birth of Joseph Needham*, December 8-9, 2000, in Kaohsiung, Taiwan (to appear).

Alexeï Volkov, who as noted above studied with Adol'f Pavlovich Yushkevich at the Institute for History of Science in Moscow, has worked in Paris and Hong Kong, but currently teaches in Montreal, Canada. Many of his most recent publications are in English, and range from studies of the Chinese classic mathematical texts to works he has recently discovered in Vietnam. His dissertation, *Matematika v drevnem Kitae III-VII vv* (Mathematics in Ancient China during the 3rd-7th Centuries A.D.) was completed in 1988 [4258], a short abstract of which appeared in English in *Historia Mathematica*, **8** (1991), pp. 185-187. Subsequently, Volkov has published extensively in Russian, French, and English. Among his works in English are a number of studies devoted to calculation of *pi*: «Supplementary Data on the Values of π in the History of Chinese Mathematics,» *Philosophy and the History of Science. A Taiwanese Journal*, **3** (1994), pp. 95-110 [4327]; «Calculation of π in Ancient China: from Liu Hui to Zu Chongzhi,» *Historia Scientiarum*, **4** (1994), pp. 139-157 [4394]; «Zhao Youqin and his calculation of π,» *Historia Mathematica*, **24** (1997), pp. 301-331 [4395/4457]; and «The Mathematical Work of Zhao Youqin: Remote Surveying and the Computation of π,» *Taiwanese Journal for Philosophy and History of Science*, **8** (1997), pp. 129-189 [4456]. This was a special issue on science in fourteenth-century China, including a case study of the Daoist polymath ZHAO Youqin (1271-1335?), of which Volkov was the guest

editor; see A. Volkov, «Science and Daoism: An Introduction,» *Taiwanese Journal for Philosophy and History of Science,* 8 (1997), pp. 1-58.

Volkov has also written about the Chinese means of computation using rods on a counting board: «Counting Rods,» in *Instruments of Science: An Historical Encyclopedia*, R. Bud and D.J. Warner, eds. (New York: Garland, 1998), pp. 155-156 [4342]. Recently, he has turned his attention to mathematical works in Vietnam: «On the Origins of the *Toan phap dai thanh* (Great Compendium of Mathematical Methods),» in *From China to Paris: 2000 Years of Mathematical Transmission*, Proceedings of a Conference Held at the Rockefeller Foundation Research and Conference Center, Bellagio, Italy, May, 2000, Yvonne Dold-Samplonius, Joseph W. Dauben, Menso Folkerts, and Benno van Dalen, eds., a special issue of *Boethius,* vol. 46 (Stuttgart: Steiner Verlag, 2002), pp. 369-410.

The Canadian-American linguist Brendan Gillon contributed «Introduction, Translation, and Discussion of Chao Chun-Ch'ing's 'Notes to the Diagrams of Short Legs and Long Legs and of Squares and Circles',» *Historia Mathematica*, 4 (1977), pp. 253-293 [4288].

Australia and New Zealand

Jock Hoe, who teaches at Massey University in New Zealand, obtained his doctorate at the University of Paris. Among his writings on history of Chinese mathematics in English is: «A Problem in the *Siyuan yujian: The Jade Mirror of the Four Unknowns,*» in *Proceedings of the First New Zealand International Conference on Chinese Studies, Waikato University China Papers*, vol. 2 (Hamilton, New Zealand: University of Waikato, 1972) [4441].

In Australia, John N. Crossley and Anthony W.-C. LUN have collaborated in translating two important works into English, LI Yan and DU Shiran's *Chinese Mathematics, A Concise History* (Oxford: Clarendon Press, 1987) [4222]; and with SHEN Kangshen , a translation and edition with substantial commentary: *The Nine Chapters on the Mathematical Art—Companion and Commentary* (Oxford: Oxford University Press, 1999). Crossley and Lun have also published a joint work on the concept of proof in early Chinese mathematics, «The Logic of Liu Hui and Euclid as Exemplified in Their Proofs of the Volume of a Pyramid,» *Philosophy and the History of Science. A Taiwanese Journal*, **3** (1994), pp. 11-27 [4425]. For a critique of and reply to this work, see the article by Christopher Cullen noted above.

Chinese Authors in Australia, Hong Kong, Malaysia, and Singapore

ANG Tian-Se wrote his doctoral dissertation, *Study of the Mathematical Manual of Chang Ch'iu-chien* (unpublished), at the University of Malaysia in 1969 [4272]. He has published several articles since on aspects of computational astronomy and right triangles: «The Use of Interpolation Techniques in Chinese Calendar,» *Oriens Extremus*, **23** (1976), pp. 135-151 [4338]; and «Chinese Interest in Right-Angled Triangles,» *Historia Mathematica*, **5** (1978), pp. 264-265 [4383]. His most ambitious work is the book he wrote with LAM Lay Yong, *Fleeting Footsteps. Tracing the Conception of Arithmetic and Algebra in Ancient China* (Singapore: World Scientific, 1992) [4294], in which the authors argue in terms of a careful translation and study of the *Sunzi suan jing* (Master Sun's Mathematical Classic) that the decimal place-valued number system actually originated in China and was transmitted therefrom to India and then via Islamic mathematics to the West. LAM and ANG have also jointly authored several articles together, including «The Conceptual Origin of our Numeral System and the Symbolic Form of Algebra,» *Archive for History of Exact Sciences*, **36** (1986), pp. 183-195 [4311]; and «The Earliest Negative Numbers: How They Emerged from a Solution of Simultaneous Linear Equations,» *Archives internationales d'histoire des sciences*, **37** (1987), pp. 222-262 [4373]. ANG also collaborated with Frank Swetz on an article devoted to the double difference method, «A Chinese Mathematical Classic of the Third Century: The Sea Island Manual of Li Hui,» *Historia Mathematica*, **13** (1986), pp. 99-117 [4273].

HO Peng-Yoke, who now resides in Australia, is the author of a number of biographies of Chinese mathematicians included in the *Dictionary of Scientific Biography*, «Ch'in Chiu-shao» [Qin Jiushao] [4512], «Chu Shih-chieh» [Zhu Shijie] [4513], «Li Chih» [Li Ye] [4514], «Liu Hui» [4515], and «Yang Hui» [4516]. He also wrote «The Lost Problem of the *Chang Ch'iu-chien Suan Ching*, a Fifth-Century Chinese Mathematical Manual,» *Oriens Extremus*, **12** (1965), pp. 37-53 [4290]. This is of particular interest because the extant versions of the *Zhang Qiujian suan jing* are incomplete; in this article the author discusses the missing portions that occur between the end of the second chapter and the beginning of the third chapter. HO Peng Yoke's book, *Li, Qi, and Shu: An Introduction to Science and Civilization in China* (Hong Kong: Hong Kong University Press, 1985; revised, New York: Dover, 2000), devotes the second of its four parts to mathematics (pp. 53-112).

Of all Chinese authors writing in English, none has been as prolific or as influential as LAM Lay Yong, Professor Emerita from the National University of Singapore. In addition to writing two books, *Critical Study of the Yang Hui Suan Fa, a 13th-Century Mathematical Treatise* (Singapore: Singapore University Press, 1977) [4449]; and (with ANG Tian-Se) *Fleeting Footsteps. Tracing the Conception of Arithmetic and Algebra in Ancient China* (Singapore: World Scientific, 1992) [4294], she has also written extensively on the most famous of the *Ten Classics*, the *Nine Chapters*: «Yang Hui's commentary on the '*ying nu*' chapter of the *Chiu Chang Suan Shu*,» *Historia Mathematica*, **1** (1974), pp. 54-55 [4291]; and «*Jiu Zhang Suanshu* (Nine Chapters on the Mathematical Art): An Overview,» *Archive for History of Exact Sciences*, **47** (1994), pp. 1-51 [4292]. Among the other *Ten Classics* of ancient Chinese mathematics, in addition to the *Sunzi suan jing* (translated with commentary in *Fleeting Footsteps*), she has written on the «*Zhang Qiujian Suanjing* (The Mathematical Classic of Zhang Qiujian): An Overview,» *Archive for History of Exact Sciences*, **50** (1997), pp. 201-240 [4293]; and (with SHEN Kangshen), «Right-angled Triangles in Ancient China,» *Archive for History of Exact Sciences*, **30** (1984), pp. 87-112 [4384].

LAM Lay Yong is also the author of numerous articles, many dealing with the *Yang Hui suan fa* and other thirteenth-century works, including «On the Existing Fragments of Yang Hui's *Hsiang Chieh Suan Fa* [*Xiang jie suan fa*],» *Archive for History of Exact Sciences*, **6** (1969), pp. 82-88 [4447]; «The *Jih Yung Suan Fa* [*Ri yong suan fa*]: an Elementary Textbook of the Thirteenth Century,» *Isis*, **63** (1972), pp. 370-383 [4448]; and «Chu shih-chieh's *Suan Hs'ueh Ch'i-meng* (Introduction to Mathematical Studies),» *Archive for History of Exact Sciences*, **21** (1979), pp. 1-31 [4450]. This work gives a general introduction to Zhu Shijie's *Suan xue qi meng* of 1299, including aspects of numeration, metrology and special terminology found in this book, as well as the influence of the *Jiu zhang suan shu* (The Nine Chapters) on Zhu Shijie's book. LAM Lay Yong has also written about another thirteenth-century work, in collaboration with ANG Tian-Se: «Li Ye and his *Yi Gu Yan Duan* (Old Mathematics in Expanded Sections),» *Archive for History of Exact Sciences*, **29** (1984), pp. 237-266 [4452], a study devoted to a work by Li Ye written in 1259 (printed in 1282).

She has also written extensively about the Chinese origins of the decimal place-value system: «Linkages: Exploring the Similarities Between the Chinese Rod Numeral System and our Numeral System,» *Archive for History*

of Exact Sciences, **37** (1979), pp. 365-392 [4340]; «The Conceptual Origin of our Numeral System and the Symbolic Form of Algebra,» *Archive for History of Exact Sciences*, **36** (1986), pp. 183-195 [4311]; «A Chinese Genesis: Rewriting the History of Our Numeral System,» *Archive for History of Exact Sciences*, **38** (1988), pp. 101-108 [4312]; and «The Development of Hindu-Arabic and Traditional Chinese Arithmetic,» *Chinese Science*, **13** (1996), pp. 35-54 [4352].

LAM Lay Yong has also studied the different computational methods of the ancient Chinese: «The Geometrical Basis of the Ancient Chinese Square Root Method,» *Isis*, **61** (1969), pp. 96-102 [4364]; «The Chinese Connexion Between the Pascal Triangle and the Solution of Numerical Equations of any Degree,» *Historia Mathematica*, **7** (1980), pp. 407-424 [4371], and «Chinese Polynomial Equations in the Thirteenth Century,» in *Explorations in The History of Science and Technology in China*, LI Guohao, *et al.*, eds. (Shanghai: Chinese Classics Publishing House, 1982), pp. 231-272 [4451].

In Hong Kong, SIU Man-Keung teaches at the University of Hong Kong, and has written on matters related to education and history of mathematics, for example: «Mathematics Education in Ancient China: What Lesson Do We Learn From It?» *Historia Scientiarum*, **4** (1995), pp. 223-232 [4249]. Among his studies of ancient Chinese mathematics: «Pyramid, Pile, and Sum of Squares,» *Historia Mathematica*, **8** (1981), pp. 61-66; and «Proof and Pedagogy in Ancient China: Examples from Liu Hui's Commentary on the *Jiu Zhang Suan Shu*,» *Educational Studies in Mathematics*, **24** (1993), pp. 345-357 [4430].

English Works by Chinese Authors in the PRC and Taiwan

Both mainland China and Taiwan have active groups of historians of mathematics, most of whom work on one aspect or another of the history of Chinese mathematics. Of authors in Taiwan, the best-known is HORNG Wann-Sheng, who has written extensively on ancient and modern mathematics. His doctoral dissertation was devoted to *Li Shanlan, The Impact of Western Mathematics in China During the late Nineteenth Century* (New York: City University of New York, 1991) [4517]. His articles on ancient Chinese mathematics include: «How Did Liu Hui Perceive the Concept of Infinity: A Revisit,» *Historia Scientiarum*, **4** (1995), pp. 207-222 [4417], where the author considers questions of circle measurement and infinite divisibility. Concerning mathematics in the modern period, he has also written: «Hua Hengfang (1833-1902) and His *Notebook on Learning Mathematics* 'Xue Suan

Bi Tan',» *Philosophy and the History of Science. A Taiwanese Journal,* 2(2)(1993), pp. 27-76 [4493]; and «Chinese Mathematics at the Turn of the 19th Century: Jiao Xun, Wang Lai and Li Rui,» in *Philosophy and Conceptual History of Science in Taiwan*, LIN Cheng-Hung and FU Daiwie, eds., *Boston Studies in the Philosophy of Science*, vol. 141 (Dordrecht: Kluwer Academic Publishers: 1993), pp. 167-208 [4504]. This work analyzes the advances made by Chinese mathematicians working in the nineteenth century in the tradition of the Qian-Jia school, which revitalized interest in ancient Chinese mathematics to show that the results and methods of Western mathematics were already known in traditional Chinese mathematics.

Professor of mathematics at the Academia Sinica in Nangang, Taiwan, LIH Ko-Wei (LI Guo-wei) has written on both ancient and modern Chinese mathematics alike: «From One Gnomon to Two Gnomons: A Methodological Study of the Method of Double Differences,» in *Philosophy and Conceptual History of Science in Taiwan*, LIN Cheng-Hung and FU Daiwie, eds., *Boston Studies in the Philosophy of Science*, vol. 141 (Dordrecht: Kluwer Academic Publishers: 1993), pp. 149-165 [4382]; «Bao Qi-Shou (Bao Qishou) and His Polyhedral *Hun Yuan Tu*,» in *Science and Technology in Chinese Civilization*, CHEN Cheng-Yih, Roger Cliff, and CHEN Kuei-Mei, eds. (Singapore: World Scientific Publishing Co., 1987), pp. 93-107 [4523]; and «Bao Qi-shou (Bao Qishou) and His Polyhedral *Hun Yuan Tu*,» in *Philosophy and Conceptual History of Science in Taiwan*, LIN Cheng-Hung and FU Daiwie, eds., *Boston Studies in the Philosophy of Science*, vol. 141 (Dordrecht: Kluwer Academic Publishers: 1993), 209-220 [4524].

FU Daiwie, a graduate of Columbia University (New York), teaches at Tsing Hua University in Hsinchu (Taiwan), and is the author of «Why Did Liu Hui Fail to Derive the Volume of a Sphere?» *Historia Mathematica*, **18** (1991), pp. 212-238 [4398].

The People's Republic of China

No mathematician in China has done more to promote history of mathematics than the topologist and proof theorist WU Wen-tsun (Wu Wenjun/Wu Wenchun). Among his contributions are «Recent Studies of the History of Chinese Mathematics,» *Proceedings of the International Congress of Mathematicians* (Berkeley, California, 1986,) pp. 1657-1667 [4262]. WU sets out two principles for studying ancient Chinese mathematics, i.e. «All conclusions

drawn should be based on original texts fortunately preserved up to the present time,» and «All conclusions drawn should be based on reasoning in the manner of our ancestors in making use of knowledge and in utilizing auxiliary tools and methods available only at that ancient time,» (p.1657). Among his earliest contributions to analysis of the methods of ancient Chinese mathematics is «The Out-In Complementary Principle,» in *Ancient China's Technology and Science* (Beijing: Foreign Languages Press, 1983), pp. 66-89 [4263]. His most recent publication was a contribution to the *Beijing Intelligencer* published in conjunction with the International Congress of Mathematicians held in Beijing in August of 2002: «A Tentative Comparative Study of Mathematics. Developments in Ancient China and Ancient Greece,» *Beijing Intelligencer* (Beijing: Higher Education Press, and Heidelberg: Springer Verlag, 2002), pp. 23-41.

A leading member of the Institute for History of Natural Science of the Chinese Academy of Sciences in Beijing is Professor GUO Shuchun, an expert on Liu Hui and the *Nine Chapters on Mathematical Procedures*. He has written extensively on this subject in Chinese, and edited numerous texts related to the history of Chinese mathematics from antiquity to the present. Among his publications in English is «The Numerical Solution of Higher Equations and the *Tianyuan* Method,» in *Ancient China's Technology and Science* (Beijing: Foreign Languages Press, 1983), pp. 111-123 [4370]. This work studies the «*kai fang shu*,» a Chinese method for solving algebraic equations developed in the Song Dynasty (960-1279), as well as related methods for extracting roots by successive additions and multiplications.

LI Di, Professor of the History of Mathematics at Inner Mongolia Normal University, has trained several generations of historians of mathematics in China, and is editor of the *Journal of the Cultural History of Mathematics,* which is published in English, but not on an annual basis. LI Di has written on all periods of the history of Chinese mathematics, and in English has published: «The Literary Problems in the Mathematical Works of Ming Dynasty in China,» *Journal of the Cultural History of Mathematics,* 1 (1991), pp. 19-27 [4478]; and «400 Years of the History of Mathematics in China. An Introduction to the Major Historians of Mathematics Since 1592,» *Historia Scientiarum*, 4 (1994), pp. 103-111 [4539]. In 1978, with his colleague BAI Shangshu, LI Di discovered ten calculators in a storeroom of the Palace Museum in Beijing, and together with Michael R. Williams they have published: «Chinese Calculators Made During the Kangxi Reign in the Qing Dynasty,» *Annals of the History of Computing*, 14 (4)(1992), pp. 63-67 [4479].

LI Wenlin is a member of the Institute of Mathematics of the Chinese Academy of Sciences in Beijing, and has devoted much of his research to the history of modern mathematics. In English he has written: «The Chinese Indigenous Tradition of Mathematics and the Conceptual Foundation to Adopt Modern Mathematics in the 19th Century,» in *Zhongguo shuxueshi lunwenji* (Collected Papers on the History of Chinese Mathematics), BAI Shangshu, LI Di, and SHEN Kangshen, eds. (Jinan: Shandong Educational Press, 1996), pp. 146-156 [4501], and with YUAN Xiangdong, «The Chinese Remainder Theorem,» in *Ancient China's Technology and Science* (Beijing: Foreign Languages Press, 1983), pp. 99-110 [4403].

LIU Dun is Director of the Institute for History of Natural Science of the Chinese Academy of Sciences in Beijing, and an authority on ancient and modern Chinese mathematics. Among other studies, in English he has published: «A Comparison of Archimedes' and Liu Hui's Studies of Circles,» in *Chinese Studies in the History and Philosophy of Science and Technology*, FAN Dainian and Robert S. Cohen, eds., Kathleen Dugan and JIANG Mingshan, trans. (Dordrecht: Kluwer Academic Publishers, 1996), pp. 279-289 [4391]; and «A Homecoming Stranger: Transmission of the Method of Double False Position and the Story of Hiero's Crown,» in *From China to Paris: 2000 Years of Mathematical Transmission*, Proceedings of a Conference Held at the Rockefeller Foundation Research and Conference Center, Bellagio, Italy, May, 2000, Yvonne Dold-Samplonius, Joseph W. Dauben, Menso Folkerts, and Benno van Dalen, eds., a special issue of *Boethius*, vol. 46 (Stuttgart: Steiner Verlag, 2002), pp. 157-166. He has also written, in collaboration with Joseph W. Dauben, «Historians of Mathematics in China,» in *Writing the History of Mathematics: Its Historical Development*, Joseph Dauben and Christoph J. Scriba, eds. (Basel: Birkhäuser, 2000), pp. 297-306 [4540]. LIU Dun also contributed the biographies of LI Yan [4541] and QIAN Baocong [4542] to this same volume.

MEI Rongzhao, also a member of the Institute for History of Natural Science of the Chinese Academy of Sciences in Beijing, has written on aspects of proof and argumentation in Chinese mathematics, and on the origins of arithmetic in ancient China: «The Decimal Place-Value Numeration and the Rod and Bead Arithmetics,» in *Ancient China's Technology and Science* (Beijing: Foreign Language Press, 1983), pp. 57-65 [4313]; «Mathematical Formalism in Ancient China,» in *Science and Technology in Chinese Civilization*, CHEN Cheng-Yih, Roger Cliff, and CHEN Kuei-Mei, eds.

(Singapore: World Scientific Publishing Co., 1987, pp. 53-75 [4429]; and «Liu Hui's Theories of Mathematics,» in *Chinese Studies in the History and Philosophy of Science and Technology*, FAN Dainian and Robert S.Cohen, eds., Kathleen Dugan and JIANG Mingshan, trans. (Dordrecht: Kluwer Academic Publishers, 1996), pp. 243-254 [4529].

QU Anjing teaches in the Department of Mathematics at Northwest University in Xi'an, China, and has written in English on various aspects of ancient Chinese mathematics, including: «Bian Gang: A Mathematician of the 9th Century,» *Historia Scientiarum*, **6** (1996), pp. 17-30 [4530], in which the author discusses calendrical research and the last calendar of the Tang Dynasty, the Chong Xuan Calendar (892 A.D.); and «On Hypotenuse Diagrams in Ancient China,» *Centaurus*, **39** (1997), pp. 193-210 [4574].

SHEN Kangshen, of Hangzhou University (since 1998, merged to become part of Zhejiang University), is an expert on the *Nine Chapters*, among other topics related to history of ancient Chinese mathematics. His most ambitious work, a translation with commentary of the *Nine Chapters*, was recently published in English with the collaboration of John N. Crossley and Anthony W.-C. LUN, *The Nine Chapters on the Mathematical Art. Companion and Commentary* (Oxford: Oxford University Press, 1999). In addition to numerous works in Chinese, in English SHEN has published: «Historical Development of the Chinese Remainder Theorem,» *Archive for History of Exact Sciences*, **38** (1988), pp. 285-305 [4405]. He has also collaborated on several occasions with LAM Lay Yong, and together they have written: «The Chinese Concept of Cavalieri's Principle and its Applications,» *Historia Mathematica*, **12** (1985), pp. 219-228 [4402], which presents a method developed by LIU Hui to calculate the volume of a sphere that is similar to Cavalieri's method; «Mathematical Problems on Surveying in Ancient China,» *Archive for History of Exact Sciences*, **36** (1986), pp. 1-20 [4380]; and «Methods of Solving Linear Equations in Traditional China,» *Historia Mathematica*, **16** (1989), pp. 107-122 [4374].

WANG Yusheng is a member of the Institute for History of Natural Science of the Chinese Academy of Sciences and Director of the Beijing Science and Technology Museum. He has written in English about the development of modern mathematics in China, including: «Hua Hengfang: Forerunner and Disseminator of Modern Science in China,» in *Chinese Studies in the History and Philosophy of Science and Technology*, FAN Dainian and Robert S. Cohen, eds., Kathleen Dugan and JIANG Mingshan, trans. (Dordrecht: Kluwer Academic Publishers, 1996), pp. 369-394 [4533]; and «Li Shanlan: Forerunner

of Modern Science in China,» also in *Chinese Studies in the History and Philosophy of Science and Technology*, pp. 345-368 [4534].

ZHANG Dianzhou teaches in the Department of Mathematics at East-China Normal University in Shanghai, and has written primarily about the history of modern mathematics in the West and in China. In English, he collaborated with Joseph W. Dauben to write: «Mathematical Exchanges Between the United States and China,» in *History of Modern Mathematics*, Eberhard Knobloch and David E. Rowe, eds. (Orlando: Academic Press, 1994), pp. 263-297 [4492].

Journals

In closing, it is worth noting that there are a number of journals, including *Llull*, that publish material related to history of Chinese mathematics. Of those publishing articles in English, the most important are *The Archive for History of Exact Sciences*, *Historia Mathematica*, *Philosophy and the History of Science. A Taiwanese Journal*, and *Historia Scientiarum*. Other journals that from time to time include works devoted to history of Chinese mathematics are *Centaurus*; *East Asian Science, Technology and Medicine* (formerly *Chinese Science*); *Extrême-Orient, Extrême-Occident*; *Science in Context*; and *Isis*. There is also the journal in English edited by LI Di that appears occasionally, as mentioned above: *Journal of the Cultural History of Mathematics* (Huhehot, Inner Mongolia Normal University, PRC).

Contributions by Historians of Chinese Mathematics Writing in Chinese

The earliest examples of documents devoted to the history of mathematics in China can be traced back to the sixteenth, or the eleventh, or even much earlier to the eighth century, depending upon how the word «historical» is interpreted [LIU and Dauben 2002, p. 253; LI Di 1998, p. 64; LI Di 2001, p. 412; Martzloff 1997, p. 10]. Many early historical works now seem to be lost and unfortunately no longer exist, but among extant documents, history of mathematics in any sense approaching our contemporary understanding of the term did not occur until the seventeenth century, when Chinese mathematicians, including the most influential of all, MEI Wending, launched a campaign to «prove» that Western mathematics as introduced by the Jesuits actually originated in ancient China. However lacking in evidence such studies may have been, they nevertheless prompted systematic investigation of the most

basic issues on and methods of ancient Chinese mathematics. One example is that the true meaning of the *Tian yuan shu*, a method which was developed in the twelfth century (possibly even earlier) for using unknown elements in Chinese algebra, had been forgotten. By the sixteenth and seventeenth centuries, no one understood the method, but it was subsequently rediscovered as mathematicians tried to discover the Chinese «origin» of algebra itself.

Historical studies of mathematics were also pursued under the Emperors Qianlong (reigned 1735-1796) and Jiaqing (reigned 1796-1820), when textual criticism of the Chinese classics, including ancient mathematical texts, was popular. One major result was that classics of mathematics such as the *Suan jing shi shu*, the ten books of mathematical classics, were brought under scrutiny, and better versions of these books were subsequently published. Another result of historical research at this time was the appearance of a book entitled *Chouren zhuan*, a compilation of biographies and excerpts from the writings of the most important mathematicians and astronomers first printed in 1799. Three supplements were issued in the following century, bringing the total of individuals covered to nearly seven hundred, and ranging from legendary figures in prehistory to such eminent nineteenth-century mathematicians as LI Shanlan. Nearly two hundred Japanese and Western scholars were also included [FU 1990, pp. 219-260; LIU and Dauben 2002, pp. 255-259].

By the twentieth century, not only the example of MIKAMI Yoshio's *The Development of Mathematics in China and Japan* (Leipzig: Teubner, 1913; repr. New York: Chelsea, 1974) [4224], but the exposure to Western methods of Chinese students studying abroad, stimulated interest in more technical, scientific historical research. In the decades prior to World War II, a new generation of historians of mathematics emerged, including LI Yan, QIAN Baocong, XU Chunfang, YAN Dunjie, and ZHANG Yong [Martzloff 1997, pp. 11-12; LI Di 1998, p. 69; and Dauben and Scriba 2002, pp. 259-260]. One consequence of this approach was an excessive use of symbols and formulas. The influence of *Chouren zhuan*, however, was still evident because the new generation still focused more on presenting historical evidence than on interpretation. But the research done by a handful of scholars due largely to their own interests built a solid foundation for future studies. In particular, they provided a concrete body of new historical works to which Joseph Needham and his collaborator, WANG Ling, could turn for support as they wrote their account of Chinese mathematics in the third volume of *Science and Civilisation in China* (1959) [4225].

When the People's Republic of China was founded in 1949, historical studies on mathematics, like other studies, were encouraged. LI Yan, QIAN Baocong, and YAN Dunjie were called to Beijing to form a research group devoted to history of mathematics within the newly-founded Chinese Academy of Sciences. From this small group, a more ambitious research program for the history of science generally was established in 1957, and with it, the Institute for History of Natural Science. To help stimulate the study of history of mathematics, the Science Press in Beijing reprinted articles and books published by LI Yan in five volumes: *Zhongsuanshi luncong* (Series on History of Chinese Mathematics, 1954-1955). In the following decade, a number of high-quality studies were produced, including LI Yan's studies on Chinese methods of interpolation (1957), QIAN Baocong's collation and commentary on the *Suan jing shi shu* (Ten Books of Mathematical Classics), and his influential *Zhongguo shuxueshi* (A History of Chinese Mathematics, 1964).

Unfortunately, this promising beginning was soon brought to a halt by the Cultural Revolution, and only after the Revolution came to an end did a new phase in the history of science in China begin, a phase that would also see the unprecedented development of history of mathematics. The last twenty-five years has indeed been extraordinary, not only for the status of history of Chinese mathematics in China, but abroad as well, as outlined in the preceding sections of this article. What follows is a brief survey of studies on the history of Chinese mathematics in the last quarter of the twentieth century. Surveying publications in Chinese by scholars in both mainland China and Taiwan, it does not pretend to cover all of the work done in this period, but is selective, partial, and incomplete. Readers interested in more information are encouraged to consult bibliographies in such recent works as HORNG 1991 [4517], Martzloff 1997 [4223], and Bréard 1999 [4557].

Changing Academic Environments

The Cultural Revolution officially ended in October of 1976. The sweeping political changes that followed resulted in especially favorable policies on science, technology, and education, and the situation for scholars and intellectuals generally improved dramatically. Rather than the ideology of class struggle, the government regarded science and technology as keys to social progress, and correspondingly, the value of historical studies of science and technology was increasingly appreciated. The program for the history of science mentioned above was upgraded to the status of an Institute in 1978, at the

same level as the Institute of Mathematics in the Chinese Academy of Sciences. That same year, the Institute again started to recruit graduate students in history of Chinese mathematics, first for the Masters degree, and soon thereafter for the Ph.D. (prior to 1978, there were only two graduate students in this field in all of China). Outside the Institute, a number of universities also began to train graduate students, first at Inner Mongolia Normal University, then at Beijing Normal University, followed by Hangzhou University (now part of Zhejiang University), Northwest University, and Tianjin Normal University. Higher education in the field of the history of Chinese mathematics provided much needed new blood. In the decade following the Cultural Revolution, the number of professional historians and researchers in this field has increased steadily, and so has the number of publications devoted to the subject [LI Di 1998, p. 83; LIU and Dauben 2002, p. 261].

In addition to more favorable national policies, impetus also came from Western scholars, especially from Joseph Needham and the great stimulus his series of volumes on Chinese science and technology exerted, even in China. The heated debate that ensued over the so-called Needham question (Why did modern science not occur in China?) generated considerable interest both in China and abroad. And the account Needham and WANG Ling gave of Chinese mathematics in volume three of the series directly inspired research around the globe [Jami 1999; XU, in press]. Studies on the history of Chinese mathematics in China also benefited from increasingly active international exchanges through international conferences exclusively devoted (or closely related) to the subject, and from increasingly frequent visits by foreign scholars to China, and by Chinese scholars and graduate students going abroad, primarily to Europe and North America [LI Di 1998, pp. 80-83; LI Di 2001, p. 417].

The flourishing of studies on the history of Chinese mathematics in the past twenty-five years has also been due to the strong support prestigious mathematicians have given the subject, most notably WU Wenjun, a topologist and expert on proofs by computer. WU studied ancient mathematical texts in his spare time during the Cultural Revolution, and found that one of the major characteristics of traditional Chinese mathematics was what he termed the «mechanization of algorithms.» Subsequently WU has not only published intensively himself in this field, but has also provided leadership and help in many ways [LI Di 2001, pp. 419-421]. In 2001, WU received a prestigious award from the Chinese government, a part of which he donated to establish

the «Silk Road Project,» a program which supports research and study of the transmission of mathematics between China and other cultures.

Studies on the history of Chinese mathematics have become increasingly important in Taiwan as well, specifically at such institutions as Taiwan Normal University, Tsinghua University, and the Academia Sinica. This has been due primarily to the return to Taiwan of several students trained in the United States in the history and philosophy of science.

Primary Sources

One of the most basic tasks for historians is the discovery, study, collation, editing, and publication of primary sources. Historians of Chinese mathematics, along with scholars in other fields, have made considerable efforts to publish traditional Chinese mathematical texts. In 1993, a group of historians, mainly from the Institute for the History of Natural Science (IHNS) in Beijing, under the leadership of GUO Shuchun, a research professor at IHNS, selected and published in facsimile nearly ninety Chinese mathematical texts from the earliest, the *Zhou bi suan jing*, to works published at the end of the Qing dynasty late in the nineteenth century. The best editions they could find from libraries in all parts of China were used to produce this five-volume collection. All extant Chinese mathematical texts prior to 1368 are included, and their major contents, the different versions or editions, as well as the basic scholarship related to each text are clearly described in the introductions to each work. The Chinese translations of Euclid's *Elements* (the first six books by Matteo Ricci and XU Guangqi, as well as the last nine books by Alexander Wylie and LI Shanlan) are also included as an appendix [GUO Shuchun 1993].

A year later, JING Yushu, a rare book collector whose primary interest is in the Chinese abacus, published another set in four volumes of Chinese mathematical texts, also in facsimile. Though much of the material in this edition overlaps with the collection published by GUO Shuchun, JING's edition offers different versions of some texts, and is especially valuable for the texts it includes on the abacus [JING 1994].

Inspired by the popular source books for mathematics edited by David E. Smith and Dirk J. Struik, LI Di, Professor of the History of Chinese Mathematics at the Institute for the History of Science at Inner Mongolia Normal University, together with some of his students and SHEN Kangshen,

published a series of source books on Chinese mathematics [SHEN 1997, KONG 1997, GUO Xihan 1997, LI Di 1999, and GUO Shirong 2000]. Unlike the collections by GUO and JING, these works focus on only the most important and interesting parts of the major mathematical texts included, from the earliest times to the modern period, with some texts on calendar-making as well. The original texts were reset and punctuated, along with scholarly commentaries and detailed explanations. The main purpose of this series is to help readers to study traditional Chinese mathematics through carefully edited primary sources, rather than from the original documents.

Among traditional Chinese mathematical texts, the *Jiu zhang suan shu* (Nine Chapters on Mathematical Procedures) is one of the most important, both for its style and for the commentaries by LIU Hui, which had a decisive influence upon the subsequent development of virtually all mathematics in China. Collating the extant different versions of the text, amending errors and corruptions, and explaining obscure terminologies and methods have long occupied Chinese scholars from the time of DAI Zhen, an erudite scholar from the reign of Qianlong, down to QIAN Baocong [LIU and Dauben 2002, p 256]. Prominent scholars in the last quarter century have been especially active in producing new editions of the *Nine Chapters*, including the late Professors BAI Shangshu of Beijing Normal University and LI Jimin of Northwest University, as well as GUO Shuchun [BAI 1983, GUO Shuchun 1990, LI Jimin 1993].

The most sensational discovery related to primary sources in the last twenty-five years was the excavation of a book on bamboo slips, the *Suan shu shu* (Book on Numbers and Computation), unearthed from a second-century BCE tomb between December of 1983 and January of 1984. The *Suan shu shu*, comprised of some 190 bamboo strips, was not published *in toto* until 2000. With only a few words and several problems from isolated strips to go on, much speculation about the contents and nature of the *Suan shu shu* was produced until a preliminary transcription was published [Jiangling 2000], followed a year later by a more careful edition by PENG Hao [PENG 2001] and a large volume providing photocopies of the entire set of bamboo strips [Zhangjiashan 2001].

Journals

The most prestigious journal in China is published by the Institute for History of Natural Science [IHNS] and the Chinese Society for the History of Science and Technology [CSHST]: *Ziran kexueshi yanjiu* (Studies on the

History of Natural Sciences). The journal, a quarterly (founded in 1980; first issue dated 1982), publishes research on all facets of the history of science and technology, including the history of medicine. In the past two decades, however, the history of Chinese mathematics has been one of the journal's priorities, and from 1982 to 1996, more than eighty articles on history of Chinese mathematics have been published [Editorial Staff 1997, pp. 80-82].

The IHNS and the CSHST are also responsible for issuing another quarterly, *Zhongguo keji shiliao* (Chinese Historical Materials on Science and Technology), also created in 1980. This journal emphasizes documentation and covers largely the modern period. Thus far it has published nearly one hundred articles on history of mathematics, including topics ranging from interviews with contemporary mathematicians, to obituaries and histories of important institutions and organizations.

Due to the growing interest in history of mathematics, these two journals alone could not accommodate the increasing number of historians of mathematics and their graduate students in China, and in order to meet this need, LI Di created a new journal in 1990: *Shuxueshi yanjiu wenji* (Collected Papers of Research on the History of Mathematics), published jointly by Inner Mongolia University Press and the Nine Chapters Publishing House in Taipei. This journal is irregular, and published six issues in the 1990s. Beginning in 1999, the Chinese Society for History of Mathematics, founded in 1981, adopted this series as its official journal. Since then, *Wenji* has been dropped from its title, and the latest issue of *Research on History of Mathematics* (December, 2001) includes twenty-three articles, fifteen of which are on history of Chinese mathematics.

Studies on the history of Chinese mathematics may also be found in numerous other journals published by universities and colleges throughout China. Among such journals at institutions where there are a substantial number of historians of mathematics, and thus a correspondingly large number of articles related to the subject, are *Neimenggu shida xuebao* (Journal of Inner Mongolia Normal University, natural science series); *Beijing shifan daxue xuebao* (Journal of Beijing Normal University, natural science series), *Xibei daxue xuebao* (Journal of Northwest University, natural science series), *Hangzhou daxue xuebao* (Journal of Hangzhou University, natural science series, until 1998), and *Zhejiang daxue xuebao* (Journal of Zhejiang University, natural science series, since 1998). In addition to these regular publications, some university journals produce special or supplementary issues exclusively devoted to

history of mathematics. Among these, for example, are the 1986 issue of *Liaoning shida xuebao* (Journal of Liaoning Normal University, natural science series), the third issue for 1991 of the *Journal of Beijing Normal University,* and the third issue for 1993 of the *Journal of Inner Mongolia Normal University.*

Because history of science enjoys a close relationship to philosophy of science, journals devoted to philosophy from time to time also welcome historical contributions. In the last twenty-five years, studies on Chinese mathematics emphasizing philosophical issues may be found in two journals in particular: *Ziran bianzhengfa tongxun* (Journal of Dialectics of Nature), a bimonthly journal founded in 1978 by the Institute on Science Policy and Scientific Management of the Chinese Academy of Sciences, and *Kexue jishu yu bianzhengfa* (Science, Technology and Dialectics), also a bimonthly journal, founded in 1984 and issued by Lanzhou University.

In Taiwan, three journals have given particular emphasis to history of science, including history of mathematics: *Qinghua xuebao* (Tsinghua Journal of Chinese Studies, new series), published by Tsinghua University in Hsinchu); *Hanxue yanjiu* (Chinese Studies), published by the Central Library in Taipei; and *Kexueshi tongxun* (Newsletter for the History of Science), issued by the Taiwan History of Science Society.

Collected Papers

The predecessor of the journal *Ziran kexueshi yanjiu* (Studies on the History of Natural Sciences), was *Kejishi jikan* (Collected Papers on the History of Science), an irregular publication that first appeared in 1958. *Kejishi jikan* ceased publication during the Cultural Revolution, and did not resume until 1982. Volume eleven, the last volume of *Kejishi jikan*, appeared in 1984 and is a special issue on Chinese mathematics.

Meanwhile, beginning in the 1980s, the Institute for History of Natural Science in Beijing has issued a series of volumes, *Kejishi wenji* (Collected Essays on History of Science and Technology), one of which (volume 8 for 1982) is exclusively devoted to mathematics. Following the traditional example of publishing collected papers on mathematics begun during the Song and Yuan periods (960-1363 AD) [QIAN 1966], the IHNS has produced a recent volume of collected essays on mathematics during the Ming and Qing dynasties (1368-1911) under the editorship of MEI Rongzhao, a research professor of the IHNS [MEI 1990].

Other collections of papers have been edited by WU Wenjun: *Zhongguo shuxueshi lunwenji* (Collected Papers on the History of Chinese Mathematics), the first volume of which appeared in 1985; to date, six volumes have been published in this series. Articles on specific ancient texts or mathematicians may also be found in such collections of essays as those on the *Jiu zhang suan shu* (The Nine Chapters) and LIU Hui [WU 1982 and 1993], on the *Shu shu jiu zhang* (Mathematical Treatise in Nine Sections) and its author QIN Jiushao [WU 1987], and on three mathematicians of the nineteenth century, WANG Lai, LI Rui and JIAO Xun, and their works [HORNG 1993].

Collected papers of prominent mathematicians and historians of mathematics have also been published. Those of greatest interest to historians of mathematics are the collected papers of WU Wenjun [WU 1986], LI Di [LI Di 1991], LI Zhaohua [LI Zhaohua 2000], HORNG Wann-Sheng [HORNG 1999], and YAN Dunjie [YAN 2000]. The works of the two leading historians of Chinese mathematics of the last century, LI Yan and QIAN Baocong, have also been reproduced in a set of ten volumes edited by members of the Institute for History of Natural Science [DU, GUO, and LIU 1998].

Several volumes in honor of late or retired eminent historians or mathematicians contain valuable contributions to Chinese mathematics, including those in honor of YAN Dunjie [BO 1992], DU Shiran [LIU and HAN 1997], and WU Wenjun [LIN, LI, and LU 2001]. Moreover, conference proceedings and articles published in celebration of institutional anniversaries also contain papers on Chinese mathematics, for example: *Proceedings of the Third International Symposium on the History of Chinese Science and Technology* [DU 1990], *Proceedings of the International Symposium on the History of Chinese Science and Technology* [CHEN 1992], and *Exploration of the Roads to Modern Science* (commemorating the tenth anniversary of Inner Mongolia Normal University) [LI Di 1993].

Books

Numerous works covering the history of Chinese mathematics, from ancient to modern times, have been written by Chinese authors, of which some of the most representative are those by LI Di, *A Brief History of Chinese Mathematics* [LI Di 1984]; SHEN Kangshen, *An Introduction to Chinese Mathematics* [SHEN 1986]; LIU Dun, *Great to Talk About Mathematics* [LIU 1993]; and LI Zhaohua, *A History of Chinese Mathematics* [LI Zhaohua 1995].

LI Di is revising and significantly enlarging his studies of the history of mathematics into a four-volume set. The first two volumes, which cover the periods from ancient times to 589 CE, and from then up to 960 CE, respectively, have already been published [LI Di 1997 and 1999].

Many other books are devoted to specific topics, such as the *Jiu zhang suan shu* and LIU Hui [LI Jimin 1990, GUO Shuchun 1992]; the three most prominent mathematicians of the Qing dynasty, MEI Wending, MING Antu, and WANG Lai [LI and GUO 1988, LUO 1998, and LI Zhaohua 1998]; mathematical methods involved in calendar making [QU, JI, and WANG 1994; CHEN Meidong 1995]; the Chinese abacus [HUA 1987]; and surveying [FENG 1995].

At the end of the last century and in anticipation of the new millennium, historians of mathematics in China decided it was timely and appropriate to synthesize the work done in the field in the past century. Accordingly, two similar projects were organized, each planning to produce ten-volume sets of historical studies in chronological order. The project under the leadership of WU Wenjun, LI Di, and SHEN Kangshen thus far has produced nine volumes [WU 1998-]. The other, organized by LIU Dun and WANG Yusheng, has produced five volumes to date [WANG and LIU 2000, JI 2000, KONG 2000, LAO 2000, ZHANG 2000, and ZOU 2002]. Although their contents overlap to a great extent, these two series in some ways complement each other. For instance, a bibliography of traditional Chinese mathematical texts is included only in the first project [WU and LI Di 2000], whereas an account of the development of modern mathematics in China is available only in the latter [ZHANG 2000].

Special Topics

One of the major reasons for studying mathematics in ancient China was for the determination of calendars. Consequently, research on extant calendars and the documents related to their construction in the official records and histories from the Han to Qing dynasties has provided considerable material for the history of mathematics. Although this has been a subject of study for centuries, in the 1990s research on calendars became an especially active area of study among younger Chinese historians of mathematics.

Similarly, studies of the *Jiu zhang suan shu* and especially the commentary by LIU Hui have focused primarily on two aspects: collation of texts and

study of the theoretical aspects of LIU Hui's commentaries. Apart from the practical nature of applied mathematics in ancient China, LIU Hui's commentaries raise important issues concerning the nature of proof and questions about whether ancient Chinese mathematics included such concepts as irrational numbers, about which there has been considerable debate over the past twenty-five years.

Traditional Chinese mathematics reached its climax during the Song and Yuan periods. As a result, the most important mathematicians of this period, YANG Hui, QIN Jiushao, LI Ye and ZHU Shijie have all been subjects of historical research. Much attention has been paid to biographical studies of QIN Jiushao and LI Ye in particular, including the details of the mathematical procedures and derivations they used that were omitted from their published texts, and possible links between the methods they used and those of their predecessors, all of which may be traced back to the *Jiu zhang suan shu*.

As for the results and works published by Chinese mathematicians of the Qing dynasty, these were of much less significance than what was being produced in Europe during the same period. Nevertheless, it was in this period that Western mathematics was first introduced to China, and exposure to the new mathematics served to revive interest among Chinese scholars in traditional Chinese mathematics. Throughout the Qing dynasty a large number of mathematical texts was produced, providing especially rich material for historical study. Scholars in the past quarter-century have focused to a large extent on the following topics: 1) the mathematics introduced by the Jesuits in the seventeenth and early eighteenth centuries, and later by Protestant and other missionaries in the second half of the nineteenth century; 2) the influence of Western mathematics on Chinese mathematicians; 3) major works by prominent Chinese mathematicians of the Qing dynasty, such as MEI Wending, MING Antu, WANG Lai, LI Rui, DONG Youcheng, XIANG Mingda, LUO Shilin, DAI Xu, XU Youren, LI Shanlan, and HUA Hengfang, among many others.

Conclusion

The history of Chinese mathematics is arguably the most active area among studies of the history of science and technology in China today. Thanks to LI Yan, QIAN Baocong, YAN Dunjie, and other pioneering historians working in the last century prior to the Cultural Revolution, the subject was

given a solid foundation. During the past twenty-five years, history of mathematics has developed significantly in terms of the growing number of professionals and the substantial output of literature due mainly to scholars affiliated with the Institute for the History of Natural Science in Beijing, with the Chinese Academy of Sciences, and with universities and research institutes throughout the country. Also, favorable government policies towards science and technology, and the proliferation of higher education throughout China, enhanced by the increasing frequency of international exchanges, have all served to support the history of science in general and the history of mathematics in particular.

Although much research in China still relies on the tradition of collating texts, or using contemporary mathematics to interpret earlier results, there are strong indications that in the first quarter of this century the history of Chinese mathematics as a field of Chinese scholarship will continue to prosper, and will encourage the younger generation to develop diverse research methodologies using more sophisticated interpretations of historical material. Such optimism is based on the following indicators: 1) In the aftermath of the Cultural Revolution, Chinese intellectuals quickly set about the task of rebuilding China's academic infrastructure, and in colleges, universities, and research institutes throughout the country, Chinese scholars have enjoyed a generation of relatively peaceful and stable political and social environments in which to work; 2) National and local policies have favored studies on the history of science and technology, resulting for example in the creation of new centers for research and study, including the Department of History and Philosophy of Science at Shanghai Jiaotong University in 1999, the Department of History of Science, Technology, and Scientific Archeology at the China University of Science and Technology in Hefei in 1999, and the Department of History of Science and Scientific and Technological Administration (formerly the Institute for History of Science at Inner Mongolia Normal University, Huhehot) in 2001. These new institutions, together with the many already existing ones, will educate more students and promote the study of history of Chinese science, including mathematics, at much higher levels. 3) Strong support from prominent mathematicians. WU Wenjun, for example, when he was awarded China's highest Award for Science and Technology (approximately US$600,000) in 2001, used a portion of the award to establish a foundation to support research on the transmission of mathematics and astronomy along the Silk Road, including mathematical exchanges with Japan, Korea, Vietnam, and other neighboring countries. 4) Last but not least, younger scholars and students of the current generation have more opportunities

to master foreign languages, which are prerequisites for Chinese scholars to consult primary documents in foreign languages, and to enjoy the benefits of free exchanges with their foreign colleagues not only in the field of Chinese mathematics, but with respect to the history of mathematics as a whole.

In closing, in helping to celebrate the twenty-fifth anniversary of the journal *Llull*, it is gratifying to note how international the study of history of mathematics has become, and how much the history of Chinese mathematics in particular has become a matter of world-wide interest. For historians of Chinese mathematics both in and out of China, the celebration of *Llull's* twenty-fifth anniversary is a strong indicator of the success the history of science has enjoyed in the past quarter-century, and we look forward to *Llull* as a publication of continuing international importance in the years and decades ahead.

NOTES

1. We follow throughout this article the convention of using all capital letters to denote Asian surnames. Thus XU is the surname, Guangqi is the given name of XU Guangqi.
2. For a brief account of the history of history of mathematics in China, see Joseph W. Dauben and LIU Dun, «China,» Chapter 17 in *Writing the History of Mathematics: Its Historical Development*, Joseph W. Dauben and Christoph J. Scriba, eds. (Basel: Birkhäuser, 2002), pp. 297-306.
3. Numbers in square brackets are keyed to entries in the section on «China» compiled by Karine Chemla, Joseph W. Dauben, Alexeï Volkov, and XU Yibao for the revised edition on CD-ROM of *The History of Mathematics from Antiquity to the Present: A Selective Annotated Bibliography*, Joseph W. Dauben, ed. (New York: Garland Press, 1985); revised edition by Albert C. Lewis, ed. (Providence, RI: The American Mathematical Society, 2000), available on CD-ROM from The American Mathematical Society <http://www.ams.org>. The bibliography for «China» comprises pp. 737-851, and updates the 1985 bibliography with a total of 358 entries ([4217]-[4574]) covering the literature in Western languages primarily between 1985 and 1999.
4. Yushkevitch's correspondence with Vogel has been published by Menso Folkerts, M.M. Rozanskaja, and I. Luther, eds., *Mathematikgeschichte ohne Grenzen. Die Korrespondenz zwischen K. Vogel und A.P. Juschkewitsch*, *Algorismus*, 22 (München: Institut für Geschichte der Naturwissenschaften, 1997).

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