Journal for History of Mathematics
Vol. 26 No. 1 (Feb. 2013), 1–9
Special Invited Paper

Chinese Mathematics in Chosun

Lee Chang Koo Hong Sung Sa

It is well known that the development of mathematics in eastern Asia was based on Chinese mathematics. Investigating Chinese mathematics books that were brought into Chosun, we study how Chinese mathematics influenced Chosun mathematics. Chinese mathematics books were brought into Chosun in three stages, namely basic mathematics books in the era of King SeJong(1397–1450), Chinese mathematics books influenced by western mathematics in the 17th century and finally those with commentaries on mathematics of Song–Yuan era in the 19th century. We also study the process of their importations.

Keywords: Chosun mathematics, Chinese mathematics books in Chosun, King SeJong, Chosun mathematics in the 18th and 19th centuries influenced by Chinese mathematics books.

MSC: 01A07, 01A13, 01A25, 01A40, 01A45, 01A50, 01A55

1 Introduction

As in the history of mathematics in other Asian countries, Korea developed its mathematics based on the Chinese mathematics. There were a few occasions of contact between mathematicians of two countries but they occured during short visits and moreover were carried out through conversations in writing, so that their impact to the development of mathematics in Korea should have been minimal. Thus mathematical interactions between two countries were carried out mainly through the exchange of mathematical books. Further there were quite a lot indigenous results in Korean mathematics but Korean mathematics books were all written in Chinese characters and followed basic formations of Chinese mathematics books. Thus we are concerned with the history of importations of Chinese mathematics books into Korea.

We do not have any mathematics books published before Chosun (1392–1910) but a few historical sources on official matters related to mathematics, e.g., government officials dealing with matters related to mathematics and state examinations to appoint those officials[1]. Thus we restrict ourselves to Chosun mathematics for our study of the influence of Chinese mathematics on Korea.

Receiveded on Oct. 30, 2012, revised on Nov. 1, 2012, accepted on Nov. 12, 2012.

We divide the history of entries into three periods. The first one was the era of King SeJong(世宗, 1397–1450) who is the most well known King in the whole history of Korea and collected mathematics books together with astronomy books. The second one began in the 17th century when the new calendar system, ShiXianLi(時憲曆) was introduced in Chosun and it lasted up to the middle of 18th century. Finally the last one was the mid-19th century when Chinese mathematicians recognized the superiority of Song–Yuan era in the whole history of Chinese mathematics and published books with commentaries on them. The importation of those books was single handedly carried out by Nam Byung Gil(南秉吉, 1820–1869), probably with the hep of his mathematical collaborator Lee Sang Hyuk(李相爀, 1810–?).

For the Chosun sources, we refer to HanGook GwaHak GiSoolSa DaeGye SooHakPyun (韓國科學技術史大系 數學篇)[2] and The Annals of the Chosun Dynasty(朝鮮王朝實錄)[4] which will be abbreviated as ACD in this paper, and for the Chinese sources, ZhongGuo KeXue JiShu DianJi TongHui ShuXueJuan(中國科學技術典籍通彙 數學卷)[7] and ZhongGuo LiDai SuanXue JiCheng(中國歷代算學集成)[8]. Those books appeared in them will not be numbered as an individual reference.

The first author presented part of this paper in HPM 12, the satellite meeting of ICME-12, July, 2012 in Daejeon, Korea.

2 King SeJong's effort

When Chosun was founded in 1392, it adoped mostly the national education system of the previous dynasty, Korea(高麗, 918–1392) which includes the eduction of mathematics(算學) for the goverment officials dealing with mathematics. Mathematical officials were selected by ChuiJae(取才) whose subjects are as follows:

> XiangMing SuanFa(詳明算法, 1373), SuanXue QiMeng(算學啓蒙, 1299), YangHui SuanFa(楊輝算法, 1273–1275), WuCao SuanJing(五曹算經, ca 6th century), JiSan(地算, ?) (ACD, Mar. 18, 12th year of King SeJong(1430)).

We cannot confirm whether JiSan is a name of a book as the others or a subject dealing with measurement of lands. The last two of the above were excluded before long. Pure mathematicians worked as officials in HoJo(戶曹) which dealt with census, taxation, compulsary services, tributes, national accounting and economy. Those officials were GyoSu(敎授), ByulJe(別提), SanSa(算士), GyeSa(計士), HunDo(訓導), HoeSa(會士). There were also some mathematical officials who worked on calendar at the State Observatory, SeoWoonGwan(書雲觀), which was later renamed as GwanSangGam(觀象監). They were selected by the national examination(雜科科擧). The State Observatory has a department of mathematics, called SeubSanGuk(習

算局) which was abolished in 1463 (See [11] for the detail).

We now return to the effort of King SeJong to promote the study of mathematics in Chosun. He is the most distinguished king in Chosun dynasty. He is well known by his creation of Korean alphabet and development of science including mathematics and astronomy. He himself studied SuanXue QiMeng and also emphasized the importance of mathematics as following articles in ACD.

> 上 學《啓蒙算》副提學 鄭麟趾 入侍待問 上曰 算數在人主無所用
> 然此亦聖人所制 予欲知之(ACD, Oct. 23, 12th year of King SeJong(1430))
> 上謂代言等曰 算法 非獨用於曆也 若有起兵量地之事 則捨是無以他求
> 其令元閔生金時遇 選通事之穎悟者以聞 乃薦司譯院注簿金汗 金自安等
> 仍命汗等習算法 (ACD, Mar. 2, 13th year of King SeJong(1431))
> 上謂承政院曰 算學雖爲術數 然國家要務 故歷代皆不廢
> 程朱雖不專心治之 亦未嘗不知也 近日改量田品時
> 若非李純之 金淡輩 豈易計量哉 今使預習算學 其策安在 其議以啓
> (ACD, Nov. 17, 25th year of King SeJong(1443))

In the 15th year of King SeJong, YangHui SuanFa was republished and distributed to HoJo and SeubSanGuk:

> 慶尙道監司進新刊宋《楊輝算法》一百件 分賜集賢殿 戶曹
> 書雲觀習算局(ACD, Aug. 25, 15th year of King SeJong(1433))

King SeJong's effort to import mathematics books is notably revealed in the ACD of his son King SeJo(世祖, 1455–1468).

> 吏曹啓: 今下曆算提調單子內 正統十三年正月二十三日傳旨
> 曆算生徒勸懲之法頗有未盡 今更磨勘以啓
> 一 算法居六藝之一 自周賓能教國子 歷代沿襲 設科取士 魏唐間算學尤專
> 如劉徽之註《九章》續撰《重差》淳風之解《十經》發明《補問》
> 博綜精微 一時獨步 厥後科目旣廢 算法罕傳
> 況吾東方邈在海徼 旣未得算書 誰能知算法乎 算法未知 又焉能知曆法乎
> 惟我世宗慨念曆法之未明 博求曆算之書 幸得《大明曆》《回回曆》《授時曆》《通軌》及《啓蒙》《楊輝全集》《捷用九章》等書
> 然書雲觀 習算局 算學重監等無一人知之者 於是別置算法校正所
> 命文臣三四人及算學人等先習算法 然後推求曆法
> 數年之內算書與曆經皆能通曉
> 然猶慮未傳於後世 又設曆算所訓導三人 學官十人 算書 曆經 常時習熟
> 每日置簿 每旬取才 考其勤慢 勸懲鍊業 故知算法者相繼而出
> 彼三司之人則粗習乘除而已 立方開法 尙未知也 安能知三乘方 四乘方
> 以至九乘方之法與夫方程正員〔負〕開方釋鎖 度高 測深 重表 累矩

三望 四望 句股 重差之法乎 (ADC, June 6, 6th year of King SeJo(1460))

In the first sentence, the writer quotes a part of the preface of SuanXue QiMeng. After that, he says, "because of the geological distance between Chosun and China, it is quite difficult to get mathematics books. Without mathematics, how can one know the calendar(曆法)?". King SeJong tried to import books on mathematics and the calendar and succeeded in getting DaMingLi(大明曆), HuiHuiLi(回回曆), ShouShiLi(授時曆), TongGui(通軌) and SuanXue QiMeng, YangHui SuanFa, JieYong JiuZhang(捷用九章). Using these books, officials in the era of King SeJong could comprehend mathematics and astronomy and the King urged the officials to continue studying mathematics. But in the era of King SeJo, this practice was declined to such a degree that the officials barely did operations of multiplications and divisions and hence they could not understand main subjects in SuanXue QiMeng, e.g., system of linear equations(方程正負), theory of equations(開方釋鎖) and theory of right triangles and its applications to survey. Further, they discussed how to redress the problem, which is omitted.

We note that the result by the study mentioned in the quote above was culminated as a publication of the books ChilJungSanNaeOePyun(七政算內外編, 1442) and JeGaYeokSangJib(諸家曆象集, 1445) (See ACD, Mar. 30, 27th year of King SeJong(1445) and [3]).

Although we have books on astronomy published in the era of King SeJong as above, there is only one mathematical work, SanHak BalMong(算學發蒙) which was published in the period. It is an appendix to GyoSik ChuBoBub(交食推步法, 1458) compiled by Lee SunJi(李純之, ? –1465) and Kim SukJe(金石梯). SanHak BalMong consists of 23 pages and deals with multiplications, divisions and extractions of square roots. It is indeed only one book written before the 17th century and handed down to the present. As YangHui SuanFa mentioned above, HoJo might retain SuanXue QiMeng and XiangMing SuanFa until the end of the 16th century.

3 Renewal of mathematics in the 17th century

Chosun suffered devastating foreign invasions in 1592 and 1636 and consequently losing most of its mathematics books, its mathematical works had completely disappeared. Since the Jesuit priest Ricci(利瑪竇, 1552–1610) came to China in 1583, the western astronomy and mathematics were brought into China and they prevailed over the traditional astronomy and mathematics in the 17th century China. The Qing dynasty adopts a new system of calendar called ShiXianLi(時憲曆) in 1645(See [5, 6, 9] for the detail).

In 1645 (ACD, Dec. 18, 23rd year of King InJo(仁祖)), an envoy to Qing brought

privately ShiXianLi into Chosun which evoked great attentions in Chosun government. In order to understand the calendar, they had to obtain books of new mathematics and astronomy. The effort to get them is reported as follows:

> 臣等又以《時憲曆》密買之事 廣求於人 而得之甚難
> 所謂湯若望者 又無路可見 適逢本國日官李應林之子奇英 被擄在彼
> 其人頗通算術 且慣華語 臣使之學習曆法於湯若望 約以他日 當遣其父
> 傳學以來 且給白金數十兩 使買曆法之書於湯若望 以爲他日取來之計
> 其書凡一百四五十卷云《時憲曆》者 西洋國人湯若望所造也
> 我國使臣之入北京也 俾得一本 較之舊曆 二十四候氣至之日
> 頗有不同 聞湯若望仍在北京 景奭之行 使求其法而不能得
> (ACD, June 3, 24th year of King InJo(1646))

The envoy to Qing, Lee KyungSuk(李景奭) reports that he had a great difficulty secretely buying the calendar and managed to arrange for Lee GiYoung(李奇英) to meet Adam Schall von Bell(湯若望, 1591–1666) and learn about ShiXianLi. Further, he paid tens liangs of white gold(白金數十兩) to buy books on the calendar system from Adam Schall which totaled 140–150 volumes. The number of volumes in the ACD suggests that the books were XiYang XinFa Lishu(西洋新法曆書, 1645). As is well known, Adam Schall ammended ChongZen LiShu(崇禎曆書) initiated by Xu GuangQi(徐光啓, 1562–1633) and renamed it to XiYang XinFa Lishu. The book contains western mathematics as follows:

JiHe YaoFa(幾何要法), DaCe(大測), GeYuan BaXianBiao(割圓八線表), CeLiang QuanYi(測量全義), BiLi GuiJIe(比例規解), ChouSuan(籌算) among others.

Thus we can gather that the books on western mathematics were introduced to Chosun in the second half of the 17th century. They were studied mainly in the State Observatory(觀象監) but it should be a very difficult job and a great shock to Chosun mathematicians.

Incidentally, the Qing government sent officially ShiXianLi to Chosun in 1648 (ACD, Feb. 27, 26th year of King InJo) and Chosun adopts ShiXianLi as an official calendar in 1653(ACD, Jan. 6, 4th year of King HyoJong(孝宗)).

For the traditional mathematics in Chosun, Kim SiJin(金始振, 1618–1667) obtained SuanXue QiMeng privately owned by Gyung SunJing(慶善徵, 1616–?), the author of MukSa JibSanBub(默思集算法). Kim republished it in 1660, which made a great contribution to the revival of Chosun mathematics after the catastrophe caused by the foreign invasions[10]. Further SuanFa TongZong(算法統宗, 1592) was also introduced to Chosun in the second half of the 17th century.

In the last decade of the 17th century, TianXue ChuHan(天學初函, 1623) compiled by Li ZhiZao(李之藻, 1565–1630) was brought into Chosun. It consists of LiBian(理

編) and QiBian(器編). The former deals with the catholic theology and the latter with mathematics and astronomy. We include books in QiBian to show the range of the book:

TaiXi ShuiFa(泰西水法), BiaoDuShe(表度說), JianPingYiShe(簡平儀說, S. de Ursis (1575–1620)), HunGai TongXian TuShe(混蓋通憲圖說, Terrenz(1576–1630)), JiHe YuanBen(幾何原本, the first six chapters of Euclid's Elements, tr. Ricci and Xu GuangQi, 1607), TianWenLue(天問略, Junior(1574–1659)), TongWen SuanZhi (同文算指, Clavius(1537–1562), tr. Ricci, Li ZhiZao, 1613), YuanRong JiaoYi(圓容較義, Ricci, Li ZhiZao, 1614), CeLiang FaYi(測量法義, Ricci, Xu GuangQi, 1605), GouGuYi(句股義, Xu GuangQi, 1605).

Western mathematics in TianXue ChuHan was studied by Choe SukJung(崔錫鼎, 1646–1715), the author of GuSuRyak(九數略) and Cho TaeGu(趙泰耉, 1660–1723), the author of JuSeo GwanGyun(籌書管見, 1718). TianXue ChuHan was probably bought by Choe SukJung when he visited YanJing(燕京, Beijing) as an envoy to Qing in 1686 and 1697. Cho TaeGu also visited YanJing in 1709. It has been quite common for envoys to China to try to buy books at its capitals.

We quote the following to show Chosun government's effort to obtain informations on mathematics and astronomy.

> 日官宋仁龍 專爲學得曆法 而曆書私學 防禁至嚴 僅得一見湯若望
> 則略加口授 仍贈縷子草冊十五卷 星圖十丈 使之歸究其理云
> (ACD, 27th year of King InJo(1649))

In 1649, an official at the State Observatory, Song InYong(宋仁龍) visited Beijing to learn the new calendar whose private learning was forbidden. But with much difficulty he met Adam Schall who gave a short lecture and 15 transcribed books and 10 celestial atlases for Song's future research.

> 泰耉曰 五官司曆出來時 許遠學得儀器 算法 仍令隨往義州 盡學其術矣
> 儀器之用 有《儀象志》《黃赤》《正球》等冊 算書及此等冊 使之印布
> 儀器亦令造成 而司曆又言 爾國所無書冊 器械 當歸奏覓給 云 日後使行
> 許遠使之隨往好矣 上允之
> (ACD, July 30, 39th year of King SukJong(肅宗) (1713))
> 知事趙泰耉奏言 許遠曾以隨使行入送事稟定 而儀器未及造成
> 且其自義州所學來算法 未盡解出 今行有難入送 姑使遠
> 先以筆墨 紙扇等物 書問司曆 致其日後請教之意 而從後入送似好 上可之
> (ACD, Sep. 18, 39th year of King SukJong)
> 朝廷命觀象監官員許遠 從節使赴燕 見五官司曆 貿來其《曆法補遺方書》
> 及推算器械 遠見司曆 仍得其《日食補遺》《交食證補》《曆草駢枝》等合九
> 冊 及測算器械六種 而又得西洋自鳴鍾而來 其制極奇妙

備局竝進之 仍請以自鳴鍾 依樣造置於本監 許之
(ACD, Apr. 18, 41st year of King SukJong(1715))

In 1713, Qing sent the envoys to Chosun who included A ZhaiTu(阿齊圖) and He GuoZhu(何國株). It was quite exceptional that such well known scholars of astronomy and mathematics came to Chosun together. Indeed, they both appear in LiXiang KaoCheng(歷象考成, 1722) as editorial board members for KaoCe(考測) and JiaoSuan(校算) respectively. They discussed mathematics with a great mathematician in Chosun, Hong Jung Ha(洪正夏, 1684–?) who was the then lowest-ranking official in HoJo though. The discussion is well described in the appendix of Hong's GuIlJib(九一集, 1724). Cho TaeGu was the then minister of HoJo. He GuoZhu also met an official in the State Observatory, Heo Won(許遠) who followed He up to the boader city to learn about astronomical devices and related mathematics. So the minister Cho recommended Heo for a future envoy to Qing but he found in September that Heo's preparation was not enough and hence withdrawed his recommendation. Heo's visit to He was realized later in 1715 and he could bring nine books from He.

In the mid-18th century, ShuLi JingYun(數理精蘊, 1722) was brought into Chosun which had a great influence on the study of western mathematics in Chosun. In particular, JiaGenBang(借根方) replaced the TianYuanShu(天元術) for the representation of polynomials during the period until the mid-19th century.

4 Exchange of mathematics books in the 19th century

Beginning at the end of the 18th century, mathematics of Song-Yuan era(宋元 算學) was revived greatly and commentaries on books of the era, in particular those by Li Ye(李冶, 1192–1279), Qin JiuShao(秦九韶) and later Zhu ShiJie(朱世傑), were published in China. Zhu ShiJie's SiYuan YuJian(四元玉鑑, 1303) had been completely annotated by many mathematicians, notably Luo ShiLin(羅士琳, 1774–1853) whose commentary was published in 1835.

Zhu ShiJie's SuanXue QiMeng was completely lost in China but Luo bought Kim SiJin's republication at a book store in Beijing and published it with some corrections in 1839. We quote the following in the preface of SuanXue QiMeng by Ruan Yuan(阮元, 1764–1849).

以未見啓蒙爲憾 近年羅君又從都中人
于琉璃廠書肆中 得朝鮮重刊本計三卷

The above shows that Chosun not only imported mathematics books from China but exported them to China as well.

Since Lu's commentary on SiYuan YuJian was brought into Chosun in the mid-19th century, Chosun mathematicians noticed that the theory of equations built in Song-Yuan era is much advanced than theory based on western mathematics. Lee SangHyuk(李尙爀, 1810–?) and Nam ByungGil(南秉吉, 1820–1869) obtained remarkable results in this direction[10, 12]. Nam was a minister of YeJo(禮曹判書) and the head of the State Observatory(觀象監提調) and Lee an official at the State Observatory.

Nam has a great collection of Chinese mathematics books. It includes the following:

JiuZhang SuanShu(九章算術); ZhiBuZuZhai CongShu(知不足齋叢書) including SunZi SuanJing(孫子算經), ZhangQiuJian SuanJing(張丘建算經), JiGu SuanJing Xicao(輯古算經細艸), Li Ye's CeYuan HaiJing Xicao(測圓解鏡細草), YiGu YanDuan(益古演段) among others; Qin JiuShao's ShuShu JiuZhang (數書九章); Collections by Mei WenDing(梅文鼎, 1633–1721); books by Wang XiChan(王錫闡, 1628–1682), Jang Yong(江永, 1628–1762), Jiao Xun (焦循), Li Rui(李鋭, 1768–1817), Luo ShiLin, Yi ZhiHan(易之瀚) and Ruan Yuan.

The list of Nam's collection shows that he collected almost all the Chinese mathematics books available from JiuZhang SuanShu to the books published in the 19th century. Choe SukJung mentions in his GuSuRyak that he tried to buy JiuZhang SuanShu at bookstores in YanJing but did not succeed.

> 此書(九章算術)不傳於東國 求之燕肆 亦不可得

Chosun mathematicians before Nam have quoted just titles of nine chapters as those in XiangMing SuanFa including "SuBu(粟布)".

With Nam's collection and continuous collaboration, Nam ByungGil and Lee SangHyuk could achieve great mathematical works which were a final contribution to the traditional mathematics in Chosun.

5 Conclusion

As other east Asian countries, Chosun mathematics was greatly influenced by Chinese mathematics. There might have been private transactions of books between two countries but we don't have yet any evidence for them. There were numerous occasions of transactions which were done by envoys to China and their attendants. We also note that the study of astronomy was governed by the State Observatory and it was also strongly related to mathematics. Thus import of mathematics books have occured when the government paid more attentions to astronomy. King Se-Jong tried to get many books from China, which in turn resulted in a great progress

of both subjects in Chosun. After the disastrous foreign invasions and loss of most mathematical works, Chosun could get a large number of books on astronomy influenced by western mathematics in the mid-17th century. Since those books were controlled by the government, their influences for ordinary mathematicians had been quite limited. In the 19th century, Nam ByungGil had a great collection of books from China which gave a direct impact to the development of mathematics, for he himself was a mathematician and had a great mathematician collaborator, Lee SangHyuk.

Since the transactions of books had occured sporadically and they were not controlled by mathematicians, the development of Chosun mathematics before the mid-19th century had relied on a very few books.

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Lee Chang Koo
Department of Mathematics, Hanyang University
E-mail: Ichangkoo@hanmail.net

Hong Sung Sa
Department of Mathematics, Sogang University
E-mail: sshong@sogang.ac.kr

Journal for History of Mathematics
Vol. 26 No. 1 Feb. 2013

ABSTRACTS

Lee Chang Koo, Hong Sung Sa 이창구, 홍성사 Chinese Mathematics in Chosun『朝鮮과 中國 數學』

중국 수학을 토대로 조선 수학이 발전된 것은 잘 알려져 있다. 이 논문에서는 조선에 유입된 중국 산서의 역사를 조사하여 중국 수학이 조선 수학에 끼친 영향을 연구한다. 15세기 世宗대에 들어온 중국 수학, 17세기 서양 수학의 영향을 받은 중국 수학과 19세기 중국에서 재정리된 송, 원대의 수학으로 나누어 이들이 유입되는 과정도 함께 조사한다.

Morimoto Mitsuo Three Authors of the Taisei Sankei

The Taisei Sankei(大成算経 in Japanese) or the Dacheng Suanjing(in Chinese) is a book of mathematics written by Seki Takakazu 関孝和, Takebe Kataakira 建部賢明 and Takebe Katahiro 建部賢弘. The title can be rendered into English as the Great Accomplishment of Mathematics. This book can be considered as one of the main achievements of the Japanese traditional mathematics, wasan, of the early 18th century. The compilation took 28 years, started in 1683 and completed in 1711. The aim of the book was to expose systematically all the mathematics known to them together with their own mathematics. It is a monumental book of wasan of the Edo Period (1603–1868). The book is of 20 volumes with front matter called Introduction and altogether has about 900 sheets. It was written in classical Chinese, which was a formal and academic language in feudal Japan. In this lecture we would like to introduce the wasan as expressed in the Taisei Sankei and three authors of the book. The plan of the paper is as follows: first, the Japanese mathematics in the Edo Period was stemmed from Chinese mathematics, e.g., the Introduction to Mathematics (1299); second, three eminent mathematicians were named as the authors of the Taisei Sankei according to the Biography of the Takebe Family; third, contents of the book showed the variety of mathematics which they considered important; fourth, the book was not printed but several manuscripts have been made and conserved in Japanese libraries; and finally, we show a tentative translation of parts of the text into English to show the organization of the encyclopedic book.

Kim Daniel G., Kim Sung Sook 김계환, 김성숙 The Rebirth of the IMU and ICM『IMU의 재탄생과 ICM』

20세기 초에 발생하였던 제1, 2차 세계대전들은 유럽 사회뿐만 아니라, 수학계에도 지대한 손실을 끼쳤다. 1차 세계대전 이후 프랑스를 중심으로 탄생되었던 국제 수학연맹(IMU)은 정치적으로 이용되었던 이유로 해체되어졌고, 제 2차 세계대전이 발생함에 따라 모든 국제 학회모임은 중단되었다. 독일에 나치정권이 들어선 후, 많은 뛰어난 수학자들이 수용소에서 죽음을 맞거나 미국으로 이주하면서 학문의 중심은 유럽에서 미국으로 이동하였다. 전쟁이 끝난 후 심각한 정치 경제 위기에 처한 유럽의