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How the counting rod configuration affects the presentation of the method of fangcheng in Qin Jiushao's Shushu jiuzhang

Abstract

Chapter 8 of the *Jiuzhang suanshu* 九章算術 (1st century CE, *Nine Chapters on Mathematical Art*, from here on abbreviated as the *Jiuzhang*) is called *fangcheng* 方程,[1] in which there are 17 problems with solutions as well as their solving formulas and algorithms. Liu Hui 劉徽 (263 CE) made commentary to the texts upon which the subsequent scholars could base to better understand *Jiuzhang*. After Liu Hui, many Chinese mathematicians also made in-depth researches on *Jiuzhang*. This study is, however, devoted to the *Shushu jiuzhang* 數書九章 (*Mathematical Treatise in Nine Sections*) written by Qin Jiushao 秦九韶 in Southern Song Dynasty 南宋. We will try to explain how Qin Jiushao came up with a different viewpoint from Liu Hui in terms of the methodology of *fangcheng shu* 方程術and *zhengfu shu* 正負術.

Qin Jiushao 秦九韶 (1202 ~ 1261) lived in Puzhou 普州in Southern Song Dynasty.[2] During Qin's life, Southern Song Dynasty was menaced by North Country Mongol. The threat from the Mongols continued until the Mongols conquered the regime of the Southern Song Dynasty and established a new dynasty, Yuan Dynasty 元朝. Qin was in this turbulent era to do research and publish his book *Shushu jiuzhang*. The text, consisting of 18 *juan*卷 (volumes),[3] is a mathematical treatise which could be compared, in form and content, to *Jiuzhang* at the time. In fact, there are several subjects with which the author deals and can be divided into nine chapters: indeterminate analysis (Vol.1, 2), astronomy (Vol.3, 4), surveying (Vol. 5, 6), telemetry (Vol. 7, 8), taxes and levies of service (Vol. 9, 10), storage volumes (Vol. 11, 12), fortifications and buildings (Vol. 13, 14), military affairs (Vol. 15, 16), and commercial affairs (Vol. 17, 18). This presentation basically explores solving simultaneous linear equations that is applied to Volume17.

When solving simultaneous linear equations, authors of the *Jiuzhang* provide the methods of *fangchengshu* and *zhengfu shu* which can be regarded to be an algorithm. It is interesting to note that the presentation of the methods of the *Shushu jiuzhang* is different from that of *Jiuzhang*. And it seems that the difference escapes historians' attention.

Therefore, this paper will be devoted to the explanation of the following questions:

(1) What happened to the order of the steps of the procedure in Qin's text?

(2) In contrast to the original version of *Jiuzhang* why did Qin Jiushao give a method with different order of procedure?

(3) Was this different order beneficial to the readers in Qin's contemporaries and the time that followed?

[1] *Fangcheng* means simultaneous linear equation.
[2] Puzhou is located in the province of Sichuan四川in China today.
[3] There are two volumes in each chapter in *Shushu jiuzhang*.