3.8 THE POSITION OF THE *FUTIAN* CALENDAR ON THE HISTORY OF EAST-WEST INTERCOURSE OF ASTRONOMY

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It is proved that the *Futian* calendar, a non-official one compiled in the Jianzhong reign period (780-783) in China, was brought to Japan in 957 by a Buddhist monk and was employed as the basis of horoscopes by the Buddhist school of astrology (Memo 1964). It was also used in competition with the official Chinese *xuanming* calendar for the usual functions demanded of a Chinese type lunisolar ephemerides, such as eclipse predictions. According to the view of the Song Dynasty Chinese scholar Wang Yinglin that the *Futian* calendar was "originally an Indian method of astronomical calculation" but Kiyosi Yabuuti has commented that Wang Yinglin's appraisal of the *Futian* calendar is solely based on a resemblance in form as it copied the trivial point of taking its epoch as the *Jiuzhi* calendar according to Indian astronomical methods and does not display a fundamental understanding of the Indian calendar (Yabuuti 1944).

We have lately discovered a fragmentary manuscript copy of the solar table of the *Futian* calendar, which was originally copied in 1230, transmitted by the Court Astrologer family with the title of *Futian lijing richancha licheng* and now preserved in the Tenri Library. I undertook to carry on the work of investigating the significance of the text from the viewpoint of the history of astronomy (Nakayama 1964). Its major findings were already summarized in English (Nakayama 1966) and here I present a fuller discussion of it.

ANALYSIS AND COMMENT

The table consists of the solar mean anomaly x in contrast to the equation of centre y in each Chinese degree. By analysing it, I found that this table is calcualted rather than observed as it precisely coincides with a parabolic function of

$$y = 1/3300 \times (182-x)$$

though the maximum value of the solar equation of centre may have some empirical origin.

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On the other hand, in Chinese official calendar in those days such as *xuanming* calendar the solar equation of centre is given in a round number in contrast to each 30^0 solar longitude. A simple glance of the table suggests us that these values given were possibly semi-empirical ones, by no means under a consistent mathematical treatment.

The Chinese smoothed over the variations in between these semi-empirical values by developing complicated interpolation formulae.

The Indian method, as seen in the *Jiuzhi* calendar, expresses it in terms of trigonometric function, the *Futian*'s parabolic treatment is not known in India (David Pingree's personal communication). It should be noted that the Indian calendar also employs Western degree of 360^0, which differs from the *Futian*'s traditional Chinese degree, *tu*, the number of one solar year. It should also be noted that the official Chinese calendrical scientists, who were unfamiliar with schematic and geometric representation and Indian trigonometric function, and only worked within the bound of their cherished algebraic tadition, must have approached a parabolic function, more advanced than a zigzag linear function, to such cases as parallactic elements in eclipse prediction (Nakayama 1969) as late as Ming dynasty.

The *Futian* calendar is undoubtedly advanced in mathematical treatment to other contemporary Chinese official calendars, while it cannot prove to be observationally superior. I show at the end of this paper a graph of solar equation of centre of several calendarical systems, in which apparently the *Futian* is not closer to modern value of Simon Newcomb. However, its unique mathematical feature was taken over by the later Uighur calendar and still further developed from *Futian*'s second degree to *Shoushi's* third degree algebraic function. In tracing this trend, I have an impression that the *Futian*'s mathematical formultion is a spontaneous development within Chinese tradition, rather than a product of Western influence.

In Chen Jiujin's recent article (Chen 1986) he argued that the *Futian* calendar was basically an importation from India under Buddhist influence, but as shown in the above, the close examination of the contents proved its independence of Indian influence. We can still safely say that the *Futian* calendar was practised among Buddhist sectors for the determination of their unique religious feast and horoscopic arts, as was the case in medieval Japan where the *Futian* calendar was employed by Buddhist monks in competition with the mainstream official Chinese calendrical system. It is still my unproven surmise that the different religious groups in China needed to adopt their own unique calendar for their religious observances and for that purpose, Confucian, Buddhist and Islamic calendrical offices and schools were maintained throughout Chinese history.

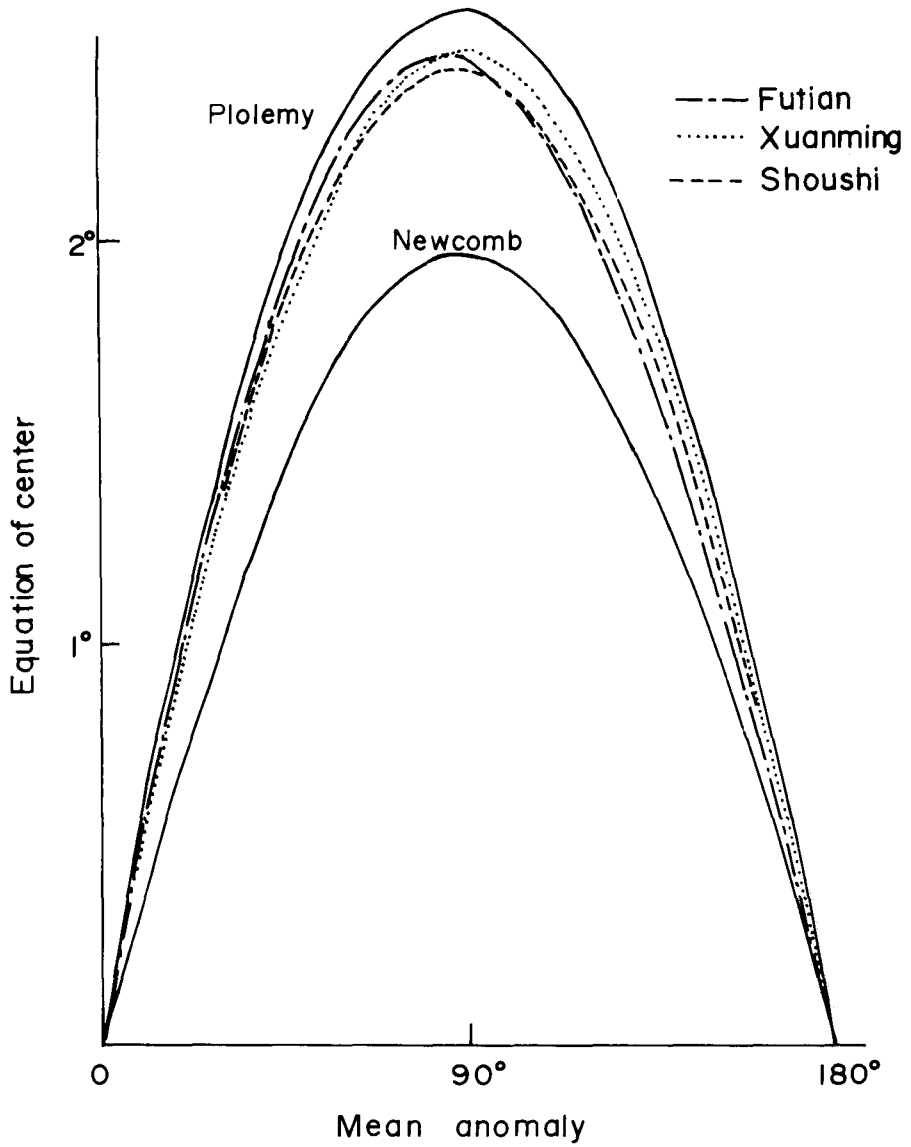

Fig - Solar equation of centre of several calendarical system

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DISCUSSION

L.C.Jain : Could you kindly comment on whether the Chinese parabolic function was related to spiro-elliptic function ? I have discussed these in Indian context in one of the papers on the spiro-elliptic orbit of the Sun in the Tiloyapannatti (Prakrit text of the 4th-5th Century A.D.).

S. Nakayama : The Chinese approach is purely algebraic rather than geometrical. Hence, it may be misleading to call it 'parabolic' but 'second degree equation'.

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