

# Biographical Encyclopedia of Astronomers

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Zu Chongzhi

Born in Fanyang, (Hebei), China, 429

Died 500

Zu Chongzhi (public name, Wen Yuan) was a Chinese mathematician and astronomer of the Southern dynasties during the Northern and Southern dynasties period (420–589).

Zu Chongzhi served as an official during the Song (Liu-Song) dynasty (420–479) and Southern Qi dynasty (479–502). He created a new calendar entitled the Daming calendar and requested its official use in 462. He was strongly opposed, and the calendar was not accepted. Zu Chongzhi's son, Zu Gengzhi (or Zu Geng), was also a mathematician and astronomer. Thanks to Zu Gengzhi's efforts, the Daming calendar was officially used, beginning in 510.

It was during the Eastern Jin dynasty (317–420) that the precession of the equinoxes was discovered by Yu Xi (281–356; probably independently of Hipparchus). After the fall of Eastern Jin in 420, the Northern and Southern dynasties period (420–589) began. In the Song (Liu-Song) dynasty (420–479), the first of the Southern dynasties, an astronomer named He Chengtian (370–447) created an excellent calendar called the Yuanjia calendar. Before this, all Chinese calendars assumed that the length of a calendrical synodic month was constant, although the inequality corresponding to the equation of the center of the Moon had been discovered in the 1st century during the later Han dynasty. He Chengtian tried to adjust the first day of a calendrical synodic month to the true conjunction of the Moon, corrected by lunar inequality, and proposed a new calendar in 443. However, he was opposed by Qian Lezhi, the then director of the Imperial Bureau of Astronomy and Calendrics, and Yan Can, the deputy director. They felt that the new calendar was too complicated, although Qian Lezhi and others admitted that He Chengtian's calendar was quite accurate. He Chengtian modified his calendar and made the length of a calendrical synodic month constant. In 445, He Chengtian's Yuanjia calendar was finally accepted as an official calendar. This controversy shows how opinions could diverge regarding the difference between mathematical astronomy as a pure science and the civil calendar as applied technology.

Zu Chongzhi thought that He Chengtian had carried out a reform, but his calendar was still inaccurate. Zu Chongzhi then devised a more accurate calendar called the Daming calendar. However, he was vehemently opposed by the conservative Dai Faxing. (Mention may also be made here of Zhang Sixun of the Northern dynasties, who discovered the inequality corresponding to the equation of the center of the Sun in the 6th century, probably independently of ancient Mediterranean astronomy.) Most Chinese calendars before Zu Chongzhi used the 19-year cycle for intercalation, during which 7 intercalary months are added. This cycle is called the zhang and was already in use by the end of the Warring States period (475–221 BCE). Although this cycle is the same as the Greek Metonic cycle, the Chinese and Greek cycles are probably independent discoveries. The earliest Chinese calendar to abandon

the 19-year cycle was the Xuanshi calendar (412) of Zhao Fei of the northern Liang dynasty (396–440), who used a 600-year cycle during which 221 intercalary months were added. The Daming calendar (462) of Zu Chongzhi was the second to abandon the 19-year cycle; it used a 391-year cycle during which 144 intercalary months were added.

Another important innovation of the Daming calendar of Zu Chongzhi is that it took into account the precession of the equinoxes. Precession had already been discovered by Yu Xi (281–356), but Zu Chongzhi was the first to accept it in a calendar. The Daming calendar also used a length of  $717,777/26,377$  ( $= 27.212230\dots$ ) days for the nodical month, which is quite accurate

Zu Chongzhi further devised a method to determine the exact time of the winter solstice from observations of the midday gnomon shadow.

Zu Chongzhi was also a great mathematician. He calculated that the value of  $\pi$  lies between 3.1415926 and 3.1415927. He is said to have composed a high-quality mathematical work, *Zhuishu*, which is not extant.

**Alternate name:**

Tsu Chung-chih

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