

Biographical Encyclopedia of Astronomers

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Khayyām: Ghiyāth al-Din Abū al-Fath 'Umar ibn Ibrāhīm al-Khayyāmī al-Nīshāpūrī

Born Nīshāpūr, Khurāsān, (Iran), 18 May 1048

Died Nīshāpūr, Khurāsān, (Iran), circa 1123

Better known in the West as "Umar Khayyam," Khayyam was one of the most prominent scholars of medieval times, with remarkable contributions in the fields of mathematics and astronomy. His worldwide fame today mainly comes from a number of quatrains attributed to him that have tended to overshadow his brilliant scientific achievements. Besides his ingenious achievements in mathematics, Khayyam is said to have supervised or actively taken part in the formulation and compilation of a solar calendar that potentially surpasses all calendar systems ever composed in precision and exactness—a legacy alive today in his native Iran. Khayyam's contributions to astronomy should be viewed within the context of his efforts to compile this calendar

Nishapur was known for its great learning centers and its prominent scholars. Khayyam studied the sciences of the day in his native town and is said to have mastered all branches of knowledge in his early youth. Khayyam soon rose to prominence in Khurasan, the political center of the powerful Saljuq dynasty that ruled over a vast empire extending from the borders of China to the Mediterranean. As the leading scientist, philosopher, and astronomer of his day, he enjoyed the support and patronage of the Saljuq court.

With the ascent of Jalal al-Din Malik Shah to the throne in 1072, Isfahan was chosen as the new capital of the Saljuq dynasty. Consequently, a group of prominent scientists and scholars from Khurāsān, including Khayyam and al-Muzaffar al-Isfīzārī, were summoned to the court in the new capital to embark on two major projects: the construction of an observatory and the compilation of a new calendar to replace the existing ones. In addition to other deficiencies, these existing calendars had proven inefficient in monetary and administrative matters related to timekeeping. No details have survived regarding the observatory and its site, except for brief notes stating that enormous sums of money were spent on it and that it was very well equipped. However, one finds references made by Naṣīr al-Din al-Tūsi, Qutb al-Din al-Shīrāzī, and others to a *Zīj-i Khayyam* or *Zīj-i Malikshāhī* (Astronomical handbooks of Khayyām or Malikshāh) that could possibly be one major outcome of the observatory.

By 1079, a solar calendar was developed that was named the "Jalālī" or "Maliki" calendar, thus bearing the name of the monarch who was the project's patron. The most remarkable feature of the new calendar was the correspondence of the beginning of the year (Nowrūz or new day) and the beginning of Aries, i.e., when the Sun passing from the Southern Celestial Hemisphere to the northern appears to cross the Celestial Equator, marking the beginning of spring or the vernal equinox. The Jalālī year was a true solar year that followed the astronomical seasons. The length of this year was the mean interval between two vernal equinoxes. Recent studies

have underscored the advantage of the Jalālī calendar by demonstrating the superiority of the vernal equinox as a calendar regulator, arguing that the vernal equinox year length is much more consistent than other natural regulating points

The second important feature of this calendar was the introduction, for the first time, of leap years using the rule of quinquennia (5-year periods for leap years). After a normal period of 7 quadrennia (4-year periods for leap years, in exceptional cases 6 or 8), there comes a quinquennia in which the extra day is added to the 5th and not the 4th year as usual. This produces patterns of 33-, 29-, and 37-year cycles for 7, 6, and 8 quadrennia, respectively. As modern calculations have shown, this introduction of 5-year leap days into the calendar has the potential, provided that a correct pattern is employed, of rendering the calendar quite accurate over relatively long time spans, indeed more accurate than the modern Gregorian calendar. However, there is a wide variety of opinions on the pattern (the number of times 29 or 37 cycles are combined with 33-year cycles) of leap years originally built into the Jalālī calendar, thus leaving its actual accuracy an open question to be investigated.

Khayyam's major role in the court of Malik-Shah, as well as the historical testimony of prominent astronomers such as Tūsī, Shīrāzī, and Nīsābūrī, all associating the name of Umar Khayyām with the Jalali calendar, leaves little doubt about his leading role in the compilation of the Jalali calendar. His prominence as a major astronomer of his time is also borne out by his critical notes on Ibn al-Haytham's *Maqāla fī harakat al-iltifaf* (Treatise on the Winding Motion). This work, which is discussed by Shīrāzī, demonstrates the fact that Khayyam had been engaged in quite complicated and difficult aspects of theoretical astronomy that involved the development of new models to replace the unwieldy latitude models of Ptolemy

Khayyam's work in astronomy has been overshadowed by his outstanding achievements in mathematics, in which his genius and originality are best manifested. His contributions to the subject may well be considered some of the greatest during the entire Middle Ages. In particular, his treatise entitled *Risāla fī al-barāhīn alā masā'il al-jabr wa-'l-muqabala* (Treatise on the Proofs of the Problems of *al-jabr* and *al-muqabala*) is one of the most important algebraic treatises of the Middle Ages. He also dealt with the so-called parallel postulate and arrived at new propositions that were important steps in the development of non-Euclidean geometries. His work in the theory of numbers was also significant, eventually leading to the modern notion of real positive numbers that included irrational numbers

Khayyam also wrote short treatises in other fields such as mechanics, hydrostatics, the theory of music, and meteorology. Through his work in ornamental geometry, he contributed to the construction of the north dome of the Great Mosque of Isfahan. He may also have served as a court physician.

Though little remains of his work in philosophy, Khayyam was a follower of Ibn Sīnā and much respected by his contemporaries for his work in this field. In a later work, he concludes that ultimate truth can be grasped only through mystical intuition. This perhaps gives some clue as to how to read his famous poetry, not all of which has been accepted as authentic by modern scholarship

Khayyam seems to have spent the most fruitful scientific years of his life in Isfahan. But with the assassination of Malikshah in 1092, he returned to Khurasan, spending the rest of his life in Marw and Nishapur. His death brought to an end a brilliant chapter in Iranian intellectual history.

Behnaz Hashemipour

Alternate name

Omar Khayyam

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