Encyclopædia Iranica

Article by **David Pingree**

Published: March 8, 2021
Last Updated: March 18, 2021

ĠIĀṬ-AL-DIN JAMŠID MASʿUD KĀŠĀNI

GIĀṬ-AL-DIN JAMŠID MASʿUD **KĀŠĀNI** (or Kāši), astronomer and mathematician (b. in Kāšān in ca. 770- 80/1368-78; d. in Samarqand 19 Ramażān 832/22 June 1429). We know nothing of Kāšāni's early life save that his father must have been an accomplished astronomer and mathematician in order to understand the anecdotes that Kāšāni related to him in his letters, describing his life at the court (tr. in Bagheri, E. Kennedy, 1960; Tk. and Eng. tr. in Sayili, 1960b). The first dated event in Kāšāni's life was his observation of a lunar eclipse at Kāšān on 12 Ḏu'l-ḥejja 808/2 June 1406, the first in a triplicity of observed lunar eclipses that he compared in his *Zij-e ḵāqāni* to a triplicity observed by Ptolemy. In the next year, on 21 Ramażān 809/1 March 1407, he completed, presumably still in Kāšān, his *Sollam al-samāʾ* on the sizes and distances from the earth of the planets and stars; he dealt with the distances of the planets again in the *Zij-e ḵāqāni*. Kāšāni dedicated the *Sollam al-samāʾ* to an as yet unidentified vizier named Kamāl-al-Din Maḥmud.

A few years later, he dedicated a Persian work on cosmology, the *Moḵtaṣar dar ʿelm-e hayʾat*, to Sultan Jalāl-al-Din Eskandar Solṭān (q.v.), a grandson of Timur and the governor of Fārs, who was put to death at Šāhroḵ's command in 818/1415 (Ḥāfeẓ-e Abru, p. 596); a fragmentary manuscript in the British Library was copied for Eskandar in 813-14/1410-11 (Rieu, *Persian Manuscripts*, p. 869).

Shortly after this, he received for the first time the patronage of another grandson of Timur, Ologʰ Beg (r. 850-53/1447-49), the son of Šāhroḵ and the ruler of Samarqand, for whom he completed an astronomical table (*zij*) in 816/1413-14 (*Zij-e ḵāqāni dar takmil-e Zij-e il-ḵāni*), which was intended to correct Naṣir-al-Din Ṭusi's *Zij-e il-ḵāni* (Kennedy, 1956a, pp. 127-28, no. 20, abstracted on pp. 164-66; idem, 1998). The Istanbul manuscript (Aya Sofya 2692) was copied in the year of its composition, perhaps by the author himself. Kāšāni divided his *Zij* into six treatises (*maqāla*); each treatise is made of an introduction followed by a couple of chapters (*bāb*), except for the first one that is comprised of the introduction and four chapters. This important *zij* has not yet been published, although several sections of it have been studied by Edward Stewart Kennedy and some of his students. The first treatise is devoted to the description of calendars (*dar maʿrefat-e tawāriḵ-e mašhur*):the Seleucid, Hejri, and Yazdegerdi; the Chinese-Uighur; and the Jalāli; and their festivals. The description of the Chinese-Uighur calendar was discussed by Edward Kennedy (1964; repr. in D. A. King and M. H. Kennedy, eds., pp. 652-60; see also van Dalen, Kennedy, and Saiyid). The second treatise deals with the determination of the trigonometric, declination, and ascension functions and includes a geographical table of the longitudes and latitudes of more than five hundred cities (*dar maʿrefat-e jayb o sahm o ẓell o mayl o maṭāleʿ o ḏekr-e ṭul o ʿarż-e boldān*); the geographical table was published by Edward and M. H. Kennedy (1987). The double-argument tables for the equations of planetary longitudes (3rd treatise: *dar maʿrefat-e mawāżeʿ-e kawākeb dar ṭul o ʿarż wa tawābeʿ-e ān*) were analyzed by Mark Tichenor (1967, repr. in D. A. King and M. H. Kennedy, eds., pp. 122-24), and his method for computing planetary ephemerides using second order differences by Edward Kennedy (1962, repr. in D. A. King and M. H. Kennedy, pp. 522-25). Kāšāni's parallax theory was studied by Edward Kennedy (1956b, repr. in D. A. King and M. H. Kennedy, pp. 164-84), who also (1985) elaborately described the fourth treatise of the *Zij* on the various operations of spherical astronomy (*dar maʿrefat-e qessi-e mašhura*), as well as the fifth treatise on the determination of the ascendant (*dar maʿrefat-e tāleʿ az maʿlumāt-e moḵtalefa*; Kennedy, 1995-96; for a section of this latter see also Kennedy and Debarnot). In the last treatise (*dar bāqi-e aʿmāl-e nojumi*) the computation of astrological entities is discussed. Kāšāni's method of determining the cusps of the astrological places was explained by Edward Kennedy (1994). Finally, a part of the *Zij* dealing with planetary stationary points and retrogressions was translated into Sanskrit at Jayapura in about 1730 (see Pingree, 2000).

Kāšāni's next work was a short Persian treatise on astronomical instruments entitled *Resāla dar šarḥ-eālāt-e raṣad*, which he completed in Ḏu'l-Qaʿda 818/ January 1416 and dedicated to Solṭān Eskandar, perhaps the son of the Qara Qoyunlu prince Qara Yusof, who ruled western Persia from 823/1420 till 841/1438; it describes the triquetum, the armillary sphere, the equinoctial ring, the double ring, the Faḵri sextant, the azimuth-altitude instrument and an instrument employing sine and versed sine, all well-known instruments. At the end Kāšāni calls himself a physician (*ṭabib*). A facsimile of the unique manuscript with an English translation and a commentary was published by Edward Kennedy (1961, repr. in D. A. King and M. H. Kennedy, eds., pp. 394-404). A month later, on 10 Ḏu'l-ḥejja 818/ 10 February 1416, Kāšāni finished at Kāšān the first version of his *Nozhat al-ḥadaʾeq* on the planetary equatorium that he invented; he corrected and supplemented this first version at Samarqand in Šaʿbān 829/June 1426. Edward Kennedy dealt with the various applications of the plates of this instrument in several articles (1947, 1950, 1951a, 1951b, 1952; all reprinted in D. A. King and M. H. Kennedy, eds., pp. 448-80). An anonymous Persian summary of the

Nozhat al-ḥadāʾeq, which is dedicated to the Ottoman Sultan Bāyazid II (1481-1512), was published in facsimile with an English translation by Edward Kennedy in his edition/translation of *Ṭabaq al-manāṭeq*... (1960). The astronomical problems that can be solved with these computing instruments are the determination of the times of the conjunctions of the planets, of the true longitudes of the sun, the moon, and the planets, of the latitudes of the moon and the planets, and of the times and magnitudes of lunar eclipses.

In about 1412, when Olōg Beg began to construct the observatory at Samarqand, Kāšāni was called to his court and was soon considered the leading scientist of the group assembled. Kāšāni explains the process of how he reached this favorable position at the court in two letters that he wrote to his father in Kāšān, the first after he had been at Samarqand for two years (i.e., in ca. 1423; tr. with comm. by Bagheri) and the second slightly later (tr. with comm. by Kennedy, 1960, repr. in D. A. King and M. H. Kennedy, eds., pp. 722-44; ed. and tr. into Turk. and English by Sayili, 1960b). These letters provide a fascinating picture of the interactions between the prince, his scientists, and his workmen as they designed and constructed the observatory.

Besides his work on the observatory Kāšāni was also engaged in composing his truly extraordinary works on mathematics. In Šaʿbān 827/July 1424 he completed his *al-Resāla al-moḥiṭiya*, in which he computed the value of p to

nine sexagesimal or sixteen decimal places. This was edited (incom- pletely) and translated into German by Paul Luckey (1953); a facsimile of a complete manuscript and a translations into Russian were published by B. A. Rosenfeld, V. S. Segal, and A. P. Yushkevich. On 3 Jomādā I 830/2 March 1427 Kāšāni completed his masterpiece, the *Meftāḥ al-ḥesāb*, which he dedicated to Olōg Beg. This work consists of five books: the first is on the arithmetic of integers, and includes innovative sections on root-extraction and binomial expansions (see Luckey, 1948); the second is on the arithmetic of fractions; the third is on sexagesimal fractions, including a chapter on the root-extraction of sexagesimals (see Dakhel, 1960), and on decimal fractions, which Kāšāni claims to have invented, apparently being unaware of their use by Aḥmad b. Ebrāhim Oqlidesi in 952-53 (Saidan, pp. 481-85); the fourth is on the mensuration of geometrical figures, including sine-tables, specific gravity, and a chapter on the geometry of arch façades (*morqarnas*; see Dold-Samplonius, 1992, 1996); and the fifth is on algebra, including square root extractions of polynomials. The *Meftāḥ al-ḥesāb* was lithographed in Tehran in 1889; it was edited and commented on in Arabic by Aḥmad Saʿid Damardāš and Moḥammad Ḥamdi Ḥefni; a facsimile of the Leiden manuscript with a Russian translation was published by Rosenfeld, Segal, and Yushkevich; and it was edited with notes by Nader Nābolosi. The contents of the first three books, on arithmetic are described by Paul Luckey in his edition/translation of *al-Resāla al– moḥiṭiya* (1951).

Finally, Kāšāni computed the value of the sine of 1° by an iterative solution of a cubic equation. He described this computation in a *Resālat al-watar wa al-jayb*, which, apparently, he did not live to finish; it was completed, it is said, by Qāżizāda Rumi, his colleague at Olōg Beg's court. The *Resāla* exists in manuscript form and was lithographed at Tehran in 1888, but is best known from Miram Ŭelebi's commentary of 1499 on Olōg Beg's *Zij-e jadid* (see Sédillot; see also Aaboe for an exposition of the method). This computation appears in Sanskrit texts from the 17th and 18th centuries (see, e.g., Pingree, 1978).

There exist in manuscripts a number of other treatises in Arabic and in Persian attributed to Kāšāni; none of them has as yet been studied or published, but their names can be found in Kennedy (tr, *Ṭabaq al-manāṭeq*, pp. 6-7 and Youschkevitch and Rosenfeld, p. 261). Without taking them into consideration one must conclude on the basis of the works already discussed that Kāšāni was one of the most brilliant mathematicians of medieval Islam. A few lines of poetry are ascribed to him by Moḥammad.

BIBLIOGRAPHY

A. Aaboe, “Al-Kashi’s Iteration Method for the Determination of Sin 1°,” *Scripta Mathematica* 20, 1954, pp. 24-29.

M. Bagheri, “A Newly Found Letter of Al-Kāshi on Scientific Life in Samarkand,” *Historia Mathematica* 24, 1997, pp. 241-56.

Brockelmann, *GAL*, Suppl. 2, p. 295.

A.-K. Dakhel, *Al-Kāshi on Root Extraction*, ed. W. A. Hijab and E. S. Kennedy, Beirut, 1960.

B. van Dalen, E. S. Kennedy, and M. K. Saiyid, “The Chinese-Uighur Calendar in Ṭusi’s Zij-i Ilkhāni,” *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 11, 1977, pp. 111-51.

Y. Dold- Samplonius, “Practical Arabic Mathematics: Measuring the Muqarnas by al-Kāshi,” *Centaurus* 35, 1992, pp. 193-242.

Idem, “How al-Kāshi Measures the Muqarnas: A Second Look,” in M. Folkerts, ed., *Mathematische Probleme im Mittelalter*, Wiesbaden, 1996, pp. 57-90.

Giāṯ-al– Din Jamšid Kāšāni, *Meftāḥ al-ḥesāb*, ed. A. S. Demerdāš and M. Ḥ. Hefni, Cairo, 1948; ed. N. Nābolosi, Damascus, 1977.

Idem, *al-Resāla al– moḥiṭiya*, ed. and tr. P. Luckey as *Die Rechenkunst bei ·amšid b. Masʿud al-Kāši, mit Ruckblicken auf die altere Geschickte des Rechnes*, Abhandlungen fuür die Kunde des Morgenlandes 31/1, Wiesbaden, 1951.

Idem, *Resālat al-ḥesāb wa al-Resāla al– moḥiṭiya*, tr. B. A. Rosenfeld, V. S. Segal, and A. P. Yushkevich as *Klyuch Arifmetiki*, Moscow, 1956.

Idem, *Ṭabaq al-manāṭeq* and *Lawḥ al-etteṣālāt*, ed. and tr. with comm. E. S. Kennedy, as *The Planetary Equatorium of Jamshid Ghiyāth al-Din al-Kāshi*, Princeton, 1960.

Idem, *Resāla-ye ṭāq wa azaj*, tr. ʿA.-R. Jadʾbi, Tehran, 1366 Š./1987 (Pers. tr. of chap. 9/4 of *Meftāḥ al-ḥesāb*).

Ḥ abib al-siar IV, p. 21.

Ḥāfeẓ-e Abru, *Zobdat al-tawāriḵ*, ed. S. K. Ḥājj Sayyed-Jawādi, 2 vols., Tehran, 1372 Š./ 1993.

E. S. Kennedy, "Al-Kāshi's 'Plate of Conjuctions'," *Isis* 38, 1947, pp. 56-59.

Idem, "A Fifteenth Century Planetary Computer," *Isis* 41, 1950, pp. 180-83.

Idem, "A Fifteenth-Century Lunar Eclipse Computer: al-Kāshi's 'Ṭabaq al–Manāṭeq'," *Scripta Mathematica* 17, 1951a, pp. 91-97.

Idem, "An Islamic Computer for Planetary Latitudes," *Journal of the American Oriental Society* 71, 1951b, pp. 13-21.

Idem, "A Fifteenth Century Planetary Computer: al-Kāshi's 'Ṭabaq al-Manāṭeq'," *Isis* 43, 1952, pp. 42-50.

Idem, "A Survey of Islamic Astronomical Tables," *Transactions of the American Philosophical Society* 46/ 2,1956a, pp. 123-77.

Idem, "Parallax Theory in Islamic Astronomy," *Isis* 47, 1956b, pp. 33-53.

Idem, "A Letter of Jamshid al-Kāshi to His Father," *Orientalia*, N.S. 29/2, 1960, pp. 191-213.

Idem, "Al-Kāshi's Treatise on Astronomical Observational Instruments," *Journal of Near Eastern Studies* 20, 1961, pp. 98-108.

Idem, "A Medieval Interpolation Scheme Using Second Order Differences," in W. B. Henning and E. Yarshater, eds., *A Locust's Leg: Studies in Honour of S. H. Taqizadeh*, London, 1962, pp. 117-20.

Idem, "The Chinese-Uighur Calendar as Described in the Islamic Sources," *Isis* 55, 1964, pp. 435-43.

Idem, "Spherical Astronomy in Kāshi's Khāqāni Zij," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 2, 1985, pp. 1-46.

Idem, "The Prime Vertical Method for the Astrological Houses as Presented in Kāshi's Khāqāni Zij," in A. von Gotstetter, ed., *Ad Radices*, Stuttgart, 1994, pp. 95- 97.

Idem, "Treatise V of Kāshi's Khāqāni Zij: Determination of the Ascendent," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 10, 1995, pp. 123-45.

Idem, "Kāši's Zij-i Ḵāqāni," in Ü. Vezel, H. Beikbaghban, and B. Thierry de Crussol, eds., *La science dans le monde iranien à l'époque islamique*, Tehran, 1998, pp. 33-38.

E. S. Kennedy and M.-Th. Debarnot, "Al– Kāshi's Impractical Method of Determining the Solar Altitude," *Journal for the History of Arabic Science* 3, 1979, pp. 219-27.

E. S. Kennedy and M. H. Kennedy, *Geographical Coordinates of Localities from Islamic Sources*, Institute für Geschichte der Arabisch-Islamischen Wissenschaften, Frankfurt, 1987.

Idem, ed., *Al-Kāshi's Geographical Table*, Transactions of the American Philosophical Society 77/7, Philadelphia, 1987.

D. A. King and M. H. Kennedy, eds., *Studies in the Islamic Exact Sciences*, Beirut, 1983.

P. Luckey, "Die Auziehung des *n*-ten Wurzel und der binomische Lehrsatz in der islamischen Mathematik," *Mathematische Annalen* 120, 1948, pp. 244-54.

Idem, *Der Lehrbrief über den Kreisumfang,* Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin, Kl. Math. 1950, 6, Berlin, 1953.

Modarres, *Rayḥānat al-adab* III, pp. 256-57.

Monzawi, *Nosḵahā* I, pp. 204, 229, 301-2, 370.

M. Moḥiṭ Ṭabāṭabā'i, "Ḡiāṯ-al-Din Jamšid Kāšāni," *Ā muzeš o parvareš* 10/3, 1319 Š./1940, pp. 1-8, 10/4, pp. 17-24.

Idem, ed., "Nāma-ye pesar ba pedar …," *Ā muzeš o parvareš* 10/3, 1319 Š./1940., pp. 9-16, 57.

Idem, "*Nawāder-e Samarqand* az āṯār-e Ḡiāṯ-al– Din Jamšid Kāšāni," *Ā muzeš o parvareš* 10/3, 1319 Š./1940, pp. 55- 60.

Moḥammad-Ṭāher Naṣrābādi, *Ta ḏ kera-ye Naṣrābādi*, ed. Ḥ. Waḥid Dastgerdi,

Tehran, 1361 Š./1982.

D. Pingree, “Islamic Astronomy in Sanskrit,” *Journal for the History of Arabic Science* 2, 1978, pp. 315-35.

Idem, “Sanskrit Translations of Arabic and Persian Astronomical Texts at the Court of Jayasimha of Jayapura,” *Suhayl* 1, 2000, pp. 101-6.

A. Qorbāni, “Naḵostin moḵtareʿ-e kasrhā-ye aʿšāri … Jamšid Kāšāni …,” *Soḵan* 5, 1333 Š./1954, pp. 747-53.

Ṣafā, *Adabiyāt* IV, pp. 102-4.

A. S. Saidan, *The Arithmetic of Al-Uqlidisi*, Boston, 1978.

ʿA-A. Šehābi, “Nāma-i az Ġiāṯ-al– Din Jamšid Kāšāni ba pedar-e ḵod,” *Elāhiyāt-e Mašhad*, nos. 26-27, 1357 Š./1978, pp. 5-18.

A. Sayili, *The Observatory in Islam and Its Place in the General History of the Observatory*, Ankara, 1960a; 2nd ed., Ankara, 1988.

Idem, *Ulua Bey ve Semerkanddeki Ilim Faaliyeti Hakkinda Giyasuddin-i Kaˆ ş ı̈nin Mektubu*, Ankara, 1960b. L. A. Sédillot, “De l’algèbre chez les Arabes,” *Journal asiatique* 5/2, 1853, pp. 323-50.

Storey, II/1, pp. 67, 72-73. Sezgin, *GAS* V, pp. 63-69.

H. Suter, *Die Mathematiker und Astronomen der Araber und ihre Werke,* Leipzig, 1900, pp. 173-74 (no. 429).

M. J. Tichenor, “Late Medieval Two- Argument Tables for Planetary Longitudes,” *JNES 26*, 1967, pp. 126-28.

J. Vernet, “Al-Kāshi,” in *El*2 IV, pp. 702-3.

A. P. Youschkevitch and B. A. Rosenfeld, “al-Kāshi,” *Dictionary of Scientific Biography* VII, 1973, pp 255-62.

ʿAbd-al-Raḥim Kalāntar Żarrābi, *Tāriḵ-e Kāšān*, ed. I. Afšār, Tehran, 1341 Š./1962, pp. 410-11.