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Khāzin: Abū Jaʿfar Muḥammad ibn al-Ḥusayn al-Khāzin al-Khurāsānī

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Born **probably Khurāsān, (Iran)**

Died ***circa* 971**

Abū Jaʿfar al-Khāzin was an astronomer and mathematician whose main work was the *Zīj al-ṣafāʾiḥ* (*zīj* of the plates). A *zīj* is an astronomical handbook; "plates" here refer to the plates of an astronomical instrument, like an astrolabe or an equatorium. This work was considered by later scholars as the best work in this field.

Abū Jaʿfar al-Khāzin was a Sabian of Persian origin. (The Sabians were a Hellenized, pagan sect that was tolerated in early Islam.) He was called al-Khurāsānī, meaning from Khurāsān, a province in eastern Iran. Khāzin was attached to the court of the Būyid ruler Rukn al-Dawla (932–976), Prince of Rayy (a town near Tehran destroyed in the 12th century). There he benefited from the patronage of Abū al-Faḍl ibn al-ʿAmīd, the vizier of Rukn al-Dawla, and his fame reached Baghdad. In 953/954 Khāzin played the role of negotiator in the war in which the army of Nūḥ ibn Naṣr of Khurāsān opposed Rukn al-Dawla.

As an astronomer, Khāzin knew and commented upon the works of earlier astronomers. For instance, he wrote a commentary on **Ptolemy**'s *Almagest* in which he provided information regarding the astronomical activities of early Islamic astronomers.

Later authors mention the astronomical observations carried out by Khāzin. He measured the obliquity of the ecliptic at Rayy in 960. This measurement was ordered by the aforementioned Vizier Ibn al-ʿAmīd, who also ordered the construction of a mural quadrant in Rayy. Khāzin, together with another astronomer called al-Khirāwī, measured the obliquity of the ecliptic with this instrument. We are also told of the determination of the latitude made by Khāzin and a number of collaborators using a ring of 4 m. Another source mentions observations made in Kāshān on 6 October 960, also ordered by Ibn al-ʿAmīd, in order to obtain the latitude of this city. In 970 he also measured the obliquity of the ecliptic in Edessa.

Khāzin was not only a good observer but also a theoretician. He believed in the solid character of the heavenly spheres, supported the theory of the progressive diminution of the obliquity of the ecliptic, and, probably, the theory of the trepidation of the equinoxes along an arc of 8° on the ecliptic.

Among his writings there is a *maqāla* in which Khāzin developed a solar model without eccentrics and epicycles. This *maqāla* is not preserved, but there are some references to it preserved in some of the works of **Bīrūnī**. It was a homocentric model in which the Sun has a circular motion with the Earth as the circle's center, but in such a way that its motion is uniform with respect to a point that does not coincide with the center of the Universe. In this model the Sun moves on a circle, which is concentric and coplanar with the ecliptic, at a variable speed. The uniform movement of the Sun takes place on a different circle. The distance between the centers of these two circles has the same value as the Ptolemaic eccentricity. But there is neither an apogee nor a perigee, contrary to the Ptolemaic model, although the line joining the two centers intersects the circle of the Sun's path where it reaches its minimum and maximum speeds. This system reappeared in a more complete version in the 14th century, in the work of the astronomer **Henry of Langenstein** entitled *De reprobatione ecentricorum et epiciclorum* (1364).

Khāzin was also the author of a book (now lost) entitled *Kitāb al-abʿād wa-ʾl-ajrām*, in which he gave the diameters of stars from the first to the sixth magnitude but without saying how he obtained these values.

The *Zīj al-Ṣafāʾiḥ*, written for Ibn al-ʿAmīd, dealt with a variant of the astrolabe. This work was considered lost for a long time, but in the late 1990s a manuscript with a copy of an incomplete text of this treatise was found in the Research Library of the Government of Srinagar in India (number 314). Pages 17–87 and pages 95–102, as well as in all likelihood some of the last part of the manuscript (215b–?), are missing in the copy. The lost pages contain the details of the construction of the instrument and the use of the planetary plate of the instrument. In the first page of the treatise there is an index of the contents from which we can confirm that the treatise is divided into two books (or *maqālāt*) as reported by later authors. The first book of the treatise deals with the computation of the longitude and latitude of the planets. This analysis is preceded by an introduction that is mostly theoretical. The second book is divided into seven chapters. It deals with the astronomy of the *primum mobile*, calculations of spherical astronomy, and the elements of trigonometry that are necessary to carry them out. The instrument described contains a whole set of orthogonal lines that provide graphical solutions for the standard astronomical problems usually solved by a *zīj* or by an astrolabe; Khāzin, however, uses a *safīḥat al-juyūb*, a plate of sines, instead of a conventional astrolabe with its plates.

One such instrument was made by Hibat Allāh ibn al-Ḥusayn al-Asṭurlābī, an astrolabist of early 12th-century Baghdad. He constructed the instrument in the year 513 of the Hijra (1120). The instrument was still extant at the beginning of the 20th century in Germany, but it subsequently disappeared. Photographs of this instrument were published and analyzed by David King. In the late 1990s the instrument was rediscovered in Berlin. It has more plates than the ones depicted in the preserved photographs and awaits a deeper study.

In mathematics Khāzin was the first to show that a cubic equation of the form $x3 + c = ax2$ could be solved geometrically by means of conic sections. He stated that the equation $x3 + y3 = z3$ did not have a solution in positive integers, but he was unable to give a correct proof. Khāzin also worked on the isoperimetric problem and wrote a commentary to Book X of Euclid's *Elements*.

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