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Ḥabash al-Ḥāsib: Abū Ja‘far Aḥmad ibn ‘Abd Allāh al-Marwazī

François Charette

Died probably Samarra, (Iraq), after 869

Ḥabash al-Ḥāsib (literally, “Ḥabash the calculator,” with the intended meaning of “mathematical astronomer”) was one of the most original and most influential Muslim astronomers of the formative period of Islamic astronomy. The dates of his birth and death are not known, but according to the bibliographer Ibn al-Nadīm he died as a centenarian. Ḥabash was closely associated with the ‘Abbāsīd court; he was active in Baghdad during the reign of Caliph **Ma’mūn** (813–833). Later, he lived and worked in Samarra, which in 838, became the new administrative capital of the ‘Abbāsīd Empire.

Ḥabash's biography is yet to be definitively established. The bibliographer Ibn al-Nadīm (died: 995) mentions Ḥabash as a scientist active at the time of Ma’mūn, and Ibn al-Qifṭī (died: 1248) adds that he also lived under the reign of al-Mu‘taṣim. In his own account of the achievements of the *aṣḥāb al-mumtaḥan* – the group of scholars involved in the observational project sponsored by Caliph Ma’mūn whose objective was to check the parameters of **Ptolemy's** *Almagest* – Ḥabash does not present himself as one of their protagonists, although he was certainly in close contact with them. The earliest certain date associated with him is given by **Ibn Yūnus**, who reports an observation conducted by Ḥabash in Baghdad in the year 829/830 (*i. e.*, 4 years before the death of Ma’mūn). This is also the date associated with many other *mumtaḥan* observations and with the *mumtaḥan* star-table.

Ibn al-Qifṭī attributes a *zīj* (astronomical handbook) to Ḥabash. This was compiled when he was a young man in the tradition of the Indian *Sindhind*, and was based upon the *zīj* of **Khwārizmī**. Also ascribed to him is another smaller work, the *Zīj al-Shāh*, probably following the same Pahlavi tradition as the eponym work by **Fazārī**. The composition of those two non-Ptolemaic *zīj*es must have occurred before 829/830, the year when the *mumtaḥan* observational program was inaugurated. But Ḥabash is best known to his contemporaries and successors for his authorship of a third *zīj*, whose content is almost entirely Ptolemaic, and which became known as “the” *zīj* of Ḥabash.

In the introduction to this latter *zīj*, Ḥabash informs his readers that after Ma’mūn's death he took upon himself the task of revising the observational data gathered by the “*mumtaḥan* astronomers.” Hence, inspired by Ptolemy's methodology, he conducted his own observations of the Sun and Moon, and also made repeated observations of the remaining planets at specific times. The latest dates associated with Ḥabash are recorded in his *zīj* – 22 April 849, 17 November 860, and 15 September

868. These dates coincide with the reigns of Caliph al-Mutawakkil (reigned: 847-861) and of his third short-lived successor al-Mu'tazz (reigned: 866-869). We can assume that the *zīj* was finalized after the year 869 and represented Ḥabash's ultimate achievement. A further indication of this is the fact that Ḥabash uses an obliquity of the ecliptic of $23^{\circ} 35'$, a value observed by the **Banū Mūsā** in Samarra in the year 868/869. He could not have been more than *circa* 75 years old at that time, which would then imply that he was not born before *circa* 796. The period 796-894, in fact, seems to be the most reasonable estimate for his life span, and this would make him belong to the same generation as **Abū Ma'shar** and **Kindī**. The usual modern references to him as flourishing *circa* 830 would seem to correspond in actuality to the earliest period of his life.

To summarize, we can divide Ḥabash's scientific career into the following four distinct periods:

1. The early, formative period in Baghdad (*circa* 815-829), during which he became acquainted with the Indian and Persian astronomical systems through the works of Fazārī and Khwārizmī, and composed two *zījes* based upon these systems.
2. The *mumtaḥan* period (829-834), during which he presumably had close contacts with the *mumtaḥan* group of astronomers in Baghdad and Damascus, and benefited from their new observations and insights. During this crucial period, the superiority of Ptolemy's system became gradually obvious to most specialists. With the resulting consensus in favor of Ptolemaic astronomy and the consequent abandonment of Persian and Indian theories, Islamic astronomy reached a new, stable phase of its development.
3. The post-*mumtaḥan* period, beginning after the death of Ma'mūn in August 833, and possibly based in Damascus, during which Ḥabash pursued his own observational program following the *mumtaḥan* tradition.
4. The Samarra period, covering the last half of his career, during which he finalized his Ptolemaic *zīj* and composed most of his astronomical works that are now extant.

The Ptolemaic *zīj* of Ḥabash, the only one that is extant, is known under four different names - *al-Zīj al-Mumtaḥan* and *al-Zīj al-Ma'mūnī* (because it is based on the observational program of the *mumtaḥan* group under the sponsorship of Ma'mūn), *al-Zīj al-Dimashqī* (presumably because it was also based on observations conducted by Ḥabash in Damascus), and *al-Zīj al-'Arabī* (because it is based on the Arabic Hijra calendar). There is absolutely no evidence to support the contention that the above appellations might refer to more than a single work. Every reference to "the *zīj* of Ḥabash" encountered in later sources (notably **Birūnī** and Ibn Yūnus) is in accord with the single version of the *zīj* by this author that is preserved for us. There is an instance where Birūnī mentions the *zīj* of Ḥabash in general terms, and later characterizes the same work with the epithet *al-mumtaḥan*. This *zīj* is the earliest independently compiled Ptolemaic astronomical handbook in the Arabic language that is preserved in its entirety. Undoubtedly, it was also one of the most influential *zījes* of its generation. Indeed, Birūnī, in the early (Khwārizmian) period of his life, utilized it for his own astronomical practice. Although Ḥabash follows Ptolemy's models and procedures very closely, he does introduce several new, improved parameters as well as an impressive amount of original computational methods, some of them undoubtedly of Indian origin or inspiration. His *zīj* also contains a set of auxiliary trigonometric tables, called *jadwal al-taqwīm*, which are of singular importance in the history of trigonometry.

Two copies of this *zīj* are available, one preserved in Istanbul, which preserves fairly well the

original text, and a second one in Berlin. The latter is a recension of the original, mixed with materials due to various later astronomers. (A table of concordance with the Istanbul MS is appended to M. Debarnot's survey of the Istanbul MS.) Unfortunately, Ḥabash's *zīj* is yet to be published.

Another work of Ḥabash, his *Book of Bodies and Distances*, is in fact devoted to five different topics of scientific activity conducted under the patronage of Ma'mūn, including an interesting report on the geodetic expedition to determine the radius of the Earth (or equivalently the length of 1° of the meridian). Ḥabash also devoted several works to the topic of astronomical instrumentation. An important treatise on the construction of the melon astrolabe, which he probably invented and whose principle is based on an "azimuthal equidistant" mapping, has been published by E. Kennedy *et al.* (1999). An anonymous treatise on the construction of a highly original but still unexplained universal instrument for timekeeping with the stars, preserved in a unique and incomplete copy, has been published lately, and Ḥabash's authorship has been established. D. King recently suggested that this instrument could be a companion to the medieval European universal dial known as *navicula de venetiis*, which he hypothesizes to be, ultimately, of Islamic origin. Ḥabash also composed treatises on the use of the celestial globe, the spherical astrolabe, and the armillary sphere.

Ḥabash's graphical procedure (a so-called analemma construction) for determining the direction of Mecca (*qibla*) is preserved in a letter of Bīrūnī to an Abū Sa'īd (most probably **Sijzī**), in which the contents of Ḥabash's treatise - not extant in its original form but incorporated in his *zīj* - are summarized. Among several works of his that have not survived are treatises on the construction of the standard planispheric astrolabe, on the prediction of lunar crescent visibility, on the construction of sundials, and on some geometrical problem; also lost are his two critical reports on the observations conducted by the *umtaḥan* group in Baghdad and Damascus.

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