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Ibn al-Hāʾim: Abū Muḥammad ʿAbd al-Ḥaqq al-Ghāfiqī al-Ishbīlī

Roser Puig

Flourished **Seville, (Spain), thirteenth century**

In addition to his own astronomical accomplishments, Ibn al-Hāʾim provides important historical information on earlier astronomers in al-Andalus. All we know of his life is that he came from Seville, and that he probably worked in North Africa under the Almohad dynasty.

At the beginning of the 13th century (1204–1205), Ibn al-Hāʾim composed a single work entitled *al-Zīj al-kāmil fī al-taʿālīm*, which he dedicated to the caliph Abū ʿAbd Allāh Muḥammad al-Nāṣir, who reigned from 1195 to 1213. It is a relatively long text, consisting of an introduction and seven books (*maqālāt*). The text can be considered a *zīj* (astronomical handbook) on the basis of its structure and contents, even though it does not include numerical tables; it contains only the canons giving calculating procedures together with geometrical proofs. Ibn al-Hāʾim was a good mathematician and was familiar with the new trigonometry introduced in al-Andalus by **Ibn Muʿādh** (11th century) and extended by **Jābir ibn Aflaḥ** (12th century).

Al-Zīj al-kāmil is important because it describes the astronomy practiced in al-Andalus and the Maghreb at the beginning of the 13th century and informs us of the Toledan observations (*al-arṣād al-Ṭulayṭuliyya*) and the activities of the Toledan astronomers (*al-jamāʿa al-Ṭulayṭuliyya*) working under the patronage of **Ṣāʿid al-Andalusī** in the 11th century. The work also gives us historical data on the Andalusian astronomer **Zarqālī**, who seems to have had a considerable influence on Ibn al-Hāʾim's theories and models. In the introduction to his book, Ibn al-Hāʾim criticizes two books by Zarqālī's student **Ibn al-Kammād**: *al-Kawr ʿalā al-dawr* and *al-Muqtabas*.

In *al-Zīj al-kāmil*, Ibn al-Hāʾim seems to describe all he knows about the trepidation and obliquity of the ecliptic models developed in al-Andalus, especially Zarqālī's third model, in which variable precession becomes independent of the oscillation of the obliquity of the ecliptic. Trepidation has to be taken into account in most of the calculations and procedures presented in the book. He provides a description and a geometrical demonstration, explains how to use the tables, and also presents the spherical trigonometrical formulae involved. Ibn al-Hāʾim attributes the *Risālat al-iqbāl wa-ʾl-ibdār* (Epistle on accession and recession) to the 11th century astrologer Abū Marwān al-Istijjī, and preserves some data from that book.

Since Zarqālī's treatise on the Sun (*Fī sanat al-shams*, On the solar year) is only known through secondary works, Ibn al-Hāʾim's text is a useful additional source. Ibn al-Hāʾim follows Zarqālī in establishing and calculating the basic elements of solar theory. He gives a longitude of the solar apogee of 85° 49′, which coincides with the value determined by Zarqālī in his observations performed in 1074/1075, as documented in the Latin tradition of Bernard of Verdun. To calculate the solar equation and the true longitude of the Sun, Ibn al-Hāʾim follows Zarqālī's solar model of variable eccentricity. Ibn al-Hāʾim describes three different types of year: tropical, sidereal, and anomalistic. His classification is practically identical to the one given by Zarqālī himself. Ibn al-Hāʾim devotes great attention to the computation of the anomalistic year which, in his opinion, is the basis for obtaining the other two types of year; since its value is fixed, it is the one that should be used to obtain mean motions and to carry out astronomical calculations.

As for lunar theory, the *zīj* deals with two aspects of the theory of the Moon: the computation of its longitude, and the computation of its latitude. Ibn al-Hāʾim proposes two corrections to the standard Ptolemaic lunar theory. The first is an attempt to correct the theory of lunar longitude. The correction is ascribed to a lost astronomical work of Zarqālī, which Ibn al-Hāʾim had read in a manuscript written by the Toledan astronomer himself. It seems to imply the existence of a lunar equant point that rotates with the motion of the solar apogee. We do not know to what extent the generalization of the correction of the Ptolemaic lunar model is due to Zarqālī himself or is the result of Ibn al-Hāʾim's interpretation of his work. In any case, this model met with some success, for we find the same correction in later *zīj*es although restricted to the calculation of eclipses and the New Moon. The second correction is a peculiar one: It is a correction of the computation of the lunar latitude that is directly related to a practice in the calculation of longitudes that had been standard among Muslim astronomers since the *Mumtaḥan zīj* of **Yaḥyā ibn Abī Manṣūr**, though with Ibn al-Hāʾim there is a change of approach. He believes that his lunar model gives ecliptic longitudes, that Yaḥyā's reduction to the ecliptic is unnecessary for the computation of longitudes, and that an inverse reduction to the lunar orbit should be operated to calculate latitudes. The results of Ibn al-Hāʾim's model are different from **Ptolemy**'s, and also from those obtained by Yaḥyā ibn Abī Manṣūr and his followers.

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