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# Battānī: Abū ʿAbd Allāh Muḥammad ibn Jābir ibn Sinān al-Battānī al-Ḥarrānī al-Ṣābiʾ

Benno van Dalen

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**Alternate name**

Albategnius [Albatenius]

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*Born* **Harran, (Turkey), before 858**

*Died* **near Samarra, (Iraq), 929**

Battānī was one of the most influential astronomers of the early Islamic period. He was particularly well known for the accuracy of his observations, which he carried out at Raqqa in northern Syria over a period of 40 years. He wrote an important astronomical handbook with tables (*zīj*) and some astrological treatises in the tradition of **Ptolemy**'s *Tetrabiblos*.

Battānī hailed from Harran in southern Anatolia, possibly from the district Battān of that city, which is mentioned by the famous 16th-century Egyptian scholar **Suyūṭī** in his lexicon of epithets of location, the *Lubb al-lubāb*. Battānī was born into a family of Sabians. Adherents of this pagan religion, mainly centered in Harran, were characterized by a type of star idolatry going back to Babylonian times, and included numerous prominent scholars such as **Thābit ibn Qurra**. From his first name Muḥammad and his *kunya* Abū ʿAbd Allāh, we see that Battānī himself was a Muslim. In European works up to the 19th century, Battānī was mistakenly presented as a noble, a prince, or a king, but there is no justification for such attributions in Arabic sources.

Battānī was probably the son of Jābir ibn Sinān al-Ḥarrānī, a well-known instrument maker from Harran mentioned by the earliest bibliographer of Muslim scientists, Ibn al-Nadīm (died: 990). So we may assume that Battānī learned about astronomical instruments from his father before he moved to Raqqa in northern Syria.

In Raqqa, Battānī devoted considerable financial resources to establish a private observatory at which he regularly conducted observations during the period from 877 to 918. Among the instruments that he is known to have used are a gnomon, horizontal and vertical sundials, a triquetrum, parallactic rulers, an astrolabe, a new type of armillary sphere, and a mural quadrant with an alidade. For several of these instruments, Battānī recommended sizes of more than a meter in order to increase the accuracy of the observations. In 901, Battānī observed a solar and a lunar eclipse in Antioch.

The accuracy of Battānī's observations of equinoxes and solstices, as judged from the one existing report and his determination of the lengths of the seasons, is not much inferior to that of **Tycho Brahe** 700 years later. This remarkable achievement must have been due to a careful construction and alignment of his large instruments, as well as to a clever method of combining multiple observations of the same type of phenomenon (which was certainly not simple averaging). The value obtained by Battānī for the Ptolemaic solar eccentricity, expressed sexagesimally as 2;4,45 parts out of 60, is almost exact. In fact, it is clearly better than the values found by **Nicolaus Copernicus**, who was troubled by refraction because of his high geographical latitude, and Brahe, who incorporated the much too high Ptolemaic value for the solar parallax in the evaluation of his observations.

Battānī also made accurate measurements of the obliquity of the ecliptic, which he found as 23°35' (the actual value in the year 880 was 23°35'6"), and the geographical latitude of Raqqa (36°1', modern value 35°57'). Furthermore, he determined all planetary mean motions anew. He found the parameters of the lunar model to be in agreement with Ptolemy and the eccentricity of Venus the same as derived by the astronomers working under **Maʾmūn**. (See, for example, **Yaḥyā ibn Abī Manṣūr**.) Battānī also confirmed the discovery of Maʾmūn's astronomers that the solar apogee moves by 1° in 66 Julian years, and found the precession of the equinoxes to be equal to the motion of the solar apogee. He accurately measured the apparent diameters of the Sun and the Moon and investigated the variation in these diameters, concluding that annular solar eclipses are possible. In the 18th century, Battānī's observations of eclipses were used by **Richard Dunthorne** to determine the secular acceleration of the motion of the Moon.

Battānī's most important work was a *zīj*, an astronomical handbook with tables in the tradition of Ptolemy's *Almagest* and *Handy Tables*. Ibn al-Nadīm mentions that this work (later called *al-Zīj al-Ṣābiʾ*) existed in two editions, “the second being better than the first,” but modern attempts to date or differentiate the two versions have been unconvincing.

The *Ṣabiʾ Zīj* is extant in its entirety (57 chapters plus tables) in the 12th- or 13th-century manuscript Escorial árabe 908, copied in the western part of the Islamic world. Five or six insignificant fragments are scattered over several libraries in Western Europe. Between 1899 and 1907, C. A. Nallino published his monumental edition, translation, and commentary of the *Zīj* in Latin, and this remains the standard work on Islamic astronomy in general and on Battānī and *zīj*es in particular.

The *Ṣābiʾ Zīj* is the earliest extant *zīj* written completely in the Ptolemaic tradition with hardly any Indian or Sasanian–Iranian influences. As with many Islamic *zīj*es, its purpose was much more practical than theoretical. Although the planetary models and the determination of the solar parameters are explained in some detail (but with various errors), most of the text in the *Zīj* consists of instructions for carrying out practical calculations by means of the tables, which constitute a third of the book. With the exception of Ptolemy and some other Greek observers, Battānī does not express indebtedness to any of his predecessors. On the basis of linguistic arguments, it can be seen that he used an Arabic translation of the *Almagest* made from the Syriac. A remarkable characteristic of the text is the almost complete absence of foreign technical terminology. Although Battānī copied some of the planetary tables directly from the *Handy Tables*, he also computed many tables anew. His star table (containing approximately half the number of stars found in the *Almagest*) was obtained by increasing Ptolemy's stellar longitudes by 11°10', the precession in the period of 743 years between the respective epochs 137 and 880.

The *Ṣābiʾ Zīj* enjoyed a high reputation in the Islamic world and was very influential in medieval and Renaissance Europe. **Bīrūnī** wrote a treatise entitled *Jalāʾ al-adhhān fī zīj al-Battānī* (Elucidation of genius in al-Battānī's *Zīj*), which is unfortunately lost. Later *zīj*es such as those of **Kūshyār ibn Labbān**, **Nasawī**, and **Ṭabarī** were based on Battānī's mean motion parameters. In Spain, the *Ṣābiʾ Zīj* exerted a large influence on the earliest astronomical developments and left many traces in the *Toledan Tables*. Two Latin translations of the canons of the *Zīj* were prepared in the 12th century. The one by Robert of Chester has not survived, but the translation by Plato of Tivoli, made in Barcelona, was printed in Nuremberg in 1537 (together with **Farghānī**'s introduction to Ptolemaic astronomy) and again in Bologna in 1645 under the title *Mahometis Albatenii de scientia stellarum liber, cum aliquot additionibus Ioannis Regiomontani ex Bibliotheca Vaticana transcriptus*. The Castilian translation made from the Arabic around 1260 on the order of **Alfonso X** is partially extant with tables in the manuscript Paris, Arsenal 8.322, which was prepared for Alfonso himself. Hebrew versions or reworkings of the *Ṣābiʾ Zīj* were written by **Bar Ḥiyya** (12th century) and Immanuel ben Jacob Bonfils (14th century); furthermore, Battānī's influence can also be seen in the works of **Ibn ʿEzra**, **Maimonides**, and Levi ben Gerson (**Gersonides**). Finally, European scholars such as **Regiomontanus**, Copernicus, Brahe, **Johannes Kepler**, and **Galileo Galilei** made use of Battānī's work.

Besides the *Ṣābiʾ Zīj*, the following smaller works by Battānī are known:

1. The *Kitāb fī dalāʾil al-qirānāt wa-ʾl-kusūfāt* (On the astrological indications of conjunctions and eclipses) is extant in Ankara, İsmail Saib Library 199/2. This astrological treatise presents horoscopes and astrological interpretations in connection with Saturn–Jupiter conjunctions during the life of the prophet Muḥammad and the early period of Islam. It is written in the tradition of Ptolemy's *Tetrabiblos*.

2. The *Sharḥ Kitāb al-arbaʿa li-Baṭlamiyūs* (Commentary on Ptolemy's *Tetrabiblos*) is extant in the manuscripts Berlin Spr. 1840 (Ahlwardt #5875) and Escorial árabe 969/2.

3. A small work on trigonometry, *Tajrīd uṣūl tarkīb al-juyūb* (Summary of the principles for establishing sines) is extant in the manuscript Istanbul Carullah 1499/3. Since Battānī does not use the Indian loanword *jayb* for "sine" in the *Ṣābiʾ Zīj*, the authenticity of this work has been questioned.

4. A *Kitāb taḥqīq aqdār al-ittiṣālāt [bi-ḥasab ʿurūḍ al-kawākib]* (On the accurate determination of the quantities of conjunctions (?) [according to the latitudes of the planets]) is mentioned by Ibn al-Nadīm and is probably identical with Chapter 54 of the *Ṣābiʾ Zīj*. It deals with the astrological concept of the projection of the rays, for which Battānī was the first to take into account the latitudes of the planets.

5. A *Kitāb Maṭāliʿ al-burūj fī mā bayna arbāʿ al-falak* (On the ascensions of the zodiacal signs between [the cardinal points of] the quadrants of the sphere) is also mentioned by Ibn al-Nadīm and is probably identical with Chapter 55 of the *Zīj*. It provides methods of calculation needed in the astrological problem of finding the *tasyīr* (*aphesis* or *directio*).

According to Ibn al-Nadīm, Battānī lived for some time in Baghdad towards the end of his life, because of financial difficulties brought about by dealings with the family of the Banū al-Zayyāt (presumably descendents of the famous poet and vizier ʿAbd al-Malik ibn Abān al-Zayyāt) in Raqqa. On his way back to Raqqa, Battānī died at the castle Qaṣr al-Jaṣṣ near Samarra, 100 km north of Baghdad.

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