Biographical Encyclopedia of Astronomers

Battānī: Abū 'Abd Allah Muhammad ibn Jābir ibn Sinan al-Battānī al-Harrānī al-Şabi'

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 came from Harran in southern Anatolia, possibly from the Battān district of that city, which is mentioned by the famous 16th-century Egyptian scholar Suyūtī 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 Thabit ibn Qurra. From his first name Muhammad and his kunya Abū 'Abd Allah, we see that Battānī himself was a Muslim. In European works up to the 19th century, Battānī was mistakenly presented as a nobleman, a prince, or a king, but there is no justification for such attributions in Arabic sources.

Battānī was probably the son of Jabir ibn Sinan al-Harrānī, a well-known instrument maker from Harran mentioned by the earliest bibliographer of Muslim scientists, Ibn al-Nadim (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 establishing 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 one 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 to be 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 re-determined all planetary mean motions. He found the parameters of the lunar model to be in agreement with Ptolemy and the eccentricity of Venus to be the same as derived by the astronomers working under Ma'mūn. (See, for example, Yahya ibn Abi Manşür.) Battānī also confirmed the discovery of Ma'mūn'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 Moon's motion.

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-Nadim mentions that this work (later called *al-Zij al-Şabi'*) 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 *Şabi' Zij* 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 Zij in Latin, and this remains the standard work on Islamic astronomy in general and on Battānī and zījes in particular.

The *Şabi' Zij* is the earliest extant zij written completely in the Ptolemaic tradition with hardly any Indian or Sasanian-Iranian influences. As with many Islamic zījes, its purpose was much more practical than theoretical Although the planetary models and the determination of solar parameters are explained in some detail (but with various errors), most of the text in the Zij consists of instructions for carrying out practical calculations using 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. Based on 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 *Şabi' Zij* enjoyed a high reputation in the Islamic world and was very influential in medieval and Renaissance Europe. Bīrūnī wrote a treatise entitled *Jalā al-adhhān fī zīj al-Battānī* (Elucidation of genius in al-Battānī's Zīj), which is unfortunately lost. Later zījes such as those of Küshyār ibn Labbān, Nasawī, and Tabarī were based on Battānī's mean motion parameters In Spain, the *Şabi' Zij* exerted a large influence on the earliest astronomical developments and left many traces in the Toledo Tables. Two Latin translations of the Zij's canons 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 addi-tionibus 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 Şabi' Zij were written by Bar Hiyya (12th century) and Immanuel ben Jacob Bonfils (14th century); furthermore, Battānī's influence can also be seen in the works of Ibn Ezra, 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 Şabi' Zij, the following smaller works by Battānī are known:

1. The *Kitāb fi dalā'il al-qirānāt wa- 'l-kusufāt* (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 Muhammad and the early period of Islam. It is written in the tradition of Ptolemy's Tetrabiblos.

2. The *Sharh Kitab al-arba'a li-Batlamiyūs* (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 uşül tarkib 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 Şabi' Zīj, the authenticity of this work has been questioned.

4. A *Kitab tahqiq aqdār al-ittişālāt* [*bi-hasab urüd 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 Şabi' 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 Matāli al-burūj fi mā bayna arba 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-Nadim and is probably identical with Chapter 55 of the Zij. It provides methods of calculation needed in the astrological problem of finding the tasyîr (aphesis or directionio).

According to Ibn al-Nadim, Battani 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 Banu al-Zayyat (presumably descendants of the famous poet and vizier Abd al-Malik ibn Aban al-Zayyat) in Raqqa. On his way back to Raqqa, Battani died at the castle Qasr al-Jass near Samarra, 100 km north of Baghdad.

Benno van Dalen

Alternate name

Albategnius [Albatenius]

Selected References

Al-Qifsi, Jamal al-Din (1903). *Ta'rikh al-hukama'*, edited by J. Lippert. Leipzig: Theodor Weicher

Bagheri, Mohammad (1992). "Battani's Version of Trigonometric Formulas." *Tahqiqat-i Islāmī* (Journal of the Encyclopaedia Islamica Foundation, Tehran) 7, no. 2: 176-169 [sic]. (Edition and translation of Battani's small treatise on the sine.)

Bossong, Georg (1978). *Los canones de Albateni*. Tübingen: Niemeyer. (Edition and philological discussion of the Castilian translation of the canons of the Şabi' Zij.)

Bruin, Frans (1977). "The First Visibility of the Lunar Crescent." *Vistas in Astronomy* 21:331-358, esp. 345-357

Hartner, Willy (1970). "Al-Battānī." In *Dictionary of Scientific Biography*, edited by Charles Coulston Gillispie. Vol. 1, pp. 507-516. New York: Charles Scribner's Sons. (With a summary of the most important results found in Nal-lino 1899-1907.)

Hogendijk, Jan P. (1988). "New Light on the Lunar Crescent Visibility Table of Ya qüb ibn Tariq." *Journal of Near Eastern Studies* 47: 95-104. (Describes and analyzes Battāni's method for solving the typical Islamic problem of predicting the first visibility of the lunar crescent after the New Moon.)

Ibn al-Nadim (1970). *The Fihrist of al-Nadim: A Tenth-Century Survey of Muslim Culture*, edited and translated by Bayard Dodge. 2 vols. New York: Columbia University Press. (This and al-Qifţi are the main sources for information on al-Battānī's life.)

Kennedy, E. S. (1956). "A Survey of Islamic Astronomical Tables." *Transactions of the American Philosophical Society*, n.s., 46, pt. 2: 121–177, esp. 132–133 and 154–156. (Reprint, Philadelphia: American Philosophical Society, 1989.)

King, David A. (1986). "The Earliest Islamic Mathematical Methods and Tables for Finding the Direction of Mecca." *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 3: 82-149. (Discusses Battānī's approximate method for the determination of the qibla.)

Kunitzsch, Paul (1974). "New Light on al-Battāni's Zij." *Centaurus* 18: 270-274. (Corrects mistakes in Nallino's edition of the star table on the basis of a treatise by Ibn al-Şalāḥ, and confirms that Battānī used a Syriac or "old" Arabic version ofthe Almagest.)

Maeyama, Yasukatsu (1998). "Determination of the Sun's Orbit: Hipparchus, Ptolemy, al-Battāni, Copernicus, Tycho Brahe." *Archive for History of Exact Sciences* 53: 1-49. (Analyzes the sources of error in the solar observations of five important premodern astronomers.)

Nallino, Carlo Alfonso (1899-1907). Al-Battānī sive Albatenii Opus astronomi-cum (al-Zij al-Şabi'). 3 Vols. Milan: Ulrich Hoepli. (1960). "Al-Battāni." In *Encyclopaedia of Islam*. 2nd ed. Vol. 1, pp. 1104-1105. Leiden: E. J. Brill

Ragep, F. Jamil (1996). "Al-Battānī, Cosmology, and the Early History of Trepidation in Islam." *In From Baghdad to Barcelona: Essays on the History of the Islamic Exact Sciences in Honour of Prof. Juan Vernet, edited by Josep Casulleras and Julio Samsó*. Vol. 1, pp. 267-298. Barcelona: Instituto "Millás Vallicrosa" de Historia de la Ciencia árabe. (Argues that Battani provided a physical-cosmological alternative to Theon's simple arithmetic theory of trepidation and therewith influenced later developments in the western Islamic world.)

Said, Said S. and F. Richard Stephenson. "Solar and Lunar Eclipse Measurements by Medieval Muslim Astronomers." I: Background, II: Observations. *Journal for the History of Astronomy* 27 (1996): 259–273; 28 (1997): 29–48. (Translates and recomputes Battānī's eclipse reports.)

Sayılı, Aydın (1960). *The Observatory in Islam*. Ankara: Turkish Historical Society, esp. pp. 96–98

Sezgin, Fuat. *History of Arabic Literature*. Vol. 5, *Mathematics* (1974): 287-288; Vol. 6, *Astronomy* (1978): 182-187; Vol. 7, *Astrology - Meteorology and Related Subjects* (1979): 158-160. Leiden: E. J. Brill.

Swerdlow, Noel (1973). "Al-Battānī's Determination of the Solar Distance." *Centaurus* 17: 97-105. (Shows that Battani's treatment is different from Ptolemy's but likewise mathematically problematic, and that it involves some Indian elements.)

Yano, Michio and Mercè Viladrich (1991). "Tasyir Computation of Küshyär ibn Labban." *Historia Scientiarum*, no. 41: 1-16. (Relates Küshyär's method of calculating tasyīrs to those of Battāni.)