Bīrūnī: Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī

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Born **4 September 973**

Died **possibly Ghazna (Afghanistan)**, *circa* **1050**

Bīrūnī was one of the most accomplished scientists of the entire Middle Ages, and his interests extended to almost all branches of science. The total number of his works, mostly in Arabic, is 146, of which only 22 are extant. Approximately half of these writings are in the exact sciences. In addition to mathematics, astronomy, and astrology, he was accomplished in the fields of chronology, geography, pharmacology, and meteorology.

Bīrūnī was born in the "outskirts" (*bīrūn*) of Kāth, a city in the district of ancient Khwārizm, which is located south of the Aral Sea. At the beginning of his career, he worked for the Sāmānid ruler Manṣūr II, but due to political turmoil he had to change his patrons frequently. Eventually, he was captured as a political prisoner by the Ghaznawid Sultan Maḥmūd and was taken to Ghazna, where he remained until his death.

In his youth, Bīrūnī studied Greek science, especially astronomy. He was convinced of the importance of observation, and he recorded many of his own observations in his books. One of these works is his *Taḥdīd al-amākin* (Determination of coordinates of cities), which he wrote as a prisoner on his journey in 1018 from Khwārizm to Ghazna. In this book, Bīrūnī mentions a lunar eclipse of 997 that he observed in Khwārizm, having arranged a simultaneous observation with **Abū al-Wafāʾ al-Būzjāni** who was residing in Baghdad. Bīrūnī's aim was to find the difference in longitude of the two cities.

Bīrūnī's *The Chronology of the Ancient Nations*, written in about 1000, is a mine of information on calendars used by the Persians, Sogdians, Kwārizmians, Jews, Syrians, Ḥarrānians, Arabs, and Greeks. This is still one of the most reliable sources on ancient and medieval chronology. Bīrūnī does not mention much about India, because at this time he was not yet well informed about the Indian calendar.

In the second half of his life, Bīrūnī became more and more interested in Indian culture. This change may have been the result of his accompanying Sultan Mahmūd on several expeditions to India. By virtue of Bīrūnī's service as an interrogator of Indian prisoners, among whom were learned scholars, he was able to accumulate much knowledge of Indian culture, especially that of

the exact sciences written in Sanskrit. His studies on India resulted in his masterpiece called *India*, completed in 1030. With this book, Bīrūnī well deserves to be called "the first Indologist" in the modern sense of the word.

One may characterize Bīrūnī's attitude toward Indian culture as a mixture of sympathy and criticism; on the whole, he was fair and without prejudice. Because he was well acquainted with Greek science, Bīrūnī was able to compare Greek and Indian astronomy and make evaluative comments. The Indian astronomer whom he referred to most frequently was **Brahmagupta**. He even stated that he intended to translate Brahmagupta's *Brāhmasphuṭasiddhānta* into Arabic; however, since he was unable to complete it, he instead provided a table of contents.

Bīrūnī was most productive in the years around 1030, after Maḥmūd died and the throne passed on to his elder son Masʿūd, to whom Bīrūnī dedicated his *magnum opus* on astronomy, *al-Qānūn al-Masʿūdī*. The book consists of 11 treatises (*maqālas*), each containing several chapters (*bābs*); some chapters are further subdivided into sections (*faṣls*). Treatise I is an introduction, dealing with the principles and basic concepts of astronomy as well as cosmology, time, and space. Treatise II deals with calendars, the three best known being the Hijra, Greek (*i. e.*, Seleucid), and Persian. Treatise III is on trigonometry. Treatise IV takes up spherical astronomy. Treatise V discusses geodesy and mathematical geography. Treatise VI is on time differences, the solar motion, and the equation of time. Treatise VII deals with the lunar motion. Treatise VIII is on eclipses and crescent visibility. Treatise IX is on the fixed stars. Treatise X is on the planets. Treatise XI describes astrological operations.

Al-Qānūn al-Masʿūdī is primarily based on **Ptolemy**'s *Almagest*, but many new elements, of Indian, Iranian, and Arabic origin, are added. Bīrūnī also tried to improve Ptolemy's astronomical parameters using the observations that were made by his predecessors and by himself. He refers to the elements of Indian calendar and chronology in Treatises I and II. In Treatise III, after explaining the chords according to Ptolemy, he offers a table of sines as well as a table of tangents (gnomon shadows). The 1,029 fixed stars are tabulated in Table IX.5.2 following the model of those in the *Almagest* (where the number is 1,022). To the longitude of the stars in the *Almagest*, Bīrūnī added 13° according to the increase from Ptolemy's time due to the precession of equinoxes. The magnitudes of the stars are given in two columns, one based on the *Almagest* and the other from **Ṣūfī**'s book on 48 constellations. Bīrūnī's planetary theory, which is found in Treatise X, is essentially the same as Ptolemy's, with some modifications in the parameters. The last treatise is on the topic of astrology, which require highly advanced knowledge of mathematics; these include the equalization of the houses and the determination of the length of one's life by means of the computation of an arc called *tasyīr*.

Although *al-Qānūn al-Masʿūdī* did not have much influence in medieval Europe, the book was well read in the eastern half of the Muslim world and indeed further east. One example of this is that a very peculiar irregularity in Mercury's first equation table in the *al-Qānūn* can be attested to in the Chinese text *Huihui li* (composed in 1384).

Another major work of Bīrūnī is on astrology: *Kitāb al-tafhīm li-awāʾil ṣināʿat al-tanjīm*. The Arabic manuscript in the British Museum was published with an English translation by R. R. Wright. The translation, however, was made from a Persian version. This book is divided into three parts with the subject areas being mathematics, astronomy, and astrology. Bīrūnī's aim is very clearly stated by himself: "I have begun with geometry and proceeded to arithmetic and the science of numbers, then to the structure of the Universe, and finally to judicial astrology, for no one is worthy of the style and title of astrologer who is not thoroughly conversant with these four sciences."

It is undoubtedly because Bīrūnī and his work were not well known to medieval Europeans that his

Latinized name survives in a modern French dictionary as "aliboron," which means "stupid person" – clearly an inept description for this Islamic medieval polymath whose passion for knowledge was reflected in the scope and areas of interest he pursued.

Selected References

Al-Bīrūnī, Abū al-Rayḥān Muḥammad b. Aḥmad (1954–1956). *Al-Qānūn al-Mas'ūdī*. Hyderabad. (This book has been translated into Russian; for English readers, Kennedy prepared a very convenient table of contents with brief summaries in English.)

Ali, Jamil (trans.) (1967). *The Determination of the Coordinates of Cities: Al-Bīrūnī's Taḥdīd al-Amākin*. Beirut: American University of Beirut.

Barani, Syed Hasan (1951). "Muslim Researches in Geodesy." In *Al-Bīrūnī Commemoration Volume, A.H. 362–A.H. 1362*. Calcutta: Iran Society, pp. 1–52.

Boilot, D. J. (1955). "L'oeuvre d'al-Beruni, Essai bibliographique." *Mélange de l'Institut dominicain d'étude orientales* 2: 161–256.

Kennedy, E. S. (1970). "Al-Bīrūnī." In *Dictionary of Scientific Biography*, edited by Charles Coulston Gillispie. Vol. 2, pp. 147–158. New York: Charles Scribner's Sons.

——— (1971). "Al-Bīrūnī's Masudic Canon." *Al-Abhath* 24: 59–81. (Reprinted in E. S. Kennedy, Colleagues, and Former Students, *Studies in the Islamic Exact Sciences*, edited by David A. King and Mary Helen Kennedy. Beirut: American University of Beirut, 1983, pp. 573–595. [Contains a convenient table of contents of the *al-Qānūn al-Mas'ūdī* with brief summaries in English.])

——— (1973). *A Commentary Upon Bīrūnī's Kitāb Taḥdīd al-Amākin*. Beirut: American University of Beirut.

——— (1976). *The Exhaustive Treatise on Shadows by Abū al-Rayḥān Muḥammad b. Aḥmad al-Bīrūnī*, translation and commentary. 2 Vols. Aleppo: Institute for the History of Arabic Science.

Sachau, C. Edward (1879). *The Chronology of Ancient Nations*. London.

——— (1910). *Alberuni's India*. 2 Vols. Reissue of the 1888 edition. London.

Samsó, Julio (1996). "Al-Bīrūnī in al-Andalus." 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. 2, pp. 583–612. Barcelona: Instituto "Millás Vallicrosa" de Historia de la Ciencia Árabe.

Wright, R. Ramsey (1934). *The Book of Instruction in the Elements of the Art of Astrology*. London: Luzac and Co.

Yano, Michio (2002). "The First Equation Table for Mercury in the *Huihui li*." In *History of Oriental Astronomy*, edited by S. M. Razaullah Ansari, pp. 33–43. Dordrecht: Kluwer Academic Publishers.