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Jābir ibn Aflaḥ: Abū Muḥammad Jābir ibn Aflaḥ

Emilia Calvo

Flourished **probably Seville, (Spain), 12th century**

Jābir ibn Aflaḥ was a mathematician and astronomer in 12th-century Andalusia, who wrote a treatise entitled *Iṣlāḥ al-Majisṭi* (Correction of the *Almagest*) in which, as the title suggests, the author made a long series of criticisms and corrections of **Ptolemy**'s main astronomical treatise.

Little is known of Jābir's life. It seems that he was from Seville, since he is referred to in several sources as al-Ishbīlī. One of these sources is **Maimonides**; in his *Guide for the Perplexed*, he claims to have met Jābir's son. This reference suggests that Jābir was alive sometime between the end of the 11th century and the first half of the 12th century.

Jābir's main work is a commentary on Ptolemy's *Almagest*, a treatise that he had seen in two translations from the Greek. The *Almagest* is both the great synthesis and the culmination of mathematical astronomy of the ancient world, composed in Alexandria in the second century. It was translated into Arabic at least five times, and, from the late ninth century onward, constituted the basis of the mathematical astronomy carried out in the Islamic world.

In one of the preserved manuscripts (Berlin MS 5653), Jābir's work appears under the title *Iṣlāḥ al-Majisṭi* (Correction of the *Almagest*); in fact, it is a reworking of Ptolemy's work. Mathematical precision and proof seem to be Jābir's maximum aspiration in his *Iṣlāḥ*. It is divided into nine books. In the foreword, the author outlines the main differences between the *Iṣlāḥ* and the *Almagest*. The theorem of **Menelaus** that Ptolemy used is systematically replaced by theorems related to spherical triangles. These theorems were probably taken from mathematicians such as **Abū al-Wafā' al-Būzjānī** and **Abū Naṣr Manṣūr 'Alī ibn 'Irāq**, who were responsible for what has been called the "trigonometric revolution" in eastern Islam around the year 1000. In Andalusia, these theorems were formulated for the first time by **Ibn Mu'ādh** at the beginning of the 11th century. Somewhat surprisingly, Jābir does not mention any Arab authors in his treatise—not even Ibn Mu'ādh despite the fact that both authors were Andalusians.

Jābir's most notable divergence from Ptolemy concerns the model of the inferior planets, Venus and Mercury. Ptolemy placed them between the Moon and the Sun. He had to explain the fact that these two planets do not pass in front of the Sun by arguing that they are never on the line between the Sun and the view of the observer. Jābir affirmed that this argument was mistaken, and he placed these planets above the Sun.

Jābir criticizes Ptolemy harshly. He says that the mathematical basis of the *Almagest* should be

improved, though both the parameters and some planetary models had already been modified by previous Arab astronomers.

Jābir's work is the first criticism of the *Almagest* in the Islamic West. Its focus is original, far removed from that of the Aristotelian philosophers who launched the "Andalusian Revolt" against Ptolemy or from the criticisms of the astronomers at the Marāgha Observatory in the 13th century.

Jābir's criticisms of Ptolemy bear witness to his great mathematical ability but also suggest that his grasp of more practical matters was limited. It would have been extremely difficult to obtain the observations of planets required to apply his alternative methods.

The *Iṣlāḥ* is, clearly, the work of a theoretical author. The demonstrations include neither numerical examples nor tables. However, the work describes an instrument, which the author claims, can replace the four instruments described by Ptolemy for astronomical determinations. With the exception of **Zarqālī**'s armillary sphere, this is the first description in an Andalusian text of an instrument designed for astronomical observation. It is extremely large and has been considered a forerunner of the torquetum, an instrument of European tradition described for the first time in a 13th-century Latin text.

The text of the *Iṣlāḥ* was probably revised by the author himself—if not all, at least the section on trigonometry. It was later introduced in Egypt by Maimonides who, with one of his pupils, revised the text around 1185. In Andalusia, **Ibn Rushd** and **Biṭrūjī** were clearly influenced by this author.

During the 13th century the text spread in the East: a manuscript of this work, preserved in Berlin, was copied in Damascus in 1229. A summary of the text was also compiled by **Quṭb al-Dīn al-Shīrāzī**, a Persian astronomer and physicist.

Jābir's work seems to have had considerable influence upon Hebrew astronomy. There are two Hebrew translations of this work, one dating from 1274, by **Moshe ben Tibbon**, and the second by his nephew **Jacob ben Makhir**, revised in 1335 by Samuel ben Yehuda of Marseilles. Thanks to these Hebrew translations and the Latin translation, due to **Gerard of Cremona**, the text reached a wide readership in Europe.

In the Latin world, Jābir was considered a vigorous critic of Ptolemy's astronomy. His treatise helped to spread trigonometry in Europe; in the 13th century, the trigonometric theorems were used by the astronomers who compiled the *Libro del Cuadrante Sennero* (Book of the sine quadrant) working under the patronage of King **Alfonso X** the Wise. In the 14th century, **Richard of Wallingford** used the theorems in his work on the Albion. Jābir is probably the source of much of **Johann Müller**'s (Regiomontanus's) trigonometric work entitled *De triangulis* (On the triangles) although he is not mentioned. Finally, he may also be the source of the trigonometric section in **Nicolaus Copernicus**'s *De Revolutionibus* (On the revolutions [of the celestial spheres]).

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