KHWARIZMI, AL-

Abu Ja'far Muhammad ibn Musa al-Khwarizmi is remembered as the founder of *algebra; however, he was a scholar with interests and writings ranging across most of the ancient mathematical sciences. As his name indicates, he was probably of central Asian origin, although little else is known of his early life. From the dedications of his works, it is clear that he wrote for the Abbasid Caliph al-Ma'mun (813–833 C.E.) and was an active member of the circle of scholars in ninth century Baghdad, associated with the *Bayt al-hikma. These scholars worked for many patrons of the highest political and social circles—including caliphs and viziers—and produced a body of knowledge in Arabic that became the basis for advances in Islamic philosophy, medicine, mathematics, and engineering (Gutas). Before he died, sometime in the middle of the century, al-Khwarizmi's fame was established on the basis of his written works. Early in his reign, al-Ma'mun expressed a desire for practical *astrology and the mathematics required to support its application. Al-Khwarizmi filled this bill and more. His most famous text was the Handbook for Calculation by Completing and Balancing (Kitab al-muktasar fi hisab al-jabr wa'l-muqabalah). As the title indicates, the book demonstrates two main processes for solving equations. While he may have found both methods in Diophanes' Arithmetic and probably derived some of his terminology from Indian mathematical practice, it was al-Khwarizmi who brought these elements together. He shows that solvable equations take one of six standard forms. The remainder of the book deals with the practical applications of algebra to problems of inheritance, trade, and legacies, and he uses geometrical figures to explain equations. Confusing and ironic as it may be, al-Khwarizmi did not use any kind of numerical symbols or algebraic notation—all problems were discussed in words. This work became the foundational text of algebra, even within his lifetime. The Latin translation of this text was one of the crucial elements in the so-called Twelfth-Century Renaissance.

Also important to the history of mathematics, al-Khwarizmi wrote a small work on Calculation with Hindu Numerals. This book was clearly written after the Algebra, to which it refers. Like the Algebra, it appears to be the first work of its kind, treating the Hindu numbers and place-value notation as derived from Indian mathematics. It teaches the use of the numerals, the basic arithmetical operations, fractions, and the extraction of square roots. This work was not of great consequence in the Arabic-speaking world and the Arabic original has not survived. However, it had a revolutionary impact in Europe, in its Latin translation titled Algoritmi de numero Indorum (Khwarizmi on Indian Numbers), the deformation of his name yielding the modern mathematical term, algorithm. His third major work was his astronomical tables, or Zij al-Sindhind. This book described the positions of the planets, the Moon, and the Sun, based in a calendar and a specific location. It then included the tables and the instructions for computations of the positions of the heavenly bodies. Like the mathematical works, this was based on a Sanskrit original, known as Siddhanta. His tables indicate familiarity with Greek and Persian tables, as well as the Indian text; as in his other works, he was attempting a synthesis of the knowledge from the legacy of sources created in earlier civilizations. Surprisingly, none of the tables was correlated with observation, even though contemporary Baghdadi astronomers had already found more accurate values for some astronomical phenomena. Perhaps most surprising, the original text was based on the Yazdigird III calendar rather than the Hijra calendar. Because of its practical importance, this work had wide diffusion, appearing in Muslim Spain within his lifetime. Here, his original tables were studied by *Maslama of Madrid and his pupils whose adaptation, more accurate than the original, adjusted the tables to make them useful to astronomers in the West. This version was then translated by *Adelard of Bath and *Pedro Alfonso, and it is only this Latin version that survives complete whereas in Arabic only selections from the original survive.

Al-Khwarizmi's two other surviving works are the Geography and the Extraction of the Jewish Calendar. It appears that the Geography represents an important advance over *Ptolemy's work of the same name. It has been speculated that al-Khwarizmi's work was based on a world map constructed by a collection of scholars for al-Ma'mun; the Geography represents superior knowledge of the Islamic lands and the areas visited by Muslim traders and merchants. The work on the Jewish calendar is curious. He says that he wrote it because an explanation of that calendar was necessary for those who happen to use it. Its occasion or purpose remains obscure; perhaps it was used by historians and writers trying to reconcile the differences between the Islamic and Christian calculations of the annus mundi.

Al-Khwarizmi wrote several other books which do not seem to have survived: a Book on the Construction of the Astrolabe, a Book on the Use of the Astrolabe, a Book of the Sundial, and a Chronicle which is frequently quoted by later historians.

Al-Khwarizmi is one of the most influential medieval mathematicians and astronomers. While his creativity was inspired by borrowing, the developments, especially of algebra, were his own. Even though he was only one of a circle of savants working in al-Ma'mun's Baghdad, he is the only one who created a branch of knowledge and gave his name to a process: algebra and algorithm. Because he brought disparate elements together in a new structure of scientific knowledge, others were able to advance the science beyond his foundations. It is fair to characterize his work as more "practical" than "theoretical": his algebra, his astronomical tables, his geography, and his lost works all fulfill useful purposes. But precisely for this reason his works endured, especially in Western Europe.

See also

Astronomy, Islamic; Commercial arithmetic; Geography, chorography; Planetary tables

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