VITA

Ibn al-Haytham

Brief life of an Arab mathematician: died circa 1040

by ABDELHAMID I. SABRA

One of the most distinguished and prolific mathematicians in the medieval tradition of Arabic Islamic science, al-Ḥasan ibn al-Haytham (Latinized as Alhacen or Alhazen) became known in Europe in the thirteenth century as the author of a monumental book on optics—the mathematical theory of vision. In his *Kitâb al-Manâẓir* (*De aspectibus*), the eleventh-century scholar offered a new solution to the problem of vision, combining experimental investigations of the behavior of light with inventive geometrical proofs and constant forays into the psychology of visual perception—all systematically tied together to form a coherent alternative to the Euclidean and Ptolemaic theories of "visual rays" issuing from the eye.

Like his contemporaries Ibn Sînâ (Avicenna), the most influential Islamic philosopher, and al-Bîrûnî, one of the great scientific minds in all history, Ibn al-Haytham lived in a period of competitive patronage of the sciences, especially mathematics and astronomy, in the Middle East and Central Asia. He is said to have been a high administrative official in a small principality made up of Baṣra, in what is now Iraq, and the adjacent region of Ahwâz—but when the job encroached on his scientific interests, he moved to Egypt. He ended up living in what is described as a domed structure, probably a modest mausoleum, outside the Azhar Mosque and its famous school in Cairo. There he supported himself by teaching and by copying Arabic translations of Greek mathematical classics such as Euclid's *Elements* and Ptolemy's *Almagest*.

A story from the thirteenth century, which may well be true, says Ibn al-Haytham went to Egypt hoping to persuade its ruler to undertake an engineering project to regulate the flow of the Nile. But the prospective site, just south of Aswân, did not match the scholar's expectations, and he admitted failure. To escape almost certain punishment at the hands of the notoriously unbalanced ruler, he had to feign madness until his patron died, in 1021.

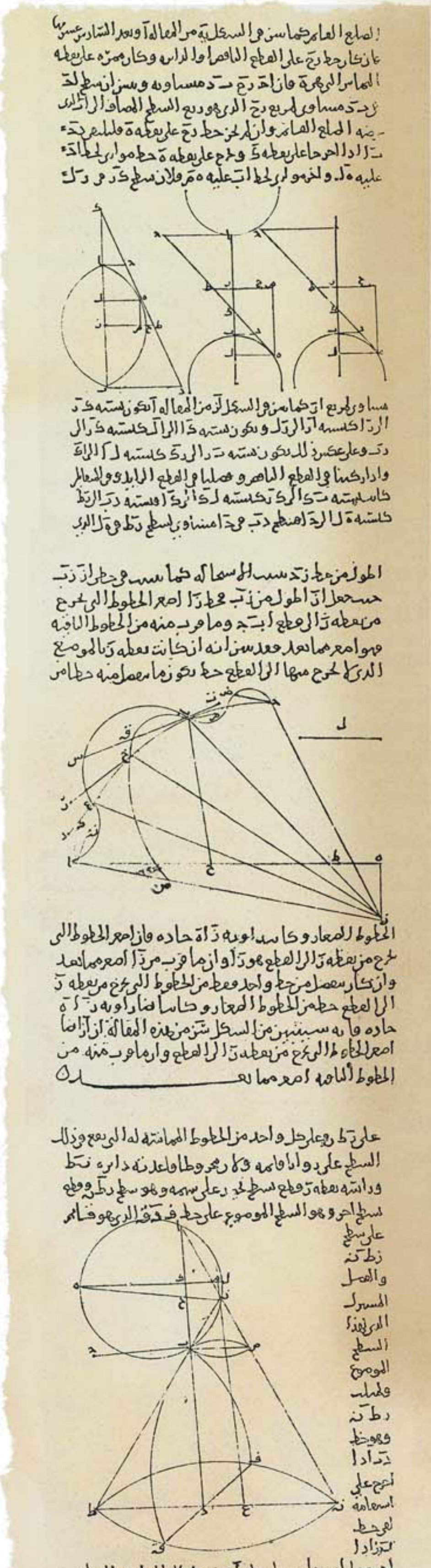
In a short autobiography, Ibn al-Haytham tells us that in his youth he scrutinized the claims of the many religious sects teeming around him. In the end it was the empirical strain and rational thinking he recognized in Aristotelian natural philosophy, and the rigor of mathematics, that finally won his heart. An early essay of his, now lost, was entitled "All matters secular and religious are the fruits of the philosophical sciences." In his time "philosophy" comprised all of mathematics, the natural sciences, and theology or metaphysics. He wrote on arithmetic, astronomy, music, ethics, politics, and poetry; defended astrology as a science based on mathematical proof; and criticized contemporary Muslim theological theses as well as positions taken by followers of the Christian philosopher-theologian Philoponus who were active in Baghdad.

Geometry was Ibn al-Haytham's forte: the subject in which most of his writings have survived and for which he was most appreciated. In these writings he was drawn to tackle problems in Greek mathematics, both elementary (Euclidean) and advanced (Apollonian and Archimedean), some of which he was the first to solve. The word "doubt" (*aporia* in Greek), indicating the critical bent of his mind, occurs in the titles of several of his geometrical essays, even when presented as commentaries. Other works concern the philosophy and methodology of mathematics.

But it was Ibn al-Haytham's early embrace of empiricism and trust in mathematical proof that underlay the revolutionary project of his mature magnum opus, the *Optics*, the book that pointed the science of vision in the direction later pursued in seventeenth-century Europe. It was wholly composed of systematically arranged experiments and geometrical proofs, all expressed in clear, consistent vocabulary and orderly exposition. The Latin translation influenced medieval European scientists and philosophers such as Roger Bacon and Witelo. But the book came into its own later, when it attracted the attention of mathematicians like Kepler, Descartes, and Huygens, thanks in part to Friedrich Risner's edition published in Basel in 1572.

Relatively late in his life, apparently stimulated by controversies with contemporaries about truth and authority and the role of criticism in scientific research, Ibn al-Haytham articulated some remarkably sophisticated statements on the practice of science and the growth of scientific knowledge. In a critical treatise, *Aporias against Ptolemy*, he asserts that "Truth is sought for itself"—but "the truths," he warns, "are immersed in uncertainties" and the scientific authorities (such as Ptolemy, whom he greatly respected) are "not immune from error...." Nor, he said, is human nature itself: "Therefore, the seeker after the truth is not one who studies the writings of the ancients and, following his natural disposition, puts his trust in them, but rather the one who suspects his faith in them and questions what he gathers from them, the one who submits to argument and demonstration, and not to the sayings of a human being whose nature is fraught with all kinds of imperfection and deficiency. Thus the duty of the man who investigates the writings of scientists, if learning the truth is his goal, is to make himself an enemy of all that he reads, and, applying his mind to the core and margins of its content, attack it from every side. He should also suspect himself as he performs his critical examination of it, so that he may avoid falling into either prejudice or leniency."

Abdelhamid I. Sabra is professor of the history of Arabic science emeritus.



At left: Proofs and diagrams from the Arabic translation of the Conics *of Apollonius, transcribed and drawn by Ibn al-Haytham himself (MS Aya Sofya, no. 2762, Istanbul). Above: Ibn al-Haytham (at left) and Galileo appear on the frontispiece of* Selenographia, *a 1647 description of the moon by Johannes Hevelius. The frontispiece presents the two scientists as explorers of nature by means of rational thought* (ratione*—note the geometrical diagram in Ibn al-Haytham's hand) and by observation* (sensu*—illustrated prominently by the long telescope in Galileo's hand). The two approaches were probably conceived here as complementary, a view both scientists would have shared.*

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