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Ibn al-Haytham: Abū ʿAlī al-Ḥasan ibn al-Ḥasan

Y. Tzvi Langermann

Alternate names

Alhazen

Born **Basra (Iraq), 965**

Died **Cairo (Egypt)**, ***circa* 1040**

Ibn al-Haytham (often referred to in the literature as Alhazen, the Latin version of al-Ḥasan) was one of the most important and influential figures in the history of science. He wrote on topics that included logic, ethics, politics, poetry, music, and theology (*kalām*), and produced summaries of **Aristotle** and Galen. His extant works are mostly on mathematics, optics, and astronomy. As a young man, Ibn al-Haytham moved to Egypt from Iraq and was involved in an abortive engineering project in Egypt on regulating the flow of the Nile. The sources do not agree on the details of the story; however, it is clear that after this brief try at government work, Ibn al-Haytham chose a life of quiet scholarship. He earned his living copying scientific manuscripts, and carried out extensive research and correspondence in philosophy and the sciences.

In his youth Ibn al-Haytham inquired into the different religions and came to the conclusion that the truth is one. This fundamental insight of gaining favor with God by seeking knowledge of the truth underlies some of his most important scientific activity. Specifically with regard to astronomy, Ibn al-Haytham was troubled by inconsistencies in the treatment of problems of interest to astronomy and two other disciplines, natural philosophy and optics. His most repercussive writings critically examine the issues and propose solutions.

At least since Aristotle, it has been taken for a fact that the motions of the celestial bodies are uniform and circular, and that the stars are embedded within a set of concentric spheres. However, astronomy had progressed much in the intervening centuries; in particular, the *Almagest*, **Ptolemy**'s landmark text, had set out a theory far more detailed and complex than anything Aristotle had proposed. True, Ptolemy himself had tried to give a physical account in his *Planetary Hypotheses*. However, no one was quite sure how all the pieces fit together. Moreover, some of the mathematical devices that Ptolemy had employed, for example, the equant or lunar prosneusis, were in direct violation of the principle of uniform circular motion about a fixed center.

Ibn al-Haytham addressed these issues in a number of his writings. In his *al-Shukūk ʿalā Baṭlamyūs* (Doubts concerning Ptolemy), a thoroughgoing critique of the *Almagest, Planetary Hypotheses*, and *Optics*, he showed in great detail where and how Ptolemy had violated the principles of natural philosophy. An early monograph, which does not survive but which is mentioned in a later defense of his views and is summarized by **Naṣīr al-Dīn al-Ṭūsī**, attempts to provide a physical solution for one of the knottiest problems, the motion called *iltifāf*, which was produced by Ptolemy's models for the motion in latitude of the planets.

Fī Hay'at al-'ālam (On the configuration of the world) is perhaps Ibn al-Haytham's most ambitious effort in this area of research; it certainly was his most influential astronomical writing. Like other books of the genre known as *hay'a* (a cosmography of the Universe), Ibn al-Haytham's treatise explains basic astronomical concepts (*e. g.*, longitude, latitude, and altitude) and discusses mathematical geography. This work proposes to match the geometry of mathematical astronomy to the three-dimensional picture endorsed by natural philosophy, so that the reader will be aware of the identity between the two systems. However, Ibn al-Haytham does this only schematically. That is to say, in each of the chapters devoted to the planets, he first describes the three-dimensional orbs, moving inward from the planet to the center of the Earth; this is the depiction of natural philosophy. Ibn al-Haytham then reverses this description, this time showing how these orbs are in fact the intersections of the three-dimensional bodies with the planes of the circles produced by either the planet or devices such as the center of the epicycle; these are the geometrical constructs of the astronomers. Note that the outstanding problems of celestial physics – those elucidated in detail in the *Doubts* – are left unresolved. Nonetheless, *On the Configuration* does give a consistent report in which both the philosophical and the mathematical accounts harmonize. As noted above, the book was widely repercussive, especially in translation; two different Latin translations are extant, and no less than five different Hebrew translations have been identified.

The divergences between the physical and the mathematical accounts were fundamental, and their resolution required a rethinking of astronomical modeling. Ibn al-Haytham provided only basic direction in this matter; however, his influence is felt on later people, most notably Naṣīr al-Dīn al-Ṭūsī, who worked toward a fuller resolution of the issues.

The conflicts between astronomy and optics were far less serious, affecting only some specific problems. The so called Moon illusion, *i. e.*, the apparent enlargement of celestial bodies and the distances between them when they lie low on the horizon, occupied Ibn al-Haytham's attention throughout his career. In his youthful commentary to the *Almagest*, he endorsed and even provided with "proof" Ptolemy's remarks that the enlargement is produced by refraction through the Earth's "vapors" (*i. e.*, atmosphere), similar to the way bodies immersed in water are magnified. In a later monograph devoted exclusively to this topic, *Fī Ru'yat al-kawākib* (On seeing the stars), he distanced himself somewhat from Ptolemy's explanation. In his masterful compendium *al-Manāẓir* (Optics) Ibn al-Haytham correctly identified the problem as one belonging to the psychology of perception, though he did allow that thick vapors could sometimes be a secondary factor.

Ibn al-Haytham's writings are distinguished by a clarity of exposition and originality of approach. He contributed to the technical literature on astronomy, but at the same time he strove to make astronomical knowledge accessible to a wider public. *On the Configuration* employs minimal mathematics. It could thus be understood by philosophers, the audience most troubled by the discrepancies between mathematics and physics; this is probably one reason for its great success. Ibn al-Haytham's commentary to the *Almagest*, unlike other commentaries that had been written before, aimed to clarify obscure points for the beginner. His monograph *Fī Kayfiyyat al-arṣād* (On the method of [astronomical] observations) offers a historical explanation, unique in medieval literature, of how astronomical theory was built on observation.

Ibn al-Haytham also authored several monographs on isolated problems, such as the determination of the meridian and of the *qibla* (*i. e.*, the direction of Mecca), sundials, and the visible appearance of the lunar surface.

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