The Institute of Ismaili Studies

Ibn al-Haytham, or Alhazen

Medieval Islamic Civilization, An Encyclopaedia

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The polymath Abu Ali al-Hasan ibn al-Haytham (ca. 965-1041 CE), known in Latin as Alhazen, was born in Basra, Iraq. After completing his studies in Iraq, he settled in Egypt, wherein he was commissioned by the Fatimid imam_caliph al-Hakim (1021 CE) to design a dam on the Nile. Although his prolific contributions covered a variety of disciplines in mathematics, astronomy, and mechanics, his impact was greatest in the field of optics. His chef-d'ouvre *Kitab al-Manazir* (*The Optics*, ca. 1027 CE), which was translated into Latin as *De aspectibus* (ca. 1270 CE), decisively shaped the emerging theory of perspective in medieval and Renaissance science and art. His influence is noticeable in medieval scholars such as Roger Bacon, John Peckam, and Witelo, and in Renaissance theorists such as Leon Battista Alberti and Lorenzo Ghiberti.

In medieval science in Islam, Kamal al-Din al-Farisi's *Tanqih al-Manazir* (*The Revision of the Optics*) advanced the most substantive critical interpretation of Ibn al-Haytham. His theory of vision constituted an outstanding achievement in optics in the period between Claudius Ptolemy and Johannes Kepler. He resolved the ancient Greek dispute over the nature and causation of vision, which had either been derived, in physical terms, from the intromission of the form of a visible object into the eye or from the mathematical model of the extromission of a cone of light from the eye. Following physicists like Aristotle, Ibn al-Haytham argued that vision occurs by intromission of the luminous form of the visible object into the eye. However, in elucidating this process, he employed the model of the cone of vision as formulated by mathematicians such as Euclid and Ptolemy. He thus demonstrated that vision results from the intromission of a luminous form by way of the rectilinear propagation of light through a transparent medium; there is a virtual cone whose vertex is in the centre of the eye and whose base is on the surface of the visible entity. He also held that visual perception is not a mere sensation but is primarily an inferential act of discernment and judgement.

Moreover, he supplemented his *Optics* with *Treatise on Light* (*Risala fi l-Daw'*), which further investigated the essence and comportment of luminosity and its radiant dispersion through various transparent and translucent media. His ocular observations were founded on anatomical examinations of the structure of the eye, as well as being supported by experimental installations devised to detect errors and illusions in visual perception and to explore phenomena like the *camera obscura* (the darkroom principle behind the pinhole camera). Ibn al-Haytham also investigated meteorological aspects related to the rainbow and to the density of the atmosphere, as well as inquiring about the nature of celestial phenomena such as the eclipse, the twilight, and moonlight. In this endeavour, he relied on his accounts of refraction and on catoptrical experimentations with spherical and parabolic mirrors and magnifying lenses.

He also presented a thorough critique of the conception of place (*topos*) as set in Aristotle's *Physics*, wherein it was stated that the place of something is the two-dimensional boundary of the containing body that is at rest and is in contact with what it contains. In contrast with this definition, Ibn al-Haytham rather attempted to demonstrate in his *Risala fi'l-makan* (*Treatise on Place*) that place (*al-makan*) is the imagined three-dimensional void between the inner surfaces of the containing body. Consequently, he showed that place was akin to space in a manner that prefigures Descartes' *extensio*. Building on the legacy of Euclid, and partly informed by the works of the mathematician Thabit ibn Qurra (d. 901 CE), Ibn al-Haytham further systematised the arts of analytical geometry (linking algebra to geometry), infinitesimal mathematics, conics, and number theory. In addition, he studied the mechanics of the first law of motion according to which it is held that a body moves perpetually unless prevented from doing so by an external force that arrests it or alters its direction. In examining the attraction between masses, he also seems to have been tangentially aware of the magnitude of acceleration due to a principle akin to the force of gravity. A pioneer in his pursuits, he also strived to develop rigorous experimental methods of controlled scientific testing in view of verifying theoretical hypotheses and substantiating inductive conjectures.

Primary Sources

Ibn al Haytham, *Kitab al-manazir*. Edited by Abdelhamid I. Sabra. Kuwait: National Council for Culture, Arts and Letters, 1983.
-- *The Optics of Ibn al-Haytham, Books I-III, On Direct Vision*. Translated by Abdelhamid I. Sabra. London: The Warburg Institute, University of London, 1989
-- *Majmu' al rasa'il*. Haydar Abad: Da'irat al-Ma'arif al-'Uthmaniyya, 1937.

Further Reading

Beshara, Saleh O. *Ibn al Haytham's Optics: A Study of the Origins of Experimental Science*. Minneapolis: Bibliotheca Islamica, 1977.

Nasif, Mustafa. *al-Hasan bin al-Haytham*. 2 vols. Cairo: *Matba'at al nuri*, 1942-1943.

Rashed, Roshdi. Les mathématiques infinitésimales du IXe au XIe siècle: Ibn al-Haytham, Volumes II-IV. London: al-Furqan Islamic Heritage Foundation, 1993-2002.

Sabra, Abdelhamid I. "The Physical and the Mathematical in Ibn al-Haytham's Theory of Light and Vision." In *The Commemoration Volume of Biruni International Congress in Tehran*. Vol. 38. Tehran: High Council of Culture and Arts, 1976.

-- "Sensation and Inference in Alhazen's Theory of Visual Perception." In *Studies in Perception: Interrelations in the History of Philosophy and Science*. Edited by Peter K. Machamer and Robert G. Turnbull. Ohio: Ohio State University Press, 1978.

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