Optics
In 1890 Leopold Schnaase gave an excellent evaluation of Ibn al-Haitam’s (d. around 1041) “Optics” and its significance, on the basis of its Latin translation. This evaluation was corroborated in a masterly way by Schramm’s study. Referring to Ibn al-Haitam with the Latinized form of his name, Schnaase writes: “A comparison of Alhazen’s achievements with those of Ptolemy shows what remarkable progress optics owe especially to the former; Alhazen was the first physicist to take into account the anatomy of the eye and to develop, on that basis, an elaborate theory of vision, a theory which—in spite of incorrect premises on the functions of the crystal lens—achieved results that almost agree with modern findings. The assumptions and experiments by which he determines the conditions of seeing single and double images must be regarded as his discoveries. Furthermore, he was the first to find definite proof that the theory of visual rays is incorrect, thus removing this theory once and for all from physics and establishing its opposite—a shift in the fundamentals of optics which was of far-reaching consequence. Even the claim that the transmission of light takes a certain time was already made by him. What a tremendous gap separates Ptolemy and Alhazen, the Greek and the Arabic school in this regard!” (Catalogue I, p. 30)
Visual Perception

Like his Arab predecessors Abū Bakr ar-Rāzī (d. 925), al-Fārābī (d. 950) and his contemporary Ibn Sinā (d. 1037), and opposing Euclid and Ptolemy, Ibn al-Haṭṭām (d. ca. 1041) supported the Aristotelian view according to which visual perception does not involve rays emanating from the eye but rays emanating from the object. Mathematics and experiment always remain in the foreground in all the problems he addressed, not only in the case of visual perception. According to Schramm, the “Optics” display the mathematical genius of their author. For experimental purposes, Ibn al-Haṭṭām constructed several instruments and devices, including a camera obscura. (Catalogue I, p. 29)

Measuring the Height of the Atmosphere

Attempts by Arabic–Islamic scholars to measure the height of the atmosphere by optical and astronomical methods are known from the 11th century CE. The earliest treatment of the question is to be found in the Latin translation of the work by Muḥammad b. Yūsuf b. Muʿād (11th c.). The basic idea and its reduction to a trigonometric equation has occupied the attention of many scholars in the Occident for centuries since the translation of the treatise under the title De crepusculis ed nubium ascensionibus. (Sezgin, Geschichte des arabischen Schrifttums VI, p. 44)

The height of the atmosphere \( h \) is to be measured

Use of Segments made of Glass

A particularly remarkable achievement of the experiments of Ibn al-Haṭṭām (d. ca 1041) is the discovery of the magnifying power of spherical segments made of glass, a discovery that certainly had some influence on the early development of spectacle lenses. (Catalogue I, p. 30)
Explanation of the Phenomenon of the Rainbow

In the field of optics in the 14th century the Arabic-Islamic world proved to be as creative as ever and produced one of the most important scholars of the time. We are referring to Kamāladdīn Muḥammad b. al-Ḥasan al-Fārisī (b. 1267, d. 1318), otherwise known as an outstanding physicist and mathematician. He wrote a monumental commentary, Tanqīḥ Kitāb al-Manżīr, on the “Optics” of Ibn al-Haitham which has not yet been exhaustively studied; in it we find an epochal explanation of the phenomenon of the rainbow, the like of which his predecessors Ibn al-Haitham and Ibn Sīnā in the 11th century, despite their attempts, had not been able to give. In Kamāladdīn al-Fārisī’s opinion, the perception of a rainbow is caused by the optical behaviour of fine transparent spherical drops close to each other in the air, through double refraction and single or double reflection of the sunlight as it enters into and comes out of the individual drop. Kamāladdīn came to this conclusion after a series of systematic experiments conducted with a spherical ball made of glass or rock-crystal.

With regards to the history of reception of Arabic–Islamic sciences in the West, it is of particular significance that Kamāladdīn’s explanation of the phenomenon of the rainbow appears again with a few minor alterations in the treatise De iride et radialibus impressibus by Dietrich of Freiberg (Theodoricus Teutonicus), a little known Dominican monk in the first decade of the 14th century. (Catalogue I, p. 56; III, pp. 166-167)

Geometrical representation of the explanation of the light refraction in the generation of the rainbow, by Kamāladdīn al-Fārisī, Tanqīḥ, Haydarabad, Vol. 2, fig. 192.
The well-known optical-mathematical “problem of Ibn al-Haṭṭām” is discussed here because of the fact that Leonardo da Vinci (1452–1519) constructed an apparatus for its mechanical-graphical solution. In 1910 Otto Werner expressed the view that Leonardo seems to have had amongst his sources the great book on optics (Kitāb al-Manāẓir) by Ibn al-Haṭṭām and that from there he knew of the problem to find the point of reflection with spherical, cylindrical and conical mirrors and attempted their solution. Werner surmised that Leonardo used Ibn al-Haṭṭām’s book in an Italian translation. The problem, treated in the 5th tract (maqāla) of Ibn al-Haṭṭām’s book, has to do with the definition of the point of reflection on spherical, cylindrical, conical, convex as well as concave mirrors when the two values of “eye” and “luminous point” are given. “The problem in its general form leads analytically to an equation of the 4th degree.”

In the West the problem was included by Vitello in his book on optics already in 1270. His detailed treatment of the subject was “copied or rephrased” from the Latin translation of Ibn al-Haṭṭām’s Kitāb al-Manāẓir. After Leonardo da Vinci, it was Isaac Barrow (1669) who occupied himself with the problem. Then René François de Sluse (1673), Christiaan Huyghens (1695), Guillaume François Antoine d’Hospital (1720), Robert Simson (1st half 18th c.), Abraham Gotthelf Kästner (1719–1800), Thomas Leybourn (1817) and Charles Hutton (1737–1823) attempted to solve the problem. Kästner wanted “to solve the problem without the construction of the hyperbola which had no practical use.” Five years after Kästner, William Wales published a study “in which Alhazen’s problem is used as an example for a method of solving equations of higher degrees through approximation with the help of trigonometric functions.” (Catalogue I, p. 187)
That the historiography of sciences in our times considers Ibn al-Ha'tam (b. ca. 965, d. after 1041) the true inventor of the camera obscura was the result solely of the research on this subject done and inspired by Eilhard Wiedemann since the first decade of the 20th century. Before that several occidental scholars were considered its inventors, among them Roger Bacon (d. ca. 1290), Witelo (Vitellius, Vitellio, d. ca. 1280), John Peckham (Pecham, d. 1292), Levi ben Gerson (d. 1344), Leone Battista Alberti (1404–1472), Leonardo da Vinci (1452–1519), Francesco Maurolico (1494–1575) or Giambattista della Porta (d. 1615).

Our model serves to demonstrate the basic principles of the method of representation of the camera obscura, according to the descriptions of Ibn al-Ha'tam and Kamāladdīn al-Fārisī. The form of the model is the material expression of the image visualized by us. (Catalogue III, p. 184–186)

Apparatus for the study of the refraction of light designed by Ibn al-Ha'tam (d. after 1041 CE). Our model was made after his description.

(Cat. III, 178; E 2.03)
Device for the study of the reflection of light. Our model was made after the description of the eminent astronomer, mathematician, physicist and optician Ibn al-Haitham (d. after 1041 CE).

(Cat. III, 172; E 2.06)

Instrument for observing the moonlight according to Ibn al-Haitham (d. after 1041 CE).

(Cat. III, 174; E 2.07)

Experimental Setup by Ibn al-Haitham (d. after 1041 CE), in order to demonstrate that the rays of early morning light travel in straight lines. Model after Kamāladdīn al-Fārisī’s description.

(Cat. III, 180; E 2.05)

Experimental Setup by Ibn al-Haitham (d. after 1041 CE) to demonstrate that accidental light travels in straight lines. Our model of this intricate setup follows the interpretation of Muṣṭafā Nazif.

(Cat. III, 182; E 2.04)