

PUBLICATIONS OF A. I. SABRA

-First Before 1996-

(Asterisks mark publications in book form.)

1954

“Note on a Suggested Modification of Newton’s Corpuscular Theory of Light to Reconcile it with Foucault’s Experiment of 1850.”

In: *British Journal for the Philosophy of Science*, 5(1954), pp. 149-51.

1959a

“*Burhān Naṣīr al-Dīn al-Ṭūsī ‘alā muṣādarat Uqlīdis al-khāmisa.*”

[Naṣīr al-Dīn al-Ṭūsī’s Proof of Euclid’s Fifth Postulate. Edition of the Arabic text in Ṭūsī’s Recension (*Tahrīr*) of Euclid’s *Elements*.]

In: *Bulletin of the Faculty of Arts of the University of Alexandria*, 13(1959), pp. 133-70.

1959b*

Uqm al-Madhab al-Tārikhī.

— Arabic translation of Karl Popper, *The Poverty of Historicism*.

Alexandria: Munsha’at al-Ma’ārif, 1959. — (See below, 2nd edition, 1992b*.)

1960a

“Developments of Theories of Light: from Ibn al-Haytham to the Present Time.”

Cairo: Publications of the Egyptian Scientific Association, 1960.

[In Arabic, “*Taṭawwur al-naẓariyyāt fī ‘ilm al-ḍaw’ min Ibn al-Haytham ilā ‘l-waqt al-ḥāḍir*, pp. 72-95.”]

1960b*

Al-‘ilm al-qadīm wa ‘l-madaniyya ‘l-ḥadītha.

— Arabic translation of George Sarton’s “*Ancient Science and Modern Civilization*. — Cairo: Franklin Publications, 1960.

1961a*

Umar al-Khayyām: Explanation of Difficulties in Euclid’s Postulates.

— Edition of the Arabic text of Khayyām’s *Risāla fī Sharḥ mā ashkala min muṣādarāt Kitāb Uqlīdis*. — Alexandria: Munsha’at al-Ma’ārif, 1961.

1961b*

Naẓariyyat al-Qiyās al-Aristīyya, min wijhat naẓar al-manṭiq al-ṣūrī al-ḥadīth.

— Arabic translation of the second, enlarged edition of Jan Lukasiewicz, *Aristotle's Syllogistic, from the point of view of modern formal Logic*, Oxford: Clarendon Press, 1957/8. — Alexandria: Munsha'at al-Ma'arif, 1961.

1961c

“Czeslaw Lejewski: Jan Lukasiewicz and the Warsaw School of Logic,”
— Arabic translation included in 1961b*, pp. 45-69.

1962

“Explanation of Optical Reflection and Refraction: Ibn al-Haytham, Descartes, Newton.”

In: *Actes du X^e Congrès International d'Histoire des Sciences*, Ithaca-26 VIII-2, IX, 1962 (published, Paris, 1964), pp. 551-54.

1963

“Newton and the ‘Bigness’ of Vibrations,”

In: *Isis*, 54(1963), pp. 267-68.

1965a

“A Twelfth-Century defence of the Fourth Figure of the Syllogism.”

In: *Journal of the Warburg and Courtauld Institutes*, 28(1965), pp. 10-28.

[Includes a facsimile of the *Maqāla* by Abū 'l-Futūḥ Aḥmad ibn Muḥammad ibn al-Sarī, *Fī al-Shakl al-rābi' min ashkāl al-qiyās al-ḥamlī wa-huwa 'l-shakl al-mansūb ilā Jālīnūs*, MS Ayasofya 4830, fols. 123a-128b.]

1965b

“Problems of Scientific Borrowing: The Historical Background.”

In: *Science and Technology in the Eastern Arab Countries: Seventeenth Annual Near Eastern Conference*, Princeton University, 1965, pp. 3-14.

1965c

“Review of: *Al-Fārābī's Short Commentary on Aristotle's Prior Analytics*, translated from the original Arabic with Introduction and notes by Nicholas Rescher.

University of Pittsburgh Press, 1963.”

In: *Journal of the American Oriental Society*, 85(1965), pp. 241-43.

1966

“Ibn al-Haytham's Criticism of Ptolemy's Optics.”

In: *Journal of the History of Philosophy*, 4(1966), pp.145-49.

[Includes English translation of the section dealing with Ptolemy's *Optics* in Ibn al-Haytham's treatise, *al-Shukūk 'alā Baṭlamyūs*. — See below: 1971a.

1967a

“The authorship of the *Liber de crepusculis*, an eleventh-century work on Atmospheric Refraction.”

In: *Isis*, 58(1967), pp. 77-85.

1967b*

Theories of Light from Descartes to Newton, London: Oldbourne, 1967.

— See below for the 2nd edition, 1981*.

1968a

“The Astronomical Origin of Ibn al-Haytham's Concept of Experiment.”

In: *Actes du XIII^e Congrès International d'Histoire des Sciences*, Paris 1968, T.IIIA. Published, Paris, 1971, pp. 133-36.

1968b

Review of: Seyyed Hossein Nasr, *An Introduction to Islamic Cosmological Doctrines*, Cambridge, MA: Harvard University Press, 1964.

In: *Journal of the American Oriental Society*, 88(1968), pp. 602-04.

1968c

“Thābit ibn Qurra on Euclid's Parellels Postulate.”

In: *Journal of the Warburg and Courtauld Institutes*, 31(1968), pp. 12-32.

1969

“Simplicius's Proof of Euclid's Parallels Postulate.”

In: *Journal of the Warburg and Courtauld Institutes*, 32(1969), pp. 1-24.

1970-80

Dictionary of Scientific Biography. Associate editor in charge of articles on Arabic/Islamic subjects. 16 volumes. — Editor in Chief: Charles C. Gillispie. New York: Charles Scribner's Sons, 1970-80.

1971a*

Ibn al-Haytham's *al-Shukūk 'alā Baṭlamyūs* = *Dubitaciones in Ptolemaeum*, or *Aporiae Against Ptolemy*.

— Edition of the Arabic Text, Cairo: Dār al-Kutub, 1971. — Co-editor: N. [al] Shehaby. — See below, second edition, 1996c*.

1971b

Article on: “al-Farghānī.”

In: *Dictionary of Scientific Biography*, IV(1971), pp. 541-45. — See above 1970-1980.

1971c

Article on: “*ʿIlm al-Ḥisāb*, The Science of Reckoning, Arithmetic.”

In: *Encyclopaedia of Islam*, New Edition, III(1971), pp.1138-41.

1972

Article on: “Ibn al-Haytham.”

In: *Dictionary of Scientific Biography*, VI(1972), pp. 189-210. — See above 1970-80.

1973

Article on: “al-Jawharī.”

In: *Dictionary of Scientific Biography*, VII(1973), pp. 79-80. — See above 1970-80.

1974

Article on: “al-Nayrīzī.”

In: *Dictionary of Scientific Biography*, X(1974), pp. 5-7. — See above 1970-80.

1975a

“Abū ʿAlī, al-Ḥasan ibn al-Haytham (Alhazen).”

In: John R. Hayes, ed., *The Genius of Arab Civilization* [see below 1975c], pp. 138-39. — Arabic translation in *ʿAbqariyyat al-Ḥaḍāra ʿl-ʿArabiyya*, [see below, 1975c, pp. 150-51].

1975b

“Abū ʿl-Ḥasan Thābit ibn Qurra al-Ṣābiʿ al-Ḥarrāni.”

In: John R. Hayes, ed., *The Genius of Arab Civilization* [see 1975c], pp. 140-41. Arabic translation in *ʿAbqariyyat al-Ḥaḍāra ʿl-ʿArabiyya* [see 1975c], pp. 152-53.

1975c

“The Exact Sciences.”

In: John R. Hayes, ed., *The Genius of Arab Civilization*, New York: New York University Press, 1975; Oxford: Phaidon, 1976, pp. 121-35. Arabic translation in *ʿAbqariyyat al-Ḥaḍāra ʿl-ʿArabiyya*, Cambridge, MA: MIT Press, 1978, pp. 133-47.

1975d

“The Sons of Mūsā ibn Shākir (Banū Mūsā),”

In: John R. Hayes, ed., *The Genius of Arab Civilization* [see 1975c], pp. 136-37.

Arabic translation in *‘Abqariyyat al-Ḥaḍāra al-‘Arabiyya* [see 1975c], pp. 148-49.

1976a

“The Scientific Enterprise.”

In: Bernard Lewis, ed., *The World of Islam*, London: Thames and Hudson, 1976, pp. 181-200 = *Islam and the Arab World*, New York: Alfred Knopf, 1976.

1976b

“The Physical and the Mathematical in Alhazen’s Theory of Vision.”

In: *The Commemoration Volume of Birūnī International Congress*, Tehran, Council of Culture and Art, Publication no. 38, Tehran, 1976.

— First delivered at the International Conference of the History and Philosophy of Science, Jyväskylä, Finland, 1973.

— [For a corrected version, see below, 1994a, Chapter VII, pages numbered 1-20.]

1976c

“*Tārīkh al-‘ulūm ‘inda l-‘Arab: ahdāfuhu wa mushkilātuhu.*”

— [The study of the History of Arabic Science: Prospects and Problems.]

Proceedings of the First International Symposium for the History of Arabic Science, 5-12 April, 1976. Vol. I(Arabic Section), Aleppo, 1977, pp. 59-79.

1977a

“Ibn al-Haytham and the Visual-Ray Hypothesis.”

In: S.N. Nasr, ed., *Ismā‘īlī Contributions to Islamic Culture*, Tehran: Imperial Iranian Academy of Philosophy, 1977.

1977b*

Ibn Sīnā’s ‘Uṣūl al-handasa. [Edition of the Arabic text of Avicenna’s “Elements of [Euclidean] Geometry,” being the First Part (*al-Fann al-Awwal*) of the First Section (*al-Jumla al-‘Ulā*) of *Kitāb al-Shifā’*.]

— [This consists of condensed proofs of all theorems of the Thirteen Books of Euclid’s Elements and the so-called “books XIV and XV.”] — Co-editor: A. Luṭfi. General editor: Ibrahim Madkour. Cairo: Al-Hay’a al-Miṣriyya al-‘Āmma li-l-Kitāb, 1977. — See below, 1980c.

1977c

“*Ibn Sīnā wa Kitāb ‘Uqlīdis fī l-Uṣūl*” [Avicenna and Euclid’s *Elements*], in *Ibn Sīnā’s Uṣūl al-handasa* [1977b], pp.3-13. - Reprinted with corrections, in 1980c.

1977d

“*Maqālat al-Ḥasan ibn al-Haytham fī l-Athar al-zāhir fī wajh al-qamar.*”

— [Edition of the Arabic text of Ibn al-Haytham’s *Treatise on the Mark Seen on the Face of the Moon*],”

In: *Journal for the History of Arabic Science*, vol. I, no. 1, May 1977, Arabic Section, pp. 5-19, English summary, p. 19.

1977e

“A Note on Codex Bibliotheca Medicea Laurenzeana, Or.152.”

In: *Journal for the History of Arabic Science*, vol. 1, no. 2, pp. 276-83.

1978a

“*Ibn Rushd wa mawqifuhu min falak Baṭlamyūs,*” [Averroes on Ptolemaic Astronomy].”

In: *Proceedings of the Commemoration Conference on Averroes*, organized by the Arab League Educational, Scientific and Cultural Organization: Algiers, 4-10, November 1978, vol.2, 13 pages.

1978b

“al-Khwārazmī, Abū ‘AbdAllāh Muḥammad ibn Aḥmad ibn Yūsuf al-Kātib.”

In: *Encyclopaedia of Islam*, New Edition, IV(1978), pp. 1068-69.

1978c

“*Maqālat al-Ḥasan ibn al-Haytham fī kayfiyyat al-arṣād.*”

— Edition of the Arabic Text of *Ibn al-Haytham’s Treatise on the Method of [Astronomical] Observations.*

In: *Journal for the History of Arabic Science*, vol. 2, no. 1, May 1978. Arabic Section, pp. 3-37, English summary, p. 155.

1978d

“An Eleventh-Century Refutation of Ptolemy’s Planetary Theory.”

In: *Science and History: Studies in Honor of Edward Rosen (Studia Copernicana XVI)*, The Polish Academy of Sciences Press, Wrocław etc., 1978, pp. 117-31.

1978e

“Sensation and Inference in Alhazen’s Theory of Visual Perception.”

In: Peter K. Machamer and Robert G. Turnbull, eds., *Studies in Perception: Interrelations in History of Philosophy and Science*, Columbus, Ohio, State University Press: 1978, pp. 160-85.

1979a

“The Role of the Scientific Scholar in Medieval Islam.”

— Written for: The Second International Symposium on the History of Arabic Science, Aleppo, Syria, April 5-12, 1979. Unpublished?

1979b

“A Thirteenth-Century Magnetic Compass of the Yamani Sultan al-Ashraf.”

— Written for: Proceedings of the Second International Symposium on the History of Arabic Science, Aleppo, Syria, April 5-12, 1979. Co-author: Subir K. Banerjee. Unpublished?

1979c

“Maqālat al-Ḥasan ibn al-Haytham fī Ḥall ‘Shukūk ḥarakat al-iltifāf’.”

— [Edition of the Arabic Text of Ibn al-Haytham’s “Treatise on the Solution of ‘Difficulties’ [[Aporias]] Concerning the movement of ‘iltifāf’.”

In: *Journal for the History of Arabic Science*, vol. 3(1979), pp. 183-212 Arabic; English summary, pp. 388-492.

1980a

“Science and the Civilization of Islam,”

Written for: Seminar on Islam and the Modern World, Washington, DC, February 7-9, 1980. Unpublished?

1980b

“Avicenna on the Subject Matter of Logic.”

In: *Journal of Philosophy*, 77, no.11 (November 1980), pp. 746-64.

1980c

“The Sources of Avicenna’s Geometry in *Kitāb al-Shifā’*.”

In: *Journal for the History of Arabic Science*, 4(1980), pp. 241-53 (in Arabic). — See 1977b, 1977c.

1981*

Theories of Light from Descartes to Newton, 2nd edition [with some corrections and updated bibliography]. Cambridge: Cambridge University Press, 1981. — See 1967b.

1982

“Ibn al-Haytham’s Lemmas for Solving ‘Alhazen’s Problem’.”

Archive for History of Exact Sciences, 26(1982), pp.299-324. — See below, 2002*.

1983*

The Optics of Ibn al-Haytham. Books I-II-III: On Direct Vision.

— The Arabic text, edited and with Introduction, Arabic-Latin Glossaries and Concordance Tables. Kuwait: National Council for Culture, Arts and Letters, 1983. 781 pages + Plates + English Preface & Table of Contents, 15 pages.

— See below, 1989b* (for the English translation of Books I-II-III), 2002*.

1984

“The Andalusian Revolt Against Ptolemaic Astronomy: Averroes and al-Biṭrūjī.”
In: *Transformation and Tradition in the Sciences: Essays in honor of I. Bernard Cohen*, ed. Everett Mendelsohn, Cambridge: Cambridge University Press, 1984, pp. 133-53.

1987a

“The Appropriation and Subsequent Naturalization of Greek Science in Medieval Islam.”

In: *History of Science*, 25(1987), pp. 223-43. [Reprinted in 1994a*; and in: F. Jamil Ragep & Sally P. Ragep, with Steven Livesey, edn; *Tradition, Transmission, Transformation. Proceedings of Two Conferences on Pre-Modern Science, held at the University of Oklahoma*. Leiden etc: E.J. Brill, 1996, pp. 3-27.

1987b

“Optics, Islamic.”

In: *Dictionary of the Middle Ages*, ed. J.R.S. Strayer, New York: Charles Scribner's Sons. Vol. IX(1987), pp. 240-47.

1987c

“Psychology *versus* mathematics: Ptolemy and Alhazen [I.H.] on the ‘Moon Illusion’.”

In: Edward Grant and John E. Murdoch, eds, *Mathematics and Its Application to Science and Natural Philosophy in the Middle Ages: Essays in Honor of Marshall Clagett*; Cambridge: Cambridge University Press, 1987, pp. 217-47. — See below, 1992a, 1996b.

1987d

“*Manāẓir, the science of optics.*”

In: *Encyclopaedia of Islam*, New Edition, VI(1991), pp. 376-77.

1988

“Science, Islamic.”

In: *Dictionary of the Middle Ages*, ed. J.R.S. Strayer, New York: Charles Scribner's Sons. Vol. XI(1988), pp. 81-89.

1989a

“Form in Ibn al-Haytham's Theory of Vision.”

In: *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 5(1989), pp. 115-40.

1989b*

The Optics of Ibn al-Haytham. Books I-II-III: On Direct Vision.

English Translation and Commentary. In Two volumes. Vol. I: vii-ix+367 pages, Translation; vol. II: vii-cx+246 pages: Introduction, Commentary, Arabic-Latin Glossaries, Concordance, Indices. London: The Warburg Institute, University of London. [= “Studies of the Warburg Institute, vol. 40.”]

1991

“Arabernes vitenskapelige erobringer.”

In: *Dyade*, n. 4, pp. 42-50. [Norwegian translation of 1988: “Science, Islamic.”]

1992a

“On Seeing the Stars: Edition and translation of Ibn al-Haytham's *Risāla fī Ru'yat al-kawākib*.”

In: *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 7(1991/92), pp. 31-72. Co-editor: Anton Heinen. See above, 1987c, below, 1996b.

1992b*

Bu's al-idyūlūjiyā. Second edition of the Arabic translation of Karl Popper's *The Poverty of Historicism* [see 1959b*].— London/Beirut: Dār al-Sāqī, 1992.

1993a

Review of: M.J.L. Young, J.D. Latham, and R.B. Serjeant (editors), *Religion, Learning, and Science in the 'Abbāsīd Period. Cambridge History of Arabic Literature*, xxiv+587pp. Cambridge/NewYork: Cambridge University Press, 1990.

In: *Isis*, 84(1993), pp. 367-68.

1993b

“Science in Islamic Culture.”

In: *Traditional Science and Modern Science*, Papers presented at the Taejon International Symposium on “Traditional Science”. Seoul, South Korea., 1993.

1994a*

Optics, Astronomy and Logic: Studies in Arabic Science and Philosophy.

[A collection of previously published articles, with some corrections and Index.]
Variorum: Aldershot, 1994.

1994b

Review of: Roshdi Rashed, *Géométrie et dioptrique au X^e siècle: Ibn Sahl, al-Qūhī et Ibn al-Haytham*. Paris: Les Belles Lettres, 1993.

In: *Isis*, 85(1994), pp. 685-86.

1994c

“Science and Philosophy in Medieval Islamic Theology. The Evidence of the Fourteenth Century.”

In: *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 8(1994), pp. 1-42. (First presented at the Symposium on Science and Theology in Medieval Islam, Judaism, and Christianity, held at Madison, Wisconsin, April 1993.)

PUBLICATIONS OF A.I. SABRA, since 1996:

(Asterisks mark publications in book form.)

1996a

Review of: Paul Lettinck, *Aristotle's Physics and Its Reception in the Arabic World*, with an edition of the unpublished Parts of Ibn Bājjā's *Commentary on the Physics*, Leiden/New York: E.J. Brill, 1994.

In: *Isis*, 87(1996), pp. 153-54.

1996b

“On Seeing the Stars, II. Ibn al-Haytham's “Answers” to the “Doubts” Raised by Ibn Ma'dān.”

In: *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 10(1995/96), pp. 1-59. — See 1987c, 1992a, on the same subject.

1996c*

Ibn al-Haytham: *al-Shukūk 'alā Baṭlamyūs* [*Dubitaciones in Ptolemaeum*].

2nd Edition of the Arabic text, with annotations. Cairo: Dār al-Kutub, 1996. — See 1971a*.

1996d

“Situating Arabic Science: Locality versus Essence.”

In: *Isis*, 87:1996, pp. 654-670. [Lecture delivered at the annual meeting of the History of Science Society, Minneapolis, Minnesota, October 28, 1995, with a few additions and corrections.—Reprinted in: Michael H. Shank, ed., *The Scientific Enterprise in Antiquity and the Middle Ages, Readings from Isis*, The University of Chicago Press, Chicago and London, 2000, pp. 215-31.

1997

“Thābit ibn Qurra on the Infinite and Other Puzzles: Edition and Translation of His Discussions with Ibn Usayyid.”

In: *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, 11(1997), pp. 1-33.

1998a

“Configuring the Universe: Aporetic, Problem Solving, and Kinematic Modeling as Themes of Arabic Astronomy.”

In: *Perspectives on Science*, 6:1998, pp. 288-330. — See below, 2000b.

1998b

“One Ibn al-Haytham or Two? An Exercise in Reading the Bio-bibliographical Sources.”

In: *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, Band 12: 1998, pp. 1-50 [continued, see 2003a].

2000a*

Al-‘Ilm al-‘arabī fī haḍārat al-Islām. Arabic translation, by Dr ‘Abdallāh al-‘Omar, of three articles by A.I. Sabra on science in Islamic civilization, Kuwait: Qurṭās-Publishing, 2000. 154 pages.

2000b

“Reply to Saliba.” [Response to the article by George Saliba, “Arabic versus Greek Astronomy: A Debate over the Foundations of Science,” *Perspectives on Science*, 2000, vol. 8, no. 4, pp. 328-41].

In: *Perspectives on Science*, 2000, vol. 8, no. 4, pp.342-45.

2002*

The Optics of Ibn al-Haytham. Edition of the Arabic Text of Books IV-V: On Reflection and Images Seen by Reflection. Two volumes: I: Text, Introductions, Concordance Tables; II: Apparatus, Diagrams, Appendices, Analytical Index, Plates. 760pp. Kuwait: The National Council for Culture, Arts and Letters, 2002.

— The complete English translation of Books IV&V are now being prepared for publication by the Warburg.—Following is the short English preface to 2002*:

PREFACE [Vol.I, pp. 5-8]

The seven Books of Ibn al-Haytham's *Optics* (*Kitāb al-Manāẓir*) constitute a coherent group of arguments designed to solve the problem of normal vision of the external world and, simultaneously, to redirect and reshape the mathematical theory of vision (*'ilm al-manāẓir: hē optikē technē*) as conceived and practiced first in Greek antiquity and then all the way up to Ibn al-Haytham's own time. Rather than criticize aspects of the Greek or Arabic works of his predecessors, or point out aporias against their treatment of visual perception, Ibn al-Haytham actually set out to construct a system of optics that made a clean and definitive break with the so-called extramission or visual-ray hypothesis which Euclid, Ptolemy, and their Arabic followers had adopted, and to propose instead a new approach to the subject based on observations and experiments generally in agreement with the Aristotelian view of vision as the reception of visual "forms" of light and colour in the eye. By construing the "forms" (*ṣuwar*) as configurations of "points" of light and colour naturally stretching out in all rectilinear directions from individual points on the surface of the visible object, he was able to introduce a doctrine and a methodology that had the intended advantage of saving both mathematical rigour and physical truth. In carrying out this ambitious project, and particularly in his elucidations of vision through the reception of direct, reflected, and refracted rays or point-forms, Ibn al-Haytham was led to weave together or, as he put it, synthesize investigations from the various fields of physics, mathematics, physiology, and psychology. The result was an image- or picture-oriented theory of vision which, as a consequence of having abandoned the old extramissionist hypothesis, was to put a special emphasis on the role of mental activity, and hence on psychology, that permeated the whole of his book. As Ibn al-Haytham consciously argued, vision was not merely a matter of receiving forms, but a complex process that involved interpretation or, to use his own word, "inference" (*qiyās, istidlāl*) based on a variety of experiences, in addition to the imprints caused by light and colour (or their forms) in the eye and transmitted from the eye to the brain.¹

The present publication is the third part in a project which began with the *editio princeps* of the Arabic text of Books I-III of *Kitāb al-Manāẓir*, published by The National Council for Culture, Arts and Letters, Kuwait, 1983. The second consisted of an English translation and commentary published in two volumes by

¹ A. I. Sabra, "The Physical and the Mathematical in Ibn al-Haytham's Theory of Light and Vision," originally read at The International Conference on History and Philosophy of Science, Jyväskylä, Finland, 1973, published in *The Commemoration Volume of Birūnī International Congress*, Tehran, 1976, and reprinted with corrections in A. I. Sabra, *Optics, Astronomy and Logic: Studies in Arabic Science and Philosophy*, Variorum Collected Studies Series, Ashgate Publishing: Aldershot, Great Britain, 1994, Chapter VII, pp.1-20; idem, "Form in Ibn al-Haytham's Theory of Vision," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 5(1989), pp. 115-40; idem, "Ibn al-Haytham's Revolutionary Project in Optics: The Achievement and the Obstacle," see References at the end of the Arabic Introduction in this volume.

The Warburg Institute, The University of London, 1989, with financial help from the Sabah al-Salem al-Mubarak al-Sabah Foundation in Kuwait. The present publication, also by the National Council for Culture in Kuwait, contains the first edition of the Arabic text for Books IV-V.— An English translation and commentary of the same two Books are being prepared for publication.

The first three Books expound Ibn al-Haytham's theory of the rectilinear "extension" or propagation of light and colour, and of vision by means of rectilinear rays directly emanating from the object seen. In Books IV-V, which deal with the reflection of light and with vision by means of rays reflected from smooth surfaces or mirrors, Ibn al-Haytham presents what he believed, rightly, to be the first explanation of this mode of perception in terms of the operation of light as an external agent that exists and behaves independently of the seeing eye, while admitting the "mathematical" agreement of his own conclusions with those of the earlier mathematicians (*aṣḥāb al-ta'ālīm*). Books IV-V can be said to contain the core of the experimental and mathematical investigations of Ibn al-Haytham's theory of reflection, excluding only the examination of visual errors (illusions) due to reflection, which are treated extensively in Book VI. The organization of Books IV-V is based on a clear and methodical distinction between what can and must be determined only by experiments, in Bk IV, as for example the general rules of reflection, and what can then be deduced mathematically from them regarding the locations of the "images" (*khayālāt*) perceived by mediation of the "forms" (*ṣuwar*) reflected to the eye from mirrors of various shapes. The highly inventive and ingenious demonstrations in Book V in fact present the first systematic treatment of specular images that was made possible only by Ibn al-Haytham's own solution of what has been known since the seventeenth century as "Alhazen's problem" (*Alhazeni problema*): namely the problem of finding the position of the reflection-point on the surface of a spherical-convex mirror, given the positions of the eye and the shining visible point (and, by extension, the determination of such point or points on the surfaces of other spherical, cylindrical, or conical mirrors, convex or concave).

Some problems specific to editing the text of Books IV-V are discussed in some detail in the Arabic Introduction in this volume. But there is no harm in describing them briefly here for the benefit of the non-Arabic reader. We have only two manuscript copies of Books IV-V that are independent of one another. Both are kept in Istanbul libraries. One of them, the Fatih MS dated 636/1239 and designated here by the letter F (*fā'*), completely lacks the geometrical diagrams to which the mathematical proofs of Book V continually refer. The other, the Köprülü MS (13th-14th c. AD) designated by K (*kāf*), lacks a large part of the text, and with it, the diagrams associated with that part (see the Concordance Tables following this Preface). The two missing diagrams could be redeemed from an excellent copy of the Commentary written before 708/1308-1309 in Tabrīz by Kamāl al-Dīn al-Fārisī (d. 718/1319), under the title *Tanqīḥ al-Manāẓir*. It is also fortunate that the *Tanqīḥ* incorporates what proves to be a faithful though abbreviated version of Ibn al-Haytham's text as Kamāl al-Dīn found it in a copy of *Kitāb al-Manāẓir* which his teacher Quṭb al-Dīn al-Shīrāzī (d. 710/1311) had especially obtained for him "from a distant land". The present edition is therefore based on MSS F & K, with the help of the *Tanqīḥ* especially for the indispensable

task of reconstructing the diagrams, and also sometimes for the purpose of checking, completing, clarifying, or refining sentences or phrases in the original text by quoting Kamāl al-Dīn's words in the body of our edited text or in the Critical Apparatus, *but always in such a manner as to set them clearly apart from Ibn al-Haytham's own words as we find them in F and K.*

Another important problem has to do with the relationship between the Arabic text for Books IV-V and the medieval Latin translation carried out (probably in Spain) towards the end of the twelfth or the beginning of the thirteenth century AD, that is, some hundred years before Kamāl al-Dīn worked on his Commentary/*Tanqīh*. In my edition and English translation of Books I-III, I was able to provide a concordance of the Arabic and Latin texts for approximately every ten lines in Books I-II and part of Book III in Risner's edition of 1572. It was also possible to provide extensive Arabic-Latin Glossaries as a result of these comparisons. After several trials at a comparable exercise for Books IV-V, I finally decided to abandon the task. The reason is that the Latin version for these Books departs from the Arabic text in such significant ways that tabular collations and comparisons, in the absence of a critical edition of the Latin, would probably produce only misleading, or at best highly tentative and perhaps even confusing results. Here I will mention only the major and most consequential departure resulting from the decision, by the Latin translator or translators, to bring out, not a strict translation of Books IV-V, but rather a somewhat modified text that is both a translation and a commentary at one and the same time. It is easy to guess how that might have happened, though the guess has to be tested by examining the extant manuscripts. The Latin text for Book IV has (in Risner's edition) diagrams to which nothing corresponds in the Arabic text which nowhere refers to any diagrams, either in the manuscripts of *Kitāb al-Manāẓir* itself or in Kamāl al-Dīn's *Tanqīh*. Obviously neither the author nor his Arabic commentator found it necessary to illustrate diagrammatically the purely descriptive but precisely worded text (exception made for one rather helpful addition from Kamāl al-Dīn which we have included as *Mulḥaq*/Appendix I in the present edition). With regard to Book V, however, we find the much larger and more serious discrepancy between the number of diagrams in the Latin (close to one hundred in Risner) and their number in the *Tanqīh*—exactly 48, of which only 24 are represented, sometimes unsuccessfully, in the incomplete text of MS K. It seems clear that rather than provide a separate commentary with additional diagrams, as we would do nowadays, the translator(s) found it more convenient to simply enter the alphabetical letters attached to the added diagrams into the textual expositions and modify the text accordingly.—How and when this happened, and with what consequences, can be settled only with reference to an edition based on the extant Latin manuscripts. I have therefore restricted myself to the task of providing a critical edition of the Arabic text as Ibn al-Haytham had left it and, I believe, as it reached the Latin West, and Kamāl al-Dīn. As well as putting us in touch with the original text for the first time in print, the present edition should now help as the basis for any meaningful comparisons with a critical Latin edition. A.I. Sabra

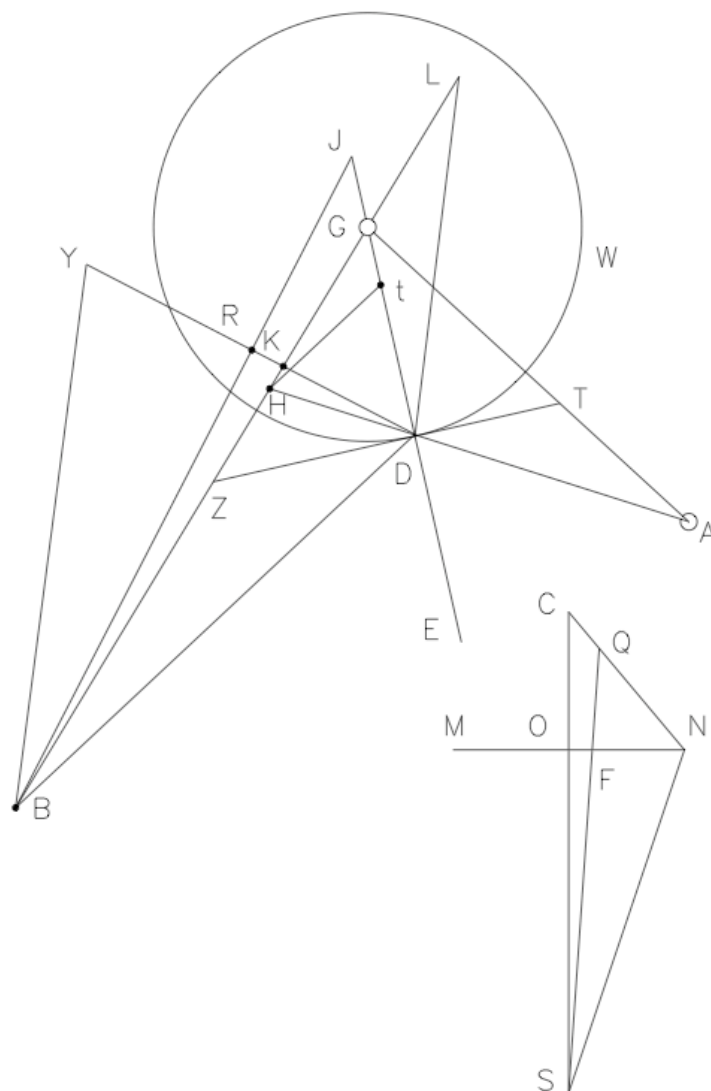
[Continued on the next page]

Optics, Bk. V, Figure V.18. Arabic text, Vol. I, V2 [150-154]; vol. II, p. 181.

“Alhazen’s Problem”:

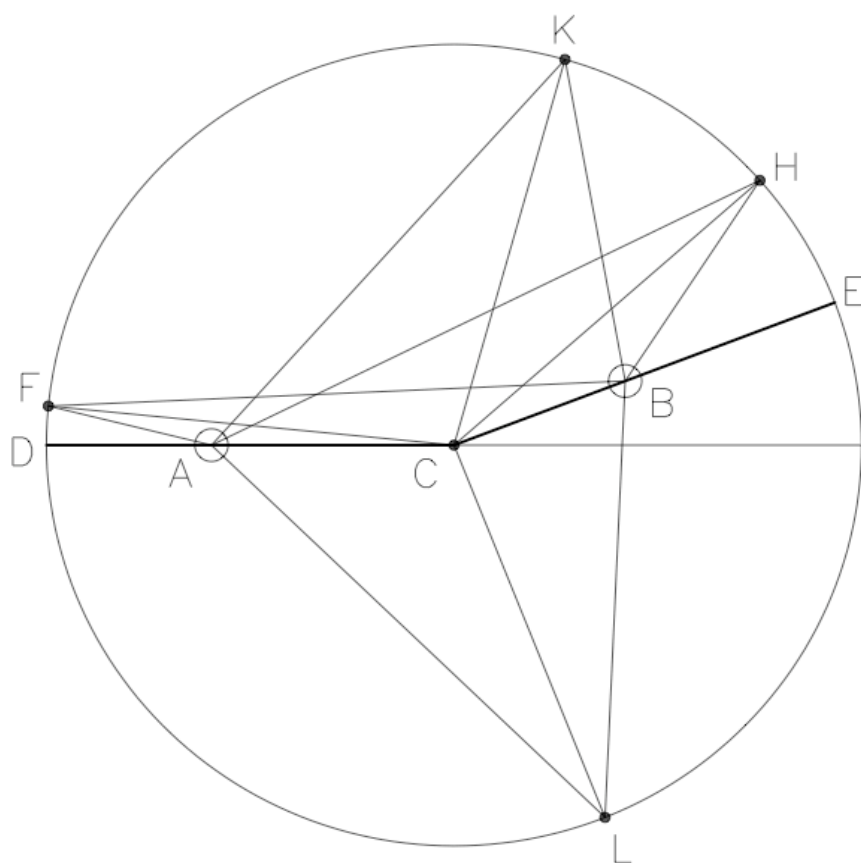
Given the position of the eye A, and the visible point B: to find the point of reflection D on the surface of the spherical-convex mirror DW.

[See also Publication 1982.]



Points A, B on sides CD, CE of the sector defined by arc DKE; and points A, B are unequally distant from the center C of circle DKL on the surface of a spherical-concave mirror. In a series of propositions in *Optics* Book V, Ibn al-Haytham proves that points A, B on the sides CD, CE may be reflected one to the other from no more than four points on the circle's circumference.

This website has a Java applet that illustrates this proposition: go to <http://www.people.fas.harvard.edu/~sabra/applets>. (By Peter A. Sabra).



2003a

“One Ibn al-Haytham or Two? Conclusion.”

In: *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften*, Band 15: 2002/2003, pp. 95-108, see 1998b). — See also on Ibn al-Haytham’s biography: 1972, 2003d.

2003b*

The Enterprise of Science in Islam: New Perspectives, Cambridge MA & London: Massachusetts Institute of Technology, 2003.

[Papers presented at the Conference on “Science in Medieval Islam” held at the Dibner Institute for the History of Science and Technology, MIT. Co-editor: J.P. Hogendijk.

2003c

“Ibn al-Haytham’s Revolutionary Project in Optics: The Achievement and the Obstacle.”

In: J.P. Hogendijk and A.I. Sabra, eds, *The Enterprise of Science in Islam: New Perspectives*, pp. 85-118. — See 2003b*.

2003d

“*IBN AL-HAYTHAM: Brief life of an Arab mathematician: died circa 1040.*”

Harvard Magazine, September-October 2003, pp. 54-55. — See above, 1972, 1998b, 2003a.

2003e

Review of: A. Mark Smith, *Alhacen’s Theory of Visual Perception: A Critical Edition, with English Translation of the First Three Books of Alhacen’s De aspectibus*, the Medieval Latin Version of Ibn al-Haytham’s *Kitāb al-Manāẓir*. Volumes 1 and 2, 819 pp. figs., glossary, bibl. index. Philadelphia: American Philosophical Society, 2001. *Isis*, 94: 1(2000), pp.134-37.

2006a*

Ibn al-Haytham’s Kitāb al-Manāẓir, Books I-II-III: On Direct Vision.

— Reprint of 1983* by the same publisher.

2006b

“*The Commentary that Saved the Text. The Hazardous Journey of Ibn al-Haytham’s Kitāb al-Manāẓir.*” Presented in a short version at a conference

arranged by the Manuscripts Centre, The Library of Alexandria, on “Manuscript Commentaries,” March 7-9, 2006.

— Forthcoming publication of the full text in *Early Science and Medicine*, 12(2007), pp. 117-133.

2006c

“Alhazen’s Optics in Europe: Some Notes on What It Said and What It Did Not Say.”

— Presented at the Max Planck Institute for the History of Science, Berlin: Workshop on “Inside the Camera Obscura – Optics and Art under the Spell of the Projected Image,” ed. Wolfgang Lefevre, July 20-23, 2006.

— Published as a Preprint, No. 333. Issued by the Institute, June 2007.

2006d

“Kalām Atomism as an Alternative Philosophy to Hellenizing Falsafa,” in: *Arabic Theology, Arabic Philosophy: Essays in Celebration of Richard M. Frank*, ed. James E. Montgomery. Orientalia Lovaniensia Analecta 152, Leuven, 2006, pp. 199-272.

2007, 2009

“*The Simple Ontology of Kalām Atomism*.” Presented at Boston University, in a conference in honor of John Murdoch, May 2007, and in *Early Science and Medicine*; Introduction by William R. Newman and Edith Dudley Sylla, Vol. XIV (2009), pp. 68-78.

Forthcoming

The Optics of Ibn al-Haytham, Bks IV-V: On the Reflection of Lights;

and On Visual Perception by Reflection; and

On Visual Perception by Reflection, and Images Seen by Reflection.

(English translation of the Arabic Text published in 2002 .

See above: 2002*.)

CONTENTS

Preface

Introduction:

1. Problems of Editing Bks. IV and V of Ibn al-Haytham's Arabic *Optics: Kitāb*

al-Manāẓir

2. Manuscripts Used in Editing Bks. IV and V
3. Kamāl al-Dīn's *Tanqīḥ al-Manāẓir*, and Its Role in Editing Bks. IV and V
4. The Geometrical Diagrams and Their Problems
5. Editing the Text
6. References

Book IV

Chapter One: Preface [1-2].

Chapter Two: That the Forms of Visible Objects are Reflected from Polished Bodies or Mirrors <<In Six Propositions: 1-6>>:
 <<IV2.1>> [1-5]. <<IV2.2>> [6-14]. <<IV2.3>> [15-16].
 <<IV2.4>> [17]. <<IV2.5>> [18-20]. <<IV2.6>> [21-24].

Chapter Three: On The Manner of Reflection of Forms from Polished Bodies

<<Introduction and Nine Propositions: IV.1-9>>:
 <<Introduction>> [1].
 <<IV3.1>> [2].

<Design of Experiments for Examining the Manner of Reflection>:
 <The Copper Plate> [3-4].
 <The Ring-like Wooden Piece> [5-8].
 <Using a Wooden Panel in the Shape of a Sector of a Circle to draw Two Arcs on the Concave Surface of the Ring's Thickness> [9-10].
 <Mounting the Copper Plate into the Ring> [11].
 <Drilling the Holes in the Ring> [12].
 <Mounting the Instrument on Its Base> [13-15].
 <The Copper Tube> [16-17].
 <Construction of the Seven Mirrors> [18-26].

<The Wooden Posts> [27-29].

<Mounting the Mirrors into the Posts> [30-40].

<Experimental Examinations of the Manner of Reflection of Lights>: <Examination of the Reflection of Light from Plane Mirrors> [41-54].

<Examination of the Reflection of Light from Other Types of Mirror> [55-61].

<Examination of Accidental Lights> [62-65].

<Conclusions from the Preceding Experiments.—The Concept of *Least Light*> [66-72].

<<IV3.2>> <The Rules of Reflection Apply to the *Least Light*> [73].

<Precise Determination of the Line of Reflection for Each One of the Seven Mirrors> [74-91].

<<IV3.3>> [92-99].

<<IV3.4>> [100-101].

<<IV3.5>> [102].

<<IV3.6>> [103].

<<IV3.7>> [104-105].

<The Light Shining or Reflected Along Straight Lines Is Not the Imagined Lines> [106-108].

<<IV3.8>> [109-112].

<Explanation of the Reflection of Light from Polished Bodies> [113-117].

<The Reflection of Light Has a Parallel in Natural Bodies> [118-119].

<Why Light is Reflected in a Certain Plain and in a Certain Direction> [120-130].

<The Reflection of Light *versus* the Reflection of Heavy Bodies> [131-133].

<IV3.9>> Explanation of the Manner of Reflection of Colours from Polished Bodies> [134-140].

<Examination of the Forms of Colours by Means of the
Described Instrument> [141-145].

Chapter Four: That What Sight Perceives in Polished Bodies is
Perceived by reflection

<Introduction> [1]. And One Proposition:
<<IV4.1>> [2-11].

Chapter Five: The Manner in Which Sight Perceives Visible Objectes
by Reflection

<<Introduction, and Eleven Propositions: IV5: 1-11>>

<<Introduction>> [1-4].

<<IV5.1>> [5-9].

<<IV5.2>> [10].

<<IV5.3>> [11].

<<IV5.4>> [12-17].

<<IV5.5>> [18-19].

<<IV5.6>> [20-24].

<<IV5.7>> [25-31].

<Concerning the Intersections Between the Surface of the
Cylindrical Mirror and the Planes of Reflection> [32-41].

<<IV5.8>> [42-53].

<Intersections of the Cone's Axis with the Reflection-
Planes> [54-56].

<Elliptical Common Sections> [57-58].

<<IV5.9>> [59-62].

<<IV5.10>> [63-66].

<<IV5.11>> [67-73].

<Recapitulation> [74-82]. – End of Book IV.

Book V

Chapter One: Preface [1].

Chapter Two: On Images <Perceived by Reflection>

<<Consisting of Introduction and Nine Inquiries: I-IX>>:

<Introduction> [1].

<<V2: Inquiry I: Experimental Examination of the Location of Images.
Seven Experiments: 1-7>>:

<<V2: I.1: Experimental Examination of the Location of the Image in
the Plane Mirror>> [2-16].

<<V2: I.2: Experimental Examination of the Location of the Image in
the Spherical-Convex Mirror>> [17-24].

<<V2: I.3-4: Experimental Examination of the Location of the Image in
the Cylindrical-Convex and the Conical-Convex Mirror>> [25-39].

<<V2: I.5: Experimental Examination of the Location of the Image in
the Spherical-Concave Mirror>> [40-46].

<<V2: I.6-7: Experimental Examination of the Location of the Image in
the Cylindrical-Concave and the Conical-Concave Mirror>> [47-55].

<<V2: Inquiry II: Explanation of Vision-by-Reflection. Two Propositions:
1-2>>:

<<V2: II.1: Reason Why the Object Seen-by-Reflection is Perceived to be
at the Location of the Image>> [56-57].

<<V2: II.2: Reason Why the Object Seen-by-Reflection is Perceived to be
on the perpendicular dropped from the Object to the Mirror's Surface>>:
<Case of the Plane Mirror> [58-62]. — <Case of the Spherical-Convex Mirror>
[63-66] — <Cases of the Remaining Mirrors> [67]. <The Universal Reason>
[68-69].

<<V2: Inquiry III: On the Locations of Images in the Seven Mirrors.
Six Propositions: 1-6>>:

<<V2: III.1: General Statement on the Locations of Images in Each of the
Seven Mirrors>> [70-74].

<<V2: III.2: Demonstrations of the Preceding Propositions>> [75].

<<V2: III.3: Determination of the Position of the Reflection-Point on a

Plane Mirror>> [76].

<<V2: III.4: Only One Point on the Perpendicular Dropped from the Center of the Eye to the Surface of a Plane Mirror Will Be Perceived by Reflection>> [77-81].

<<V2: III.5: A Visible Point Seen by One Eye in a Plane Mirror Will Have Only a Single Image and a Single Reflection-Point>> [82-83].

<<V2: III.6: Perception of a Visible Object with Both Eyes by Reflection from a Plane Mirror>> — Three cases [84-89].

<<V2: Inquiry IV: On the Images of Spherical-Convex Mirrors and Related Matters>> — <<In Eighteen Propositions: 1-18>>:

<<V2: IV.1>> [90]; IV.2 [91-92]; IV.3 [93]; IV.4 [94]; IV.5 [95]; IV.6 [96-101]; IV.7&8 [102-103].

<<V2: IV.9-16: Determination of the Locations of Images on Any One of the Diameters of the Spherical-Convex Mirror>> [104-123].

<<V2: IV.17: On Determining the Point of reflection>> <Six Lemmas> [124-149]. — [[To Find the Point of Reflection on the Surface of a Spherical-Convex Mirror]] [150-154].

<<V2: IV.18: Binocular Perception of a Single Object in the Spherical-Convex Mirror>> [155-162].

<<V2: Inquiry V: On the Images of the Cylindrical-Convex Mirror. Introduction [163] and Seven Propositions: 1-7>> [164-183].

<<V2: Inquiry VI: On the Images of the Right Conical-Convex Mirror. Consisting of an Introduction and Three Propositions: 1-3>>: Introduction [184-186].

<<V2: VI.1>> [187-190].

<<V2: VI.2>> [191-198].

<<V2: VI.3>> [199-200].

<<V2: Inquiry VII: On the Images of the Spherical-Concave Mirror.

Consisting of an Introduction and Thirty-Three Propositions: 1-33>>:

<<Introduction>> [201].
 <<V2: VII.1>> [202-205].
 <<V2: VII.2>> [206].
 <<V2: VII.3>> [207].
 <<V2: VII.4>> [208]. <<Experimental Examination: [209]>>.
 <<V2: VII.5>> [210].
 <<V2: VII.6>> [211].
 <<V2: VII.7>> [212].
 <<V2: VII.8>> [213-217].
 <<V2: VII.9>> Five Cases [218-220].
 <<V2: VII.10>> [221].
 <<V2: VII.11>> [222-225].
 <<Summation>> [226]. <<Precisions>> [227]. <<More Precisions>> [228].
 <<Reminder>> [229].
 <<V2: VII.12>> [230]. <<Recapitulation>> [231].
 <<V2: VII.13>> [232-235]. <<Summation>> [236].
 <<V2: VII.14>> [237-240].
 <<V2: VII.15>> [241-245].
 <<V2: VII.16>> [246-247]. <<Summation>> [248].
 <<V2: VII.17>> [249-251].
 <<Summing up the Results of the three figures or propositions>> [252].
 <<V2: VII.18>> [253-257].
 <<V2: VII.19>> [258-259].
 <<V2: VII.20>> [260].
 <<V2: VII.21>> <<Summation>> [261].
 <<V2: VII.22>> [262].
 <<V2: VII.23>> [263]. <<Summation>> [264].
 <<V2: VII.24>> [265-266]. <<Summation>> [267].
 <<V2: VII.25>> [268].
 <<V2: VII.26>> [269-274].
 <<V2: VII.27>> [275].
 <<V2: VII.28>> [276]. <<Conclusion>>.
 <<V2: VII.29>> [277-281]. <<Conclusion>>.

<<V2: VII.30>> [282].

<<V2: VII.31>> [283].

<<V2: VII.32>> [284].

<<Precisions Regarding All Reflections of Points from this
Spherical-Concave Mirror>> [285-289].

<<Summation>> [290-292]. <<Notice>> [293]. <<Experimental
Examination>> [294].

<<V2: VII.33>> [295].

<<Inquiry VIII: On the Images of the Cylindrical-Concave Mirrors>>

<<Consisting of Ten Propositions: 1-10>>

<<V2: VIII.1>> [296-300].

<<V2: VIII.2>> [301-302].

<<V2: VIII.3>> [303].

<<V2: VIII.4>> [304].

<<V2: VIII.5>> [305].

<<V2: VIII.6>> [306].

<<V2: VIII.7>> [307-309].

<<V2: VIII.8>> [310-319].

<<V2: VIII.9>> [320].

<<V2: VIII.10>> [321].

<<Inquiry IX: <<On the Images of the Conical-Concave Mirrors>>>>

<<Consisting of Introduction and Eight Propositions: 1-8>>:

<<Introduction>> [322].

<<V2: IX.1>> [323].

<<V2: IX.2>> [324].

<<V2: IX.3>> [325].

<<V2: IX.4>> [326].

<<V2: IX.5>> [327-329].

<<V2: IX.6>> [330-339].

<<V2: IX.7>> [340-344].

<<V2: IX.8>> [345-346]. — Colophon [347]. — End of Book V.