Claudius Ptolemy (Greek: Κλαύδιος Πτολεμαῖος, *Klaudios Ptolemaios*; Latin: *Claudius Ptolemaeus* ; c. AD 90 – c. AD 168), was a Roman citizen of Egypt who wrote in Greek. [1]

He was a mathematician, astronomer, geographer, astrologer, and poet (of a single epigram in the Greek Anthology). [2] [3]

He lived in Egypt under Roman rule, and is believed to have been born in the town of Ptolemais Hermiou in the Thebaid. He died in Alexandria around AD 168. [4]

Ptolemy was the author of several scientific treatises, at least three of which were of continuing importance to later Islamic and European science. The first is the astronomical treatise now known as the *Almagest* (in Greek, Ἡ Μεγάλη Σύνταξις, "The Great Treatise", originally Μαθηματικὴ Σύνταξις, "Mathematical Treatise"). The second is the *Geography*, which is a thorough discussion of the geographic knowledge of the Greco-Roman world. The third is the astrological treatise known sometimes in Greek as the *Apotelesmatika* (Ἀποτελεσματικά), more commonly in Greek as the *Tetrabiblos* (Τετράβιβλος "Four books"), and in Latin as the

Quadripartitum (or four books) in which he attempted to adapt horoscopic astrology to the Aristotelian natural philosophy of his day.

Background

Engraving of a crowned Ptolemy being guided by the muse Astronomy, from *Margarita Philosophica* by Gregor Reisch, 1508. Although [Abu Ma'shar](#) believed Ptolemy to be one of the Ptolemies who ruled Egypt after the conquest of Alexander the title ‘King Ptolemy’ is generally viewed as a mark of respect for Ptolemy's elevated standing in science.

The name *Claudius* is a Roman *nomen*; the fact that Ptolemy bore it indicates he lived under the Roman rule of Egypt with the privileges and political rights of Roman citizenship. It would have suited custom if the first of Ptolemy's family to become a citizen (whether he or an ancestor) took the *nomen* from a Roman called Claudius who was responsible for granting citizenship. If, as was common, this was the emperor, citizenship would have been granted between AD 41 and 68 (when Claudius, and then Nero, were emperors). The astronomer would also have had a *praenomen*, which remains unknown. It may have been *Tiberius*, as that *praenomen* was very common among those whose families had been granted citizenship by these emperors.

Ptolemaeus (Πτολεμαῖος – *Ptolemaios*) is a Greek name. It occurs once in Greek mythology, and is of Homeric form. [5] It was common among the Macedonian upper class at the time of Alexander the Great, and there were several of this name among Alexander's army, one of whom made himself King of Egypt in 323 BC: Ptolemy I Soter. All the kings after him, until Egypt became a Roman province in 30 BC, were also Ptolemies.

Perhaps for no other reason than the association of name, the 9th century Persian astronomer Abu Ma'shar assumed Ptolemy to be member of Egypt's royal lineage, stating that the ten kings of Egypt who followed Alexander were wise "and included Ptolemy the Wise, who composed the book of the *Almagest*". Abu Ma'shar recorded a belief that a different member of this royal line "composed the book on astrology and attributed it to Ptolemy". We can evidence historical confusion on this point from Abu Ma'shar's subsequent remark “It is sometimes said that the very learned man who wrote the book of astrology also wrote the book of the *Almagest*. The correct answer is not known”. [6]

There is little evidence on the subject of Ptolemy's ancestry, apart from what can be drawn from the details of his name (see above); however modern scholars refer to Abu Ma’shar’s account as erroneous, [7] and it is no longer doubted that the astronomer who wrote the *Almagest* also wrote the *Tetrabiblos* as its astrological conterpart. [8]

Beyond his being considered a member of Alexandria's Greek society, few details of Ptolemy's life are known for certain. He wrote in Ancient Greek and is known to have utilized Babylonian astronomical data. [9] [10]

He was a Roman citizen, but most scholars conclude that Ptolemy was ethnically Greek, [11] [12]

[13] although some suggest he was a Hellenized Egyptian. [12] [14] [15] He was often known in later Arabic sources as "the Upper Egyptian", [16] suggesting he may have had origins in southern Egypt. [17] Later Arabic astronomers, geographers and physicists referred to him by his name in Arabic: □□□□□□□ □ *Batlaymus*. [18]

Astronomy

The *Almagest* is the only surviving comprehensive ancient treatise on astronomy. Babylonian astronomers had developed arithmetical techniques for calculating astronomical phenomena; Greek astronomers such as Hipparchus had produced geometric models for calculating celestial motions. Ptolemy, however, claimed to have derived his geometrical models from selected astronomical observations by his predecessors spanning more than 800 years, though astronomers have for centuries suspected that his models' parameters were adopted independently of observations. [19] Ptolemy presented his astronomical models in convenient tables, which could be used to compute the future or past position of the planets. [20] The *Almagest* also contains a star catalogue, which is an appropriated version of a catalogue created by Hipparchus. Its list of forty-eight constellations is ancestral to the modern system of constellations, but unlike the modern system they did not cover the whole sky (only the sky Hipparchus could see). Through the Middle Ages it was spoken of as the authoritative text on astronomy, with its author becoming an almost mythical figure, called Ptolemy, King of Alexandria.

[21]

The *Almagest* was preserved, like most of Classical Greek science, in Arabic manuscripts (hence its familiar name). Because of its reputation, it was widely sought and was translated twice into Latin in the 12th century, once in Sicily and again in Spain. [22]

Ptolemy's model, like those of his predecessors, was geocentric and was almost universally accepted until the appearance of simpler heliocentric models during the scientific revolution.

His *Planetary Hypotheses* went beyond the mathematical model of the *Almagest* to present a physical realization of the universe as a set of nested spheres, [23] in which he used the epicycles of his planetary model to compute the dimensions of the universe. He estimated the Sun was at an average distance of 1210 Earth radii while the radius of the sphere of the fixed stars was 20,000 times the radius of the Earth. [24]

Ptolemy presented a useful tool for astronomical calculations in his *Handy Tables,* which tabulated all the data needed to compute the positions of the Sun, Moon and planets, the rising and setting of the stars, and eclipses of the Sun and Moon. Ptolemy's *Handy Tables* provided the model for later astronomical tables or *zījes*. In the *Phaseis* (*Risings of the Fixed Stars*) Ptolemy gave a *parapegma*, a star calendar or almanac based on the hands and disappearances of stars over the course of the solar year.

Geography

Ptolemy's other main work is his *Geographia*. This also is a compilation of what was known about the world's geography in the Roman Empire during his time. He relied somewhat on the work of an earlier geographer, Marinos of Tyre, and on gazetteers of the Roman and ancient Persian Empire, but most of his sources beyond the perimeter of the Empire were unreliable.

The first part of the *Geographia* is a discussion of the data and of the methods he used. As with the model of the solar system in the *Almagest*, Ptolemy put all this information into a grand scheme. Following Marinos, he assigned coordinates to all the places and geographic features he knew, in a grid that spanned the globe. Latitude was measured from the equator, as it is today, but Ptolemy preferred in book 8 to express it as the length of the longest day rather than degrees of arc (the length of the midsummer day increases from 12h to 24h as one goes from the equator to the polar circle). In books 2 through 7, he used degrees and put the meridian of 0 longitude at the most western land he knew, the "Blessed Islands", probably the Cape Verde islands (not the Canary Islands, as long accepted) as suggested by the location of the six dots labelled the "FORTUNATA" islands near the left extreme of the blue sea of Ptolemy's map here reproduced.

A 15th-century manuscript copy of the Ptolemy world map, reconstituted from Ptolemy's *Geographia* (circa 150), indicating the countries of "Serica" and "Sinae" (China) at the extreme east, beyond the island of "Taprobane" (Sri Lanka, oversized) and the "Aurea Chersonesus" (Malay Peninsula).

Ptolemy also devised and provided instructions on how to create maps both of the whole inhabited world (*oikoumenè*) and of the Roman provinces. In the second part of the *Geographia* he provided the necessary topographic lists, and captions for the maps. His *oikoumenè* spanned 180 degrees of longitude from the Blessed Islands in the Atlantic Ocean to the middle of China, and about 80 degrees of latitude from Shetland to anti-Meroe (east coast of Africa); Ptolemy was well aware that he knew about only a quarter of the globe, and an erroneous extension of China southward suggests his sources did not reach all the way to the Pacific Ocean.

The maps in surviving manuscripts of Ptolemy's *Geographia*, however, date only from about 1300, after the text was rediscovered by
Maximus Planudes
. It seems likely that the topographical tables in books 2–7 are cumulative texts – texts which were altered and added to as new knowledge became available in the centuries after Ptolemy (Bagrow 1945). This means that information contained in different parts of the Geography is likely to be of different date.

A printed map from the 15th century depicting Ptolemy's description of the Ecumene , (1482, Johannes Schnitzer, engraver).

Maps based on scientific principles had been made since the time of Eratosthenes (3rd century BC), but Ptolemy improved projections. It is known that a world map based on the *Geographia* was on display in Augustodunum, Gaul in late Roman times. In the 15th century Ptolemy's *Geographia*
began to be printed with engraved maps; the earliest printed edition with engraved maps was produced in Bologna in 1477, followed quickly by a Roman edition in 1478 (Campbell, 1987). An edition printed at Ulm in 1482, including woodcut maps, was the first one printed north of the Alps. The maps look distorted as compared to modern maps, because Ptolemy's data was inaccurate. One reason is that Ptolemy estimated the size of the Earth as too small: while Eratosthenes found 700
stadia
for a great circle degree on the globe, in the

Geographia
Ptolemy uses 500
stadia
. It is highly probable that these were the same
stadion
since Ptolemy switched from the former scale to the latter between the
Syntaxis
and the
Geographia
, and severely readjusted longitude degrees accordingly. If they both used the Attic
stadion
of about 185 meters, then the older estimate is 1/6 too large, and Ptolemy's value is 1/6 too small, a difference explained as due to ancient scientists' use of simple methods of measuring the earth, which were corrupted either high or low by a factor of 5/6, due to air's bending of horizontal light rays by 1/6 of the Earth's curvature. See also Ancient Greek units of measurement and History of geodesy.

Because Ptolemy derived many of his key latitudes from crude longest day values, his latitudes are erroneous on average by roughly a degree (2 degrees for Byzantium, 4 degrees for Carthage), though capable ancient astronomers knew their latitudes to more like a minute. (Ptolemy's own latitude was in error by 14'.) He agreed (*Geographia* 1.4) that longitude was best determined by simultaneous observation of lunar eclipses, yet he was so out of touch with the scientists of his day that he knew of no such data more recent than 500 years before (Arbela eclipse). When switching from 700 stadia per degree to 500, he (or Marinos) expanded longitude differences between cities accordingly (a point first realized by P.Gosselin in 1790), resulting in serious over-stretching of the Earth's east-west scale in degrees, though not distance. Achieving highly precise longitude remained a problem in geography until the invention of the marine chronometer at the end of the 18th century. It must be added that his original topographic list cannot be reconstructed: the long tables with numbers were transmitted to posterity through copies containing many scribal errors, and people have always been adding or improving the topographic data: this is a testimony to the persistent popularity of this influential work in the history of cartography.

Astrology

The mathematician Claudius Ptolemy "the Alexandrian" as imagined by a 16th century artist [35]

Music

Ptolemy also wrote an influential work, *Harmonics*, on music theory and the mathematics of music. After criticizing the approaches of his predecessors, Ptolemy argued for basing musical intervals on mathematical ratios (in contrast to the followers of Aristoxenus and in agreement with the followers of Pythagoras) backed up by empirical observation (in contrast to the overly theoretical approach of the Pythagoreans). Ptolemy wrote about how musical notes could be translated into mathematical equations and vice versa in *Harmonics*. This is called Pythagorean tuning because it was first discovered by Pythagoras. However, Pythagoras believed that the mathematics of music should be based on the specific ratio of 3:2 whereas Ptolemy merely believed that it should just generally involve tetrachords and octaves. He presented his own divisions of the tetrachord and the octave, which he derived with the help of a monochord. Ptolemy's astronomical interests also appeared in a discussion of the "music of the spheres".

Optics

His *Optics* is a work that survives only in a poor Arabic translation and in about twenty manuscripts of a Latin version of the Arabic, which was translated by Eugene of Palermo (c. 1154). In it Ptolemy writes about properties of light, including reflection, refraction, and colour. The work is a significant part of the early history of optics. [30] and influenced the more famous 11th century Optics by Alhazen

(Ibn al-Haytham). The work is also important for the early history of perception. Ptolemy combined the mathematical, philosophical and physiological traditions. He held an extramission-intromission theory of vision: the rays (or flux) from the eye formed a cone, the vertex being within the eye, and the base defining the visual field. The rays were sensitive, and conveyed information back to the observer's intellect about the distance and orientation of surfaces. Size and shape were determined by the visual angle subtended at the eye combined with perceived distance and orientation. This was one of the early statements of size-distance invariance as a cause of perceptual size and shape constancy, a view supported by the Stoics. [31]

Ptolemy offered explanations of many phenomena concerning illumination and colour, size, shape, movement and binocular vision. He also divided illusions into those caused by physical or optical factors and those caused by judgemental factors. He offered an obscure explanation of the sun or moon illusion (the enlarged apparent size on the horizon) based on the difficulty of looking upwards. [32] [33]

Named after Ptolemy

There are several characters or items named after Ptolemy, including:

- The crater Ptolemaeus on the Moon;
- The crater Ptolemaeus [34] on Mars;
- the asteroid 4001 Ptolemaeus;
- a character in the fantasy series *The Bartimaeus Trilogy*: this fictional Ptolemy is a young magician (from Alexandria) whom Bartimaeus loved; he made the journey into "the Other Place" being hunted by his cousin, because he was a magician;
- the name of Celestial Being's carrier ship in the anime *Mobile Suit Gundam 00* .
- track number 10 on Selected Ambient Works 85–92 by Aphex Twin .
- the Ptolemy Stone used in the mathematics courses at both St. John's College campuses.
- English astronomer and TV presenter Sir Patrick Moore has a cat named Ptolemy.

Ptolemy in pop culture

In Jonathan Stroud's Bartimaeus Trilogy, the djinni Bartimaeus often assumes Ptolemy's form and frequently refers to him as one of his favorite masters. The third and final book in the series is also called *Ptolemy's Gate* .

See also

- Pei Xiu
- Ptolemy's Canon – a dated list of kings used by ancient astronomers.
- Ptolemy Cluster – star cluster described by Ptolemaeus
- Ptolemy's theorem – mathematical theorem described by Ptolemaeus
- Ptolemy's table of chords
- Ptolemy's world map – map of the ancient world as described by Ptolemaeus.
- Zhang Heng

Footnotes

1. ^ See 'Background' section on his status as a Roman citizen
2. ^ Select Epigrams from the Greek Anthology By John William Mackail Page 246 ISBN 1406922943 2007
3. ^ Mortal am I, the creature of a day..
4. ^ Jean Claude Pecker (2001), *Understanding the Heavens: Thirty Centuries of Astronomical Ideas from Ancient Thinking to Modern Cosmology*, p. 311, Springer, ISBN 3-540-63198-4.
5. ^ Πτολεμαῖος, Georg Autenrieth, *A Homeric Dictionary*, on Perseus
6. ^ Abu Ma'shar, *De magnis coniunctionibus*, ed.-transl. K. Yamamoto, Ch. Burnett, Leiden, 2000, 2 vols. (Arabic & Latin text); 4.1.4.
7. ^ Jones (2010) 'Ptolemy's Doctrine of the Terms and Its Reception' by Stephan Heilen, p. 68.
8. ^ Robbins, *Ptolemy Tetrabiblos* 'Introduction'; p. x.
9. ^ Asger Aaboe, *Episodes from the Early History of Astronomy*, New York: Springer, 2001, pp. 62–65.
10. ^ Alexander Jones, "The Adaptation of Babylonian Methods in Greek Numerical Astronomy," in *The Scientific Enterprise in Antiquity and the Middle Ages*, p. 99.
11. ^ Enc. Britannica 2007, "Claudius Ptolemaeus" Britannica.com
12. ^ *a* *b* Victor J. Katz (1998). *A History of Mathematics: An Introduction*, p. 184. Addison Wesley, ISBN 0-321-01618-1.
13. ^ "Ptolemy." Britannica Concise Encyclopedia. Encyclopædia Britannica, Inc., 2006. Answers.com 20 Jul. 2008.
14. ^ George Sarton (1936). "The Unity and Diversity of the Mediterranean World", *Osiris* **2**, p. 406–463 [429].

15. ^ John Horace Parry (1981). *The Age of Reconnaissance*, p. 10. University of California Press . ISBN 0-520-04235-2 .

16. ^ J. F. Weidler (1741). *Historia astronomiae*, p. 177. Wittenberg: Gottlieb. (cf. Martin Bernal (1992). "Animadversions on the Origins of Western Science", *Isis* **83** (4), p. 596–607 [606].)

17. ^ Martin Bernal (1992). "Animadversions on the Origins of Western Science", *Isis* **83** (4), p. 596–607 [602, 606].

18. ^ edited by Shahid Rahman, Tony Street, Hassan Tahiri. (2008). "The Birth of Scientific Controversies, The Dynamics of the Arabic Tradition and Its Impact on the Development of Science: Ibn al-Haytham's Challenge of Ptolemy's Almagest". *The Unity of Science in the Arabic Tradition* . **11** . Springer Netherlandsdoi =10.1007/978-1-4020-8405-8. pp. 183–225 [183]. doi: 10.1007/978-1-4020-8405-8 . ISBN 978-1-4020-8404-1 .

19. ^ "Dennis Rawlins" . The International Journal of Scientific History. http://www.dioi.org/cot.htm#mjpg . Retrieved 2009-10-07.

20. ^ Bernard R. Goldstein, "Saving the Phenomena: The Background to Ptolemy's Planetary Theory", *Journal for the History of Astronomy*, 28 (1997): 1–12

21. ^ S. C. McCluskey, *Astronomies and Cultures in Early Medieval Europe*, Cambridge: Cambridge Univ. Pr. 1998, pp. 20–21.

22. ^ Charles Homer Haskins, *Studies in the History of Mediaeval Science*, New York: Frederick Ungar Publishing, 1967, reprint of the Cambridge, Mass., 1927 edition

23. ^ Dennis Duke, Ptolemy's Cosmology

24. ^ Bernard R. Goldstein, ed., *The Arabic Version of Ptolemy's* Planetary Hypotheses, Transactions of the American Philosophical Society, 57, 4 (1967), pp. 9–12.

25. ^ Jones (2010) 'The Use and Abuse of Ptolemy's Tetrabiblos in Renaissance and Early Modern Europe' by H. Darrel Rutkin, p. 135.

26. ^ Robbins, *Ptolemy Tetrabiblos*, 'Introduction' p. x.
27. ^ Jones (2010) p. xii.
28. ^ Robbins, *Ptolemy Tetrabiblos*, 'Introduction' p. xii.
29. ^ FA Robbins, 1940; Thorndike 1923)
30. ^ Smith, A. Mark (1996). *Ptolemy's Theory of Visual Perception– An English translation of the Optics*. The American Philosophical Society. ISBN 0-87169-862-5 . http://books.google.com/?id=mhLVHR5QAQkC&pg=PP1&dq=ptolemy+theory+of+visual+perception . Retrieved 27 June 2009.

31. ^ Ross, H.E. and Plug, C. (1998) The history of size constancy and size illusions. In Walsh, V. & Kulikowski, J. (Eds) *Perceptual constancy: Why things look as they do*. Cambridge: Cambridge University Press, pp. 499-528.

32. ^ Ross, H.E. and Ross, G.M. (1976) Did Ptolemy understand the moon illusion? *Perception*, 5: 377-395.

33. ^ Sabra, A. I. (1987) Psychology versus mathematics: Ptolemy and Alhazen on the moon illusion. In Grant, E. & Murdoch, J.E. (Eds) *Mathematics and its application to science and natural philosophy in the Middle Ages* (pp.217-247). Cambridge: Cambridge University Press.

34. ^ Mars Labs . Google Maps.

References

Texts and translations

- Bagrow, L. (January 1, 1945). "The Origin of Ptolemy's Geographia". *Geografiska Annaler* (Geografiska Annaler, Vol. 27) **27** : 318–387. doi : 10.2307/520071 . ISSN 16513215 . JSTOR 520071 .

- Berggren, J. Lennart, and Alexander Jones. 2000. *Ptolemy's* ***Geography:*** *An Annotated*

Translation of the Theoretical Chapters
. Princeton and Oxford:
Princeton University Press
.
ISBN 0-691-01042-0
.

- Campbell, T. (1987). *The Earliest Printed Maps*. British Museum Press.
- Hübner, Wolfgang, ed. 1998. *Claudius Ptolemaeus, Opera quae exstant omnia* Vol III/Fasc 1: ΑΠΟΤΕΛΕΣΜΑΤΙΚΑ (= Tetrabiblos). De Gruyter.
ISBN 978-3-598-71746-8
(Bibliotheca scriptorum Graecorum et Romanorum Teubneriana). (The most recent edition of the Greek text of Ptolemy's astrological work, based on earlier editions by F. Boll and E. Boer.)

- Lejeune, A. (1989) *L'Optique de Claude Ptolémée dans la version latine d'après l'arabe de l'émir Eugène de Sicile.* [Latin text with French translation]. Collection de travaux de l'Académie International d'Histoire des Sciences, No. 31. Leiden: E.J.Brill.

- Neugebauer, Otto (1975). *A History of Ancient Mathematical Astronomy*. **I-III**. Berlin and New York: Sprnger Verlag.

- Nobbe, C. F. A., ed. 1843. Claudii Ptolemaei Geographia. 3 vols. Leipzig: Carolus Tauchnitus. (The most recent edition of the complete Greek text)
- Ptolemy. 1930. *Die Harmonielehre des Klaudios Ptolemaios*, edited by Ingemar Düring. Göteborgs högskolas årsskrift 36, 1930:1. Göteborg: Elanders boktr. aktiebolag. Reprint, New York: Garland Publishing, 1980.

- Ptolemy. 2000. *Harmonics*, translated and commentary by Jon Solomon. Mnemosyne, Bibliotheca Classica Batava, Supplementum, 0169-8958, 203. Leiden and Boston:
Brill Publishers
.
ISBN 90-04-11591-9

- Robbins, Frank E. (ed.) 1940. *Ptolemy Tetrabiblos*. Cambridge, Massachusetts: Harvard University Press (Loeb Classical Library).
ISBN 0-674-99479-5
.

- Smith, A.M. (1996) *Ptolemy's theory of visual perception: An English translation of the Optics with introduction and commentary.* Transactions of the American Philosophical Society, Vol. 86, Part 2. Philadelphia: The American Philosophical Society.
- Stevenson, Edward Luther (trans. and ed.). 1932. *Claudius Ptolemy: The Geography*. New York: New York Public Library. Reprint, New York: Dover, 1991. (This is the only complete English translation of Ptolemy's most famous work. Unfortunately, it is marred by numerous mistakes and the placenames are given in Latinised forms, rather than in the original Greek).

- Stückelberger, Alfred, and Gerd Graßhoff (eds). 2006. *Ptolemaios, Handbuch der Geographie, Griechisch-Deutsch*. 2 vols. Basel: Schwabe Verlag. ISBN 978-3-7965-2148-5. (Massive 1018 pp. scholarly edition by a team of a dozen scholars that takes account of all known manuscripts, with facing Greek and German text, footnotes on manuscript variations, color maps, and a CD with the geographical data)

- Taub, Liba Chia (1993). *Ptolemy's Universe: The Natural Philosophical and Ethical Foundations of Ptolemy's Astronomy*. Chicago: Open Court Press. ISBN 0-8126-9229-2.
- *Ptolemy's Almagest*, Translated and annotated by G. J. Toomer. Princeton University Press, 1998

External links

- Online Galleries, History of Science Collections, University of Oklahoma Libraries High resolution images of works by Ptolemy in .jpg and .tiff format.

Primary sources

- Ptolemy's Tetrabiblos at LacusCurtius (English translation of a portion of the material, with introductory material)
- Entire *Tetrabiblos* of J.M. Ashmand's 1822 translation.
- Ptolemy's Geography at LacusCurtius (English translation, incomplete)
- Extracts of Ptolemy on the country of the Seres (China) (English translation)
- Geographia (the Balkan Provinces, with old maps) at Sorin Olteanu's LTDM Project (soltdm.com)
- *Almagest* books 1–13 The complete text of Heiberg's edition (PDF) Greek.
- *Almagest* books 1–6 (Greek) with preface (Latin) @ archive.org

Secondary material

- Arnett, Bill (2008). "Ptolemy, the Man". obs.nineplanets.org. http://obs.nineplanets.org/psc/theman.html. Retrieved 2008-11-24.

- Danzer, Gerald (1988). "Cartographic Images of the World on the Eve of the Discoveries". The Newberry Library. http://www.newberry.org/smith/slidesets/ss08.html. Retrieved 26 November 2008.

- Haselein, Frank (2007). "Κλαυδιου Πτολεμιου: Γεωγραφικῆς Ὑφηγήσεως (Geographie)" (in German and some English). Frank Haselein. http://wwwuser.gwdg.de/~fhasele/ptolemaeus/index.html . Retrieved 2008-11-24.

- Houlding, Deborah (2003). "The Life & Work of Ptolemy" . Skyscript.co. http://www.skyscript.co.uk/ptolemy.html . Retrieved 2008-11-24.

- Jones, Alexander (ed.) 2010. *Ptolemy in Perspective: Use and Criticism of his Work from Antiquity to the Nineteenth Century* . New York: Series: Archimedes, Vol. 23., ISBN 978-90-481-2787-0

- Toomer, Gerald J. (1970). "Ptolemy (Claudius Ptolemæus)" . In Gillispie, Charles. *Dictionary of Scientific Biography* . **11** . New York: Scribner & American Council of Learned Societies. pp. 186–206. ISBN 9780684101149 . http://www.u.arizona.edu/~aversa/scholastic/Dictionary%20of%20Scientific%20Biography/Ptolemy%20(Toomer).pdf .

- Sprague, Ben (2001–2007). "Claudius Ptolemaeus (Ptolemy): Representation, Understanding, and Mathematical Labeling of the Spherical Earth" . Center for Spatially Integrated Social Science. http://www.csiss.org/classics/content/76 . Retrieved 26 November 2008.

Animated illustrations

- Java simulation of the Ptolemaic System – at Paul Stoddard's Animated Virtual Planetarium, Northern Illinois University
- Animation of Ptolemy's Two Solar Hypotheses
- Epicycle and Deferent Demo – at Rosemary Kennett's website at the University of Syracuse
- Flash animation of Ptolemy's universe. (best in Internet Explorer)