

# Geminus | Encyclopedia.com

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(fl. Rhodes [?], ca. 70 b.c.)

*astronomy, mathematics.*

Geminus' name is Latin, but his works and manner are patently Greek—the forms Γ'εμνος and Γ'εμνος, also found in the manuscripts, are probably false analogies based on true Greek forms such as Ἀλέξανδρος and Ἐργάβος. He was author of an *Introduction (Isagoge) to Astronomy* (still extant) and of a work on mathematics (lost, except for quoted extracts from it). Nothing is known of the circumstances of his life, but his date and place of work may be inferred from internal evidence in the *Isagoge*. In chapter 8, sections 20–24 of the Manitius edition, Geminus corrects a widespread Greek view that the Egyptian festival of Isis coincided with the winter solstice; he explains that although this was so 120 years ago, in his own time there was a whole month's difference between the two dates, since every four years the Egyptian calendar (based on a “year” of twelve months of thirty days each plus five additional days)<sup>1</sup> became out of step with the solar year by one day. The festival of Isis took place from the seventeenth to the twentieth day of the Egyptian month Athyr, and a papyrus fragment tells us that in the calendar of [Eudoxus of Cnidus](#) the winter solstice occurred on 20 or 19 Athyr. By Julian reckoning the winter solstice in Eudoxus' time (ca.350 b.c.) occurred on 25 December or 28 December, and the first years in which these Julian dates can coincide with 19 Athyr are 185 b.c. and 197 b.c.<sup>2</sup> Hence, the papyrus presumably was written at this time; and subtracting the 120 years mentioned by Geminus, we obtain a date for the *Isagoge* of 65 or 77 b.c., which agrees with other evidence indicating a date about 70 b.c.<sup>3</sup>

We have no definite evidence about where Geminus was born or worked, but the commonly held opinion that his place of work was Rhodes may be correct. It is the “clima” of Rhodes that he uses to illustrate his account of various astronomical phenomena (e.g., I, 12; III, 15; V, 25); in XVII, 4, he refers to Mt. Atabyrius,<sup>4</sup> i.e., the modern Mt. Attaviros, in the center of Rhodes, without feeling it necessary to specify its location, whereas in the same passage he is careful to explain that Mr. Cyllene is in the Peloponnese; and Rhodes had a reputation in the last two centuries b.c. as a center for those subjects (philosophy, astronomy, and mathematics) with which Geminus was concerned, Panaetius, Posidonius, and Hipparchus all having worked there.

On the other hand, the choice of Rhodes as a typical example may simply have been dictated by its position on the best-known and most central parallel of latitude, 36 °N. (Geminus himself says [XVI, 12] that all globes were constructed for this “clima,” which for practical purposes was regarded as the latitude of Greece as well),<sup>5</sup> or Geminus may merely have used the examples he found in his sources, in this case almost certainly Hipparchus (see below), just as Ptolemy in the *Almagest* (II, 3 and 4), some 200 years later, was to use the same example from the same source. Similarly, Geminus may have taken the examples of Mt. Cyllene and Mt. Atabyrius straight from Dicaearchus (who is cited for their heights in XVII, 5); and even though two of his chief authorities, Hipparchus and Posidonius, worked in Rhodes, it does not necessarily follow that Geminus did.

The *Isagoge* is an early example of an elementary astronomical handbook written to popularize the main ideas in the technical treatises of the scientists; it belongs to the same tradition as the *De motu circulari*

*corporum caelestium* of Cleomedes, and there are many similarities in style and arrangement between the two works, although, as might be expected from its later date, Cleomedes' work is fuller and less elementary than its precursor. One interesting difference is that Geminus includes a chapter (*Isagoge*, II) on the astrological "aspects" of the zodiacal signs, i.e., their arrangement in pairs, triplets, quadruplets, etc., according to which the astrologers calculated the signs' influence on human affairs; Cleomedes has no such chapter and, in fact, does not mention astrological doctrines at all. Geminus gives a simplified description of basic astronomy as known in the time of Hipparchus, omitting most of the mathematics and giving (I, 23 f.) little information about the planets apart from their zodiacal periods (thirty years for Saturn, twelve for Jupiter, two and a half for Mars, one year each for Mercury, Venus, and the sun,<sup>6</sup> and 27½ days for the moon); there is no mention of epicycles, but the eccentricity of the sun's path relative to the earth is carefully described (I, 31 ff.) and the Hipparchian values for the four astronomical seasons are given (I, 13 f.) — 94½, 92½, 88¼, and 90¼ days, respectively, starting from the [vernal equinox](#).<sup>7</sup>

Chapter III describes the main constellations; chapters IV and V describe the chief circles of the [celestial sphere](#); and chapter VI explains the variations in the lengths of day and night at different latitudes. Chapter VII (which is based largely on Aratus and, almost certainly, on Hipparchus' commentary on Aratus' astronomical poem entitled *Phaenomena*) deals with the rising of the zodiacal signs, and chapter VIII with the length of the lunar month, for which a figure of 29½ + 1/33 days is given (rounded off from the accurate Hipparchian value of 29 days, 12 hours, 44 minutes, 3 seconds);<sup>8</sup> this last chapter is especially valuable for its account of how the Greeks developed an astronomically based calendar with a scientific system of intercalation.<sup>9</sup> Chapter IX explains the phases of the moon, chapters X and XI solar and lunar eclipses, and chapter XII the general motions of the planets. Chapters XIII and XIV deal with the risings and settings and courses of the fixed stars, and chapters XV and XVI with the zones of the terrestrial globe, delineated according to the estimates of Eratosthenes, which Hipparchus also accepted.<sup>10</sup>

Chapter XVII discusses sensibly the principles on which the "parapegmata" (astronomical calendars containing weather prognostications connected with the risings and settings of certain stars and constellations)<sup>11</sup> were based. Chapter XVIII deals with the "exeligmus" (*εξεγιμός*), or shortest period containing a [whole number](#) of synodic months, of anomalistic months, and of days (cf. *Almagest*, IV, 2); this chapter, far more technical than the others and out of keeping with the elementary character of the rest of the book, may well be an unrelated fragment.<sup>12</sup> Finally, there is an astronomical calendar, or "parapegma," which begins with Cancer and is evidently based on figures for the astronomical seasons which are not Hipparchian;<sup>13</sup> it seems probable that this was not part of the original treatise but represents older material.

Geminus' exposition is usually sound and clear and includes some intelligent criticism, e.g., of the notion held "by many philosophers" that the planetary bodies do not in fact exhibit two opposite motions (the diurnal and the zodiacal) but only seem to do so because they revolve at different speeds (*Isagoge*, XII, 14 ff.); this idea, says Geminus, "is not in accordance with observed phenomena" (XII, 19, *α σύ μ Φ ω ν ός εστι ιωίς φ αλνομνοις*). He also gives a shrewd appreciation of the limitations of parapegmata, points out that weather forecasting based on observation of the rising and setting of various stars is by no means an exact science but a rough codification of general trends, and asserts firmly that stellar risings do not cause changes in the weather but merely indicate them (*ούκ αύταί παραίτιοί είσι ιών, αλλά σημέτα έκκινται* XVII, 11; see the whole of this chapter, especially 6–41); this last assertion contrasts strangely with the belief underlying chapter II.

There are, of course, some errors and infelicities. The chapter which gives a rational discussion of parapegmata (XVII) also contains an absurdly exaggerated view of the restricted range of atmospheric phenomena, according to which no wind or rain is experienced at the top of a mountain under 10,000 feet high (XVII, 3–5). In chapters X and XI no mention is made that, for an eclipse to take place, the moon must be at a node: and in XVI, 13, it is wrongly stated that the magnitudes of eclipses are the same for people living on the same parallel of latitude. There are also minor errors in the description of a star's evening rising (XIII, 13) and morning setting (XIII, 16), which may be the result of scribal errors in the transmission of the text (cf. Manitius. Anmerkung 25, 26); but Manitius' theory (pp. 246–248) that our

present text represents a Byzantine compilation from an epitome of Geminus' original work, although it cannot be disproved, rests on very slender evidence.<sup>14</sup>

A work on mathematics (known only from extracts quoted by later writers) is also attributed to Geminus; and although it has been thought that this is not the same man as the author of the *Isagoge*, there can, in fact, be little doubt of the identity of the two.<sup>15</sup> The title of the work was probably *Theory of Mathematics* (*Θέωρῶν τῶν μαθημάτων*)<sup>16</sup> and it must have extended to at least six books, since Eutocius quotes from the sixth. Our chief source for its contents is Proclus,<sup>17</sup> who quotes appear in the scholia to book I of Euclid's *Elements*<sup>18</sup> and in the collection of writings attributed to [Hero of Alexandria](#);<sup>19</sup> and there are isolated quotations elsewhere<sup>20</sup>. There is also an Arabic commentary on Euclid by al-Nayrīzī<sup>21</sup> which contains extracts from a commentary on the *Elements*, by Simplicius, who quotes a certain "Aghanis" on the definition of parallels; from similarities with what we know from Proclus of Geminus' views on this subject, it has been suggested that Aghanis is actually Geminus, but there are grave objections to such an identification, which must therefore remain doubtful.<sup>22</sup> A Latin translation of this Arabic text by [Gerard of Cremona](#) is extant.<sup>23</sup>

The *Theory of Mathematics* apparently dealt with the logical subdivisions of the mathematical sciences, discussing the philosophical principles of their classification, distinguishing carefully between such terms as "hypothesis" and "theorem," "postulate" and "axiom," and paying particular attention to accurate definitions not only of the various branches of mathematics but also of concepts such as "line," "surface," "figure," and "angle." It seems to have been a more substantial work than the *Isagoge* and to have contained some very pertinent criticism of Euclid's postulates, particularly the fifth, the so-called parallel postulate, for which Geminus believed he had found a proff.<sup>24</sup>

We learn from Simplicius that Geminus wrote an exegesis on the *Meteorologica* of Posidonius;<sup>25</sup> Simplicius cites [Alexander of Aphrodisias](#) as transcribing along extract from an "epitome" of Geminus' work (*εκ της ἐπιτομης τῶν Ποσειδωνιον Μετεωρολογικων ἐξηγησέως*), but an epitome of an exegesis sounds unlikely and it is tempting to excise the word ἐπιτομης as an otiose gloss that has crept into the text. The extract discusses the different aims of physics and astronomy and has obvious relevance to a work on meteorology, which has affinities with both these sciences. Simplicius ends his citation with the following: "In this manner, then, Geminus also, or rather Posidonius in Geminus, expounds the difference ..." (συνω μὲν οὖν καὶ οὐ τέμνωσιν οὐκ ἔστιν ἡ ἀπὸ τῶν τέμνων ποσειδωνίου τῆν καὶ διαφορὰν ... παραδιδώσιν). From this it has been implied that Geminus did little else but reproduce the opinions of Posidonius.

Such an implication certainly overestimates Geminus debt to Posidonius. There is no doubt that both writers subscribed to Stoic views of the universe, and both were concerned to combat the attacks on the validity of the mathematical sciences, which, as we learn from Proclus and Sextus Empiricus, were mounted by both Skeptic and Epicurean philosophers;<sup>26</sup> but Geminus shows his independence of Posidonius in several respects. In *Isagoge* XVI, it is Eratosthenes' estimate of 252,000 stades that is taken as the basis of the division of the earth into zones and not Posidonius'; figure of 240,000 (Cleomedes, *De Motu circulari*, I, 10) or 180,000 (Strabo, *Geography*, 95),<sup>27</sup> neither of which is mentioned (nor, in fact, is Posidonius named in the entire treatise). Chapters VIII and XVIII, on the calendar and the length of the lunar month, almost certainly owe nothing to Posidonius, as there is no evidence that he did any work on calendrical problems; and there are other indications that Geminus, although he must have been well acquainted with Posidonius' opinions and was probably Proclus' chief authority for the latter,<sup>28</sup> did not hesitate to differ from the latter in following other sources (particularly Eratosthenes and Hipparchus for geography and astronomy) or putting forward his own views, as in his criticism of Euclid's postulates.

## NOTES

1. On this, see O. Neugebauer, *The Exact Sciences in Antiquity*, 2nd ed. (Providence, R.I., 1957), pp. 81, 94.

2. 25 December according to W. Kubitschek, *Grundriss der antiken Zeitrechnung* (Munich, 1928), p. 109; 28 December according to Böckh, cited by Manitius in his ed. of *Elementa*, p. 264. See also “Synchronistic Table,” in E. J. Bickerman, *Chronology of the Ancient World* (London-Ithaca, N.Y., 1968), p. 150.
3. For details, see Manitius ed. of *Elementia*, Anmerkung 16, pp. 263–266.
4. The Σαταβνϙων of the MSS must be corrected to Αταβνϙιον see D. R Dicks, *Geographical Fragments of Hipparchus* (London, 1960), p. 30.
5. See V, 48; Dicks. *op. cit.*, pp. 123, 130, 176.
6. See D. R. Dicks, *Early Greek Astronomy to Aristotle* (London, 1970), notes 174, 345.
7. See Ptolemy, *Almagest*, III, 4.
8. *Ibid.*, IV, 2.,
9. See Dicks, *Early Greek Astronomy*, pp. 86 f.
10. See Dicks, *Geographical Fragments*, p.148.
11. Se Dicks, *Early Greek Astronomy*, pp. 84 f.
12. See Manitius ed. of *Elementa*, p. 278.
13. *Ibid.*, Anmerkung 34
14. See Tittle, “Geminus I,” cols. 1031–1032.
15. *Ibid.*, cols. 1029–1030.
16. See Eutocius, *Commentaria in Conica I*, in *Apollonii Pergaei quae graece exstant*, J. L. Heiberg, ed., II (1893), 170, 25.
17. *Commentarii in primumuth Euclidis elementorum librum*, G. Friedlein, ed. (Leipzig, 1873.)
18. *Euclidis opera omnia*, J. L. Heiberg and H. Menge, eds., V (Leipzig, 1888), 81, 4; 82, 28; 107, 20.
19. *Heronis Alexandri reliquiae*, F. Hultsch, ed (Beriln, 1864), nos 5–14, 80–86.
20. See Tittle, *op. cit.*, cols 1039–1040.
21. *Codex Leidensis 399, I R*. O. Besthorn, J. L. Heiberg, G. Junge, J. Raeder, and W. Thomson, eds., 3 pts. (Copenhagen, 1893–1932).
22. T.L. Heath, *History of Greek Mathematics*, II, 224, accepts it; but the same scholar, in *The Thirteen Books of Euclid’s Elements*, 2nd ed. (Cambridge, 1925), pp. 27–28, rejects it. Compare A. I. Sabra, “Thabit Ibn Qurra on Euclid’s Parallels Postulate,” in *Journal of the Warburg and Courtauld Institutes*, 31 (1968), 13.

23. *Euclidis opera omnia. Supplementum: Anarithi in decent libros priores Elementorum Euclidis commentarii*, M. Curtze, ed. (Leipzig, 1899).

24. For details see Heath, *History of Greek Mathematics*, II, 223–231.

25. *Sirnplicii in Aristotelis Physicorum libros IV priores commentaria*, H. Diels, ed. (Berlin, 1882), pp. 291–292; this passage is also printed by Manitius in his ed. of the *Isagoge* as *Fragmetntum* I, pp. 283–285.

26. Proclus, G. Friedlein, ed., pp. 199 f., 214 ff.; Sextus Empiricus, *Adversus mathematicos*, H. Mutschmann-J. Mau, eds., I, 1 ff.; compare the whole of III

27. See E.H Bunbury, *History of Ancient Geography*, II (London, 1879), 95–96; Dicks *Geographical Fragments.*, p.150.

28. See Title, *op. cit.*, col. 1042.

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K. Manitius edited the *Gemini Elementa astronomiae* (Leipzig, 1898); chs. I, III-VI, VIII-XVI have been published by E. J. Dijksterhuis as *Gemini Elementorum astronomiae*, no. 22 in the series *Textus Minores* (Leiden, 1957).

See T. L. Heath, *History of Greek Mathematics*, II (Oxford, 1921; repr. 1960), 222–234; and Tittel, “Geminus I,” in *Real-Encyclopädie*, Halbband XIII (1910), cols, 1026–1050.

D. R. Dicks