XIV.—Eratosthenes as Platonist and Poet

FRIEDRICH SOLMSEN

CORNELL UNIVERSITY

In his *Platonicus* Eratosthenes clarified and set forth his views regarding a number of concepts which Plato in the *Timaeus* had used to construct and explain the Universe. The same concepts not only reappear in Eratosthenes' own philosophy but also play an important part in his mathematical studies and in his musical theory. In geography too, his principal contribution may be understood as an application of a Platonic point of view. Eratosthenes shared Plato's belief in a pre-existence of the souls. Finally, one of his poems, the *Hermes*, embodies the outlines of a Platonic cosmology and at the same time reflects some of Eratosthenes' own scientific convictions and interests.

Eratosthenes provided his countrymen with a good deal of information about his philosophical studies in Athens, about his affiliation with the large schools there, and about his association with outstanding thinkers.[1] Every student of the lives of ancient philosophers knows that this is the kind of information which Greek biographers were particularly anxious to have. It would be idle to question the value of such material or to minimize the stimulating effect which associations of the kind are likely to have, and yet, if our attention is too exclusively focused on these personal contacts it stands to reason that such other influences as a man may have experienced through the study of books at a time when he was particularly sensitive to their content may be overlooked or underrated. Thus scholars have attached great importance to affinities between Eratosthenes' thought and that of the Stoics, Cynics, and Academic Sceptics[2] (since he had known philosophers of these schools at Athens) but have failed to take into account an important source of his intellectual biography, his *Platonicus*. And yet, the content of the work, or at least a good deal of it, has been known for more than seventy years; for it was in 1870 that Eduard

[1] See esp. Strabo 1.2.2. Cf. *FGrH* 241, T 1ff. with Felix Jacoby's commentary.

[2] Cf. e.g. Eduard Zeller, *Die Philosophie der Griechen*, Dritter Teil, Erste Abteilung (Leipzig, 1909) 45, 307 note 1; Wilamowitz, *Antigonos von Karystos* (Berlin, 1881) 310 (but see also his *Griech. Literatur d. Altertums*[3] [Berlin, 1925] 141); Eduard Schwartz *RhM* 40 (1885) 252ff. and *Charakterkoepfe aus der ant. Literatur, Zweite Reihe* (Leipzig, 1910) 78ff. More references will be found in August Schmekel, *Die Positive Philosophie in ihrer geschichtl. Entwicklung* (Berlin, 1938) 60, note 1.

Hiller [3] published a reconstruction of the work which can, on the whole, be accepted as correct. Quite recently, August Schmekel [4] has made an attempt to give Eratosthenes his place in the Platonic tradition; but what his chapter on Eratosthenes actually contains is an analysis of the sources available for the reconstruction of his Platonism rather than the actual reconstruction itself. This task, therefore, still remains to be performed, and the obvious starting point for it is a fresh examination of the fragments of the *Platonicus*. In the next section of our paper we shall concentrate on this work.

Theon of Smyrna in his "guidebook" to the mathematical passages in Plato quotes a comment of Eratosthenes on the nature and significance of *ἀναλογία*.[5] The beginning of the passage has unfortunately fared badly in the manuscript tradition. I do not think that it is destroyed beyond repair,[6] but we need only the last words, which tell us that *ἀναλογία* is *τῆς γενέσεως αἰτία* (or possibly, *πρώτη τῆς γενέσεως αἰτία*) *πᾶσι τοῖς μὴ ἀτάκτως γενομένοις*. Shortly before this quotation we find another reference to Eratosthenes from which we learn the name of the work in which these comments occurred: it is the *Platonicus*. Yet, even if the title were not mentioned we should know that there was only one thinker before Eratosthenes who made *ἀναλογία* the cause of existence for things which came into being in an orderly, not haphazard fashion (*μὴ ἀτάκτως*). The Demiurge of Plato's *Timaeus* uses two elements,[7] water and air, as

[3] "*Der* Πλατωνικός *des Eratosthenes*," *Ph* 30 (1870) 60–72. Cf. also Rudolf Hirzel, *Der Dialog* (Leipzig, 1895) 1.405ff. Hirzel suggests that the work was a dialogue. I see no way of deciding this question.

[4] *Op. cit.* (see note 2) 60–86.

[5] Theo Smyrn. 82.22 Hiller. Theon's immediate source was the Peripatetic Adrastus. Cf. E. Hiller, *RhM* 26 (1871) 582–589; Friedrich Ueberweg and Karl Praechter, *Grundriss d. Gesch. d. Philos., Erster Teil* (Berlin, 1926) 562; Schmekel, *op. cit.* (note 2) 65, note 1 and *passim*.

[6] The Ms. which Hiller uses (A-Marc. 307) has *ὁ δὲ Ἐρατοσθένης φησὶ ὅτι τῆς ἀναλογίας φύσις ἀρχὴ λόγος ἐστὶ καὶ πρώτη καὶ τῆς γενέσεως αἰτία πᾶσι τοῖς μὴ ἀτάκτως γινομένοις*. A[2] adds another *καὶ* before *ἀρχή*, another *ἀρχή* after *πρώτη* and still another *καὶ* before *πᾶσι*. Three lines later we have again a *καὶ ἀρχή* that is out of place. The sentence would be satisfactory if *ἀρχή* and the *καὶ* after *πρώτη* could be eliminated. It seems that *ἀρχὴ καί* or *καὶ ἀρχή* had been left out somewhere and that the two words were noted in the margin of the MS. from which A was copied. Hence the unfortunate attempts of A and A[2] to work them in. We get a sentence which is in every respect correct if we write *ὅτι τῆς ἀναλογίας φύσις* [*ἀρχή*] *λόγος ἐστὶ καὶ* <*ὅτι ἀρχὴ καὶ*> *πρώτη* [*καὶ*] *τῆς γενέσεως αἰτία πᾶσι κτλ*. A *ὅτι* before the second half of the statement is needed in any case. An alternative procedure would be simply to delete *ἀρχή* and the redundant *καὶ* after *πρώτη* but this seems less advisable.

[7] *Tim.* 32b. Cf. Hiller, *Ph* 30 (1870) 68 and Schmekel, *op. cit.* 75–77.

δεσμός between the two others, fire and earth, and sees to it that ὅτιπερ πῦρ πρὸς ἀέρα τοῦτο ἀὴρ πρὸς ὕδωρ καὶ ὅτι ἀὴρ πρὸς ὕδωρ ὕδωρ πρὸς γῆν. In this way τὸ τοῦ κόσμου σῶμα . . . ἐξ ἀναλογίας ὁμολογῆσαν was created and formed an indestructible, well-organized Whole.[8] For, δεσμῶν κάλλιστος ὃς ἂν ἑαυτὸν καὶ τὰ συνδούμενα ὅτι μάλιστα ἓν ποιῇ· τοῦτο δὲ πέφυκεν ἀναλογία κάλλιστα ἀποτελεῖν.[9] By establishing a relation of ἀναλογία among the elements of the visible world the Demiurge who had found everything κινούμενα πλημμελῶς καὶ ἀτάκτως achieved his purpose: εἰς τάξιν αὐτὸ ἤγαγεν ἐκ τῆς ἀταξίας.[10]

We need not quote or discuss at length the argumentation by which Eratosthenes derives all proportions from the relation of identity (ἰσότης; 1 = 1, or 1 : 1 = 1 : 1),[11] but we may say that in this reasoning Eratosthenes is no longer relying on the *Timaeus* in which Plato by a different logical operation makes proportions resolve themselves into τὸ ἕν.[12] It is evident that Eratosthenes does not follow Plato slavishly; he develops his own mathematical philosophy on the basis of Platonic ideas.

This conclusion is borne out by the examination of a passage in Proclus' commentary on Euclid [13] in which one of Eratosthenes' views is rejected. Eratosthenes, we here learn, considered the principle of proportions as the "bond" (σύνδεσμος) of τὰ μαθήματα. This means that he regarded it as the one factor which all of them, arithmetic, geometry, solid geometry, harmonics, and astronomy, have in common and which therefore "binds" together these branches, however different they may be in other respects. Now the search for the common elements, τὰ κοινά or ἡ κοινωνία, of the mathematical branches had started with Plato, who in two passages of the *Republic* (Book VII), insists that a student of mathematics

[8] See *Tim.* 30–32, esp. 32c.

[9] *Tim.* 31b–c.

[10] *Tim.* 30a and the whole description which follows (30–32). Cf. also 56c.

[11] Theo 83.2–84.6. Cf. Hiller, *Ph* 30 (1870) 61–66. Hiller rightly insists that this whole passage must go back to Eratosthenes. He also points out (65) that Theo 107.15ff. is a sequel to the train of thought which we read at 83.3–84.6.

[12] *Tim.* 31c–32a. For the mathematical theorem involved and for the interest which it aroused among mathematicians of the period see Arist. *An. Post.* A5, 74a17ff. For Plato the theorem here provides a way from ἀναλογία to τὸ ἕν.

[13] Procl. *in Euclid.* 43.22 (Friedlein) τὸν σύνδεσμον τῶν μαθημάτων οὐ τὴν ἀναλογίαν ὥσπερ Ἐρατοσθένης οἴεται θετέον. ἡ γὰρ ἀναλογία τῶν κοινῶν τοῖς μαθήμασι ἓν τι καὶ λέγεται εἶναι καὶ ἔστιν. πολλὰ δ' αὖ καὶ ἄλλα διήκει διὰ πάντων ὡς εἰπεῖν [τὰ] καθ' αὑτὰ ὑπάρχοντα τῇ κοινῇ φύσει τῶν μαθημάτων. I have eliminated the τά and hope that the structure of the last sentence now emerges more clearly. The terminology (καθ' αὑτὰ ὑπάρχοντα) is Aristotelian; see e.g. *An. Post.* A4, 73a34ff.

will not arrive at the necessary integration of his studies unless he perceives the intrinsic affinity of these branches.[14] But we do not know and have no right to assume that Plato himself considered ἀναλογία as this "bond." This solution of the problem seems to have been Eratosthenes' contribution. It is not altogether impossible that he found a hint of it in a passage of the *Epinomis*.[15]

We may add, but merely for the sake of completeness, that elsewhere in Theon [16] Eratosthenes is quoted for the idea that "everything in mathematics consists of proportions between some quantities" (ποσῶν τινων) and that "the nature of proportions is the beginning and principle" (ἀρχὴ καὶ στοιχεῖον) of mathematics. How he satisfied himself of the truth of these propositions we do not know, for, unfortunately, "Eratosthenes says he will not go into the proofs." Again, it is asserted on his authority [17] that all figures consist ἔκ τινων ἀναλογιῶν but what we learn about the train of reasoning which led him to this conclusion is rather vague. Yet, enough is known to preclude any doubt as to the seriousness of his belief in the power of ἀναλογία in the realm of mathematics.

The type of proportion which Plato employs in *Timaeus* 32b is the "continuous" proportion with two mean proportionals; the actual relation which he sets up is Fire : Air = Air : Water = Water : Earth. Plato tells us the reason why he resorts to two mean proportionals: "If the universal frame had been created a surface only and having no depth a single mean would have sufficed to bind together itself and the other terms; but now as the world must be solid and solid bodies are always compacted not by one

[14] *Rep.* 7.531d, 537c. We know of three pupils of Plato who made contributions to the subject, Speusippus, Aristotle, and the author of the *Epinomis*. See my paper *PhR* 49 (1940) 565ff.

[15] Some ancient interpreters of Plato held the view that for him too ἀναλογία was the "bond" of the μαθήματα and found support for their view in *Epin.* 991d–992a where they read τὴν ἀναλογίαν instead of τὴν ὁμολογίαν, which according to Burnet our mss. have. See Theo 84.7–14 with Hiller's *apparatus criticus*. Theon's source is Adrastus who frequently gets his inspiration from Eratosthenes; cf. Schmekel, *op. cit.* 72ff., 74, note 4, 84ff. I am reluctant to believe that Eratosthenes regarded the *Epinomis* as a work of Plato. It happens that he is not only a Platonist but also an authority on questions of authorship and his remarkable discoveries in this field are well known. And Theon's interpretation of the passage in the *Epinomis* is in any case very problematical. For modern views on the place of λόγος and ἀναλογία in Plato's thought see Julius Stenzel, *Zahl und Gestalt in Plato und Aristoteles*[2] (Leipzig, 1933) *passim;* Otto Toeplitz, *Quellen und Stud. zur Gesch. d. Mathem.*, Abteilg. B 1 (1929) 3ff.

[16] Theo 107.15–24, esp. 20ff.

[17] Theo 111.10ff.

mean but by two, God placed water and air in the mean between fire and earth and made them to have the same proportion as far as was possible, etc." [18] One who wishes to learn more about the extent to which Plato's theory about the two means between solid bodies is borne out by facts will find ample information in the excellent recent commentaries on the *Timaeus;* [19] for our purpose it is more important to recall that the construction of two mean proportionals was the Academy's way of solving the "Delian problem" (i.e. the task of doubling a cube),[20] and to note that Eratosthenes was familiar with, and interested in, the various methods which the mathematicians of the Academy had used to construct these two proportionals.[21] He himself was to invent in time a new mechanical device for determining the two mean proportionals of a "continuous" proportion. We still read the very skillfully phrased epigram in which he recommended his new method to the attention of king Ptolemy (III) Euergetes—it begins with a reference to the Delian problem—and we know that he set up, in the temple of the king, an apparatus on which everyone interested in the matter could try out the new device.[22] Eratosthenes also wrote a treatise on "mean proportionals" (μεσότητες).[23] As, however, we do not know the date of the *Platonicus* we have to reckon with the possibility that it preceded the treatise as well as the invention. What is certain—once again thanks to the testimony of Theon—is that the *Platonicus* included a reference to the "Delian problem." We have already seen that "proportion" was

[18] *Tim.* 32b (I have made use of Jowett's translation).

[19] See in particular F. M. Cornford, *Plato's Cosmology* (London, 1936) 46ff.

[20] Cf. T. L. Heath, *A Manual of Greek Mathematics* (Oxford, 1931) 154ff.

[21] Cf. the epigram preserved in Eutocius (see note 22) and also the fragment of the *Platonicus* in Theo 2.3ff. I hesitate to make use of Eratosthenes' letter to the king which we read in Eutocius; for although Wilamowitz's arguments against its genuineness (*NGG* 1894, 15ff.) lose much of their weight if one assumes that the king had heard of the new apparatus beforehand, it remains true that the description of it (Eut. 110.12ff.) seems not to be composed for the king but rather for a reader interested in mathematics and anxious to learn more about Eratosthenes' famous device. The author of the letter certainly knows something about earlier constructions of the two mean proportionals and about Plato's interest in the subject. Wilamowitz, *loc. cit.* 21 and *Platon* (Berlin, 1920) 1.503 thinks of the *Platonicus* as a source for the letter.

[22] See Eutocius *Commentar. in Libros de Sphaera et Cyl.* (*Archimed. opera edid.* J. L. Heiberg, vol. 3) 102.21ff., esp. 110.2ff. Cf. again Wilamowitz, *loc. cit.* (note 21), who also gives an explanation of the epigram which Eutocius has preserved. For a somewhat different description of Eratosthenes' construction see Pappus, *Collect.* 3.23.

[23] Cf. Franz Susemihl, *Geschichte der griech. Lit. in der Alexandrinerzeit* (Leipzig, 1891) 1.419.

one of its main subjects, if not the main subject. Bearing all these facts in mind we are hardly rash if we suggest that Eratosthenes commented in the *Platonicus* on Plato's statement (in *Tim.* 32b) concerning the two mean proportionals, though if we make it a point to refrain from everything that smacks of conjecture we may content ourselves with saying that Eratosthenes knew this passage of the *Timaeus* and that he was conscious of the Platonic background to his own struggle with the problem of the two mean proportionals.

In tracing some of Eratosthenes' views on order (τάξις) and proportion (ἀναλογία) to *Timaeus* 32b as their source I have followed in the footsteps of E. Hiller and A. Schmekel,[24] with whom I agree that the relation between these two concepts is in this passage more clearly and definitely formulated than anywhere else in Plato's dialogues. There is, however, in the same fundamental section of the *Timaeus* another passage which must have engaged Eratosthenes' attention since all three proportions that Plato knew, the arithmetical, geometrical, and harmonic are employed in it in the construction of the World-Soul which Plato conceives in terms and concepts of a musical scale.[25] We know that Eratosthenes was deeply interested in the subject of musical scales; Ptolemy in his *Harmonica* [26] gives him credit for what are evidently new constructions of the chromatic, enharmonic, and diatonic scales. The ratios which Eratosthenes uses in his diatonic scale are actually the same as those to which Plato in constructing his soul-scale resorts in order to "fill up" his fourths, namely two tones and the λεῖμμα (i.e. the ratio 256 : 243).[27] Thus, either Plato and Eratosthenes depend on the same "Pythagorean" tradition, or Eratosthenes has adopted the Platonic ratios as the basis of his diatonic scale. For reasons which will be obvious to a reader of this paper I incline to the second alternative. Moreover, in the same construction of the World-Soul, Plato uses the term διάστημα to describe the intervals and mathematical relations between the notes on his scale, but thinks of the same relations in terms of the λόγος ("proportion"). The difference between these two notions, διάστημα and λόγος, was one of the subjects that were discussed in Eratosthenes' *Platonicus*, and

[24] See above notes 2 and 3.

[25] The geometrical proportion is employed at 35b, the other two at 36a. Cf. Cornford, *op. cit.* (see note 19) 72.

[26] Ptol. *Harm.* (*ed.* Ingemar Duering, Goeteborg, 1930) 2.14.

[27] See his diatonic scale in Ptolemy (see note 26) 2.14; 73.14 Duering. Cf. also Schmekel, *op. cit.* 74, note 4.

Hiller [28] is evidently right in suggesting that Eratosthenes made the distinction between them with reference to the passage in the *Timaeus*. Yet all the mathematical and cosmological subjects and concepts which we have mentioned in this paragraph are intimately bound up with Plato's theory of the World-Soul as set forth in the *Timaeus*, and we shall soon have occasion to mention two further subjects, Eratosthenes' definition of "Time" and his general cosmological scheme, which are also (though less closely) connected with the same fundamental topic. Are we then to assume that Eratosthenes ignored the relation between the more specific subjects and the World-Soul, and that while interested in the former he paid no attention to the latter? Fortunately, Proclus quotes a comment of Eratosthenes on the Platonic World-Soul.[29] This, I think, settles the question, and I am unable to agree with Professor E. R. Dodds [30] who suggests that the Eratosthenes to whom Proclus refers was "probably not the celebrated scientist," but another philosopher of the same name. No ancient author attests the existence of this philosopher. If it is necessary to defend the identity of the Eratosthenes whom Proclus mentions with the Hellenistic scientist I should attach particular importance to the arguments already advanced, especially to the evidence of Eratosthenes' interest in other items of Platonic thought closely connected with the concept of the World-Soul, but it may not be superfluous to mention that what Eratosthenes actually said about the World-Soul—Proclus quotes him for the view that it represents a mixture and combination of opposite principles, *τὸ ἀσώματον* and *τὸ σωματικόν*—is not essentially different from the explanation which the Academic philosopher Crantor had put forward a generation earlier.[31]

We note next that Eratosthenes is quoted for the Platonic definition of Time as the "course of the Sun" (*ἡλίου πορεία*). In the *Timaeus* this definition forms part of Plato's description of the planetary system.[32] We naturally wonder whether Eratosthenes' interest in this system was confined to the detail for which he happens to be quoted. It certainly was not; for while no further

[28] *Ph* 30 (1870) 68. For the discussion in the *Platonicus*, see Theo 81.17ff.

[29] Procl. *in Tim.* 2.152.25 Diehl.

[30] Proclus, *The Elements of Theology* (Oxford, 1932) 297.

[31] Plu. *De an. procreat.* 3.1; cf. Hiller, *loc. cit.* (note 28) 71.

[32] For Eratosthenes see Stob. 1.8.40b; Plu. *Epit.* 1.21. Cf. Pl. *Tim.* 38b, 39c and also *Doxographi Graeci* 318 Diels.

evidence is available for the *Platonicus*, it is easy to see that Eratosthenes embodied this whole phase of Plato's cosmological scheme in his poem *Hermes*. A comparison between the fragments and *testimonia* of this poem [33] and the corresponding section of the *Timaeus* shows agreement not only in the fundamental features of the one sphere of the fixed stars and the seven spheres of the planets,[34] the axis of the world and the earth pressing against (literally : through) it [35] in the centre of the Universe, but also in the spheres assigned to Moon and Sun, which Eratosthenes, like Plato, fixes in the first and second sphere, respectively.[36] We may readily grant that by the time of Eratosthenes the Platonic scheme was widely known among educated people, and that it was not necessary to resort to the *Timaeus* to study it. But—quite apart from the fact that more complicated systems (reckoning with more than eight spheres) had been put forward after Plato's *Timaeus* [37] —there is one more item in Eratosthenes' system of spheres which must be taken into account. Eratosthenes makes each of the eight spheres of the Cosmos give forth a tune and these tunes combine into a harmony.[38] Hiller has pointed out the Platonic source of this conception: it is Plato's adaptation of the Pythagorean harmony of the spheres in *Republic* 10.617b.[39] Now, the myth in the tenth book of the *Republic* gives only vague hints of Plato's cosmology, which is much more clearly and fully set forth in the *Timaeus*.

[33] Cf. Eduard Hiller, *Eratosthenis carminum reliquiae* (Leipzig, 1872) 6ff.; *Collectanea Alexandrina* (ed. J. U. Powell, Oxford, 1924) 58ff.

[34] Cf. Hiller, *op. cit.* (see note 33) 38ff., 50ff.

[35] See Hiller 53; fr. 16 Powell (see note 33). At Eur. *Hec.* 66 and elsewhere διερείδεσθαι means "to lean upon" but Eratosthenes may have tried to bring out the fact that the earth lies on both sides of the axis (cf. ἐρήρεισται in Theo 129.12). He seems to have ignored Plato's ἰλλομένην (*Tim.* 40bf). Another point in which he diverges from Plato is the place assigned to the sphere of the planet Hermes; cf. Hiller, *op. cit.* 46; A. E. Taylor, *A Commentary on Plato's Timaeus* (Oxford, 1927) 193.

[36] For Eratosthenes cf. Theo 142.7ff. and Chalcid. *in Pl. Tim.* 72; for Plato see *Tim.* 38d, 39b.

[37] Cf. Aristotle's account (*Metaph.* Λ 8, 1073b17ff.) of the systems of Eudoxus and Callippus and his own construction (*ibid.*). Theon (178.10ff.) reports these constructions but makes clear that he considers them unnecessary complications. Here again it is well to bear in mind that his source is Adrastus for whom Eratosthenes was an authority. The reconstruction of Callippus' system is still a *desideratum*. Cf. Werner Jaeger, *Aristoteles* (Berlin, 1923) 366ff., esp. 367, note 1.

[38] See Theo 142.16ff.; but the two lines quoted from this section of the poem (*fr.* 17 Hiller, 15 Powell) must be the basis for the interpretation. Compare Eratosthenes' ὀκτὼ δὴ τάδε πάντα σὺν ἁρμονίῃσιν ἀρήρει with Pl. *Rep.* 10.617b ἐκ πασῶν δ' ὀκτὼ οὐσῶν μίαν ἁρμονίαν συμφωνεῖν.

[39] Cf. Hiller, *op. cit.* (see note 33) 53.

The *Timaeus*, on the other hand, *pace* Professor A. E. Taylor,[40] includes no reference to the harmony of the spheres and the music of the Universe, though Plato allows (and probably even invites) the reader to work out a connection between the intervals on the scale of the World-Soul and those between the planets,[41] and anyone bearing in mind the passage of the *Republic* might well go a step further and read the idea of a harmony of the spheres into this section of the *Timaeus*. As we do not know how Eratosthenes interpreted the crucial sentences of the *Timaeus* we must be satisfied with saying that he combined the cosmological scheme of this work with the thought of *Republic* 10.617b. For the details of the cosmic harmony he had to rely on his own ingenuity; we know that he did not apply the Platonic scale but used the orthodox διὰ πασῶν συμφωνία.[42]

We shall come back to Eratosthenes' *Hermes* at the end of this paper, but may as well even now say one more word about his approach to the "harmony of the spheres." We know, especially from Chalcidius,[43] that the harmony of the Universe was in that poem described as identical with the συμφωνία of Hermes' lyre. Hermes himself is amazed when after having constructed his lyre he ascends through the planetary spheres to the periphery of the Universe and finds in it the same ἁρμονία which he has just produced on his lyre. Eratosthenes seems to have gone into the technical details of this ἁρμονία. It cannot have been an easy task to explain them in hexameters, but an Alexandrian poet may well have been fascinated by the technical nature and the very difficulty of the subject, and we shall see that even a lesser poet tried his hand at the same theme.[44] The subject itself, the identity between the harmony of the lyre and that in the Universe, may strike us as Pythagorean, but Eratosthenes is not known to have taken an interest in Pythagorean motifs.[45] From the Platonic point of view,

[40] *Op. cit.* (note 35) 164ff.

[41] Compare *Tim.* 35bff. with 36cf. See on the question Cornford, *op. cit.* (see note 19) 68, 72 and 79, note 1.

[42] Theo 142.19ff. Cf. Paul Tannery, *Recherches sur l'histoire de l'astronomie ancienne* (Paris, 1893) 330; T. L. Heath, *Aristarchus of Samos* (Oxford, 1913) 112.

[43] *In Tim.* 72. In the parallel passage of Theon (142.7ff.) the crucial word which would express the identity between the συμφωνία of the lyre and that of the Cosmos is missing. It has been supplied by Martin.

[44] See below p. 212.

[45] For Aratus' interest in the same subject see Achill. *Isag.* 15, 16. Cf. August Boeckh, *Kleine Schriften* (Berlin, 1870) 4.301–307; Ernst Maass, *Aratea* (Berlin, 1892) 219ff.; Susemihl, *op. cit.* (see note 23) 1.419.

the identity between the two harmonies is important because it illustrates the idea of the δεσμός, or σύνδεσμος, the unifying principle which pervades the different branches of mathematics [46] (in this instance harmonics and astronomy). Whether Eratosthenes gave his readers more than a glimpse of this δεσμός we do not know; but we do know that for him the δεσμός is ἀναλογία and it is hardly necessary to point out that a musical scale is based, and was based for Eratosthenes, on the principle of proportions, λόγοι and ἀναλογία.[47]

We have seen above that Eratosthenes commented on the World-Soul of the *Timaeus*. It is not surprising that scholars who are accustomed to think of him as a sober, "scientific" mind find it somewhat disturbing that his enthusiasm for Plato led him to take a sympathetic interest even in the more imaginative, "unrealistic" phases of the Platonic philosophy. The same preconceived idea of his mentality probably accounts for their reluctance to accept still another manifestation of his Platonism, namely, his belief in the pre-existence of individual souls. Eratosthenes' views on the subject are reported in a passage of Iamblichus' περὶ ψυχῆς which Stobaeus included in his extensive excerpts from this work.[48] It must be admitted that the affected language in which Iamblichus sets forth these views helps little to resolve the difficulty of understanding them. Moreover, a passage in which Iamblichus speaks of the incarnation of individual souls in τὰ ὀστρεώδη σώματα led Hiller [49]—the only one as far as I know who has attempted an interpretation—to refer his readers to *Timaeus* 92a, where Plato suggests that the souls of the most senseless and foolish men will find their next incarnation in oysters. Yet Eratosthenes in the passage under discussion does not treat of this, or any other specific, category of souls but of souls in general, and it would be impossible to explain why all souls should enter oysters when they come down from the "lighter bodies." Hiller's explanation, far from throwing light on the passage rendered it obscurer than it had been before, and it was simply as an act of despair

[46] See above p. 194.

[47] See below p. 210.

[48] Stob. 1.49.39; 378.1ff. Wachsmuth. It is interesting, though in the light of our results hardly surprising, to find Eratosthenes in this passage included in a αἵρεσις τῶν Πλατωνικῶν. We must, however, beware of attaching too much importance to this "tag" since the mere fact that he had written the *Platonicus* may have sufficed for him to qualify as a Platonist in the doxographic tradition.

[49] *Loc. cit.* (see note 3) 71f.

that Kurt Wachsmuth[50] fifteen years later suggested that the philosopher whose views are reported is not the Alexandrian scientist but a Neoplatonic philosopher. This suggestion not only offers no help towards an understanding of the admittedly difficult passage (it is perhaps not malicious to suppose that it sprang from the widespread belief that *Neoplatonica* are by definition unintelligible), but is also in itself far from plausible. For, no matter what one may think of the rather unorthodox views of this "Neoplatonist,"[51] it is well to note that he is cited by the same men, to wit, Iamblichus and Proclus, who mention or discuss some Platonic views of the scientist and who on no occasion bother to distinguish the one from the other by using an epithet like ὁ γεωμέτρης or ὁ Κυρηναῖος. Furthermore, if it was a mistake to cast doubt on the scientist's interest in the Platonic World-Soul it seems equally wrong to deny that he could discuss the fate of individual souls which he found set forth in the same section of the *Timaeus*. Actually, the only Neoplatonic feature in Iamblichus' report is his own language, and the proper way of penetrating to the actual thought of Eratosthenes is to pierce through the veil which Iamblichus has cast over it. This we shall now attempt to do.

Iamblichus[52] expounds the views of outstanding philosophical authorities on the subject of the κάθοδος τῶν ψυχῶν, the descent of the souls to an earthly existence. He begins with Plotinus and other Neoplatonists who held that the souls came from the "Soul beyond the world," the "intelligible" Soul.[53] Next, he contrasts with this theory that of Plato's *Timaeus* in which the Demiurge "sows" the souls into the whole world and into all the elements and parts of the Universe. This sowing, Iamblichus explains, took place in several successive stages in which the different groups of souls came into existence along with the entities which were to receive them, the World-Soul with the Cosmos as a whole, the souls of the visible gods (ἐμφανεῖς θεοί = planets and stars) with their spheres, and the souls which have to live in the four elements with these elements.

[50] See the *Index Philosophorum* in the second volume of his edition of Stobaeus (Berlin, 1884) s.v. "Eratosthenes." His suggestion was accepted by Georg Knaack, *RE* s.v. "Eratosthenes." Knaack erroneously asserts (389) that "Eratosthenes leugnete einen koerperlichen Zustand der Seelen." See also Eduard Zeller, *op. cit.* (see note 2) Dritter Teil, Zweite Abteilung 735, note 5 and E. R. Dodds, *Proclus, The Elements of Theology* (Oxford, 1932) 317.

[51] Note that the soul is said to be ἀεὶ ἐν σώματι (378.6).

[52] *Loc. cit.* (note 48) 377.13ff.

[53] See esp. Plot. 4.8.3ff.

Another group of Platonists, Iamblichus goes on to say, does not describe the *κατάβασις* of the souls in the fashion of the *Timaeus* nor does it differentiate between the souls in accordance with the Neoplatonic hierarchy (in which distinctions are made between gods, demons, angels, and men),[54] or between the different regions of the world but "it assumes that the soul is always in a body—this is the group consisting of Eratosthenes, the Platonist Ptolemaeus [55] and others—and after the souls have lived in lighter bodies" (*λεπτότερα σώματα*) "it (this group) makes them take their abodes again in *τὰ ὀστρεώδη σώματα*; for it holds that while the soul is always in some part of the visible Universe [56] it comes down into the solid body (*τὸ στερεὸν σῶμα*) sometimes from one place, sometimes from another."

To understand the phrase *τὰ ὀστρεώδη σώματα* it is essential to realize that Iamblichus' language is here modelled not on the *Timaeus* but on the *Phaedrus* from which he has also taken the *στερεὸν σῶμα*. Plato uses the word *στερεόν* (*Phaedrus* 246c) for the physical bodies, primarily of human beings; he describes how the soul when falling gets hold of something *στερεόν* and starts forthwith on an earthly existence. In the same myth of the *Phaedrus* he borrows from the imagery of the mysteries to characterize the body in which the soul is forced to live as an *ὄστρεον*, an oyster or oyster-shell, which the soul carries around with herself.[57] In Iamblichus too *τὰ ὀστρεώδη σώματα* refers to the incarnation of the soul in any earthly, physical body, no matter whether of a human being or of an animal.

Eratosthenes must not be held responsible for the imagery which Iamblichus uses; nor need we assume that he discussed the pre-existence and incarnation of the individual souls with special reference to the *Phaedrus*. It is in the *Timaeus* that Plato puts forward

[54] See e.g. Iambl. ap. Stob. 1.372.15 Wachsmuth, *De myst.* 1.5.8; 2.1ff. Cf. Ueberweg-Praechter[12] 614.

[55] This is probably Ptolemaeus Chennus; cf. A. Chatzis, *Der Philosoph und Grammatiker Ptolemaeus Chennus* (Paderborn, 1914) xv.

[56] For *διατρίβειν εἰς* (instead of *διατρίβειν ἐν*) cf. Liddell and Scott s.v. *εἰς* I, 2.

[57] *Phaedr.* 250c. I shall show elsewhere that this whole passage reflects the terminology and imagery of the mysteries. At present I merely point to *ἐτελοῦντο τῶν τελετῶν μακαριωτάτην* (b8f.), *εὐδαίμονα φάσματα μυούμενοι καὶ ἐποπτεύοντες* (c3f.), *ἀσήμαντοι τούτου δ νῦν σῶμα περιφέροντες ὀνομάζομεν* (c5); note also the figure *καθαρᾷ καθαροί*. Iamblichus borrows phrases from the same myth of the *Phaedrus* also at 380.23ff. Wachsmuth *νεοτελεῖς καὶ πολυθεάμονες* (*Phaedr.* 250e1, 251a2), *συνοπαδοὶ θεῶν* (*Phaedr.* 248c3, 252c3), *ὁλόκληρος* (*Phaedr.* 250c1, 2). For *στερεὸν σῶμα* see also Iambl. ap. Stob. 374.4; 385.9.

his most definite doctrines on the abodes of the souls prior to their incarnation, and we have satisfied ourselves that this was the work by which Eratosthenes was particularly influenced.

The references to the "places" from which the souls come down to earth have so far been rather vague, but Iamblichus becomes more specific in the next sentences that follow. There we learn that Heraclides Ponticus fixed these "places" in the galaxy, "others all over the spheres of the Heaven," still others in the moon and the air below the moon from which they "come down to the γένεσις on earth"—the last phrase is, incidentally, a confirmation of our interpretation of τὰ ὀστρεώδη σώματα. Iamblichus does not tell us which of these views was Eratosthenes', and I have to admit that this question cannot be solved even by a reference to the *Timaeus*. For not only is it impossible to know how Eratosthenes interpreted Plato's doctrines, but Plato himself mentions two different (probably successive) [58] places in which the souls dwell before their incarnation, namely, a. in the stars, b. in the moon and the other planets. It is evident, however, that the places from which the souls, according to Eratosthenes, come down to earth must be situated somewhere in the celestial region, and while I cannot offer a decisive argument I feel that the words λεπτότερα σώματα fit the stars better than anything else.[59] If anyone persists in denying that a "scientist" could hold such views as I am attributing to Eratosthenes he may do well to ponder what Pliny tells us about the opinions which another eminent scientist of the Hellenistic era, Hipparchus of Nicaea,[60] held concerning the nature of souls.

We can scarcely help recalling in this connection that one of Eratosthenes' "hobbies" was his study of καταστερισμοί. His interest in them led him not only to collect mythical or popular stories about the origin of the constellations in a monograph, of

[58] *Tim.* 41d, 42d. Cf. Wilamowitz, *Plato* 2.389; Cornford (see note 19) 143.

[59] I see no reason for referring the phrase to the "astral bodies" of the souls though I agree with Professor Dodds, *op. cit.* (see note 50) 317 that the same passage of the *Timaeus* which inspired Eratosthenes is the source (or one of the sources) of the belief in astral bodies. If Ptolemaeus Chennus is the Platonist whose views are reported by Iamblichus in the same words as those of Eratosthenes (see note 55) we may feel that we have to treat this report with some caution as the two men may not have agreed in every detail. Yet Iamblichus avoids mentioning specific details and presents merely a skeleton of their *placita*. Thus we need not fear that he gives us a distorted impression of Eratosthenes' views.

[60] *Nat.* 2.95: Hipparchus . . . quo nemo magis adprobaverit cognationem cum homine siderum animasque nostras partem esse caeli.

which the work that has come down under his name may well be a later adaptation, but also to include a number of specific *καταστερισμοί* in two of his poems, the *Hermes* and the *Erigone*.[61] To be sure, there is a great difference between *καταστερισμοί* and the Platonic conception of star-souls but Eratosthenes lived at a time when philosophers had learnt to look at the old myths as dim adumbrations and primitive formulations of their own maturer insights. Eratosthenes probably knew that even before Plato popular imagination had played with the idea *ὡς ἀστέρες γιγνόμεθ' ὅταν τις ἀποθάνῃ*,[62] and it is possible that he was interested in *καταστερισμοί* because he found in them a *testimonium animae* that there is a connection between earthly existence and the regions of the Heaven; at least I feel that it would have been excessive caution to refrain from a reference to his study of the *καταστερισμοί* when he has been found to share Plato's belief in the pre-existence of the souls in the heavenly regions of the *αἰσθητὸς κόσμος*. In the *Timaeus*, the connection between the souls and the stars and planets forms part of the grandiose cosmological scheme by which Plato established a new unity between the psychic and the physical phases of the Cosmos and tried to heighten the metaphysical status of the celestial regions. It would be arbitrary to recognize Eratosthenes' philosophical interest in other phases of this scheme and to deny it with regard to this particular item.

The doctrine which we have just restored to Eratosthenes is a part of his Platonism but not necessarily of his *Platonicus*. To go back to this work, we must certainly allow for the possibility that important ideas and arguments contained in it have left no trace

[61] The fundamental work on the subject is Carl Robert, *Eratosthenis Catasterismorum Reliquiae* (Berlin, 1878) in which a reconstruction of the original work is given. On the extant work and its relation to Eratosthenes see especially Albert Rehm, *H* 34 (1899) 251–279, an article which seems to have been the last contribution to a question on which there had been much lively discussion in the twenty years preceding its publication. On the *καταστερισμοί* in the *Hermes* see Hiller, *op. cit.* (note 33) who does not think it certain that Hermes' lyre should be included in them; on the *Erigone*, cf. Ernst Maass, *Analecta Eratosthenica* (Berlin, 1888) 61ff., 67ff., 91ff., 120ff.; Alfred Koerte, *Hellenistic Poetry*, tr. by Jacob Hammer and Moses Hadas (New York, 1929) 148.

[62] Aristoph. *Pax* 833. Cf. Herrmann Usener, *Das Weihnachtsfest*[2] (Bonn, 1911) 79, note 26; Julius Stenzel, *Ζῷον und κίνησις* (Breslau, 1914) 11; Wilamowitz, *Plato* 1.472; Eduard Fraenkel, *CQ* 36 (1942) 11, note 3. In the matter of the *καταστερισμοί* one difficulty remains: some of the constellations are supposed to represent inanimate objects like Hermes' lyre or Ariadne's crown.

at all in later Greek literature; yet we need not fear that the principal ideas elude us. That "proportion" is a basic concept of the μαθήματα, that it is the source of τάξις and of the quantities and that it forms the bond which holds together the different branches are evidently ideas fundamentally important for Eratosthenes' approach to this whole large field of human knowledge, and it is not at all probable that they were thrown out in a casual fashion or put forward in an excursus or in some other unessential part of the work.

At this point of our investigation we must face the question whether it is really credible that of all phases of Plato's thought and of all subjects brought up in his dialogues only the mathematical and philosophical concepts employed in the construction of the Cosmos should have attracted Eratosthenes' attention and prompted his comments. The question may be answered—in the affirmative—if we consider the relation between his Platonism and certain other studies to which he gave a large part of his life. While the wide range of his interests and of his productivity are justly admired, it is yet safe to say that his greatest and most lasting contribution to human knowledge (which puts even his chronological studies into the shade) is his reform of the geographical system. It is recognized [63] that the great advance which he made in this field consists in his thorough reorganization of all available knowledge on a mathematical basis. It was he who gave the subject its precise scientific foundation, and just as Plato and his Demiurge in the *Timaeus* with the help of suitable mathematical concepts introduce τάξις into cosmology, physics, and astronomy, so Eratosthenes brought mathematics and τάξις into the geographical system.[64]

Scholars have seldom wondered where Eratosthenes found precedents for his attempt to organize a subject like geography under mathematical categories. Where indeed but in the schools of Pythagoras and of Plato, of whose achievements in this field the

[63] Cf. Hugo Berger, *Die geograph. Fragmente des Eratosthenes* (Leipzig, 1880) 15; Schmekel, *op. cit.* (see note 2) 62.

[64] We do not know enough about Dicaearchus' geographical studies and know much too little about Eudoxus' to form an accurate opinion on Eratosthenes' originality in a number of fundamental points. Like E. Martini (*RE* s.v. "Dicaearchus" 560) I accept Berger's (*Gesch. d. wissensch. Erdkunde d. Griech.*[2] [Leipzig, 1903] 370) attribution to Dicaearchus of the "measurement of Lysimachea," an attempt to measure the circumference of the earth which must be older than that of Eratosthenes.

Timaeus represents the final and most impressive synthesis. But Pythagoreanism, in all likelihood, affected Eratosthenes only to the extent to which it had been assimilated by the Platonic school. Aristotle and his followers were on the whole opposed to the application of mathematical points of view to scientific investigations. It might, of course, be suggested that Eratosthenes' new approach to geography owed nothing at all to philosophy and that the only influence he experienced came from men like Eudoxus; for while no student of Greek medicine, biology, or meteorology would to-day question the great and profound influence of philosophy on the development of these studies, the idea that philosophy contributed to the growth of mathematical studies is still treated with suspicion. Yet, no matter what general arguments may be advanced for or against this influence, it is obvious that in dealing with Eratosthenes we are not allowed to ignore the evidence of his *Platonicus* which shows that he has gone back to Plato, analyzed Plato's construction of the Cosmos, reached his own conclusions and clarified his ideas on the nature and importance of the concepts which Plato had used.

In Eratosthenes' *Hermes* we find the god looking out upon the Universe from his point of vantage in the highest sphere of the heaven.[65] After noticing the spheres of the planets, the axis of the world and the earth in the centre, and perceiving the harmony of the spheres—all this is Platonic, or has at least a Platonic basis—he sees one more thing to which the Platonic Demiurge had failed to pay attention. He notices that the earth itself is divided into five zones. These zones had been introduced into geography long before Eratosthenes, who merely uses them as a starting point for a much more elaborate system of dividing the surface of the earth. We need not here consider his own improvements on the traditional theory [66] or suggest an explanation for the fact that Eratosthenes does not seem to mention these improvements in the *Hermes*. Even if the zones are the only geographical item that he included in the poem we may still say that their incorporation in the "cosmology" of the *Hermes* represents a significant addition to the scheme of the *Timaeus*. For Eratosthenes, not only the position of the earth but its structure too, at least the structure of its surface,

[65] See Hiller (note 33) 56ff.; *fr.* 16 Powell.

[66] See for the oldest theories on zones Strabo 2.2.2 with H. L. Jones' notes in the Loeb edition of Strabo (London and New York, 1917).

belonged to the cosmological system. If this was his conviction we may well understand that he was anxious to apply to the earth some of those mathematical categories which with Plato himself had been restricted to other phases of the Universe.

It would be idle to deny that Eratosthenes gives more attention than Plato to observation and "empirical" methods. He is anxious to have distances measured, he studies the reports of travelers and sailors seeking to extract from them as much reliable information as possible. He was, after all, a Hellenistic scientist and in this respect merely follows the general trend of his age. Yet, to construct a satisfactory geographical system, Eratosthenes needed more than empirical data. He needed the λόγος to interpret and organize these data, and the λόγος which he brings to bear on his material is the Platonic.

As geography with him becomes so to speak a "branch" of mathematics, we naturally wonder whether his new construction of the geographical system reflects the same fundamental convictions which we have found set forth in his *Platonicus*. Has "proportion" which pervades all phases of mathematics now been introduced into mathematical geography? Or does the "bond" not embrace the new subject? Does Eratosthenes in his geographical work think in terms of λόγος and ἀναλογία?

To see that he does think in these terms it is sufficient to look at his new computation of the circumference of the earth.[67] From the royal βηματισταί he had learnt the exact distance between Alexandria and Syene, two places which were supposed to lie on the same meridian; on his gnomon at Alexandria he read the angle which a ray of the sun formed with its axis at the same hour at which the sun was in the zenith at Syene so that its rays would form no angle with the axis of the gnomon there. Eratosthenes realized that the ray of Syene and the axis of the gnomon of Alexandria would if produced meet at the centre of the earth and form an angle identical with that which he read on his gnomon at Alexandria (for

[67] When Berger published his *Geschichte der wissenschaftlichen Erdkunde* (see above note 64) it was not yet known that Eratosthenes had set forth his new method of measuring the length of a meridian in a separate work Περὶ τῆς ἀναμετρήσεως τῆς γῆς (Hero, *Diopt.* 35). The fragments relating to this and other measurements which Berger in his collection (see note 63) assigned to the Γεωγραφικά actually belong to the monograph (cf. H. Nissen, *RhM* 58 (1903) 232 and G. Knaack, *RE* s.v. "Eratosthenes" 364). In the Γεωγραφικά Eratosthenes evidently made use of the conclusions reached in the monograph. Cf. Ivor Thomas, *Greek Mathematics* (2 vols., Loeb Library, London and Cambridge, Mass. 1939–1941) 2.266.

all rays which strike the earth were considered parallel and the two angles would therefore be alternate angles lying on parallels).[68] The final step in his reasoning is described in terms of λόγος ("proportion") by our ancient authority, the astronomer Cleomedes, as well as by modern scholars who may never have looked at the fragments of the *Platonicus*:[69] the arc which subtends the angle at the centre of the earth is the distance between Alexandria and Syene, while the arc which corresponds to its alternate angle on the gnomon is a part of the celestial sphere; as both arcs subtend identical angles they must bear the same relation (*τὸν αὐτὸν λόγον*) to the whole circles of which they are segments. Thus, as Eratosthenes knows the relation of the celestial arc to the whole circle of the heaven,[70] he also knows the λόγος between the distance from Alexandria to Syene and the whole circle of the earth, i.e. the meridian, and can compute the length of the meridian.

This computation forms the basis of his geographical system; for, knowing the length of the meridian, Eratosthenes could now relate to it any measured or estimated distance between two places on it; in other words he could, again, determine the λόγος between this distance and the entire meridian.[71] It was certainly important to know as precisely as possible the number of stadia which made up the distance between, say, Rhodes and Alexandria, but it was by relating this figure to the stadia of the entire meridian—or to the sixtieth part of it which formed the unit of his system of "degrees"[72]—that Eratosthenes succeeded in determining the exact

[68] See the diagram in Berger, *op. cit.* (note 64) 408 or in H. F. Tozer, *A History of Ancient Geography*, second edition by M. Cary (Cambridge, 1935) 171.

[69] Cf. Cleom. 1.10; 100.15 Ziegler; Berger, *op. cit.* 408; Tozer, *op. cit.* 171.

[70] On the *σκάφη* which Eratosthenes used to determine this relation, cf. Berger, *Geschichte* 407f.

[71] Berger, *Geschichte* 412 says pertinently: "Mit Huelfe der Meridianmessung war man im stande, den Stadiengehalt jedes beliebigen Teiles des Meridianes auszurechnen und umgekehrt jede beliebige Stadienzahl als einen gewissen Teil des Meridians aufzufassen." I quote Berger all the more readily as he has paid no attention at all to the mathematical and philosophical presuppositions of Eratosthenes' geography; cf. Schmekel's criticism, *op. cit.* 62, note 5. We must, however, consider that the Greeks had a tendency to formulate in terms of "proportions" (λόγοι) mathematical relations which we should formulate in terms of "fractions"; cf. Stenzel, *op. cit.* (note 15) 28 and *passim;* Hultsch, *RE* s.v. "Arithmetica" 1102. As Eratosthenes is enthusiastic about this concept of λόγος we need not hesitate to assume that he shared this tendency. On the other hand, Eudoxus and Dicaearchus (of whose methods we know even less than of their results) may also have thought in terms of this concept. While it is tempting to think that Eratosthenes, who theorized on the λόγος in his *Platonicus*, was the first to apply it to geographical questions I do not go to the length of maintaining this.

[72] See Strabo 2.5.6. Cf. Berger, *Geschichte* 412; *Fragmente* 112.

latitude of places and fixing them within his framework of degrees. We remember that in the *Platonicus* Eratosthenes insisted on the difference between διάστημα (distance, interval) and λόγος [73] and realize how fruitful this distinction must have been in mathematical geography. Any empiricist might find out the διάστημα between two places, but Eratosthenes went beyond such empirical results by applying his λόγος. As Eratosthenes had evidently also computed the length of some parallels, especially of that which was drawn from the Pillars of Hercules to India and on which the Straits of Messina, Rhodes and the gulf of Issus were placed, he could apply the same mathematical principle to distances on the parallels.[74] We know of other and perhaps less happy constructions which sprang from the same desire to organize the geographical material under mathematical units, but I do not propose to enter upon a discussion of his σφραγῖδες; [75] whether or not they too can be related to his study of Plato and Platonic mathematics I cannot decide.

We may note that in his musical theory too Eratosthenes made use of "proportions." Following the "Pythagorean"—or rather Platonic—tradition, he determined the relations between the notes on his scales in terms of "ratios" (λόγοι),[76] whereas Aristoxenus and his school, who were completely out of sympathy with this approach, preferred to fix "distances" or "intervals" (διαστήματα) between them.[77] Whether Eratosthenes set forth his theories in deliberate opposition to Aristoxenus is uncertain, but even if he

[73] See above pp. 197f. What has been said in note 71 about the tendency of the Greeks to think in terms of λόγοι rather than in terms of fractions is particularly true of such cases in which the fraction would not be an aliquot.

[74] Compare his well known statement—well known also to Columbus—that the length of the inhabitated world, i.e. the distance from the ἄκρα of the Iberian peninsula to those of India, was more than a third of the length of the entire earth in the same latitude; cf. Strabo 1.4.6. See also Berger, *Geschichte* 397, note 2.

[75] On the σφραγῖδες (geometrical figures into which Eratosthenes divided the surface of the οἰκουμένη), cf. Berger, *Geschichte* 433ff.; Knaack, *loc. cit.* (see note 50) 370ff.

[76] Cf. Ptol. *Harm.* 2.14. Note especially the agreement between the ratios of Eratosthenes' diatonic scale and those mentioned by Plato *Tim.* 36b (see above p. 197).

[77] Cf. besides the remains of Aristoxenus' own works, Ptol. *Harm.* 1.2, 1.9, 1.12 and *passim*, also the interesting scholion 70 *fin.* in Ingemar Duering's edition (see note 26). We have no right to suppose that Aristoxenus' musical πραγματεῖαι were known outside the Peripatetic school. They were just as "esoteric" as Aristotle's *Metaphysics* or logical "writings" (cf. von Jan, *RE* s.v. "Aristoxenus" 1061). Nevertheless, it is possible that the outlines of his system were known by the time of Eratosthenes.

did not do so, the fact remains—and is important for his historical position—that he was conscious of the difference between these two approaches. He had insisted on the difference between λόγος and διάστημα in his *Platonicus*,[78] even more rigorously than Plato himself had done, and both his geographical system and his musical theory benefited from his awareness of this difference.

Suidas [79] tells us that Eratosthenes had among other nicknames that of a "second" or "new Plato." The other nicknames are Βῆτα and Πένταθλον. The "reason" which Suidas gives (διὰ τὸ δευτερεύειν ἐν παντὶ εἴδει παιδείας) is probably meant to explain only one of them, Βῆτα; but it is easy to imagine that his less philosophical colleagues in Alexandria found his Platonism just as irritating as the universality of his interests.

It was certainly Eratosthenes' honest belief that ποιητὴς πᾶς στοχάζεται ψυχαγωγίας, οὐ διδασκαλίας,[80] and in writing his *Hermes* he may in fact have aimed at ψυχαγωγία rather than at διδασκαλία. And yet, this poem quite obviously reflects interests and ideas inseparably connected with his Platonism and his scientific world-view. The construction of Hermes' lyre ἐν τῇ διὰ πασῶν συμφωνίᾳ reminds us of Eratosthenes' scales; the "harmony of the spheres" bears witness to his study of Plato; the identification of this harmony with that of the lyre illustrates the δεσμός which embraces the different branches of mathematics. The eight spheres, the axis of the world, and the central position of the earth are an epitome of his cosmological system which is identical with Plato's. Moreover, there are items of geographical lore and καταστερισμοί.[81] Thus the "hymn" even if conventional in language and style must have been original in subject matter and conception. In view of Eratosthenes' intellectual rank, this originality is by no means surpris-

[78] See above p. 197. Euclid, or whoever is the author of the Κατατομὴ κανόνος which has come down under his name, declares (149.10 Jan) τοὺς φθόγγους ἀναγκαῖον ἐν ἀριθμοῦ λόγῳ λέγεσθαι πρὸς ἀλλήλους, but goes on to discuss διαστήματα. If Eratosthenes knew this work he is likely to have disapproved of what would strike him as confused terminology. I must, however, leave it to others to determine the place of the work in the history of musical theory. Cf. Erich Frank, *Plato und die sogenannten Pythagoreer* (Halle, 1923) 182. In matters relating to Greek musical theory I have received valuable help from Professor Otto Kinkeldey.

[79] S.v. "Eratosthenes." The last editor is probably right in putting a full stop before οἱ δὲ καὶ δεύτερον ἢ νέον Πλάτωνα . . . ἐκάλεσαν. On the whole, I prefer the text as printed by Jacoby (see note 1). Cf. also Hirzel, *op. cit.* (see note 3) 407.

[80] See Strabo 1.10.

[81] Individual subjects do of course occur in earlier poetry. Compare with the construction of the lyre "Hom." *h. Merc.* 47ff.; Call. *Del.* 253f.; with the "zones" Ap. Rh. 3.137ff.

ing; I emphasize it, however, because I think it may help us to settle some controversies concerning alleged models and disputed influences of the poem.

The first controversy regards the relation between the *Hermes* and the poem on Φαινόμενα which Theon of Smyrna assigns to Alexander the Aetolian, but "Heraclitus" to Alexander of Ephesus.[82] The lines which they quote show that the poem had in common with the *Hermes* the topics of the harmony of the spheres and of their identity with the ἁρμονία on Hermes' lyre but that the harmony was conceived in terms of a different theory. Thus, if Eratosthenes is original—and he is, for his poem reflects his characteristic interests —the other poet must depend on him and can for obvious chronological reasons be only Alexander of Ephesus.[83]

The second controversy concerns the relation between the *Hermes* and the magnificent vision of the Cosmos which in Cicero's *Somnium Scipionis* unfolds before the astonished eyes of Scipio Aemilianus.[84] This vision includes the spheres of the fixed stars and planets, their harmony, the position of the earth, and its five zones. Like Hermes, Aemilianus looks at the Universe from the region of the galaxy. Yet in the philosophical context of the *Somnium* the items of this cosmic vision are made to serve a new purpose. One and all, they show the illusory nature of human glory. This, then, is what Hellenistic philosophers have made of Eratosthenes' poetic conception—for I agree with Richard Harder that this new evaluation cannot be Cicero's own work.[85] Yet

[82] Theo 138.18 Hiller; "Heraclit." *Homer. Alleg.* 12. Chalcid. *in Tim.* (who draws on the same source as Theon) 72 attributes the lines to Alexander of Miletus who is not known as poet or author of Φαινόμενα and has generally and rightly been dismissed from consideration.

[83] Powell, *op. cit.* (see note 33) 129 comes on stylistic grounds to the same conclusion as I. See also August Meineke, *Analecta Alexandrina* (Berlin, 1843) 242, 372. Note how the reference to Hermes' lyre in Alexander comes in as a kind of "afterthought." See also Heath, *op. cit.* (note 42) 112.

[84] *Somn. Scip.* 16ff.

[85] *Ueber Cicero's Somnium Scipionis* (Halle, 1929) 129ff. We note as new items in the *Somnium* the periodically recurring catastrophes of the earth and the *annus magnus* (23–24). The latter goes back to *Tim.* 39b, but Hermes could scarcely stay long enough in the sky to observe its completion. Evidently the Hellenistic philosopher who adapted Eratosthenes' description to his purpose added this important feature. He also brought the astronomy up to date (17); the order in which Eratosthenes (cf. Chalcid. *in Tim.* 73) had fixed the positions of the planets relative to one another had by the middle of the second century B.C. (cf. Franz Cumont, *La Théologie Solaire du Paganisme Romain* [*Mém. de l'Acad. des Inscr.* 12 (1913)] 451, 471) been replaced by the "Chaldaean" system which puts the sun in the fourth sphere. This fact gives us a *terminus post quem* for Cicero's source.

Harder's suggestion that Eratosthenes and Cicero depend on a common "Platonic" tradition [86] simplifies the problem unduly and fails to do justice to Eratosthenes' originality. For while it is correct to find "traditional," i.e. Platonic, elements in Eratosthenes' picture of the Universe, it is he who makes Hermes rise to the sky and there absorb the picture with his eyes, and it is he, in all probability, who gave the five zones of the earth their place in the picture. Carlo Pascal [87] is clearly right in asserting that the vision of the Universe which the *Somnium* puts before us goes in its essential features back to that of Eratosthenes' *Hermes*. It is only in the question of intermediate stages that one will hesitate to agree with Pascal, for, as we have seen, the material must have passed through the hands of Hellenistic philosophers before it reached Cicero.

Finally, I cannot but disagree with the view taken by Wilamowitz [88] who denies the poet Eratosthenes every originality and is satisfied to regard him as a faithful but uninspired disciple of Callimachus. I have nothing new to say about the *Erigone*, and I do not claim for Eratosthenes any originality in the matter of diction or metre. The *Hermes* is probably his only poem in honor of a god and, scanty as its remains are, I hope that my interpretation has shown that it must have been different in type from the hymns of Callimachus since it reflects Eratosthenes' own scientific beliefs and philosophical outlook.

[86] *Op. cit.* (see note 85) 143, note 2. Harder declares: "Cicero stimmt zur Tradition," and mentions Plato and Alexander of Ephesus as representatives of the "Tradition." But Alexander depends, as we have seen, on Eratosthenes, and Plato has neither the zones of the earth nor the description of the Universe as seen from the region of the galaxy.

[87] Carlo Pascal, *Le credenze d'oltre tomba* (2nd ed., Turin, 1924) 2.22f.

[88] *Hellenistische Dichtung in der Zeit des Kallimachos* (Berlin, 1924) 1.205, 218; see also his *Die griechische Literatur etc.* (see note 2) 140. See also W. Christ and W. Schmid, *Geschichte der Griech. Literatur*[6], 2.1.252. Koerte, *op. cit.* (note 61) does not even mention the *Hermes*. It is possible that Hermes in Eratosthenes' poem bears some resemblance to the Egyptian god Thoth (cf. G. Bernhardy, *Eratosthenica* [Berlin, 1822] 111; Hiller, *op. cit.* [note 33] 43). Plato, *Phaedr.* 274c, says that the Egyptians regarded Thoth as the inventor of astronomy but Eratosthenes who lived in Alexandria need not have learnt this from Plato. We should like to know whether Eratosthenes made use of the fact that one of the planets which Hermes sees bears his own name. Auguste Couat, *Alexandrian Poetry under the First Three Ptolemies* (tr. by James Loeb, London, 1931) 492, suggests that the poem included a love story of Hermes and Aphrodite. The idea as such is attractive enough, but unfortunately Couat thinks that Eratosthenes used it to explain why the planets of Hermes and Aphrodite give forth the same sound. I fail to see how this would fit into his scheme, in which eight sounds are needed.