SCIAMVS 9 (2008), 25-131

Simplicius' Commentary on Aristotle, *De caelo* 2.10–12: An Annotated Translation (Part 2)

Alan C. Bowen
Institute for Research in Classical Philosophy and Science, Princeton
bowen@IRCPS.org

Introduction

This completes my translation of the narrowly astronomical sections of Simplicius' commentary on Aristotle's *De caelo* that first appeared in *SCIAMVS* 4 (2003) 23–58. Its aim, as before, is to supply the reader with a suitably annotated rendering of Simplicius' text that will facilitate addressing the critical questions of the nature, construction, and historical value of Simplicius' commentary, especially as it bears on the history of earlier Greek astronomical theorizing.

In completing this project, I have relied strictly on modern editions of Aristotle's *De caelo* in presenting the *lemmata* in full and have relegated comments about any differences with Simplicius' abbreviated *lemmata* to footnotes. After all, given that we have only Simplicius' *lemmata* and not the full text of the *De caelo* that he used, there seems little sense when presenting Aristotle's text in full to combine it with readings from Simplicius' and thus to imply a text that does not exist.[1] At the same time, I have preserved the fact that the text quoted or paraphrased in the commentary proper sometimes differs from the text found in the *lemmata*.[2] Thus, the *lemmata* presented here differ from those offered by Ian Mueller [2005], since he revises the received text of the *De caelo* in the light of Simplicius' text and removes any differences between Simplicius' *lemmata* and his quotations and paraphrases.

For the modern text of Aristotle's *De caelo*, my primary source is Paul Moraux's edition since it makes extensive use of the indirect tradition in establishing Aristotle's

[1] See Moraux 1965, clxxxiv–clxxxvi: cf. 1954] on the complex relation between the text of Simplicius' commentary and the medieval manuscripts of Aristotle's *De caelo*.

[2] Moraux concludes that the *lemmata* were taken from a different text of the *De caelo* than the one which Simplicius used in writing his comments and paraphrases, and that they were entered at some unknown date after the comments and paraphrases were completed [cf. Moraux 1954, 151–154, 179]. As Heinrich von Staden, however, has suggested in conversation, it would perhaps be better to say that the Simplicius' original *lemmata* were revised by a later copyist unconcerned with the quotations and paraphrases in the comments proper.

text [see 1965, clviii–clxxii]. Moreover, as before, I have used Heiberg's edition of 1894 for the text of Simplicius' commentary. But *caveat lector*. This edition has recently been criticized for its reliance on the edition of 1540 of the Latin translation of *In de caelo* made by William of Moerbeke in the 13th century; and, in addition, the case has been made for the importance of the recently discovered translation of *De caelo* 2 and related passages from Simplicius by Robert Grosseteste for establishing Simplicius' text [Bossier, Vande Veire, and Guldentops 2004, xix–xxi, ciii–cxvi: cf. Bossier 1975, Bossier 1987]. Regrettably, there is only a proper edition thus far of Moerbeke's translation of Simplicius' commentary on *De caelo* 1 [Bossier, Vande Veire, and Guldentops 2004]; and, though it certainly has proved useful, we must all await the publication of the edition of Moerbeke's version of Simplicius, *In de caelo* 2, an edition which is, I gather, to account for both of Moerbeke's translations of Simplicius' astronomical digression in his commentary on 2.12. As for Grosseteste's translation, though there is apparently a typescript edition of this by the late Fernand Bossier [see Bossier, Vande Veire, and Guldentops 2004, cxliii], it seems to be privately circulated and so far I have been unable to obtain a copy.

Next, in construing the syntax and meaning of Simplicius' Greek, I have used terminology which is faithful to our ancient sources and yet familiar to historians of science in rendering the technical language that Simplicius uses (and sometimes misuses) in the course of expounding his philosophical and astronomical interpretations.[3] As before, the line numbers in the margins of the translation indicate the line in which the first word in the line of Heiberg's text with the same number is translated. The outcome is hardly exact so far as the actual line count goes; but it should be good enough to allow readers to move between my translation and Simplicius' text, if they so wish.

Finally, I have supplied extensive footnotes and comments explicating the many issues that the reader should understand in order to assess what sort of commentary it is that Simplicius actually offers in his account of *De caelo* 2.12. Readers may well disagree with the claims and arguments made. Still, I trust that this annotation will at least help them to avoid missteps, mine included. What I have *not* done, however, is to address the voluminous literature offering reconstructions of the system of homocentric spheres that Simplicius describes in the great astronomical digression that concludes his comments on 2.12. For, as in Part 1, my overriding aim is to provide only such annotation as allows readers to confront Simplicius' testimony *on their own* without concealing this testimony beneath the many layers of learned interpretation and speculation that now lie between it and them, all in the hope that this will encourage them to view such reconstructions critically. Admittedly, this aim accords with my own conclusion that such reconstructions, which go back to Schiaparelli [see 1925–1927] in the 19th century and are for the most part variants of a project and way of reading Simplicius that was codified

---

[3] Simplicius writes for fellow philosophers of a school or trend which we now call Neoplatonic; and he draws extensively on a history of astronomical exposition that goes back to Geminus, Ptolemy, Theon of Smyrna, and Cleomedes, among others.

by Heath [1913], must be viewed today as an egregious example of how scholars and their communities read themselves into the past [see Bowen 2001, 2003b]. Moreover, it fits with my conviction that Simplicius' commentary on *De caelo* 2.10–12 is interesting and historically significant in its own right as a witness to concerns in later antiquity about the nature and foundations of what the astronomer knows and how he knows it. Accordingly, I have limited my remarks about these reconstructions to just those points where the proponents make claims about the meaning of Simplicius' Greek or criticize his meaning, thus putting aside for the most part as well the alternative reconstructions recently proposed by Maula [1974], Heglmeier [1996], Mendell [1998, 2000], and Yavetz [1998, 2001, 2003].

On the principles underlying this translation and the form of its presentation, I urge the reader to consult Part 1, especially pages 25–26.

Acknowledgments During a month recently spent in Paris as a Rechercheur Invité of the CNRS (CHSPAM), I had several opportunities to present my work on Simplicius. I am most grateful to Pierre Pellegrin and Karine Chemla for arranging these meetings, and to the participants for their very helpful comments and suggestions.

I thank Robert Todd again for his very generous help in reviewing several drafts of this part of my annotated translation. I am as ever very grateful for his advice and guidance. I also thank with great pleasure Fabio Acerbi, Bernard R. Goldstein, Taïeb Farhat, Bernard Vitrac, Heinrich von Staden, and Christian Wildberg, for their invaluable help in understanding the sense and syntax of numerous passages. I am also grateful to Andrea Falcon for his helpful comments on a recent draft and for alerting me to important issues concerning the history of Simplicius' text. It is also a pleasure to thank Dave Herald for sharing his own study of Aristotle's report at *De caelo* 292a2–6 of a lunar occultation of Mars and for preparing Figures 4 and 5, as well as Christopher Walker and Clemency Williams for advice about some Babylonian texts, and Tor Dybfest for his technical assistance at a key moment in the production of the final version of this article. Finally, I am grateful to the editorial staff of *SCIAMVS* and warmly thank the anonymous reader for his comments, Nathan Sidoli for his invaluable help in proofreading this article, and the Managing Editor, Ken Saito, for his continued interest in, and support of, this project.

Though it is true that scholars typically work alone, it is also true that they do this in a community of 'like-minded souls'. And finding such friends and co-workers as these in one's own community is both a great comfort and an inspiration. Readers will, of course, excuse each from any responsibility for the flaws that surely remain in what follows.

Contents

Conventions

() Parentheses enclose parenthetical remarks in Simplicius' exposition.

[] Brackets enclose words and phrases typically implied by Simplicius' Greek, but included explicitly in the translation in order to clarify its meaning.

< > Angle brackets enclose text that is not in the original Greek. Their main use is in the *lemmata* to mark off the parts of Aristotle's text that Simplicius omits.

Italic text in the translation serves primarily to highlight the *lemmata*, but it also serves to mark the paraphrases and quotations of Aristotle's texts in Simplicius' comments on a given *lemma*; it is used occasionally as well in the translation to convey the force of a single word.

Translation

In Aristotelis de caelo 2.12

291b24–292a18

Since there are two problems[1] *<about which anyone might reasonably be at a loss, we should try to state the apparent [solution], bearing in mind that eagerness amounts to respect more than [it does to] rashness*[2] *if someone on account of his thirst for philosophy welcomes even small advances in matters about which we have the greatest problems.*

Of such [problems] (which are numerous) not least astounding is why[3] *it is not the case that the [bodies] which are more distant from the first motion always perform more motions, but the ones in between [perform] the most motions. Certainly, it would seem reasonable*[4] *that, since the first body performs one motion, the body nearest it perform the least number of motions, for example, two, and the next [body] three, or some other such ordering [of motions]. But, as it is, the opposite is the case, since the Sun and Moon perform fewer motions than some of the wandering stars, and yet [these wandering stars] are farther from the center [of the cosmos] and nearer the first body than they.*[5] *(This has become clear in some cases even to sight.*[6] *That is to say, we have seen the Moon when it was halved as it came under the star of Mars which was in fact hidden on its dark side and*

---

[1] 480.24: *De caelo* 291b24 Δυοῖν δ᾽ ἀποριαῖν οὐσαῖν [Moraux 1965, 80]. Though this is the reading of the *lemma* found in one family of mss of Simplicius' commentary that Heiberg regards highly, he prefers the Δυοῖν δ᾽ ἀποριῶν οὐσῶν found in A, the primary ms. [1894, v].

[2] *De caelo* 291b25: ἀξίαν + gen. (lit. 'worth as much as', 'equal in worth to').

[3] *De caelo* 291b29, 292a10 διὰ τίνα ποτ᾽ αἰτίαν: lit. 'for whatever reason'.

[4] *De caelo* 291b31: εὔλογον (reasonable). For divergent interpretations of the significance of this term, see Bolton 2009, Matthen 2009, Leunissen 2009, Pellegrin 2009. The question is whether such terms always introduce purely dialectical, *a priori* arguments or whether they sometimes indicate teleological arguments that are derived from what is observed perhaps in another domain.

[5] *De caelo* 292a1–3. Mueller [2005, 20] misconstrues this sentence: the subject of εἰσιν is 'the Sun and the Moon', and καίτοι indicates an objection. Note: there will be many points in what follows where I criticize Mueller's translation of 2005. Our differences are real and, I think, worth noting because they concern the meaning of the text at a fundamental level. At the same time, however, the reader should keep in mind that the agreement of our translations in many places is not always accidental. Indeed, I have benefited by consulting Mueller's version as well as that of Aujac, Brunet, and Nadal [1979].

[6] *De caelo* 292a3: *scil.* that the Sun and Moon are nearest the center of the cosmos, the Earth.

came out on the bright, radiant side.[7] *And the Egyptians and Babylonians, who have long made observations over a very great number of years and from whom we have many reports about each of the heavenly bodies, say similar things about the other [wandering] stars.)*[8] *One might quite rightly raise this as a problem, as well as [the problem] why there is so great a multitude of heavenly bodies in the first motion that their entire ordering seems to be uncountable, whereas each of the other [heavenly bodies] is one by itself and there are not observed two or more fixed in the same motion.*

About these [matters], then, it is good to seek even greater understanding, although we have little to start with and are at such a great distance from what takes place concerning them. Nevertheless,> the problem now raised should not seem [to us] anything unreasonable[9] *<if we make our study from the following sorts of [starting-points].>*

He proposes two remaining problems about the heavenly bodies which are really quite [480.26]
intractable.[10] The first of them is like this: given that the fixed [sphere] performs one motion, why does what is closest to it, namely, the sphere of Saturn, not perform the least number of motions, say, two, and the one after that three [motions] or [motions determined] according to some other proportional ordering of numbers, so that the [wan- [30]
dering stars] which are farther [from the sphere of the fixed stars] always perform more motions. Instead, the opposite occurs. For the Sun and Moon, which are lower than the [481.1]
others—even he hypothesizes that the Sun is proximately above the Moon, just as Plato[11] did too—*perform fewer motions than some of the wandering stars*.[12] (In fact, among the wandering [stars], the motion of the Sun is the simplest and that of the Moon is simpler [5]
than the rest.)[13] And yet the higher [wandering stars], which are farther from the center

---

[7] *De caelo* 292a5, 6: κατὰ + acc. (on/at something): cf. 481.11. Mueller [2005, 20–21] has 'by' and 'from'. The Moon is halved at what we call the First and Second Quarters; it has come 'beneath' Mars when it is between Mars and the observer.

[8] *De caelo* 292a7–9 ἀστέρας...ἄστρων: see Bowen 2003b, 27n2 on the translation of these terms.

[9] 480.24 ἂν ἄλογον εἶναι δόξειε: the better mss of *De caelo* have ἄλογον ἂν δόξειεν εἶναι [cf. Moraux 1965, 81].

[10] 480.26 ἀπορωτάτας (most intractable): lit. 'most problematic' [cf. 482.5].

[11] −428 to −346. Cf. Plato, *Resp.* 616e8–6171; *Tim.* 38c7–d2.

[12] Cf. *De caelo* 291b35–292a1; Hall 1971. See Comment 1, p. 85 below.

[13] If the simplicity in question here concerns varieties of characteristic motion, Simplicius may simply be retailing the sort of theory one finds in Ptolemy's *Almagest*. That is, he may be supposing that the Sun has a simple direct motion in longitude, that the Moon has a simple direct motion in longitude as well as a motion in latitude, and that the five planets have in addition to a motion in latitude a more complex motion in longitude that is punctuated by stations and retrogradations. Alternatively, he may be indicating the sort of modified Eudoxan homocentric theory that Easterling [1961] describes: see Comment 1, p. 85 below.

and nearer the fixed [sphere]—which he calls first body[14]—should have motions that are simpler than [those] of the Sun and the Moon. (He also proves that the Moon is lower than the rest from its reported occultings,[15] of which he says that he personally has seen one, the [Moon's] occulting of Mars: for he states that, when [the Moon] was halved it came under the [star] of Mars and that [Mars] was hidden at its dark side and came out at its bright side[16]—so that [the Moon] was halved[17] as it waxed.[18] But, whereas he personally watched this, the Egyptians and Babylonians have observed the same thing occurring with the other [wandering] stars as well (that is, with those that are higher), so that many of their observations of each of the [wandering] stars have been handed down.[19]

Next, he also introduces the second problem[20]—*why there is so great a multitude of stars in the fixed [sphere] that it seems to be uncountable, whereas in each of the spheres beneath it there is not observed more than one star present*. And, then, looking to the danger of his inquiry and reckoning that it is formidable because of the magnitude of the problems, he offers encouragement by saying, *it is good, then, to inquire about these matters and*[21] *to receive, or rather to seek after, even greater understanding*.[22] Alexander thinks that the argument is rather elliptical in this [passage] because what is added to this [in what follows] seems to be more fitting.[23] But perhaps the thought has not been

---

[14] Cf. *De caelo* 292a2.

[15] 481.9 ἐκ τῶν... αὐτῆς ὑποδρομῶν: lit. 'from its passages under' [cf. Mueller 2005, 21], but this is unnecessarily ambiguous. Simplicius is thinking of the phenomenon of occultation and not just the coincidence of the Moon and some other planet in longitude.

[16] *De caelo* 292a3–6. See also Aristotle, *Meteor.* 343b30–32 (Aristotle reports Jupiter's occultation of a star in the constellation Geminus). See Comment 2, p. 86 below.

[17] 481.12 διχότομον: cf. Bowen 2003b, 44–46.

[18] 481.11: that is, the Moon was at First Quarter.

[19] 481.14–15 ὡς... παραδεδόσθαι. Simplicius rightly presents the Babylonian observations as an institutional program, one that was in fact remarkably long-lived. The existence of such a program of Egyptian observation is substantially less clear, and so one must wonder what exactly Simplicius has in mind (if it anything more than just what Aristotle writes). Mueller [2005, 21] has 'as has been conveyed by many of their observations concerning each star', but this strains the syntax.

Cf. Aristotle, *De caelo* 292a7–9 and *Meteor.* 343b28–30 with [Plato], *Epin.* 987a1–6. See Comment 3, p. 87 below.

[20] *De caelo* 292a10–14.

[21] 481.21 Heiberg has περὶ μὲν δὴ..., but notes that μέν is omitted in Karsten's edition: Moraux 1965, 81 *ad* 292a14 reports that μέν is found in some mss of the *De caelo*.

[22] 481.21–22: cf. *De caelo* 292a14–15. This is a paraphrase, not a quotation.

[23] 481.18–19. Mueller [2005, 22 and n61], assumes that Alexander and Simplicius are arguing about the use of ἀποδέχεσθαι (to receive, *not* to attain) and ἀπαιτεῖν, but finds this hard to reconcile with Simplicius' remark at 481.26–30. If, however, we suppose that both Alexander and Simplicius read *De caelo* 292a14–17 as offering encouragement—παραμυθεῖσθαι may mean 'to exhort' (so Mueller), but it can also mean 'to

stated elliptically, since Aristotle was not used to expressing his meaning in an elliptical fashion, even if he was given to abbreviated discourse. Rather, he means that those who are especially intelligent, not just anybody, should investigate matters of this sort and not shrink back, *even if they have little to start with concerning them and stand apart from what happens concerning them in more than spatial distance*, as he said elsewhere.[24] Nevertheless, even if this is the case, on the basis of the arguments to be stated the problem raised now should not seem unreasonable.

292a18–b10

> *But we <conceive> [of the heavenly bodies] as [we do] of mere bodies only,*[25] *<that is, as [we do] of units which have order but are utterly without soul; whereas we should understand them as though sharing in action and life, since in this way what follows will not seem at all unreasonable.*[26] *For the good seems to belong without action to what is in the best state; to what is nearest [this] through a single, slight action; and to things farther [from this] through many actions. Likewise, in the case of the body, one [body] is well, though it does not exercise; another [is well] by walking short distances; but for another there is in fact a need of running, wrestling, and exercise in the arena;*[27] *and again for another, however*

---

encourage' or 'to reassure'—then Alexander's point is, I take it, that the encouragement (or reassurance) follows from the claim made at 292a17–18 that the problem is not beyond reason if one proceeds on the basis of certain starting-points or arguments. In short, he would seem to think that proceeding is reasonable, but that the encouragement is still incomplete or lacking in that these starting-points or arguments (which make proceeding reasonable) are not given here but in what follows. Simplicius' objection is captious—he resents the suggestion that Aristotle ever expresses himself ἐλλειπτικῶς—and when he offers an interpretation that makes clear the flow of Aristotle's text, he effectively concedes Alexander's (very minor) point. Cf. the Latin version of the Hebrew translation of Themistius' paraphrase:

> if we nevertheless move in thought from these things [about which we can get knowledge] to our inquiry by means of the following slight resources or principles, it will be neither unreasonable nor strange too that whatever [the facts] are, they should be found out in this way. [Landauer 1902, 119].

[24] *De caelo* 292a15–17: cf., e.g., *De part. an.* 644b22–645a5, where Aristotle emphasizes our difference in nature from the celestial bodies; *De caelo* 286a3–6. Cf. Falcon 2008, 85–112.

[25] 482.1 μόνον αὐτῶν: Moraux [1965, 81] prints αὐτῶν μόνον; these readings as well as μόνων αὐτῶν and αὐτῶν μόνων are found in the mss of both Simplicius' text and the *De caelo*.

[26] *De caelo* 292a14–18: this passage has occasioned controversy. See, e.g., Elders 1966, 234–235; Leggatt 1995, 248–249; and Comment 4, p. 88 below.

[27] *De caelo* 292a26 κονίσεως (a workout in the dust). Cf. 482.30–483.2.

many things it works at, this good will still not belong to it, but something else.[28] *For succeeding either at many things or often is difficult, just as it is impossible to throw 10,000 ‘Chian’ knucklebones but easier [to throw] one or two. And again, when one must do [A] for the sake of [B] and [B] for the sake of [C] and [C] for the sake of [D], it is easy to succeed in one or two [steps] but more difficult to the degree that it is through more [steps].*

This is why we must hold that the action of the heavenly bodies is in fact of the same sort as the [action] of animals and plants. Indeed, down here the actions of man are greatest in number, since [man] can attain many goods, so that he does many things (for the sake of other things too). (What is as good as possible has no need at all of action, since it is itself its goal; whereas action always depends on two [factors] since there is both that for the sake of which [there is action] and what is for the sake of this.[29]*) But, [the actions] of the other animals are fewer in number; whereas there is perhaps some slight and single [action]of plants, since there is either some one [good] which they can attain just as man also does> or there are in fact many [goods] all conducive to the best.*[30]

[482.3] His remarks up to now have applied to the two problems. From this point, he sets out for the solution of the former and mentions first the reason why the argument seems quite intractable, [and he states] that [this is] not due to the object of inquiry but to those making the inquiry. That is to say, we consider the problem unsolvable because *we think of the heavenly [bodies] as [we think of] mere bodies without souls, that is, as it were, as numerical units having only position*[31] in relation to one another and being ‘*utterly without soul*’.[32] And, certainly, it would be unsolvable if they were so, given that from [such bodies] no starting-point for a solution is found. But we must think of [the heavenly bodies] as though living things possessing a *rational* soul so that they share in both action and an active life, since we apply ‘doing’ both in the case of irrational souls and in the case of bodies without souls but predicate ‘acting’ characteristically[33] in the case of rational souls. Thus, if we think of them as being so, what follows for the motions of the heavenly [bodies] should not seem contrary to reason.

---

[28] Cf. *De caelo* 292a15–17.

[29] *De caelo* 292b6–7: viz., a goal and a means to this goal [cf. Moraux 1965, 82]. Mueller [2005, 22] mistakenly takes ἐν δυσίν to mean ‘of two kinds’ rather signifying dependency on two items, and misconstrues what follows.

[30] See *De gen. an.* 731a24–26, where Aristotle maintains that the only function and action of plants is to produce seed.

[31] *De caelo* 292a19. Mueller takes the conjunction ὡς to mean ‘as if’: note Simplicius’ ὡς γὰρ περὶ σωμάτων… οὕτω περὶ τῶν οὐρανίων διανοούμενοι and see Comment 4, p. 88 below.

[32] *De caelo* 292a20: 482.8 τὸ πάμπαν, instead of just πάμπαν [see Moraux 1965, 81].

[33] 482.13 ἰδίως: *scil.* ‘exclusively’.

Certainly, inasmuch as these [bodies] are active and every action comes to be through motion for the sake of the good, it is clear that, in the case of what is in the best state,[34] namely, what is either good itself or united essentially to the good itself like the Prime Mover—the highly esteemed Intellect[35] is of this sort—these things[36] are and have the good apart from action and motion.[37] Or, as he himself says, in one [sense, what is in the best state] has [the good] and, in another, it shares in [the good] proximately.[38]

[It is also clear] that the good belongs to what is nearest [what is in the best state] through a slight, single motion, just as it does to the fixed [sphere]; and that [the good belongs] to those that are farther away through a greater number [of motions], as it does to the planets. And [it is clear too] that some [heavenly bodies] cannot even attain that [good] immediately but are content to approach those that do attain [the good], just as the Earth does and is for this reason immobile, or[39] [just as] the whole [region] beneath the Moon as well, given that [motion] in a straight line is in fact characteristic of imperfect beings whereas fire and the upper air have circular motion in common with the heavens.[40]

Next, he says, using the body and its health as an example, one body (which is analogous to what is immobile)[41] is well even apart from its having exercised because of its being structured in the best way. '*Another*' [body] (which he compared to the fixed [sphere]) [is well] '*by walking short distances*'. And for another [body] there is need of a

---

[34] 482.17 τῷ ἄριστα ἔχοντι (what is in the best state, what is best): not 'things which posses the best' [Mueller 2005, 23, 24, and n78]: cf. Smyth 1971, §1438.

[35] 482.19 πολυτίμητος: an epithet often used in addressing divinities. Simplicius here identifies what is in the best state (292a22, 292b5–7) with the Intellect (a Neoplatonic hypostasis) which is treated as a divinity or god: cf. Easterling 1961, 150–152; Leggatt 1995, 250.

[36] 482.19 ταῦτα (rather than τοῦτο) introduces an asyndeton.

[37] 482.20 Mueller [2005, 23] misconstrues the sentence: the point is not that these things are without action *and* posses the good, but that they both are the good and possess the good without action and motion.

[38] 482.20–21: cf. *De caelo* 292b10 ('Thus, the one has and shares in the best...'). These lines are Simplicius' attempt to read Aristotle in support of the point just made about what is in the best state: note ἤ, ὡς αὐτός φησι. Mueller [2005, 23] apparently sees no connection and proposes 'Or, as he says, one thing has it and another shares in it directly'.

[39] 482.24 reading ἢ with the mss rather than Heiberg's ᾗ.

[40] 482.24–26: Mueller [2005, 23] overlooks the use of εἰμί + gen. to indicate the nature or the characteristics of the substantive in the genitive case [see Smyth 1971, §1304].

Simplicius is addressing the Aristotle's assertion at *De caelo* 292b19–20 that the Earth (ὅλως) does not move. Cf. *De caelo* 277b12–24 and 4.4. Simplicius' assertion that fire and aether move in a circle in common with the heavens marks a significant departure from Aristotle's view that only aether moves by nature in a circle [cf. Hoffman 1987, 76–83]. The theory of natural motion indicated here was standard in late antiquity—it is accepted by Plotinus, Proclus, Simplicius, and Philoponus, for example, and goes back to Xenarchus [see Falcon 2008, 62–69].

[41] 482.28 τῷ ἀκινήτῳ: *scil.* the Prime Mover.

greater number of exercises for being healthy, say, running and wrestling, that is, athletic [483.1] training in wrestling (‘*a workout in the dust*’ is like this because wrestling moves are practised in the dust). This one is taken as analogous to a wandering [star]. But, to [a body] disposed in an extreme state ([a body] which he has likened to [the region] beneath the Moon), the unmixed benefit of health does not belong however many things it works at, since it cannot share in the divine Goodness immediately and because of this does not move by itself.[42]

But, perceiving that the argument is still inadequate—in other words, that he has not stated the reason for the distinction in what wanders, namely, why the Sun and the Moon perform fewer motions while the upper wandering [stars perform] more[43]—he fills in what is missing by saying that objects more worthy of honor do more things because of their being ‘*able to attain many good things*’,[44] and that it is more fitting for them to succeed at many things or many times, which is in fact very difficult. (Not only is it hard, say, for a knucklebone player ‘*to throw 10,000 Chian or Coan knucklebones*’[45]—it is written thus,[46] as if knucklebones are large in both islands—it is in fact impossible; but ‘*one or two is rather easy*’.)[47] But this is in fact fitting for those who are stronger, I mean, attaining the most complete good through a greater number [actions]—for instance, if it were necessary to do [A] for the sake of [B] and [B] for the sake of [C] and [C] for the sake of [D], as [it is] necessary to learn one’s letters with a view to being able to engage in the sciences and [to do] this with a view to practicing philosophy and [to do] this with a view to assimilating to the divine. Certainly, ‘*it is easy*’ also for the weaker ‘*to succeed*

---

[42] In point of fact, Aristotle likens such a body to the Earth: cf. *De caelo* 292b15–20.

[43] 483.8–9: the Latin version of Themistius’ paraphrase [Landauer 1902, 120.8–16: cf. 119.38–120.4] asserts that the planets have their number of motions in proportion to their distance from the fixed sphere, which is hardly consistent with the terms of the first ἀπορία [cf. 119.12–15].

[44] *De caelo* 292b3–4. 483.10 δύνασθαι in an articular infinitive construction instead of δύναται. Aristotle does not actually *say* this, but it is a credible inference from what he does say.

[45] *De caelo* 292a29. 483.13 ἢ Κῴους. The better manuscripts for the *De caelo* have Χίους [cf. Moraux 1965, 82], but Κῴους as well as Χίους ἢ Κῴους are attested. For an account of these various readings and Simplicius’ text, see Moraux 1954, 158–159.

[46] 483.13 γράφεται. . . οὕτως: Simplicius signals a textual remark [cf. Rescigno 2004, 677].

[47] *De caelo* 292a30. The knucklebones (ἀστράγαλοι) were four in number, each marked on four of its six surfaces—two opposed surfaces had no value presumably because neither could support the knucklebone. The flat surface (τὸ χῖον) had the value 1; the concave surface, 3; the convex surface, 4; and the irregular surface (τὸ κῷον), 6 [cf. Longo 1962, 329–330; Moraux 1965, 161; Leggatt 1995, 249]. The shape of the knucklebones was such that it was easier to roll four 1s than four 6s [cf. Elders 1966, 236]—hence, presumably, the difference in value. Simplicius’ remark about the size of the knucklebones from Chios and Cos is misleading, though certainly understandable given his text: Aristotle is surely thinking of the difficulty of attaining a particular outcome a very great number of times in succession.

in one or two [steps] but more difficult to the degree that it is through more [steps]’.[48] [20]
Thus, among living things that are generated, as the actions of man are greatest in number
because man can attain many goods (given that, for his part, he does many things, both
managing them for the sake of other things and referring their benefit to himself),[49] so
one must hold as well that the action of the [wandering] stars (that is, their motion) is [25]
many times more various than the [motion of the] others[50] in comparison, because of
their being able to attain a greater number of goods. And man too is more worthy of
honor than the other living things by virtue of his doing a greater number of things.

The argument in its entirety would be as follows: if [bodies] performing a greater
number of motions are worthier of honor, they perform a greater number of motions
because of their succeeding at a greater number of things; but if [they are] inferior, [they
perform a greater number of motions] because of their being unable to attain the best [30]
through a simple motion.[51] Consequently, even if opposites should belong to the same
things and the same things to opposites, we will not be at a loss for a solution but will
assign the reasons fittingly to the things [in question].[52] Thus, Aristotle says these things
without reconciling them to the dignity of the gods.[53] Certainly, the argument is insecure; [484.1]
but it is one that provides the starting-points of a solution, according to which we shall
not be amazed both if what is more worthy of honor should be less active and if what is
inferior should be less active.[54]

After saying of man that he does many things, that is, so [very] many things as he acts
for the sake of other things as well,[55] lest anyone suppose that this is the best [Aristotle] [5]
supplied ‘*what is perhaps in the best state has no need at all of action*’[56] and added the
reason, rather the entire proof in fact, when he said that what is in the best state is that

[48] *De caelo* 292a32–b1.

[49] There seems to be a tension in Aristotle’s analysis between a thing’s having a great number of possible ends and a thing’s having complex ends, that is, ends that are to be reached by a series of subsumed ends each of which conduces to the ultimate end. Though the two need not be the same [cf. Sharples 1976, Simplicius seems to reduce the thesis about the greater number of actions and goods available to man (and hence, man’s superiority to the other animals) to a claim about the greater complexity of human action. Whether this is right depends in part on how one interprets *De caelo* 292b2–4. Certainly, what is relevant to Aristotle’s argument in 2.12 is the issue of the complexity of motion [cf. Landauer 1902, 120.16–38].

[50] 483.25 ἄλλων παρ’ ἄλλα (*scil.* the fixed stars).

[51] 483.28–30: on the form of the condition, see Smyth 1971, §2359.

[52] 483.30–32: all the planets are inferior to the fixed stars in that they require more motions to attain the good.

[53] 483.32–484.1: that is, without saying which wandering stars are inferior or superior to one another in the current sense of these terms. Mueller [2005, 24] takes διαιτῶν τῇ ἀξίᾳ τῶν θεῶν to mean ‘judging the worth of the gods’, thus misconstruing the function of the dative.

[54] 484.1–2: e.g., the celestial sphere and the Sun (or Moon), respectively.

[55] *De caelo* 292b2–4.

[56] *De caelo* 292b4–5: 484.5 ἴσως rather than ὡς [cf. Moraux 1965, 82].

for which being this thing is being that for the sake of which [it is].[57] Certainly, the best is the goal of all things, that is, that for the sake of which all things are; and what acts is something else besides that for the sake of which [it acts]. In fact, he supplied the explanation of this premiss again when he said, '*for action depends on two [factors] since there is both that for the sake of which [there is action] and what is for the sake of this*'.[58] For, if everything that acts does what it does on account of a desire of the good, the good would be one thing and what acts another. Thus, he infers in the second figure[59] that what is in the best state has no need of action, since what is in the best state is that for the sake of which [there is action] and what acts is not that for the sake of which [it acts].

And, after stating the [qualities] of the best by way of a middle [term], he attaches to what has been said before of man '*and, what is more, [the actions] of the other animals are fewer in number*'[60] and what comes next [in the text].

He calls the action of plants, that is, the action concerning nutriment, '*slight*' and '*single, perhaps*'[61] on the ground that they are not able to succeed in many [things]. (He has called the activity of the plant an '*action*' in its more common sense, since in the strict sense at least action is activity according to reason.)[62] But what comes next, '*since there is either some one [good] which they can attain*',[63] he would surely say not of plants but of agents in general, because either there is one particular thing set forth for the agent which it can attain (just as man in fact [can attain] one of the rather great number of things set forth for him), or, if there is actually not one thing but [if] the things set forth are greater in number (as in fact they are for man), then *these many things are conducive to the best*[64] by virtue of the fact that all the other things incline to that [best thing] and are chosen because of it. But '*there is either some one [good]*' can also be applied in the case of plants when it is explicated in relation to '*there is perhaps some slight and single [action]*'[65] and means that either a plant does indeed have one particular good which it can attain (just as man also [attains] each of the many goods that are his own), or, if a plant's goods seem to be many as well—say, feeding, growing in size, begetting

---

[57] 484.6–7: cf. *De caelo* 292b5–6. Mueller [2005, 24] construes τὸ εἶναι as 'the essence', but in both occurrences it is simply a verbal noun meaning 'being', which is qualified by a predicate.

[58] *De caelo* 292b6–7. 484.10 ἡ γὰρ πρᾶξις ἐν δυσίν: Moraux [1965, 82] prints ἡ δὲ πρᾶξις ἀεί ἐστιν ἐν δυσίν (for action always depends on two [factors]).

[59] See *An. pr.* 1.5.

[60] *De caelo* 292b7. 484.16 καὶ δὴ καὶ τῶν: the mss of the *De caelo* have only τῶν δ' [see Moraux 1965, 82].

[61] *De caelo* 292b8.

[62] Cf. 482.12–14.

[63] *De caelo* 292b8–9.

[64] 484.26–27 τὰ πολλὰ ταῦτα πρὸ ὁδοῦ ἐστι πρὸς τὸ ἄριστον: this is either a paraphrase or quotation of *De caelo* 292b9–10, for which Moraux [1965, 83] has τὰ πολλὰ πάντα πρὸ ὁδοῦ ἐστι πρὸς τὸ ἄριστον.

[65] *De caelo* 292b8.

[new plants]—all these are conducive to its single, most complete good, [a good] which [485.1] is restricted in relation to the human [good].[66]

292b10–25

> *Thus, one [body] has or shares in the best,[67] <whereas another arrives at it[68] through a few [actions] and another through more [actions]; another, however, does not even try but has sufficient power[69] to arrive at what is near the ultimate [good]. For example, if health is the goal, then one [body] is always healthy; another [is healthy] after it has lost weight;[70] another, after it has run and lost weight; and another after it has done something else in fact for the sake of running so that its motions are more numerous; whereas another is unable to arrive at being healthy but only at running or losing weight and one or other of these is the goal for [these bodies]. Of course, it is best by far for all things to attain the former goal;[71] otherwise, it is always better [for them] to the degree that they are nearer what is best.*
>
> *In fact, for this reason, the Earth does not move at all and the [bodies] nearby[72] perform a few motions, since they do not arrive at the ultimate [good] but up to the [degree] which they can attain of the most divine principle. The first heaven attains [this principle] directly through a single motion. And the [bodies] between the first [heaven] and the [bodies] farthest [from it][73]> arrive <at [this principle], but do [so]> through more motions.[74]*

---

[66] As Elders [1966, 238] points out, there is reason to doubt that *De caelo* 292b8–10 actually concern plants. Elders proposes that Aristotle is thinking of the heavenly bodies again [cf. 292b1].

[67] *De caelo* 292b10: the Latin version of Themistius' paraphrase makes very clear that, for Aristotle, this best is not absolute but is defined in relation to our intentions and aims [cf. Landauer 1902, 121.6 and 8–9].

[68] *De caelo* 292b11 (ἀφικνεῖται): the mss have ἀφικνεῖται ἐγγύς (arrive near), but Moraux [1965, 83] deletes ἐγγύς, which attenuates the point and does not appear subsequently in Aristotle's discussion, and notes that Simplicius [Heiberg 1894, 485.22] has only ἀφικνεῖται. Stocks has conjectured ἀφικνεῖται εὐθύς (arrives directly), perhaps because of its occurrence at 292b23 and in Simplicius' commentary [Heiberg 1894, 487.4]. Cf., e.g., Allan 1955, *ad* 292b11.

[69] *De caelo* 292b12 ἱκανόν.

[70] *De caelo* 292b14 ἰσχνανθέν: lit. 'after it has been reduced'.

[71] *De caelo* 292b18: *scil.* what is best.

[72] *De caelo* 292b20: *scil.* the Sun and Moon.

[73] *De caelo* 292b24: *scil.* the Sun and Moon [cf. 291b29–292a3].

[74] *De caelo* 292b25 κινήσεων [Moraux 1965, 83]. Heiberg [1894, 485.4] follows A and prints τῶν κινήσεων; other mss omit τῶν.

After stating that one should think of the heavenly bodies as [we do] of living and active [things] rather than as [we do] of things without soul,[75] and after supplying the distinctions between agents,[76] [Aristotle] reaches [the goal] set forth by explicating the solution of the problem that has been raised—as Alexander says, by using what was mentioned first for explicating the reason, namely, the fact that, whereas for those things which are best there is no need of action, for some things [there is need] of a slight [action] in order to attain the best, and for others [there is need] of a greater [action]. Perhaps [Aristotle] also links up the second distinction, the one bringing to light [the fact] that a slight motion is not always better but is in fact sometimes worse than a greater [motion].[77] Thus, he says that neither the first nor the last of the things that are has need of action—the last, because it does not reach its goal proximately and the first, because it is not distinct from the good but has [the good] in accordance with its own being, that is, shares in it.[78] (In fact, he could be applying '*having*'[79] to the Goodness that is beyond Being, that is, to the One, and '*sharing*'[80] to the Intellect that is unified proximately with the Good or has a share in it. For a thing that presents [an attribute] in accordance with its own being is said to have [that attribute], whereas as a thing that takes [the attribute] from another is said to share [the attribute].[81] Certainly, that Aristotle actually has in mind something beyond Intellect and Being is clear when he says plainly in the closing parts of his book, *On Prayer*,[82]

---

[75] 485.5–6: *scil.* ὡς διανοούμεθα περὶ. . . . Cf. *De caelo* 292a18–22 and Comment 4, p. 88 below.

[76] *De caelo* 292a22–b10.

[77] 485.10–12: According to the Latin version of Themistius' paraphrase [Landauer 1902, 121.40–122.9], Alexander understood there to be two contradictory principles at work in Aristotle's argument: the first being that the nearer something is to the best the fewer the actions that it will require to attain it; and the second, that the farther something is from the best, the fewer the actions that it will need to reach it. 'Themistius' disagrees [Landauer 1902, 122.10–20, cf. 121.28–39] and proposes that there is really no contradiction. It is difficult, however, to believe that Alexander would offer a criticism phrased in quite these terms.

Simplicius likewise cites Alexander but does not indicate any criticism on Alexander's part, unless μήποτε δὲ καὶ τὸν δεύτερον μίγνυσι διορισμόν hints at one. In any case, Simplicius rightly distinguishes Aristotle's argument that the other planets are superior to the Sun and Moon in that they perform more motions from his argument that the Sun and Moon are inferior because they perform fewer motions. For, while the five planets can attain the ultimate good through many motions, the Sun and Moon cannot attain this good at all but can only manage a few motions bringing them some good that is as near the ultimate good as they can reach. But see Mueller 2005, 26, nn77 and 84.

[78] *De caelo* 292b10–13.

[79] *De caelo* 292b10.

[80] *De caelo* 292b10.

[81] 485.18–19: the subjects of the two limbs of this sentence are τὸ. . . προβεβλημένον and τὸ. . . λαμμβάνον, and not τὸ ἕν and ὁ νοῦς as Mueller [2005, 26] would have it. Simplicius is making a lexical point.

[82] 485.21 τοῦ Περὶ εὐχῆς βιβλίου. There is doubt that there ever was such a work by Aristotle: see Rist 1985 for a reconstruction of the history of this 'text'.

that God is either Intellect or in fact something beyond Intellect.[83])[84]

One thing arrives through a slight number of motions at its own goal. But the goal is twofold: in one sense, it is what is the best of all things and the most complete; in the other, it is more particular. Slight motion is also twofold: in one sense, it is as [a motion] that comprehends the multitude of motions even in itself and, because of this, attains the goal that is common and total; in the other, it is [a motion] that is part of the many and, because of this, is aimed at a particular [good]. It is also clear that the former [kind of slight motion] is better than many motions, while the latter [kind of slight motion] is inferior. Consequently, what attains its goal through a greater number of actions (that is, activities) would be a mean for what [attains its goal] through a few actions.

And, because of this, the problem is solved, [I mean the problem,] Why, given that the fixed [sphere] performs a single motion, do the [heavenly bodies] that are farther from it (the Sun and the Moon) perform fewer motions than the [bodies] that are higher and [486.1]
nearer the fixed sphere, whereas these [intermediate bodies] perform a greater number [of motions]? [The answer,] he says, [is] that, some of the [heavenly bodies] which perform a few motions are better than those which perform a greater number [motions] and some are inferior. And which [of the two], and in which [of the two] way[s], has been stated. But the last [body][85] does not even try to attain its goal immediately. This is why it does not even move, but it is enough for it come to what is near its goal.[86]

Next, after clarifying what has been said through the example of health in which he presents '*losing weight*'[87] as becoming trim,[88] and after saying that attaining the most complete goal is best, otherwise, [it is attaining] what is as near as possible to that [goal],[89] he finally adapts what has been set out to what has been said by passing from the last to the first and then including those in between.[90] In other words, he says, '*for this reason the Earth does not move at all*'[91]—not because it has its immobility for the same reason that the good (that is, its goal) [has immobility]. For, while [the good] was

[83] 485.21–22: see Ross 1955, 57.

[84] 485.16–22: Simplicius is here interpreting Aristotle through the lens of Neoplatonic thought.

[85] 486.3–4: *scil.* the Earth.

[86] 486.5 εἰς τὸ ἐγγὺς τοῦ τέλους: *scil.* some lesser good. Cf. 486.19–487.3.

[87] *De caelo* 292b14.

[88] *De caelo* 292b13–17: ἀπέριττον: lit. 'without excess parts'.

[89] *De caelo* 292b17–19.

[90] Cf. Landauer 1902, 121 *et quemadmodum in his, ita etiam in caelestibus corporibus haec conspiciuntur, atque eo magis, quo primo principio propriora extiterint. in hoc autem Aristoteles eo usque sermonem protelavit, quo usque ad speculationem terrae pervenerit.*

[91] *De caelo* 292b20.

that for the sake of which moving objects move and had no need to move to itself,[92] the Earth (being farthest [from the fixed sphere]) does not by nature share in [the good] immediately; instead, by coming close (as it can) to those which do share in [the good] proximately, it also shares in [the good].

The [heavenly bodies] near the Earth perform a slight number of motions because they do not arrive at the ultimate goal (that is, the first and utterly complete Good) because they are partitioned from it. Rather, they move up to the point where they can share in the most divine principle. And they can [do this] partially.

(Even if by '*Earth*'[93] he means Earth in the strict sense, by '"*near*"[94] it' he would mean the sublunary elements above the Earth; whereas, if by '*Earth*' he means everything beneath the Moon, by '*near*' he would mean the Moon and Sun in that they perform few motions. The latter [reading] is in fact more appropriate to what has been said, since it is about these [bodies] that the problem has in fact been raised, namely, why, given that the fixed [sphere] performs a single motion, the [wandering stars] that are farther from it (the Sun and the Moon) do not always perform more motions, whereas these perform a slight number of motions and the intermediate ones more.

Now, if '*a slight number of motions*'[95] did not refer to the Sun and Moon, what is most important for the solution of the problem would be missing. But if it does refer to the Sun and Moon, '*they do not arrive at the ultimate [good]*'[96] seems hard [to interpret], unless then it means that, given that they come to be as rather particular beings,[97] they are not comparable to the utter perfection of [the ultimate Good], since he has said plainly that they share in the first principle according to their own due measures.[98] In other words, he says, *they share in the most divine principle up to the degree which they can*.)[99]

The first heaven, he says, attains the first principle '*directly*'[100] (that is, immediately) through a motion that is single in kind, because this single [motion] is inclusive, productive, and comprehensive of all motions. That is to say, after it was first set in motion, the first heaven imitated the completeness of what is immobile through its complete motion; and it becomes just what that is through everlasting eternity, Plato would say, with [the motions]

---

92 486.13 ἐπ' αὐτό: though one editor omits ἐπ' [cf. Mueller 2005, 27 and n88], this is the better reading because it actually makes the point [cf. 482.16–21, 484.6–14]. See Landauer 1902, 121.38–31, which distinguishes what is best because it has its end in itself and a 'lesser' object which does not and so must *act*.

93 *De caelo* 292b20.

94 *De caelo* 292b20.

95 *De caelo* 292b20–21.

96 *De caelo* 292b21.

97 486.29–487.1 μερικώτερα γινόμενα: Simplicius indicates his own view that the heavens are generated. Cf. 487.6–10.

98 Cf. Elders 1965, 239–240.

99 487.2: the mss have οὗ instead of ὅτου [cf. Moraux 1965, 83]. This is a paraphrase of *De caelo* 292b21–22.

100 *De caelo* 292b23.

beneath it dividing sameness of [the immobile] through all time.[101] And if it also pleases anyone to fall back on stories of the gods, let him bear in mind that in these [stories] too the [wandering star] after the first heaven, most powerful Saturn, is the beginning of separation and division.[102] But these [matters are for discussion] elsewhere.

He says, '*The [bodies] in between the first [heaven] and the last [bodies]*',[103] calling the fixed heaven[104] '*first*' and the Sun and Moon '*last*', since these are the extremities of the divine body. Thus, he says, the ones in the middle of these, since they are more encompassing,[105] approach the completeness of the first principle closer than the last, but they approach [it] through the division of motions[106] and not through a single motion as the first heaven [does]. Thus, [they approach it] through a greater number of motions which divide the single motion [of the first heaven] completely.[107] This is why they are also said to approach that to which the single motion leads them back.

It seems even to me that, after he investigated all the heavenly motions, I mean, those extending the all-ness of immobile Unity, Aristotle discovered that the fixed [sphere] in performing its single motion is inclusive of all [motions], whereas all [the spheres] after it [perform] all [motions] in a divided sense, and that the Sun and Moon do not [perform] all [motions], since they are not observed making stations or retrogradations[108] or different

---

[101] 487.6–10. See Plato, *Tim.* 36b6–d6, 37c6–d7. Simplicius likens the sphere of the fixed stars to a moving image of eternity. He also departs from Aristotle in treating the celestial sphere as something that was once set in motion and not as something always in motion.

[102] 487.10–1: see Mueller 2005, 104n91.

[103] 487.13–14: ἐν μέσῳ instead of ἐν τῷ μέσῳ [cf. Moraux 1965, 83]. Simplicius seems to find in *De caelo* 292b23–24 an opposition between first and last where I suspect that Aristotle is only opposing first and farthest.

[104] 487.14 τὸν ἀπλανῆ οὐρανόν: *scil.* the sphere of the fixed stars.

[105] 487.16 ὁλικώτερα (lit. 'more universal'): *scil.* encompass more motions.

[106] 487.17–19 διὰ μερισμοῦ... τελείως: for Simplicius, the motion of the sphere of the fixed stars is single in the sense that it encompasses all the other celestial motions, even that motion which it does not itself present to observation, the motion from west to east.

[107] 487.18–19: for Simplicius, the motion of the celestial sphere is not just communicated to the lower spheres, it is distributed or divided. In the *Timaeus*, however, the motion of the Same, which is the motion of the celestial sphere, is neither distributed nor divided: only the motion of the Different suffers this.

[108] 487.24 ὑποποδισμούς: in an astronomical context, this term signifies a retrograde motion (that is, a synodic, as opposed to a daily, motion from east to west) and is not found used in this way before Proclus [cf., e.g., *Hyp. ast.* 7.4]. Geminus, *Intro. ast.* 12.22 seems to be the earliest extant text to affirm that the Sun and Moon do not undergo retrograde motion.

phases,[109] or advances[110] and followings[111]—this is why astronomers have in fact been satisfied with simpler hypotheses in explicating the causes of their phenomena. Thus, after hypothesizing that the motions represent actions[112] and occur because of an assimilation to the Good, he says that the first heaven attains complete assimilation proximately to the immobile through one complete motion, whereas the spheres after it arrive at complete assimilation through all the divided motions, and that the Sun and Moon share in it to the extent they can, since they do not perform all the [planetary] motions.[113]

In this way, then, Aristotle has explicated his solution of the problem, after displaying it and granting that the planets perform motions that are many in kind not only because of their apparent direct motions,[114] but also [because of] their [apparent] retrogradations, stations, [their] different phases, advances, followings, and [their] various kinds of unsmoothness.[115] In fact, those who hypothesize eccentric and epicyclic [motions] as well as those who hypothesize homocentric [motions] (the ones called turning [motions])[116]

---

109 487.24 διαφόρους φάσεις: a phase is a significant configuration of the planet with respect to the Sun. Thus, the different planetary phases presumably include as well such phenomena as first and last visibilities in the morning or evening. They would also include the phenomena which we call phases of the Moon [cf. 547.13], though Simplicius typically designates these as φωτισμοί (illuminations).

110 487.25 προηγήσεις: according to Theon [Hiller 1878, 147.19–148.1], 'A motion in advance is the appearance of a planet as though traveling in the direction of the leading signs, that is, to the west, say, from Cancer to Gemini.' προήγησις is also Ptolemy's word for retrograde motion [cf. Toomer 1984, 20], that is, motion in the direction of the leading signs. Note that the distinction of following and leading (zodiacal) signs is made with respect to the apparent daily rotation, not with respect to the eastward motion of the planets (as Mueller [2005, 104n92] supposes).

111 487.25 ἀκολουθήσεις [cf. 488.7]. I have not found any earlier use of this term in connection with the planets. One possibility is that καί in προηγήσεις καὶ ἀκολουθήσεις is explanatory and, thus, that the phrase should be rendered 'advances (that is, followings)', where 'followings' are motions that follow the leading signs. But, though this would work well for 487.23–25 (and would entail that the προηγήσεις are retrograde motions), it would strain the syntax at 488.5–7 where καί serves mainly to connect elements in a list. In any case, whatever the ἀκολουθήσεις are, as Simplicius makes clear, they are characteristic only of the five planets and not of the Sun and Moon.

112 487.27 πρακτικὰς... τὰς κινήσεις.

113 487.27–488.2: Again, Simplicius offer a Neoplatonic summary of Aristotle's argument.

114 488.5 προποδισμούς: this term is common in astronomical contexts from the first century AD onwards. It is also found in Proclus [cf., e.g., *Hyp. ast.* 7.4]. Direct motions are non-synodic motions from west to east, that is, in the direction opposite to the apparent daily rotation of the celestial sphere.

115 488.7 ἀνωμαλίας: on the idea of 'smooth' motion, see Bowen 1999, 293–295.

116 488.9: Simplicius uses ἀνελίττουσαι, Aristotle's term for the unwinding spheres in *Meta.* Λ 8, more generally of homocentric spheres whether winding or unwinding. Mendell [2000, 91–93] supposes that all of Aristotle's nested rotating homocentric spheres came to be called ἀνελίττουσαι by synecdoche. If this is correct, then, in this context, all occurrences of ἀνελίττουσαι should be translated translated by 'unwinding'. But perhaps

admit a greater number[117] of motions [than one] for each [planet] in order that these [apparent motions] be saved.[118] The true account, of course, which accepts neither the stations [of the planets] or their retrogradations nor the additions or subtractions of the numbers in their motions (even if they evidently move in this way),[119] does not admit hypotheses as being the case.[120] Rather, by drawing inferences from the substance [of the planets] it demonstrates that the heavenly motions are simple, circular, smooth, and orderly.[121]

But, since [people] were not able to grasp precisely how the features of their dispositions are appearance only and not reality, they desired to discover on what hypotheses it would be possible to save, by means of smooth, orderly, circular motions, the phenomena of the motions of the [stars] that are said to wander. Indeed, as Eudemus[122] recorded in the second book of his *Astronomical History* and as Sosigenes[123] (who took it from Eudemus) [also recorded], Eudoxus of Cnidus[124] was the first of the Greeks said to lay hold of hypotheses of this kind, after Plato, as Sosigenes states, proposed for those who are serious about these matters the following question, By hypothesizing which smooth and orderly motions will the phenomena of the motions of the wandering [stars] be saved?[125]

---

there was no synecdoche. Perhaps instead readers of Λ 8 were aware of an ambiguity in the verb ἀνελίττω itself when applied to rotational motion, much as there was an ambiguity in their usage of the verb ἀναστρέφω, for example, and thus understood that ἀνελίττουσαι could mean either 'wind back or return to the original position' (where no direction of rotation is implied) or 'wind back some other motion'. In any case, to avoid confusion, I have, when it is appropriate, translated ἀνελίττουσαι and its variants by 'turning' rather than by 'unwinding': cf. Aujac, Brunet, and Nadal 1979, 138n1.

117 488.8 πλείονας (a greater number… [than one]): alt., 'a rather great number'.

118 488.7 διὰ… τὸ ταύτας σώζεσθαι: lit. 'for the sake these [apparent motions'] being saved'.

119 488.11 τῶν ἐν ταῖς κινήσεσιν ἀριθμῶν: the allusion is to tabular numerical data recording the positions of the planets and the times when they occupy those positions; and, in particular, to the corrections to the mean values for their daily progress.

120 488.12–13 οὐδὲ τὰς ὑποθέσεις ὡς οὕτως ἐχούσας προσίεται: Mueller's 'nor does it admit hypotheses of this kind' [2005, 28] mistranslates the Greek and wrongly suggests that there might be a hypothesis that is accepted in the true account. For Simplicius, what is at issue here is the very notion of astronomical hypothesis itself. See 45n121 below.

121 This is a line of argument found in earlier Stoic writers such as Posidonius and Cleomedes: cf. Bowen and Todd 2004, 193–204; Bowen 2007.

122 Eudemus of Rhodes, a younger contemporary of Aristotle, may have been a candidate to succeed Aristotle as head of the Lyceum.

123 Sosigenes (second century AD) was a Peripatetic philosopher and teacher of Alexander of Aphrodisias [cf. Hayduck 1899, 143.12–14, Bowen 2008c]. See Comment 5, p. 89 below.

124 −389 to −336: cf. De Santillana 1940.

125 488.14–24 [cf. 422.14–24, 492.31–493.11]: for an analysis of this complicated report, see Knorr 1990, 319–320.

[25] Thus, if the motions (which are greater in number in each case than the rather numerous
wandering bodies)[126] are hypotheses, and if they are not proven to be so in truth—as the
fact that different [people] hypothesize them in different ways makes clear—what need
[30] is there to seek in this way the reason why the planets proximate to the fixed [sphere]
perform more motions than the ones that are last, as though in each case there are in truth
a greater number of bodies than the fixed [spheres] and because of this a greater number of
motions?[127] But, if we are obliged to hazard making these sorts of comparisons in general,
perhaps there is no need at all for us to define the merits [of the planets] in regard to the
[489.1] distinction between their places; instead, [we must] say that each has been posted in the
place where it benefits the universe. Thus, since bodies beneath the Moon do not have
their own light but are illuminated from without, 'the two lights of the cosmos'[128] have
rightly, one might say, been stationed proximately above them, perhaps because [these
lights] have the simplicity of their motions for what is better than what is composite.

[5] For his part, Plato seems to say in his *Laws* that, whereas the planets evidently move
thus in a variety of ways, they surely do not move in this way in truth.[129] But, in his
Timaeus,[130] he concedes that their motion is more varied on the ground that they are in
between things that are ordered in every respect and things that are disordered in every
respect, and that because of this they have an ordered unsmoothness. This is why in his

---

[126] 488.25–26 τῶν πλανωμένων... σωμάτων (the wandering bodies): *scil.* the planets themselves. Simplicius appears to be considering a particular set of astronomical hypotheses, namely, the nested rotating homocentric spheres of *Meta.* Λ 8, in which each planet has carrying and unwinding spheres.

[127] 488.28 τῶν ἀπλανῶν (than the fixed [spheres]). The sentence itself is awkward. The key is to recall that each planetary system in Aristotle's account has a single sphere which reproduces the motion of the fixed or celestial sphere. Thus, given that there is reason to doubt that Aristotle's homocentric theory really is the way things are, Simplicius wonders about the sense of proceeding as though there really is more than one body associated with each planet and, hence, more than one motion, and then worrying about the first ἀπορία. He presumably does not mean by this to deny that the planets *appear* to make more than one motion: his concern is, I take it, that addressing the first ἀπορία without knowing how many motions each planet *really* does make is pointless. That he talks of the fixed sphere rather than the planet is odd, but perhaps excusable on the ground that in Aristotle' theory each planet really is just a system of spheres.

Mueller [2005, 29, n95] proposes to read πλανωμένων or πλανητῶν instead of ἀπλανῶν: cf. αἱ πλείονες καθ' ἕκαστον τῶν πλανωμένων πλειόνων οὖσαι σωμάτων κινήσεις at 488.25–26 (which he mistranslates as 'the several motions for each of the several planets').

[128] 489.2–3 οἱ δύο τοῦ κόσμου φωστῆρες: cf. 461.28–32. Proclus [*Hyp. plan.* 4.72: see also Kroll 1899–1901, 2.43.25 and 2.300.23] also calls the Sun and the Moon φωστῆρες. Such usage appears to goes back at least to the first century BC, since it is attested in the *Septuagint* (3rd c. BC to early Christian era). It is not found in Plato and Aristotle.

[129] See Plato, *Leg.* 821b3–822d1.

[130] See Plato, *Tim.* 35a1–40d5.

Laws he also inveighs against those who predicate only wandering of them and who do not think that this [wandering] both shares in order and is theirs by nature.

Inasmuch as Alexander says flatly in regard to these [arguments] that the four elements (that is, the sublunary ones) are without soul and lack any share in action,[131] who would not be amazed if things composed of a least portion of [these elements] are living things with souls, though they possess a being that is 'ephemeral' (that is, altogether contracted into a brief [time]),[132] whereas such great portions of the universe, which are eternal in their entireties[133] had not been judged worthy of soul by the Demiurge? For, even if [the four elements] are uncompounded,[134] there would be no need for them to be without soul, since the heavens (which are also uncompounded) have been given soul—when too each of [these four elements] as composed from the four [opposites] is what it is said to be by virtue of the predominance of one [opposite].[135] But, if [the sublunary elements] do not share in action because different ones do not act at different times (just as particular living things do), the heavens too always have the same pattern of activities.[136] And if [Alexander] thinks that the Earth is without life and soul because it does not move locally, first, we should be ashamed, if we say that plants made alive by the Earth live and are ensouled, but that the Earth itself is without life and soul. Next, when Aristotle says that both Intellect and Soul are alive, he does not necessitate that they move locally. Even if the Earth, which is the 'Hearth of the universe',[137] is at rest, it has this action and activity. For, just as moving as an animal,[138] so too standing at rest as an animal is an action and an animate activity. That is why the heavenly bodies move, whereas the Earth stands at rest and particular animals both move and stand at rest.

---

[131] Cf. 482.12–14. In his *De anima*, Alexander affirms that nothing lacking a nutritive faculty can have a soul [Bruns 1887, 29.1–4], which means that, for him, none of the elements has a soul.

[132] 489.13–15: Simplicius seems to be thinking of insects such as the May fly.

[133] 489.15–16: Simplicius is referring to the heavens, which are composed of the fifth element, aether.

[134] 489.17 ἁπλᾶ (simple): *scil.* 'uncompounded'.

[135] 489.19–20: in this context, Aristotle actually calls Simplicius' elements simple bodies (ἁπλᾶ σώματα) and the opposites, elements [cf. Aristotle, *De gen. et corr.* 331a20–b4]. The point is, for example, that an element (simple body) is said to be fire because of the predominance of one opposite, the hot, in it.

[136] 489.21 τὴν αὐτὴν τάξιν τῶν ἐνεργειῶν: that is, the parts of the heavens do not act (and not act) at different times.

[137] 489.26 ἑστία τοῦ παντὸς οὖσα. The phrase ἑστία τοῦ παντός, curiously enough, is found only in reports of the views of those who thought that at the center of the universe, its hearth, was a fire: cf. [Plutarch], *Plac. philos.* 895e6–7; Stobaeus, *Anthol.* [Wachsmuth and Hense 1884, 1.22 §1d.2–4]. Simplicius appropriates the phrase but follows Plato [*Leg.* 955e6–7] in identifying the Earth as the hearth: cf. Galenus Grammaticus, *Alleg. in Hesiod. theog.* [Flach 1876, 331.7–9].

[138] 489.27 ζωτικῶς: lit. 'in a manner characteristic of life or of what is alive'.

292b25–30

> *Concerning the problem <that there is a great multitude of heavenly bodies in the first motion, which is single, whereas each of the other [heavenly bodies] gets its own motions separately, one would reasonably think that this obtains primarily because of one thing. For one should understand that> there is a great superiority of the first [motion] <of each living source [of motion]> in relation to the rest,*[139]

[489.33] After he has set forth the two problems and solved the first, he goes after the second one
[490.1] which asks why the fixed sphere, though it is single and performs a single motion, has so great a multitude of heavenly bodies that it seems uncountable, with all performing one motion, namely, that of the fixed sphere; whereas each of the [heavenly bodies] that are said to wander gets its own motion in accordance with the sphere on which it is alone
[5] by itself. Then, in solving this problem in three or two arguments,[140] he has stated[141] the first from the superiority which the fixed [sphere] has to the other spheres.[142] Certainly, even if all [the spheres] have both life and status as a source [of motion],[143] *one should*

---

[139] *De caelo* 292b28 τῆς ζωῆς καὶ τῆς ἀρχῆς ἑκάστης (of each living source [of motion]): a hendiadys. Cf. Guthrie 1960, 213 'each of these living principles'; Leggatt 1995, 149 'the life and the principle of each locomotion'; Pellegrin 2004, 261 '*pour la vie comme pour chaque principe*' (but see 2004, 439n13 '*concernant la vie et le principe*'); Mueller 2005, 30 'with regard to each's life and sovereignty'. The question is how to understand this. If Aristotle is thinking of souls in general, the claim that their first motion is greatly superior is difficult indeed. I would suggest instead that his focus here is narrower, that he has in mind the seven planetary systems of spheres and is thinking that each planetary system has an internal living source of motion or soul [cf. Comment 4, p. 88 below]. Thus, I propose, in each such system, the first motion belongs to the outermost sphere, that is, to the sphere which imitates the celestial sphere, and this outermost sphere is superior to the spheres which it contains because it causes them to perform the diurnal rotation. This is, of course, not the same view as that found in *Meta.* Λ 8, where each sphere in a given planetary system has its own unmoved mover.

[140] 490.5 ἐπιχειρήμασι: an ἐπιχείρημα is often for Aristotle a dialectical argument [see Bolton 2009]. In the Latin version of Themistius' paraphrase, it is said that there are two arguments [Landauer 1902, 122.21–25]. The first is given in *De caelo* 292b25–30 [Landauer 1902, 122.25–123.9] and the second in 292b30–293a11 [Landauer 1902, 123.9–30].

[141] 490.5 εἴρηκεν: several mss have have εἴληπται (has taken) or εἴληφεν (took) instead.

[142] 490.5–6: in the Latin version of Themistius' paraphrase [Landauer 1902, 122.25–28], this superiority is assigned to the sphere's principle of life, that is, its soul. In the first instance, however, Aristotle attributes superiority to the *motion* of the first (or fixed) sphere. But this is a minor point, since the claim about the superiority of the first sphere follows readily [cf. Landauer 1902, 122.34–35, 123.3–4]. More important is that in moving to the second problem Simplicius tacitly switches from talk of the planets and fixed stars as though they were alive to the claim that the spheres carrying these heavenly bodies are alive. This reflects the same switch in 292b28–293a2 [cf. Leggatt 1995, 250].

[143] 490.7 καὶ ζωὴν καὶ ἀρχικὸν ἀξίωμα.

bear in mind that there is in fact belonging to the first [sphere] a superiority of both life and origination [of motion].[144] The immediate kinship [of the fixed sphere] to the
primary acting and moving cause[145] makes clear the superiority of its powers, as do its [10]
being inclusive of all the other [spheres], its carrying round the other [spheres] by itself, and, still further, its attaining the most complete good entirely through one simple motion and in almost no time (if one bears in mind its magnitude). Consequently, perhaps one would wonder more rightly at the opposite, namely, if [this sphere] which is superior by
so much, nevertheless has some whole-number ratio of power to the other [spheres], [I [15]
mean, some ratio] which the multitude of [heavenly bodies] moved by it [has] to each one of the [heavenly bodies] fixed in the other [spheres].

292b30–293a4

> *and this [superiority] would turn out to be reasonable.*[146] *<For the first [motion], which is single, causes many of the divine bodies to move; whereas the [motions of the individual planets], which are many in number, each [cause] only one body [to move], since any one of the wandering [stars] performs a greater number of motions [than the fixed stars]. In this way, then, nature both makes things equal and produces a certain order, that is, by giving many bodies to one motion> and many motions to one body.*

There is no need, they say, for us to run his statements together by conjoining this [490.19]
[argument][147] to the [statements] above, but we should accept it as a second argument. [20]
Certainly, [Aristotle] does say that '*the first*'[148] motion (the motion of the fixed [stars]), though it is one in number, causes many '*of the divine bodies*'[149] to move in accordance

---

[144] 490.7–8 ἐννοῆσαι χρὴ. . . καὶ ζωῆς καὶ ἀρχῆς: a paraphrase of 292b28–30. Simplicius' text, apparently, does not preserve the hendiadys and lacks the troublesome ἑκάστης.

[145] 90.9–10 τὸ πρῶτον ποιοῦν τε καὶ κινοῦν αἴτιον: *scil.* the Prime Mover.

[146] *De caelo* 292b31 κατὰ λόγον (reasonable) [cf. 30n4]: alternatively, 'in accordance with our argument'. See Pellegrin 2004, 261 ('*une supériorité proportionelle*') with 439n13.

[147] 490.19 Τοῦτο: *scil.* ἐπιχείρημα. In his division of the text into *lemmata*, Simplicius would seem to treat *De caelo* 292b30–293a4 as offering a separate argument. But note his reservations at 490.5 ('in solving this problem in three or two arguments') and 490.29–491.11. In truth, these lines in the *De caelo* simply explicate how the superiority of the first motion to all the others is reasonable or contributes to the first solution of the puzzle at hand, depending on how one reads κατὰ λόγον [cf. 49n146, above]. In either case, they do not constitute a separate argument but are part of the first. Cf. Landauer 1902, 123.5–9 *quod autem rationi consonum sit, ut ita res se habeat, hinc profecto ostenditur. . .* ('But because it is consistent with reason that the matter [*scil.* the superiority of the fixed sphere] is so, from this it is in fact pointed out. . . ') to present 292b30–293a4; and 123.9–10 *et praeterea* ('And furthermore') to introduce 293a4–11.

[148] *De caelo* 292b31.

[149] *De caelo* 292b32.

with its own single motion; whereas the motions of the wandering [stars], since they are many in number for each star, cause one body belonging to many spheres to perform many motions. That is to say, each of the wandering stars performs a greater number of motions [than a fixed star] in that it is carried by a greater number [of spheres] (which are called turning [spheres]). ‘*In this way, then*’, he says, ‘*nature equalizes*’[150] even this great a superiority ‘*and produces a certain order by giving [the] many bodies*’ of the fixed stars ‘*to the one motion*’ of the fixed [sphere] ‘*and [the] many motions*’ of the wandering star ‘*to one body*’.[151]

Indeed, interpreters who put this argument down as distinct on its face urge not conjoining it to the previous one. But, perhaps, if it is *not* conjoined with that one, [491.1] [his assertion,] ‘*and this would turn out to be reasonable*’[,][152] is unintelligible. For what is ‘*this*’, if he did not use [it] with reference to superiority?[153] Certainly, saying ‘*this*’ is the position, order, and apparent inequality [of the first sphere in relation to the others], as Alexander states, treats the missing [part] of the explanation as extensive.[154]

Now never, after saying that the superiority of the fixed [sphere] is great in relation to the wandering [stars] and through this solving the problem, does [Aristotle] show next that this superiority is in fact equalized somehow by divine craftsmanship through proportionality.[155] That is, [never does he show in fact that] as the single motion of the fixed [sphere] stands to the many stars moved by it, so the single wandering star stands to the many motions that it performs.

Of course, if one does not accept in this way what is said [by Aristotle] but as a distinct argument completely on its own, it is in fact not at all capable of overturning [the argument] stated before it, since that one alleges superiority as a cause, whereas this one alleges equalization.[156]

---

[150] *De caelo* 293a2. The manuscripts for Simplicius have ταύτῃ οὖν where those for the *De caelo* have ταύτῃ τε οὖν.

[151] Cf. *De caelo* 293a3–4.

[152] *De caelo* 292b30–31.

[153] In *De caelo* 292b29–30, the antecedent of ‘this’ (ἥδε) has to be ὑπεροχήν.

[154] 491.1–3: the Latin version of Themistius’ paraphrase has *hic est litterae intellectus, in hoc autem non videtur Alexander recte sensuisse, siquidem ficta quaedam, aliunde adsumpta, suae explicationi adiecit* (‘This is meaning of the text. But Alexander does not seen to have perceived [the matter] rightly in this, since he adds certain false(?) [propositions] taken from elsewhere to his explanation’) [Landauer 1902, 123.21–23].

[155] 491.3 μήποτε (never). Mueller [2005, 31] takes μήποτε as ‘perhaps’, and thus has Simplicius raising the possibility that Aristotle (in another work?) offers the sort of Platonizing explanation which Simplicius outlines.

[156] 491.10 μήποτε (never). Mueller [2005, 31] again takes μήποτε as ‘perhaps’, and thus raises the gratuitous problem of how the argument from superiority could ‘refute’ the argument from equalization.

293a4–11

> *And further, the other motions have a single body [to move][157] because <the motions before the last [motion] (that is, the [motion] which has the [wandering] star [to move]) cause many bodies to move, given that the last sphere moves by virtue of being fixed in many spheres and each sphere is[158] a kind of body.[159] Thus, the work of that [last sphere] must be shared in common: for, whereas each sphere itself has by nature its own characteristic motion, this [motion] is, as it were, added[160] and> the power of every limited body is in relation to a limited [body].[161]*

This is another argument (either the second or third), which supplies on the basis of the [491.15]
spheres called turning [spheres], the explanation of the fact that the wandering [spheres] each have a single star, whereas the fixed [sphere has] such a great number [of stars]. Thus, he says that the sphere possessing the single star said to wander '*moves by virtue of being fixed*'[162] in many spheres (called turning [spheres] or, as Theophrastus[163] calls them,
starless [spheres]),[164] given that it is the last [sphere] of the entire system[165] of spheres— [20]
for example, of the [spheres] which cause Saturn or Jupiter or one of the other [planets] to move. Of course, simple motion is by nature characteristic to each of these spheres (the [sphere] possessing the [wandering] star and the ones containing this [sphere]); and the variety (that is, unsmoothness) of the [wandering] star as it seems to move directly

---

157 491.12 καὶ ἔτι διὰ τόδε... φόραι [Moraux 1965, 84]: though some mss of *In de caelo* do have φοραί in the lemma, the better ones read καὶ ἔτι διὰ τοῦτο... σφαῖραι ('And further, the other *spheres* have a single body').

158 *De caelo* 293a8 τυγχάνει ὄν = ἐστί, as often in Aristotle [cf. Liddell, Scott, and Jones 1968, *s.v.*. τυγχάνω II].

159 *De caelo* 293a4–8: Aristotle's point is that each planetary motion *qua* proper is the motion of but one body; yet this proper motion may still set other bodies in motion incidentally, that is, by virtue of the nesting of homocentric spheres.

160 *De caelo* 293a10: *scil.* added to the motions below it. Thus, all the superior spheres contribute to the motion of the last sphere and the motion each contributes is, therefore, shared in common by all lower spheres.

161 *De caelo* 293a10–11: cf. 274b33–275b4. There is no mention in Simplicius' commentary of the last four lines of *De caelo* 2.12 (293a11–14): *Concerning the heavenly bodies that perform circular motion, we have stated what sorts of things they are both with regard to their substance and their shape, and we have spoken about their motion and order*.

162 *De caelo* 293a7.

163 Theophrastus of Eresus (Lesbos) (−371 to −287), associate of Aristotle. He became head of the Lyceum when Aristotle withdrew from Athens in −322 on the death of Alexander the Great.

164 491.17–18 = Theophrastus, Fr. 165B in Fortenbaugh *et al*. 1992.

165 491.20 τῆς ὅλης συντάξεως.

and to go retrograde, to add and subtract in its numbers, and to stand still is added from outside. In fact, [this variety] is brought about by the turning [spheres] because each of them moves, as was said, according to its own characteristic motion and because each one in accordance with its own proper motion causes the [sphere] possessing the [wandering] star to move differently.

Thus, since each sphere is a body, and since in each system [of spheres for a given planet] to the outermost (which moves with the fixed [sphere]) is assigned in addition to
[492.1] its characteristic motion [the further task of] causing all the other spheres contained by it to perform in common the same motion that it performs, it would be difficult[166] for [this outermost sphere] to cause both so many bodily spheres and the sphere possessing the single star to move, *if* [that sphere] no longer possessed one but many [stars], as the fixed [sphere] indeed does. Aristotle indicated the difficulty through the statement, '*The power of every limited body is in relation to a limited [body].*'[167] To explain—if what causes motion had *unlimited* power, it would be no trouble to put any number of objects beneath it to move.[168] But, since a body which is limited has *limited* power, this power must be relative to what is limited and commensurate with it, and not relative to a [body] of just *any* sort. Thus, if it goes beyond the kinetic power of one sphere to move so many bodies[169] by itself, [and] if the sphere possessing the single [star] possessed many stars too, the task would be truly difficult.

It seems to me that this argument advances as though in dependence on the [preceding one][170] which states that there is a great superiority of the fixed [sphere] in relation to the wandering [spheres], since what is there to prevent [the following]—that just as the fixed [sphere] causes both all the stars on it and all the spheres contained by it to move together with itself, so too the outermost of the turning [spheres] causes both the turning [spheres] beneath it and the sphere which no longer possesses the single star but many to move? [Nothing,] unless, therefore, it makes a difference that the fixed [sphere] which subsists with the fixed stars and performs its own motion thus carries round together the [spheres] contained by it, and that the [sphere] possessing the wandering star would make its motion due to another more difficult for the mover if it possessed a multitude of

---

166 492.1 ἐργῶδες (difficult): alternatively, 'laborious'.

167 *De caelo* 293a10–11.

168 492.5–6 οὐδὲν ἂν ἦν πρᾶγμα ὁσαοῦν ὑποβάλλεν αὐτῳ πρὸς τὸ κινεῖσθαι: cf. Aujac, Brunet, and Nadal 1979, 159 '*point ne serait besoin de rien placer au-dessous pour transmettre le mouvement*'; Mueller 2005, 32 'nothing could overcome it with respect to being moved'.

169 492.10 *scil.* the spheres beneath the outermost sphere in each planetary system [cf. Aujac, Brunet, and Nadal 1979, 159n1].

170 492.12 ὡς ἐπ' ἐκείνῳ προϊέναι: cf. Aujac, Brunet, and Nadal 1979, 159. Mueller [2005, 32] misreads this as 'goes forward <only> against'—'against' would require ἐπ' + acc.—and goes astray in rendering 492.12–20. Cf. 492.25–26.

stars.[171] But the difficulty is not that those bodies have weight—Aristotle, after all, has denied this in a demonstration[172]—but that there must in every way even among these objects be a commensurability of the mover to what is moved. For this reason, Aristotle has made his demonstration from [commensurability].

One should understand that this argument too advances as though in dependence on [25]
astronomical hypotheses bearing on turning [spheres] that are truly the case, although
[these hypotheses] have no necessity, as I have also said earlier,[173] since different [people]
in fact saved the phenomena through different hypotheses. It would be appropriate for our
accounts of the heavens and the heavenly motions to speak briefly about these hypotheses [30]
too, given that when they are hypothesized each [of their proponents] maintains that he
saves the phenomena.

It was in fact stated earlier[174] too that Plato (who unequivocally assigned the circular,
the smooth, and the ordered to the heavenly motions) put forward a question for scien- [493.1]
tists[175]—Given what hypotheses will it be possible that the phenomena of the wandering
[stars] be saved by means of smooth, circular, and ordered motions?[176]—and that Eu-
doxus of Cnidus was the first to focus on hypotheses by means of spheres (called turning [5]
[spheres]). Callippus of Cyzicus[177] (who was a schoolmate[178] of Polemarchus, a pupil[179]

---

[171] 492.12–21: thus, Simplicius implies, if increasing the number of bodies on the innermost sphere would make the task of all the planetary or turning spheres more difficult, it follows that the fixed sphere, which moves an almost countless number of stars [cf. 481.16–18] as well as all the spheres beneath it, must surely be superior in power, even in relation to the outermost sphere of each planetary system.

[172] Cf. *De caelo* 269b18–270a12.

[173] Cf. 488.3–14.

[174] See 488.14–24: cf. 422.14–24.

[175] 493.2 τοῖς μαθηματικοῖς: see Bowen 2003b, 28n5.

[176] 493.2 τίνων ὑποτεθέντων, δι᾽ ὁμαλῶν... κινήσεων: lit. 'what things having been hypothesized, [...] through smooth... motions'. Mueller's 'by making what hypotheses about uniform... motions' [2005, 33] gets the question wrong.

[177] This passage is the only surviving source from antiquity of biographical information about Callippus.

[178] 493.6 Πολεμάρχῳ συσχολάσας: Mueller [2005, 33 and n119] takes this to mean that Callippus was a student of Polemarchus, but this does not seem right: the prefix συν (with, in the company of) entails that συσχολάσας take the dative of accompaniment [cf. Smyth 1971, §1545]. This certainly is the usage of the verb that one finds in Strabo, Plutarch, Diogenes Laertius, and Athenaeus, for instance. Note also συσχολάσας τοῖς ὑπὸ Εὐκλείδου μαθηταῖς (*et Euclidis discipulorum consuetudine... uteretur*) [Hultsch 1877, 678.38 with 679]: cf. Ver Eecke 1982, 507 *il avait ... consacré ses loisirs aux disciples d'Euclide*. The text, however, should actually read σχολάσας τοῖς <ὑπὸ> Εὐκλείδου μαθηταῖς [Jones 1986, 121]. Jones' 'had studied... under the people who had been taught by Euclid' [1986, 120] is unduly interpretative; the literal sense is 'who devoted his time (or himself) to the students of Euclid'.

[179] 493.6 γνωρίμῳ (pupil: cf. Diels 1882, 99.13–15): Simplicius may actually mean that Polemarchus was a

of Eudoxus) came to Athens after [Eudoxus][180] and lived with Aristotle,[181] correcting with Aristotle Eudoxus' discoveries and supplementing [them], since the hypothesis of turning [spheres] (which hypothesizes the turning [spheres] as homocentric with the whole [universe] and *not* eccentric as later [thinkers suppose]),[182] was pleasing to Aristotle in that he thought that all heavenly [bodies] must move about the center of the universe.

Now, Eudoxus and his predecessors thought that the Sun performs three motions, since it is brought round from east to west with the sphere of the fixed [stars], since it performs by itself the opposite [motion] through the 12 zodiacal [constellations], and since it is displaced obliquely at the [circle] through the middle of the zodiacal [constellations].[183] (This [third motion] was in fact ascertained from [the Sun's] not always rising at the same place in the summer and winter solstices.)[184] Thus, because of this, they said[185] that [the Sun] moves in three spheres (which Theophrastus called starless on the ground that they possess no star as well as compensating in relation to the [spheres] lower down, and turning in relation to the [spheres] higher up).[186] Certainly, since there were three motions for [the Sun], it was impossible that the motions in opposite directions be caused by the same thing, given that for their part neither the Sun nor the Moon nor any of the stars moves by itself, but all move by virtue of being fixed on a rotating body.[187] If, then, [the

---

member of Eudoxus' inner circle of students, that is, those advanced students who were instructed by the master himself and who bore some of the responsibility for teaching others (the ἀκροαταί) [cf. Watts 2006, 29–32, 52, 156–157, 160–161]. Polemarchus is otherwise unknown except for the additional citation at 505.21 [see Comment 20, p. 107 below]. There is no support for Neugebauer's inference [1975, 668] that Polemarchus observed an annular eclipse.

180 493.6 μετ᾽ ἐκεῖνον. Heath [1913, 212] takes the antecedent to be Polemarchus.

181 Presumably, then, some time after Eudoxus' death in −336 and, hence, after −334, when Aristotle returned to Athens from Macedonia.

182 Simplicius, it would appear, is thinking of accounts of the planetary theory in Aristotle, *Meta.* Λ 8 that rely on eccentric spheres. See Theon, *De util. math.* 3.31–32: cf. 34 [Hiller 1878, 178.3–184.23: cf. 189.7–18] which includes an account in which the planet is fixed on an 'epicyclic' sphere.

183 493.14–15 ἐπὶ τοῦ διὰ μέσων τῶν ζῳδίων (at the [circle] through the middle of the zodiacal [constellations]). For the distinction of zodiacal signs (which are divisions of the zodiacal circle and thus have length but not breadth) and zodiacal constellations, see Geminus, *Intro. ast.* 1.1–3. Mueller sometimes misreads ὁ διὰ μέσων τῶν ζῳδίων *scil.* κύκλος as 'the middle of the signs of the zodiac' [2005, 33, 34, *et passim*].

184 493.15–17: the summer and winter solstices are, presumably, the days of the year on which the daytime is longest and shortest respectively. Later writers assign the obliquity of this third sphere a specific value: cf. Heath 1913, 199–200. See Comment 6, p. 91 below.

185 493.18 ἔλεγον (they said): not ἔλεγεν (he said) as Mueller [2005, 33] has it.

186 493.17–20 = Theophrastus, Fr. 165C in Fortenbaugh *et al.* 1992. The terms are explained at 504.4–15. My 'compensating' is intended to capture ἀνταναφερούσας (lit. 'bringing back(wards) in (re)turn').

187 493.23 τῷ κυκλικῷ σώματι: lit. 'on a body that moves in a circle'.

Sun] made its revolution in longitude[188] and its displacement in latitude[189] in one and the same time-interval, two spheres would be sufficient—one [would be] the [sphere] of the fixed [stars] which rotates to the west and the other, [the sphere] which winds to the east about an axis which is fixed in the former [sphere] and at right angles to an oblique circle along which the Sun would be held to make its progress.[190] But, since [this] is not the case, instead, since [the Sun] goes round the [zodiacal] circle in one time-interval and makes its displacement in latitude in some other, it is necessary in fact to take in addition a third sphere, so that each motion supplies one of the [Sun's] apparent [motions].

Thus, given that the spheres were therefore three [in number] and all homocentric with one another and the universe, [Eudoxus] hypothesized[191] that the one containing the [other] two rotates around the poles of the cosmos in the same direction as the [sphere] of the fixed [stars], making its return [to the same position] in the same time-interval as this [sphere]; that the one which is smaller than this [outer sphere], but larger than the one remaining, rotates from west to east about an axis, as has been said,[192] which is at right angles to the plane of the [circle] through the middle of the zodiacal [constellations]; whereas the smallest sphere also rotates in the same direction as the second, though about a different axis which should be understood to be at right angles to the plane of some oblique great circle which the Sun is held to describe with its own center as it is moved by the smallest sphere on which it is in fact fixed.

Then, he posits that the direct motion[193] of this [third] sphere is slower by much than the [direct motion] of the [sphere] containing it ([a sphere] which is intermediate in size and position), as is clear from the treatise *On Speeds*, written by him.[194] Thus, the greatest

---

[188] 493.23 κατὰ μῆκος (in longitude): *scil.* its annual motion eastward along the zodiacal circle or ecliptic. This technical usage was well established by Simplicius' time.

[189] 493.24 εἰς πλάτος (in latitude). It was customary well before Simplicius' time to use πλάτος to designate vertical displacement above or below a given reference circle. Moreover, when the reference circle is the zodiacal circle [cf. Toomer 1984, 21] as it is in this case, this term is typically translated by 'latitude'. This certainly suits Simplicius' usage here and at 495.5 for instance [but see Mueller 2005, 33]. See 56n197 below on 495.5–8.

[190] 493.27–28 λοξῷ...ἥλιος: *scil.* the zodiacal circle. The author of the commentary on Aristotle, *Meta. E–N* notes that Eudoxus designated as fixed the first sphere of each planetary system as well the celestial sphere [Hayduck 1891, v, 703.12–23 = F123 in Lasserre 1966]. The author of this commentary is usually taken to be Michael of Ephesus: see Hadot 1987, but note the dissent in Tarán 1987. See also 95n383.

[191] 494.2 ὑπέθετο (he hypothesized): the subject is plainly Eudoxus [cf. Aujac, Brunet, and Nadal 1979, 162]. Mueller [2005, 34] errs in taking the verb as a passive form.

[192] See 493.26–28.

[193] 494.10 ὑπόληψιν (direct motion): lit. 'falling behind' [cf. 495.10]. The term indicates that direct motion is here being viewed as a gradual falling behind the fixed stars in their daily motion westward. On supposing that this falling behind is more than just apparent, see Geminus, *Intro. ast.* c. 12.

[194] 494.9–12: see Figure 6 and Comment 7, p. 92.

of the spheres causes both the remaining [spheres] to rotate in the same direction as the fixed [stars] because it carries in itself the poles which belong to the [second] and because [the second sphere carries] the [poles] of the third [sphere] (which carries the Sun); that is, because [the second sphere], in that it contains the poles (of the third sphere) in itself, likewise causes both [the third sphere] and together with it the Sun to rotate with itself in the direction that *it* is made to go around. And thus it results that [the Sun] appears moving from east to west. And if the two spheres (the intermediate and the smallest) were by themselves in fact immobile, the revolution of the Sun would occur in the same time-interval as the rotation of the cosmos. But as it is, since these [spheres] rotate in the opposite direction, the Sun's return from one rising to the next comes later than the time-interval [just] mentioned.[195]

These [remarks] apply to the Sun. But, in the case of the Moon, he arranged some things in the same way and other things differently. That is to say, [Eudoxus arranged] that the spheres which carry [the Moon] also be three [in number] because it appeared to have in fact three motions. And of these [spheres, he arranged] that one be [the] sphere which moves in the same way as the [sphere] of the fixed [stars]; and that a second be [the sphere which moves] in a direction opposite to this as it rotates about an axis at right angles to the plane of the [circle] through the middle of the zodiacal [constellations][196] (just as in the case of the Sun too). [He also arranged] that the third be [a sphere which] no longer [moves] just as in the case of the Sun because, though it is alike in position, [495.1] it is actually not alike in motion, since it moves instead in a direction opposite to the second [sphere] and in the same direction as the first while performing a slow motion, as it rotates, in fact, about an axis which is at right angles to the plane of the circle which is understood to be described by the center of the Moon at an inclination to the [circle] through the middle of the zodiacal [constellations] by an amount equal to the greatest displacement in latitude for the Moon. It is evident that the poles of the third sphere should be separated from the [poles] of the second by an arc on the great circle understood to be through both [poles], [where this arc] is as long as half of the breadth [of latitude][197] that the Moon travels.

Thus, he hypothesized the first sphere because of [the Moon's] circuit from east to west; the second because of its apparent direct motion beneath the zodiacal [constellations]; and the third because it evidently does not take its place in the same points of the zodiacal

---

195 494.20–22 [cf. 501.17–21]: in other words, if the Sun and a fixed star rise together on one day, the Sun will rise later than the star on the next day: see Figure 7. See also Comment 8, p. 92 below.

196 494.28: reading διὰ μέσων τῶν ζῳδίων with mss D and F [cf. Aujac, Brunet, and Nadal 1979, 163] rather than A's διὰ μέσου τῶν ζῳδίων with Heiberg.

197 495.8 τοῦ πλάτου (breadth of latitude): cf. 55n189 above. See also Comment 9, p. 93 below.

[circle][198] when it is farthest north and farthest south [of this circle], but because these sorts of points always change position in the direction of the leading zodiacal [signs].[199] That is why, then, he also [hypothesized] that this sphere also moves in the same direction as the [sphere] of the fixed [stars], and that its motion to the west[200] was slow by virtue of the fact that the change in position of the points [just] mentioned during each month is very small indeed.[201]

This, then, is the extent [of the discussion] of the Moon too. But, regarding the five planets, Aristotle, who sets out [Eudoxus'] view, says that these move by means of four spheres, of which the first and second are the same in that they have in fact the same position as the first two spheres for the Sun and for the Moon. That is to say, the one is a sphere containing all the [spheres] for each of the [planets] which rotates about the axis of the cosmos from east to west in the same time-interval as the [sphere] of the fixed [stars]; and the second, which has its poles in the first, makes its rotation contrariwise from west to east about the axis (or poles) of the [circle] through the middle of the zodiacal [constellations] in the time-interval in which each of the [planets] is held to traverse the zodiacal circle.[202] Accordingly, in the case of the star of Mercury and of the [star] of Venus, he says[203] that the [rotation] of the second sphere is completed in a year; that in the case of Mars, in two years; that in the case of Jupiter, in 12 years; and that in the case of Saturn, which the ancients used to call the star of Helios,[204] 30 years.[205]

---

[198] 495.11 ἐν τοῖς αὐτοῖς τοῦ ζῳδιακοῦ σημείοις (in the same points of the zodiacal [circle]): *scil.* at the same longitude.

[199] 495.13 ἐπὶ τὰ προηγούμενα (in the direction of the leading zodiacal [signs]): *scil.* in the direction of the apparent daily rotation, that is, westwards. See Comment 10, p. 93 below.

[200] 495.15: reading ἐπὶ δυσμάς with DEFc rather than A's ἐπὶ δυσμῶν.

[201] 495.13–16: see Figure 8 and Comment 11, p. 94 below.

[202] 495.25 τὸν ζῳδιακὸν κύκλον (the zodiacal circle): *scil.* the circle though the middle of the zodiacal constellations, *not* 'the zodiac' [Mueller 2005, 35].

[203] 495.27 φησι (he says): strictly speaking, the speaker reported should be Aristotle; but no such remark by Aristotle actually survives. So perhaps Simplicius now means Eudoxus: cf. 496.6.

[204] Cf. Geminus, *Intro. ast.* 1.23–30; Cleomedes, *Cael.* 1.2.20–43 (with Bowen and Todd 2004, 39n9). As Bouché-Leclercq [1899, 66–70] suspected, such usage goes back to the Babylonians: on Saturn as the Star of Helios (Helios = the Sun), see MUL.APIN 2.1.39 and 64 with Hunger and Pingree 1989, 147 and the references in Tarán 1975, 89n409.

According to Tarán [1975, 308–309], though there are manuscript readings which entail a reference to the star of Helios at [Plato] *Epin.* 987c4–5, it is more likely that the author wrote 'star of Saturn'. Thus, the earliest text extant in Greek to mention the star of Helios would be P. Par. 1. col. 5 (first half of second century BC: Bowen 2008b). See Tarán 1975, 89 and n410 for further references.

[205] See Comment 12, p. 95 below.

The two remaining spheres are, I suppose, disposed as follows.[206] The third sphere
[496.1] for each [planet] has its poles on the [circle] through the middle of the zodiacal [constellations]—the one understood to be on the second sphere for each [planet]—and rotates to south from north and from south to north[207] in the time-interval in which each [planet] comes from [one] phase to the next phase [of the same type] as it passes through all configurations in relation to the Sun. (Scientists[208] in fact call this time-interval a synodic period.)[209] This [period] is different for each [planet], which is why the rotation of the third sphere is also not in the same time-interval for all. But, just as Eudoxus thought, for the star of Venus [this rotation occurs in] in 19 months;[210] for the star of Mercury, in 110 days; for the star of Mars, in eight months and 20 days; and for the star of Jupiter and of Saturn, in very nearly 13 months for each.[211]

Thus, the third sphere moves in this way and in this great a time-interval.[212] The fourth sphere, however, which in fact carries the [wandering] star, rotates about [the] poles of an oblique circle, poles characteristic to each [planet]. However, it makes its rotation in the same time-interval as the third [sphere], as it moves from east to west in the direction opposite to the [motion of the third].[213] This oblique circle is said by [Eudoxus] to be inclined to the greatest of the parallel circles in the third sphere[214] by an amount that is

---

[206] 495.29 ὧδέ πως ἔχουσιν (are, I suppose, disposed as follows): cf. Mueller's 'are arranged more or less in the following way' [2005, 35]. See Comment 13, p. 96 below.

[207] 496.1–2 ἀπὸ μεσημβρίας ἐπὶ τὰς ἄρκτους ἐπιστρέφεται. Robert Grosseteste's translation supports the view that the text should be <ἐπὶ μεσημβρίαν ἀπὸ τῶν ἄρκτων καὶ> ἀπὸ μεσημβρίας ἐπὶ τὰς ἄρκτους στρέφεται [Bossier 1987, 297]. Cf. 496.24–25.

[208] 496.4 οἱ ἀπὸ τῶν μαθημάτων: lit. 'those from the sciences' and presumably equivalent to οἱ μαθηματικοί (scientists) at 493.2, for instance.

[209] 496.4 διεξόδου χρόνον: lit. 'time-interval of passage or traversal'. I have not found any instances of the usage Simplicius reports here.

Whereas the sidereal period of a planet is the time that it takes to return in longitude to a fixed star, its synodic period is the time that the planet takes to return to the same synodic phase, where this phase is defined by the planet's position in relation to the Sun. Thus, the synodic period is, for example, the interval between a planet's successive oppositions or successive first visibilities in the morning.

[210] According to Heath [1913, 210–211], assigning a synodic period to Venus that is more than 1.5 times its zodiacal period makes it impossible to account for the fact that Venus has retrograde motion.

[211] The synodic period assigned to Mars—260 days, assuming 30-day months—is about one third of what it should be. As Heath [1913, 208–210: cf. Neugebauer 1975, 681] explains, there is no way to obtain a satisfactory account of Mars' retrogradations using the value that Simplicius gives for Mars' synodic period.

[212] 496.6–9: see Comment 14, p. 97 below.

[213] 496.10–12: cf. 496.29–497.2. On the claims that the third and fourth spheres move in opposite directions and have the same period, see Yavetz 1998, 231–233.

[214] 496.14 πρὸς τὸν μέγιστον τῶν... παραλλήλων: *scil.* to the equator of the third sphere. The parallel circles are defined by the sphere's rotation.

not equal and not [in] the same [direction] in all [cases].[215]

Thus, it is evident that the [sphere] which rotates in the same way[216] as the [sphere] of the fixed [stars] causes all the remaining spheres to rotate in the same direction because they have their poles in one another, so that [it causes] both the sphere carrying the [wandering] star and the [wandering] star itself [to go round in the same way as the sphere of the fixed stars]. And for this reason then, each of the [planets] will have risings and settings. The second sphere will afford [the planet][217] its progress beneath the 12 zodiacal [constellations], since it rotates about the poles of the [circle] through the middle of the zodiacal [constellations] and causes the two remaining spheres and the [wandering] star to rotate with it in the direction of the following zodiacal [signs],[218] in the time-interval in which each is held to complete the zodiacal circle. The third sphere, which has its poles on the [circle] through the middle of the zodiacal [constellations] in the second [sphere], as it rotates from south to north and from north to south, will cause the fourth [sphere] (which also bears the [wandering] star on itself) to rotate with it and will, further, be the cause of [the planet's] motion in latitude. However, not by itself alone. The reason is that, [if the third sphere were the sole cause of the planet's motion in latitude,] in so far as the [wandering] star is subject to this sphere[219] and reaches the poles of the [circle] through the middle of the zodiacal [constellations][220] it would also come to be near the poles of

---

[215] 496.15 οὐκ ἴσον οὐδὲ ταὐτὸν ἐφ' ἁπάντων. It is not clear what Simplicius means by ταὐτόν here, since it does not seem in apposition to ἴσον. I have construed it to mean 'in the same direction', with the idea that Simplicius may be thinking that the intersection of the oblique circle and the equator of the third sphere will define a diameter, and that the direction of this line will depend on how the poles of the third sphere are oriented in the second sphere and on the orientation of the plane defined by the poles of the third and fourth spheres.

[216] 496.15 ὁμοίως: *scil.* in direction and speed.

[217] 496.20 αὐτῷ παρέχεται: Mueller's 'the second sphere will make its passage' [2005, 36] overlooks αὐτῷ and misreads παρέχεται.

[218] 96.19–20 ἐπὶ τὰ ἑπόμενα τῶν ζῳδίων: *scil.* in the direction opposite to that of the apparent daily rotation, that is, eastwards.

[219] 496.27 ἐπὶ ταύτῃ: see Smyth 1971, §1689 2c.

[220] 496.27–28: given two spheres, if the first has its poles in the equator of the second, then the poles of the second sphere are in the equator of the first. It follows, then, that the planet must be on the equator of its carrying sphere. Yavetz [1998, 231] proposes that Simplicius' πρὸς τοὺς πόλους...ἧκεν could plausibly mean 'move toward the poles', and develops a reconstruction in which the planet is no longer on the equator of the fourth sphere. Though the reconstruction is interesting, the linguistic point is quite unlikely. ἥκω is, as it were, not a verb of motion but a verb of *having* moved [cf. Smyth 1971, §1886]. Hence, it means that the planet *has* moved to the poles and, therefore, if one considers the verb's aspect, *is present* at the poles. So, in this context, one understands that it *arrives at* or *reaches* the poles. At 501.16, ἐπὶ τὸ αὐτὸ ἥξει surely means 'will have come to' or 'will arrive at', given ἐν πλείονι χρόνῳ: 'will move towards' simply ruins the argument. At 506.12, μήπω...ἥκειν εἰς τὴν Ἑλλάδα makes good sense if it means 'had not yet

[30] the cosmos.[221] But, as matters stand, the fourth sphere, by rotating about the poles of the oblique [circle] belonging to a [wandering] star[222] in a direction opposite to the [motion
[497.1] of the] third [sphere] from east to west, and by making their circuit[223] in the same time-interval [as the third sphere], will deny [the star's] passing farther beyond the [circle] through the middle of the zodiacal [constellations];[224] and it will allow the [wandering] star to describe about this same circle [the curve] called a hippopede by Eudoxus.[225]
[5] Consequently, the [wandering] star will also seem to be displaced in latitude by an amount equal to the width of this curve[226]—the very [point] on which they criticize Eudoxus.[227]

---

come to Greece': 'had not yet moved towards Greece' would be mildly bizarre. There are numerous other occurrence of this verb in Simplicius' writings and, like those of ἥκω more generally, they do not support Yavetz' conjecture.

[221] 496.28–29: this does not happen—of the seven ancient planets, Mercury travels farthest from the zodiacal circle and its greatest latitude is 7°. Cf. 501.30–502.2.

[222] 496.29–30: τοὺς τοῦ <τοῦ> ἀστέρος λοξοῦ κύκλου... πόλους: *scil.* the poles of the circle on the fourth sphere described by the planet as this sphere rotates.

[223] 497.1 τὴν στροφὴν αὐτῶν (their circuit): *scil.* its own rotation and the revolution of the planet fixed on it.

[224] 497.1 ἐπὶ πλέον (farther): that is, farther than it goes in fact.

[225] 497.3 ἱπποπέδην. Note that in affirming that the hippopede is defined about the zodiacal circle, Simplicius again makes clear what is never stated explicitly, namely, that the planet is on the equator of the fourth sphere. Cf. 496.27–29.

Curiously enough, the earliest evidence for the use of ἡ ἱπποπέδη rather than ὁ τοῦ ἵππου πέδος or just ὁ πέδος to designate a *horse-fetter* seems to come in the 9th century AD: cf. *Hipp. Berol.* 106.1. So far as I can determine, the earliest references to a curve called a hippopede in a mathematical context are found in Proclus' commentary on Euclid's *Elements*. Proclus, who does not mention Eudoxus or anyone in connection with this curve, presents the hippopede as a spiric section that is interlaced and like a horse's fetter (presumably, the figure 8) [Friedlein 1873, 112.4–5: cf. 126.24–127.3, 128.2–5]. The hippopede that Simplicius mentions is often described nowadays as a spherical lemniscate formed by the intersection of a sphere and a straight circular cylinder: cf. Neugebauer 1953; Yavetz 1998, 221–225. See also Figure 9 for a qualitative derivation which assumes a two-stage procedure for generating the hippopede (first spin the fourth sphere and then, the third sphere) rather than taking the claim that the periods are the same to concern their resultant motions: cf. Yavetz 1998, 232–233. See Yavetz 1998, 233–237, for argument that there are numerous other curves that could count as hippopedes.

[226] 497.4–5: Heath [1913, 202] makes it clear that the width of one loop of the hippopede (as measured along the zodiacal circle) is the maximum latitude (πλάτος) that the planet attains. See also Neugebauer 1953, 229.

[227] 492.31–497.5 = Eudoxus F124 in Lasserre 1966. It is not clear who 'they' are, but the point appears to be that, when the planet does in fact seem to describe loops in the heavens, the width of these loops is not twice the planet's maximum latitude: see Figure 10. But if this is right, one wonders how they learned it. One possibility is that they recorded observations made at the same time of day over a period of some months on a suitably marked spherical globe. Another is that they interpreted some planetary tables graphically (perhaps using the same globe). A reader suggests that perhaps the problem is that the inclinations of the third and

This is the construction of spheres according to Eudoxus which takes 26 spheres in all for the seven [planets], six for the Sun and Moon, and 20 for the five [planets]. Concerning Callippus, Aristotle has written the following in [book] Λ of his *Metaphysics*:

> *Callippus posited the same arrangement of spheres as Eudoxus, that is, the same order of distances;*[228] *and he assigned the same number [of spheres] to the star of Jupiter and the star of Saturn each. But he thought that two spheres should be added for the Sun and for the Moon, if one is going to account for the phenomena, and one for each of the remaining planets.*[229]

Thus, according to Callippus, there are in all five times five and two times four [spheres], that is, 33 spheres. There has neither survived a treatise of Callippus stating the explanation of these spheres that should be added nor has Aristotle added it. But Eudemus has recorded concisely the phenomena for the sake of which [Callippus] thought that these spheres should be added: for he states that [Callippus] says that, if in fact the time-intervals between the solstices and equinoxes differ by as much as Euctemon and Meton[230] thought, the three spheres are not sufficient for either one[231] to save the phenomena because of the unsmoothness clearly evident in their motions.[232] And Eudemus has related concisely and clearly for what purpose [Callippus] added the one sphere which he added in [the case of] each of the three planets: Mars, Venus, and Mercury.[233]

---

fourth spheres were wrong, but Simplicius' account of these spheres provides no independent evidence for quantifying the planetary latitudes.

228 497.10: τουτέστι... τάξιν: a phrase which appears in a quotation in the commentary attributed to Alexander [Hayduck 1891, 704.9–10]—is usually athetized by modern editors of Aristotle's treatise. This phrase seems to be a gloss that assumes a computation of the sort that one finds in Ptolemy's *Hypoth. plan.*: all Aristotle does is to posit an ordering of the spheres: given his project, there was no reason to cast this as an ordering of the planetary distances from the Earth. Indeed, given the complexity of his arrangement, this would not have been a trivial project.

229 497.9–13: *Meta.* 1073b32–38. Heiberg also has μέλλοι, and ἀνὰ μίαν in 497.13, where the better manuscripts of the *Metaphysica* have μέλλει and just μίαν, respectively [cf., e.g., Ross 1953, *ad loc.*].

230 Euctemon and Meton were apparently contemporaries engaged somehow in astronomical studies in Athens of the fifth century BC. They are not clearly distinguished in the ancient sources [cf. Rehm 1949, col. 1340; Neugebauer 1975, 623 and n12]. For a detailed study of the testimony concerning their work, see Bowen and Goldstein 1988.

231 497.20–21 οὐχ ἱκανὰς... ἑκατέρῳ (not sufficient for either one): *scil.* for the Sun and the Moon.

232 497.21–22: the thesis seems to be that the addition of motions for the Sun (to account for the lengths of the astronomical seasons) necessitates the addition of motions for the Moon.

233 Schiaparelli holds that this explanation has dropped out the received text and that the text should thus show a lacuna after this sentence. Another possibility, however, is that, though Simplicius is using a source that did report Eudemus' account of Callippus' addition of the extra planetary sphere for each of Mars, Venus,

After reporting Callippus' view about the turning spheres, Aristotle inferred [that]

> *it is necessary, if all [the spheres] when put together are going to account for the phenomena, that for each of the wandering [stars] there be other spheres fewer in number by one, the unwinding spheres, that is, [the spheres] which always restore in position to the same point the first sphere of the [wandering] star stationed below, since only in this*
> [498.1] *way is it possible that every motion of the planets be produced.*[234]

Now, since Aristotle had stated these matters concisely [and] so clearly,[235] Sosigenes praised his keenness of mind and tried to discover the need for the spheres added by him. And [Sosigenes] states that [Aristotle] says that these [spheres], which [Aristotle] calls unwinding [spheres], must be added to his hypotheses for two reasons:[236] in order that the fixed [sphere] for each [planet] and the [spheres] beneath it have their proper position, and so that there be the proper speed in all [spheres]. In other words, it was necessary that, for its part, the [sphere] similar to the [sphere] of the fixed [stars] (or to some other sphere)[237] move round the same axis as that [sphere] and complete its rotation in the same time-interval—none of this can occur without the addition of the spheres mentioned by Aristotle.

> For the sake of clarity, [Sosigenes] says, let us make the argument in the case of the spheres carrying the [star] of Jupiter. Now, if we should fit the poles of the first of Jupiter's [spheres] in the last of the four [spheres] of Saturn ([the sphere] in which [Saturn] is also fixed), in what way could these [poles] remain on the axis of the sphere of the fixed [stars] when, for its part, the [sphere] carrying

---

and Mercury, he declined to give it; or that his source reported only the existence of a clear explanation. In any case, if the text has been disturbed here—note also συντόμως at 497.17, συντόμως καὶ σαφῶς at 497.24, and συντόμως οὕτως <καὶ> σαφῶς at 498.2. So, yet another possibility, I suppose, is that a negative particle οὐ has been omitted in this last sentence due to some copyist's error and that it should be negated. That is, Simplicius' original point may have been that Eudemus did *not* explain why Callippus added the extra spheres for Mars, Venus, and Mercury, at least in a way that he, Simplicius, could understand. Consistent with this is the hesitation registered at 504.20–22 in supposing that Callippus saved the phenomena by adding the spheres he is said to have added: cf. 72n289 below.

234 497.26–498.1: *Meta.* 1073b38–1074a5. Heiberg has εἰς ταὐτὸν ἀποκαθιστώσας [497.28], where the better mss of Aristotle's treatise read εἰς τὸ αὐτὸ ἀποκαθιστάσας [cf. Ross 1953, *ad loc.*] On the following discussion of the unwinding spheres [497.24–504.3], see Comment 15, p. 98.

235 498.2: Heiberg follows A which omits καὶ, though the mss D, E, F have it.

236 498.5 ταῖς ὑποθέσεσιν: the systems of spheres for each planet attributed to Eudoxus and Callippus are hypotheses.

237 It is only in relation to the fourth planetary sphere that Simplicius considers the matter of direction. So, he may here be supposing that the second spheres of Mercury and Venus are similar and the third spheres of Jupiter and Saturn too.

them rotates around another axis that is oblique? But surely they must at least [15] remain on the axis [first] mentioned[238] in the case of the outermost motion, if the sphere rotating about them really is going to receive the disposition of the sphere of the fixed [stars]. Now, moreover, since three of the spheres carrying the [star] of Saturn are made to rotate together by one another and the first [sphere]—[these spheres] also possessing, of course, their own particular proper speed—the motion [20] of the fourth [sphere] would not be some simple motion but one sharing in all the [motions] above [it]. Indeed, it will be demonstrated that, when [spheres] move in the opposite direction, something is subtracted from the speed belonging to them[239] because of the [sphere] which turns [them] at the same time; and that, when [spheres] rotate together, something is added by the motion which goes through to them from the sphere above, because of their characteristic motion.[240] Consequently, if the first of the [spheres] of Jupiter really should be fixed in the [25] sphere carrying the [star] of Saturn and have its own proper speed for going back to the same position again in a rotation of the cosmos, the motions of the spheres above [it] will not permit it to have this speed but there will be some addition, since these [spheres] in fact move westwards while that one moves by itself in the [499.1] same direction as well.[241]

The same argument [holds] in the case of the next [spheres of Jupiter] as well, since their motion will be compounded more and more and their poles will go beyond their proper position. But, just as we said, neither of these results should occur.[242] Thus, [Aristotle] conceived of 'the unwinding [spheres], that is, [the spheres] which always restore in position to the same point the first sphere of the [wandering] star stationed below',[243] so that this would not occur and that he would not encounter anything erroneous [5] in consequence of this at least. For, certainly, he also spoke precisely[244] in revealing both of the reasons why he introduced them, namely, through his saying 'which unwind' in

---

[238] 498.16 ἐπὶ τοῦ εἰρημένου ἀξίονος: *scil.* the axis of the sphere of the fixed stars [498.14].

[239] 498.22–23 αὐταῖς τάχους ὑπάρχοντος: *scil.* their characteristic or proper speed.

[240] Cf. 500.22–501.11.

[241] 498.10–499.1: this is at the least a paraphrase of a passage from some work by Sosigenes. Mueller [2005, 37–38] supposes that Simplicius' citation extends to 499.15. But 499.3–4 (δεῖ δέ, καθάπερ ἔφαμεν, οὐδέτερον τούτων συμβαίνειν: 'But just as we said, neither of these results should occur') seem to refer back to 498.1–10 in which Simplicius is still speaking in his own voice. The use of ἔφαμεν (we said) tends to support this conclusion: when Simplicius wishes to signal that ἔφαμεν comes from Sosigenes, he adds φησίν [see 501.1].

[242] 499.3–4: cf. 498.1–10.

[243] *Meta*. 1074a2–4.

[244] 499.7 κατὰ λέξιν εἴπων: lit. 'spoke literally'.

respect to the restoration of motion[245] to its proper speed, and through his having stated 'which always restore in position to the same point the first sphere of the [wandering] star stationed below' in respect to the permanence of the poles in their proper [place]. (The position of the carrying spheres is understood in accordance with these [poles], since they alone remain in place.)[246] But he said that the first sphere of the [wandering] star stationed below is restored by the [unwinding spheres of the wandering star above], since all the [features] of the next spheres are saved when this [first sphere] takes its proper position and its proper speed because of the unwinding.

Sosigenes demonstrated that these [results] follow, after he set out some [propositions] useful for the argument. The following is a brief exposition of these [propositions].

> If there are two homocentric spheres, for instance, *DE* and *ZH*,[247] and if they are contained from outside by another [*AB*] which is either at rest or rotates,[248] and if [the spheres *DE* and *ZH*] move in directions opposite to one another and through equal time-intervals (that is, at the same speed), [then] all the points in the contained [sphere, *ZH*] will always be at the same position in relation to the containing [sphere, *AB*], as if it were in fact at rest.
>
> For, when the [sphere] *DE* moves as though from *A*[249] to *B*, if the smaller sphere *ZH* only rotated with it[250] and did not move in the opposite direction, it

---

[245] 499.8–9 τὴν τῆς κινήσεως ἀποκατάστασιν: '*le mouvement de rotation*' [Aujac, Brunet, and Nadal 1979, 170].

[246] 499.11–12 κατὰ τούτους... μένουσι (the position... remain in place): Aujac, Burnet, and Nadal [1979, 170n1] propose bracketing this on the grounds that it is an inappropriate gloss inserted into the text, perhaps because they do not see that the poles in question (κατὰ τούτους) are those of the fixed sphere: they have '*c'est en effet par rapport aux pôles que l'on définit la position des sphères tournantes puisque ce sont les seuls points immobiles*', which is true but beside the point. Mueller [2005, 38 and n156] likewise overlooks κατὰ τούτους.

[247] See Figure 11.

[248] 499.19: reading περιαγομένης (rotates) as in the mss D and E (and bracketing ἐκείνας) with Aujac, Brunet, and Nadal [1979, 171.10]. Heiberg prints περιειλούσης ἐκείνας, which is his own conjecture. F has εἴτε κινουμένης εἴτε μενούσης τῆς περιεχούσης (with the containing [sphere] either in motion or at rest) [cf. Mueller 2005, 39 and n159], but the resultant ὑπ' ἄλλης... τῆς περιεχούσης is awkward.

[249] 499.22 ὡς ἀπὸ τοῦ *A*: lit. 'seemingly in the direction from *A*'.

[250] 499.22 συνεπεστρέφετο (rotated with it): to make sense of the following arguments, one has to understand that in the present context if one sphere is said to rotate, move, or move round *with* another (dative case), or if two spheres are said to rotate, move, or move round *together*, it is assumed that they share the same period. Cf., e.g., 499.24 συμφερόμένον, 499.25 συμφέρονται, 500.2–3 συμπεριφερομένην, 500.4 συμφερομένην. But see 500.23–24, where it is apparent that the period of rotation need not be the same. In any event, Simplicius' usage of these συν-compound verbs of motion plainly does *not* entail that the relevant items are moving in the same direction.

would be seen that, as *D* is at some time beneath *B*, so too is *Z* which moves with *D* (that is, in the same time-interval). But, since the [spheres] in fact move [25] together and the [sphere] *ZH* moves in the opposite direction to the [sphere] *DE*, [the sphere *ZH*] undoes as much when it moves in an opposite direction as it adds when it moves in the same direction. And it results that, when *D* is beneath *B*, *Z* is beneath *A*, just as it appeared from the beginning. Consequently, what has [500.1] been proposed is true.

Thus, if the [sphere] *AB* is at rest, what has been proven is clear; namely, that, given the manner in which both [spheres] are laid down,[251] the inner [sphere] which goes round with the outer [sphere] and moves in the opposite direction always has the same position in respect of the same points,[252] and that it does not [have the same relative position] either when it only goes round with [the outer (= intermediate) sphere] or when it only moves in the opposite direction.

But then, if the [sphere] *AB* were also moving either in the opposite direction [5] or in the same direction as the second sphere *DE*, the results will be the same regarding the points of the third [sphere] *ZH* (which moves with the [sphere] *DE* and moves in the opposite direction likewise [as before]).[253]

For, if, when the sphere *AB* has been turned from *A* as though to *B* and draws with it the [sphere] *DE* so that *D* comes to *E*, the middle sphere *DE* moves by itself either in the opposite direction to the [sphere] *AB* or in the same direction at [10] any speed whatsoever in regard to the [sphere] *AB* but in the same time-interval as the [sphere] *ZH*, it will make point *Z* go beyond *A* on account of[254] its causing the third [sphere] to rotate with it. But the third sphere, since it moves in the opposite direction, will again make *Z* beneath *A*. And since this always happens, all the points on the sphere *ZH* will be beneath the same points of the sphere *AB*.

Now, then, what was proposed has been proven on the assumption that the [three] [15] spheres move about the same axis. But the same argument [applies] even if they do not move about the same axis. The reason is that the placement of points beneath the same points does not result because of motion over the same parallel [circles],

---

251 500.2 καὶ ὅπως ἀμφοτέρων ὑπαχόντων *scil.* σφαιρῶν: a reference to the configuration of spheres under discussion. For ὑπάρχω as equivalent to ὑπόκειμαι, see Liddell, Scott, and Jones 1968, *s.v.* ὑπάρχω B.II. Heiberg marks καὶ ὅπως as corrupt. Aujac, Brunet, and Nadal [1979, 172] replace it with σφαιρῶν. Mueller [2005, 39 and n161] proposes 'and it is clear that if both things hold and the inner sphere...', thus making one wonder what the two things are.

252 500.3 τοῖς αὐτοῖς...σημείοις: *scil.* points on the third and outermost sphere.

253 See Figure 12.

254 500.11 διὰ + acc. (on account of): if διά is deleted [cf. Aujac, Brunet, and Nadal 1979, 172.12], the meaning is that the second sphere's turning the third sphere will make point *Z* go beyond *A*. Such editorial intrusion, however, seems unwarranted in this instance.

but because of the co-rotation of the contained [sphere] in regard to the containing [sphere] and its counter-rotation,[255] since [this counter-rotation] removes as much as [the other] adds whether the rotation and counter-rotation are on an oblique circle or on a [circle] vertical [to the axis].[256]

Again, given two homocentric spheres moving in the same direction, each one at a particular speed, and given that the smaller [sphere] not only moves with the greater but also performs its characteristic motion in the same direction, if the speeds are equal, the compounded motion will show[257] a speed that is double; and if the speed of the second [sphere] is double, the [speed] of the [motion] compounded will be triple; and likewise thereafter.

For, if the larger [sphere] causes the smaller to move through a quadrant, and this [smaller sphere] being equally swift moves through a quadrant, it will have
[501.1] moved through twice a quadrant. Consequently, the [motion] arising from both [motions will be] double the second motion.[258]

We state these [conclusions], [Sosigenes] says, if the motions should be about the same poles. But, if [they should] not [be] about the same poles, something else will result because of the obliquity of the second sphere. The reason is that the speeds will not be compounded in [the way just described], but as they have customarily been shown on a parallelogram when the motion on the diagonal is produced from two motions, one being [the motion] of some point as it moves on the length of the parallelogram and the other being [the motion] of this very length as it is drawn down through the width of the parallelogram in the same time-interval.[259] Certainly, the point and the side of the length[260] that is drawn down will be coincident at the other end of the diagonal; and the diagonal is not equal to [the sum of] both the [sides] deflected around it but smaller.[261] Consequently,

---

[255] 500.19: cf. 64n250.

[256] 500.20 ἐπὶ ὀρθοῦ: circles are here defined in relation to their poles and axes; so a vertical circle, that is, any circle vertical to the axis of the sphere, is in other words a parallel circle. (It is called a parallel circle because the planes defined by such circles are parallel.) The circles in question here are presumably equatorial circles [cf. 60n225 above] that are actually in the same plane.

[257] 500.25 δείξει: Mueller [2005, 40] mistakenly supposes that the subject of this verb is 'Sosigenes'.

[258] 501.1 τῆς ἑτέρας κινήσεως (the second motion): *scil.* the motion proper to the second sphere.

[259] 501.4–8: see Figure 13. The idea seems to be that the compounded motion of a body subject to motions imposed by two oblique rotating homocentric spheres may be projected onto the plane and treated as a compounded motion along the diagonal of parallelogram.

[260] 501.9 ἡ τοῦ μήκους πλευρά: *scil.* the long side of the parallelogram.

[261] See Euclid, *Elem.* 1 prop. 20. See also [Aristotle] *Mech. prob.* 1 and Heron, *Mech.* 1.8 [Nix and Schmidt 1900, 18.28–22.3].

> the speed too is smaller than the speed arising from both together, though it is nevertheless compounded from both.

Now, that [result] too is stated alongside the following.

> Given two spheres which are homocentric either around the same poles or around different [ones] but rotate in a direction opposite to one another, where the smaller [sphere] moves in the opposite direction at a lesser [speed] but is carried round at the same time by the larger [sphere], the points on the smaller [sphere] will arrive at the same point in a greater time-interval than if the smaller sphere happened only to be fixed in the greater [sphere]. Indeed, it is for this reason that the return from rising to rising of the Sun itself is slower than the rotation of the cosmos, that is, because it moves in the opposite direction to the universe [and] more slowly—since, if [the Sun] did indeed move at the same speed as the fixed sphere while rotating in the opposite direction, given that [the Sun] always made its return in the same time-interval, it would be bound to rise always at the same point.[262]

Thus, with these things ascertained as presuppositions, Sosigenes, on coming to Aristotle's remarks about the need that for each of the wandering [stars] there be other (unwinding) spheres fewer in number by one, if the phenomena are going to be accounted for, sets out the theory of the construction of spheres according to Aristotle, when he says:

> Now, the first of the spheres carrying Saturn was one that moves in accordance with the [sphere] of fixed [stars]; and the second was one that moves directly along the [circle] through the middle of the zodiacal [constellations].[263] Third was the [sphere which moves] along the [circle] at right angles to the circle through the middle of the zodiacal [constellations]—the circle that carried [this circle] beyond in latitude beyond from the south to north. (This circle was at right angles to the [circle] though the middle [of the zodiacal constellations] because it had its poles on it—[circles] that intersect through the poles also intersect at right angles.)[264] The fourth sphere (the one containing the star) caused it to move over some oblique circle that delimits the latitude of its digression to [502.1]
> the north so that it does not come to be near the poles of the cosmos.[265]
>
> Accordingly, one must conceive of a different sphere, a fifth, before the four carrying Jupiter,[266] which moves about the same poles as the fourth [of the spheres carrying Saturn]

---

[262] 501.21 τῷ αὐτῷ σημείῳ (at the same point): *scil.* on the horizon: cf. Aujac, Brunet, and Nadal 1979, 174. Mueller's 'with the same point' [2005, 40] makes little sense. Note that it is here imagined that there are but two homocentric spheres for the Sun. Cf. 494.20–22 and Comment 8, p. 92 below.

[263] A sphere may be said to move along or over a circle if the sphere rotates about poles that are perpendicular to this circle.

[264] 501.30–32: cf. Theodosius, *Sphaer.* Dem. 11–15.

[265] Cf. 496.23–497.2.

[266] 502.2–3 δεῖ τοίνυν νοῆσαι πέμπτην σφαῖραν ἄλλην πρὸ τῶν φερουσῶν τὸν Δία τεττάρων: the better reading, which is evident in Grosseteste's translation (*Oportet igitur intelligere quintam speram aliam ante ferentes*

as it rotates in the opposite direction to it and in the same time-interval. (The reason for this is that this [sphere] will subtract the motion of the fourth [sphere] because it moves about the same poles as it, yet in the opposite direction and at the same speed—this, after all, has been proven[267]—and it will decrease the speed [of Jupiter] in accordance with what appears.)[268]

After the fifth [sphere], one should conceive of another, a sixth, which has the same poles as the third but unwinds it by moving both in the same time-interval and in the opposite direction so that the phenomena are saved, that is, so that points on the third [sphere] always appear at the same perpendicular on the fifth.[269]

After this [sphere], one should add a seventh, the one that unwinds the second [sphere] in that it is fitted about the poles of the [circle] through the middle [of the zodiacal constellations]—this [second sphere] also rotates about these poles—and rotates, however, in the opposite direction and in the same time-interval as the second [sphere]. That is, [the seventh sphere unwinds the second] in that it takes away from the motion and the speed that goes through from [the second sphere] to the spheres beneath it.[270] (For, in fact, the second [sphere], by moving with the fixed [sphere], contributed[271] to the speed

---

Iovem quattuor) [see Bossier 1987, 296]. Mueller [2005, 109n165] emends Heiberg's δεῖ τοίνυν νοῆσαι πέμπτην σφαῖραν ἄλλην πρὸ τῶν φερουσῶν τὴν διὰ τεττάρων to δεῖ τοίνυν νοῆσαι πέμπτην σφαῖραν ἄλλην πρὸ τῶν φερουσῶν τὸν Διά. But τεττάρων is well attested and appropriate.

267 Cf. 499.17–500.21.

268 502.7: given the syntax, the point is that it will reduce Jupiter's speed so that it has the speed that it actually appears to have [see Aujac, Brunet, and Nadal 1979, 175] not that it reduces Jupiter's apparent speed [Mueller, 41 and n166].

269 502.10–11 κατὰ τὴν αὐτὴν ἐπὶ τῆς πέμπτης κάθετον (at the same perpendicular on the fifth [sphere]): the line in question is a line perpendicular to the common axis of the two spheres. Something has gone awry. Given Sosigenes' preliminary theorems [499.16–500.21], introducing the fifth sphere will serve to fix the points of the fifth sphere in relation to the third sphere, whereas introducing the sixth sphere will serve to fix the points of the sixth sphere in relation to the second sphere. In short, one does not add the sixth sphere *in order to* coordinate the fifth and third spheres. The mss of the Greek text seem to be in agreement about this line. Perhaps one should emend πέμπτης to ἕκτης so that it reads 'at the same perpendicular on the sixth [sphere]': so Mueller [2005, 41] ('directly below on the sixth sphere'), but without signaling the departure from Heiberg's text.

270 502.14–15 ἀφαιροῦσαν τὴν κίνησιν καὶ τὸ τάχος τὸ ἀπ᾿ αὐτῆς διικνούμενον εἰς τὰς ὑπ᾿ αὐτὴν σφαίρας: the subject of the participle must be the seventh sphere and different from the referent in ἀπ᾿ αὐτῆς and ὑπ᾿ αὐτήν. In light of this, one has to admit that the thought is not well expressed. Though the seventh sphere does cancel the motion of the second sphere, it does so only for the spheres beneath the *seventh* sphere.

271 502.16 προσετίθει: 'contributed' rather than 'added' because, by moving from west to east, the second sphere actually diminishes the motion transmitted downwards by the first sphere. If a real addition is meant, then Sosigenes is assuming hypotheses at odds with *Meta.* 1073b24–27 [495.17–29]: cf. Aujac, Brunet, and Nadal 1979, 176n1. Mueller [2005, 109n167] does not see that the motion of the second sphere does indeed

> from east to west of the [spheres] beneath it.) Therefore, [the seventh sphere] will rotate by moving thus in the same way as the fixed [sphere]; yet it will not have the disposition of the fixed [sphere] in fact, since it rotates about different poles and not the [poles] of the fixed [sphere] but nevertheless from east to west.[272]

Finally, after this [seventh sphere], then, one should conceive of the first [sphere] of [20]
Jupiter as an eighth [sphere of Saturn], since Sosigenes has correctly established that the
last of the three unwinding [spheres] is *not* the first of the [carrying spheres] of Jupiter.
Some have thought this in fact, namely, that the last of the [spheres] unwinding the upper
motions will be the first of the [spheres] carrying the [wandering] star below,[273] so that the
same sphere is seventh *and* the one that we say is eighth (which is the first of the [carrying
spheres] of Jupiter).[274] Certainly, this follows for them because they are trying to count [25]
the same [sphere] twice in order to save the number of turning [spheres] mentioned by
Aristotle.[275] Of course, it is necessary that the unwinding [spheres] for each star be fewer
by one than the carrying [spheres]. Consequently, in the cases of Saturn and of Jupiter,
since there are four carrying spheres for either, the unwinding spheres are three in number,
whereas in the cases of the remaining four—Mars, Venus, Mercury, [and the] Sun—since [30]
there are five carrying [spheres] for each, [the unwinding spheres] are four in number [for [503.1]
each]. Thus, in all, the unwinding [spheres] of Saturn and Jupiter are twice three, and the

---

contribute to the east-west motion of the sphere below because it is carried round by the fixed sphere [cf. 494.20–22, 501.17–21], and so his proposed revision of the text is misguided [cf. 2005, 41].

272 502.17–19: that is, in unwinding the second sphere, points on the seventh will be fixed in relation to the first sphere of the planetary system of spheres, and thus move from east to west as does the sphere of the fixed stars. But this compound motion is possible only because the seventh sphere itself rotates from east to west about the poles of the zodiacal circle in the same time as the second sphere.

273 Points on the seventh sphere are fixed in relation to the first sphere of Jupiter. Since this first sphere has the motion of the sphere of the fixed stars, any sphere with its poles fixed in the seventh will have this same motion, and so this sphere can double as the first of the carrying spheres for Jupiter. Simplicius does not report Sosigenes' argument that the first carrying sphere of Jupiter must be different from the third and innermost unwinding sphere of Saturn.

274 502.20–27: Beere [2003, 8] reads into the text the thesis that Simplicius thinks that this is wrong; the most Simplicius actually does, however, is to cite Sosigenes' view [503.35–504.1] that it is better to hold that there has been a scribal error in the statement that there might be 47 spheres *in toto* than to try get this number by identifying the last unwinding sphere of the planet above with the first carrying sphere of the planet below.

275 Aristotle [*Meta.* 1074a6–14] asserts that there are 55 spheres in all but also considers the possibility that there are only 47 spheres. This latter number caused commentators no end of trouble, as Simplicius makes clear in what follows. Note: if a sphere is counted twice, that is, if it is counted as a carrying sphere *and* and as unwinding sphere, the total number of spheres required is reduced. Thus, if one identifies the first carrying sphere of each planetary system with the unwinding sphere immediately above it, there will be $55 - 6 = 49$ spheres in all.

unwinding [spheres] of Mars, Venus, Mercury, [and the] Sun are [altogether] four times four; so there are 22 in all. But the carrying spheres of Saturn and Jupiter were eight in number and 25 in number for the remaining five [planets]. Thus, when these 33 [carrying spheres] have been added to the 22 unwinding [spheres], there are in all 55. (Of course, for the [spheres] carrying the Moon there is no need of unwinding [spheres] since it is last, given that Aristotle said also that '*only [the spheres] in which the [wandering] star stationed below moves need not be unwound.*')[276]

Now, it is clear that this is the total number of all [the spheres]. But, when Aristotle inferred that '*if one does not add the motions which we mentioned to the Sun and the Moon, there will be 47 [spheres] in all*',[277] this caused confusion. To explain—if we subtract the two [spheres] of the Sun and the two [spheres] of the Moon which Callippus added and, clearly, two other [spheres] from the Sun as well (the ones that unwind these [two carrying spheres for the Sun], given that, when those [carrying spheres] have been subtracted, one must also subtract with them the spheres that are going to unwind them), there will be six [spheres] that have been subtracted, two which carry the Sun and the two which unwind these [spheres] in addition to the two added for the Moon by Callippus. But it does not yet result that, when these [spheres] have been subtracted from the 55, there are 47 [spheres] left in all; rather, there will be 49. But Aristotle says that *47* are left behind, either as though he had forgotten that he removed not four [spheres] from the Moon but only two—unless one should say, therefore, that he subtracted the four unwinding [spheres] from the Sun which he himself added and from both [the Sun and Moon] the [spheres] which Callippus [added]; and, thus, [that], since there are eight spheres that have been subtracted from the 55, the remaining [spheres] are 47 in number. This is how the number results. Yet why some [spheres] will not unwind the two spheres of the Sun (the second and the third) we cannot say, given in fact that he says only this, that *the [wandering star] lying below is not unwound*.[278] And yet Sosigenes has also established correctly that one must hypothesize the unwinding [spheres of the Sun] for the Moon, lest the speed of the upper motions when added to the spheres carrying [the Moon] no longer make it advance to the west at the same speed as the fixed [sphere]. But, thus, even when it is granted that the [Moon] alone does not have an unwinding

---

[276] 503.8–9 μόνας οὐ δεῖ ἀνελιχθῆναι ἐν αἷς φέρεται τὸ κάτω τεταγμένον ἄστρον. Simplicius' quotation of *Meta.* 1074a8 makes poor sense. In point of fact, the Aristotelian mss have μόνας οὐ δεῖ ἀνελιχθῆναι ἐν αἷς τὸ κατωτάτω τεταγμένον φέρεται (only [the spheres] in which the [wandering star] stationed *farthest* below moves need not be unwound) [cf., e.g., Ross 1953, *ad loc.*]. Mueller [2005, 43] tacitly assumes κατατάτω in Simplicius' text.

[277] 503.11–123 εἴ τις μὴ προσθείη τῷ ἡλίῳ καὶ τῇ σελήνῃ ἃς εἴπομεν κινήσεις, ἑπτὰ καὶ τεσσαράκοντα ἔσονται πᾶσαι. At *Meta.* 10743a12–14, modern editors have εἰ δὲ τῇ σελήνῃ καὶ τῷ ἡλίῳ μὴ προστιθείη τις ἃς εἴπομεν κινήσεις, ἑπτά τε καὶ τεσσαράκοντα [cf., e.g. Ross 1953, *ad loc.*]. See Comment 15, p. 98 below.

[278] 503.27–28 ταῦτα εἰπόντος. . . μὴ ἀνελίττεσθαι: a paraphrase of *Meta.* 1074a7–8.

[sphere], the number does not follow; and this disturbed Alexander and Porphyry[279] in their lectures on [book] Λ of the *Metaphysics*.[280]

Sosigenes, who understands [the problem], says that it is better to think that there has [35]
been an error in the number by scribes[281] than to make the seventh and eighth spheres [504.1]
the same. (Not even if this were the case, would the number be consonant with the text, given that there will still not be 55 [spheres] in all, just as [Aristotle] himself says.)[282]

Sosigenes also adds the following when he says that

> it is clear from what has been said that Aristotle calls [the spheres] unwinding in [5]
> one respect and that Theophrastus calls them compensating in another.[283] Indeed, both [designations] apply to them. That is to say, [these spheres] unwind the upper motions and compensate[284] the poles of the spheres beneath [the wandering stars][285] by removing the former [motions] and bringing the latter to what is required.

The reason is that the motions from above should not extend to the diverse [motions] of [10]
the stars lower down and that the poles of the [spheres] below should fall beneath the same perpendicular as the poles of similar spheres,[286] in order that the first spheres of the [wandering] stars stationed beneath (and, clearly, because of them the spheres after them) can be restored to the same position, just as he says. 'Certainly, in this way alone', he
rightly says, 'is it possible for all [the wandering stars] to make the motion of the fixed [15]
[stars],' as we have already said.[287]

The spherical construction by means of unwinding spheres is somewhat like this; [it is a construction] which cannot save the phenomena, as Sosigenes also remarks critically when he says:

---

279 AD 234–*ca.* 305. Porphyry, a student of the philosopher Plotinus (205–270), was very productive in his own right and left his mark on later Platonism: see Smith 1996; O'Meara 1989, 25–29.

280 503.34 Μεταφυσικῆς: F has Μετὰ τὰ φυσικά, the reading of A at, e.g., 422.17, 497.9, 505.27.

281 503.35–504.1: *scil.* that the number should have been 49.

282 503.10–504.3: cf. Hayduck 1891, 705.39–706.15.

283 504.4–15 = Theophrastus Fr. No. 165D in Fortenbaugh *et al.* 1992. See 493.17–20 and 54n186. For discussion, see Bodnár 2005, n25.

284 504.7 ἀνταναφέρουσι (compensate): lit. 'bring back(wards) in (re)turn'. Theophrastus' ἀνταναφερούσας is the present participle of this verb: see 54n186.

285 504.8 ὑπ' αὐτούς: *scil.* lit. 'beneath them', where 'they' (masc. pl.) cannot be the spheres (fem. pl.). This reference to items syntactically outside Simplicius' own text signals that he is quoting Sosigenes.

286 504.10–11 ὑπὸ τὴν αὐτὴν κάθετον (beneath the same perpendicular): *scil.* a perpendicular drawn from the sphere's pole to its equatorial plane. In other words, the spheres should have the same axis.

287 504.9–15: Mueller [2005, 43 and n177] includes these lines in the citation of Sosigenes. But, as καθάπερ φησίν at 504.12 indicates, in 504.9–14, Simplicius is speaking *propria voce*. 504.14–15 is another citation.

> Nevertheless, the [spheres] of the Eudoxans[288] do not in fact save the phenomena, not as they have been ascertained later nor even as they had been recognized before and accepted by those same people.[289]

And why should we speak about the rest [of the phenomena], some of which even Callippus of Cyzicus tried to save when Eudoxus was not successful, if indeed [Callippus] did save [them]? But at least this one itself, which is indeed manifest to the eye, none of them before Autolycus of Pitane[290] in fact tried to demonstrate by means of hypotheses, although not even Autolycus himself was successful—his dispute with Aristotherus[291] reveals [this]. What I mean is that the [planets] sometimes make their appearance nearby and sometimes after they have receded from us.[292]

This is indeed obvious to the eye in some cases. That is, the star said to belong to Venus and, moreover, the [star belonging to] Mars appear many times greater at the

---

[288] 504.18 τῶν περὶ Εὔδοξον: on the locution, see Bowen and Goldstein 1991, 251; Bowen 2003b, 30n13 *ad* 471.11.

[289] Aujac, Brunet, and Nadal [1979, 179–181] follow Heiberg in supposing that the citation of Sosigenes extends from 504.17 to 505.27, but there is reason to doubt that this is correct. Proclus, *Hyp. ast.* 4.98 [see p. 89 below, for translation] does, I admit, indicate that Sosigenes' account of the turning (or unwinding) spheres did include mention of solar eclipses. Moreover, 505.1–11 is consistent with Proclus' report. The problem is that such consistency is not a sufficient basis for ascribing all of 504.17–505.27 to Sosigenes, especially in light of the fact that this passage introduces argument on other subjects as well, and that its syntax does not require such an attribution. Note also that 504.20–22 seems more likely to come from Simplicius, given 497.22–24: cf. 61n233.

[290] On Autolycus' dates, see Bowen and Goldstein 1991, 246nn29–30.

[291] Aristotherus is otherwise unknown, except for the assertion made at the end of the anonymous *Vita Arati IV* [MartinJ 1974, 21.2] that Aratus 'was a student of (ἤκουσεν) a certain Aristotherus, an astronomer (μαθηματικός)' [cf. MartinJ 1956 on the history of the text]. This claim about Aratus and Aristotherus is, however, unverifiable; moreover, the entry for Aratus in the *Suda*, a lexicon compiled at the end of the 10th century AD, makes no mention of Aristotherus but asserts instead that Aratus was the pupil of Menecrates of Ephesus, a grammarian, and of the philosophers Timon and Menedemus. Admittedly, this entry, so far as it concerns Timon and Menedemus at least, may rest on inferences from other literary sources, specifically, on anecdotal remarks at Diogenes Laertius, *Vitae* 2.133 and 9.113. Now, some scholars regard *Vita Arati IV* as worthless [e.g., Mair 1955, 186: cf. Aujac, Brunet, and Nadal 1979, 9 and n2, for references going back to the 19th century]. But there is no reasonable way to decide this in light of the documents available. It is interesting that Heath [1913, 222n1] states only that Aristotherus was apparently Aratus' teacher [cf. North 1995, 84] and that he later abandoned such reticence in maintaining this relation [Heath 1921, 1.348: cf., e.g., Dreyer 1906, 141–142], despite the fact that *Vita Arati IV* was generally dismissed at the time. Cf. Bowen 2008a.

[292] Simplicius has touched on this issue earlier [32.12–33.16] in a different but related context. See Comment 16, p. 101 below.

middle of their retrogradations,[293] with the result that, on moonless nights, the [star] of Venus for its part causes shadows to fall from bodies.[294] Furthermore, even in our unaided sight,[295] the Moon obviously does not always stand the same [distance] from us because it does not always appear to us to have the same size, though the same conditions obtain with reference to the [medium] through which it is observed.[296] Nevertheless, [should the Moon *not* appear so to our unaided sight,][297] the same thing seems true to us also if we

---

[293] 504.28 προηγήσεις. See Comment 17, p. 104 below.

[294] The earliest ancient text mentioning shadows cast by Venus seems to be Pliny, *Hist. nat.* 2.37. Recent descriptions of these shadows add little more: see, e.g., Herschell 1849, 272; Steavenson 1956, 264; Moore 1961, 27. Though modern computations and observations confirm that Venus does under certain circumstances cast shadows, one should not assume that Simplicius has himself made such an observation or that he knows anyone who has. He may, after all, be relying solely on literary sources such as Pliny's *Hist. nat.* 2.37. In general, modern computations and observations serve only to disconfirm ancient observational reports and not to verify them: the reason is that modern science can at best demonstrate that an ancient report is consistent with the natural phenomena. Showing that an ancient report is truly observational requires study of the context in which the report occurs, the aim being to get positive evidence that there actually was an observation. Without such evidence, one cannot, for instance, eliminate the possibility that such reports are but adaptations of literary *topoi* some of which may only be true coincidentally. Cf. Heiberg 1894, 1.4–2.5, 431.30–32.

[295] 504.30 ἐν αὐτῇ μὲν τῇ ὄψει: lit. 'in sight (by) itself'. Simplicius is about to distinguish naked eye observation and observation with instruments, so the αὐτῇ is important. But see Mueller 2005, 43.

[296] 504.32 τῶν αὐτων περὶ τὸ δι' οὗ θεωρεῖται καθεστώτων (though the same conditions obtain with reference to the [medium] through which it is observed): lit. 'the same things obtain concerning that through which it is observed'. Cf. 505.9–11. Mueller [2005, 44] misses this clear reference to the medium. On the general claim about the Moon, see Comment 18, p. 105 below.

[297] 504.33 οὐ μὴν ἀλλὰ καὶ [cf. 1.24–2.5, 431.30–32]. This collocation of particles answers to μέν in 504.30 [cf. Denniston 1966, 30; Blomqvist 1969, 57–58], and announces the strongest case for the thesis that the Moon varies in distance to the Earth. The connection with the preceding sentence may be spelled out by 'But, *if* it is not obvious to the naked eye that the Moon varies in size and, hence, in distance, nevertheless. . . .' Heath's translation [1913, 222] does not save the contrast between naked eye and instrumental observation at issue here, a contrast that is also indicated by the comparative adverb ὀργανικώτερον ('more by means of instruments') in 504.33. Cf., e.g., Theon, *De util. math.* 3.22 [Hiller 1878, 150.7–12 and MartinTH 1848, 213]

make observations more instrumentally,[298] because sometimes a drum of 11 digits[299] and sometimes a drum of 12 digits blocks the observer's sight so that it does not fall upon [the Moon], though [the drum] is set at the same distance from him.[300] In addition to these [instrumental observations], the events at total eclipses of the Sun also testify to what has been said [about the Moon], and are in fact proofs of its truth. That is to say, when the center of [the Sun], the center of the Moon, and, moreover, our eye happen to be in a straight line, the results do not always appear the same. Instead, the Sun in fact is itself sometimes completely enclosed by the cone which encloses the Moon and has our eye as its vertex (that is, sometimes in fact [the Sun] spends some time-interval without being visible to us); and sometimes, again, [the configuration] is so far [removed] from this that at the mid time-interval of the eclipse, some rim of [the Sun] is in fact left shining round from outside [the cone].[301] Consequently, it must be necessary that the difference in the sizes [of total solar eclipses] be evident because of the inequality of the [Moon's] distances, though the atmospheric [conditions] are about the same.[302] But, in that what happens in these instances [just described] is plain in fact to sight, it is reasonable that [the same] happens in the others as well even if it is *not* manifest to sight. Indeed, not only is it reasonable, it is in fact true, since the daily motion of the [other planets] appears unsmooth.[303] But, concerning their apparent sizes, no difference

---

298 The instrument that Simplicius alludes to seems to be the Hipparchan dioptra first mentioned by Ptolemy in *Alm.* 5.14 [Heiberg 1898–1907, 1.417.1–3: cf. Proclus, *Hyp. ast.* 4.71–72]. One form of this instrument was subsequently described by Pappus [*In Ptol. syn. ad 5.14*: Rome 1931–1943, 1.90–93] and another, by Proclus [*Hyp. ast.* 4.87–96: cf. 72]: cf. Price 1957, 591. Though Simplicius does not describe the instrument in any detail, the fact that he says nothing of any holes in the movable drums suggests that he may have in mind Pappus' rather than Proclus' version. Simplicius' main departure from all previous extant accounts of this device lies in his speaking of drums (τύμπανα) rather than small prisms (πρισμάτια).

299 504.34 ἑνδεκαδάκτυλον. See Comment 19, p. 106 below.

300 According to Levi ben Gerson [Goldstein 1985, 102 sentence [10]], the apparent size of the Moon only varies a little between quadrature and opposition. Indeed, Bernard Goldstein informs me that in chapter 75 (unpublished) of his *Astronomy*, Levi asserts that he could detect no variation in the Moon's apparent size between 0° and 180° of anomaly, that is, he could find no measurable difference between the apparent sizes of the Moon no matter what the argument of anomaly was. In modern times the apparent size of the Moon has been found to vary from 0;29,20° to 0;33,32° [cf. Aujac, Brunet, and Nadal 1979, 180n1].

301 The point of this argument is, again, that the Moon varies in distance to the Earth [cf. 505.1–3]. There is no need to follow Schiaparelli in inferring that this argument also entails awareness of, or supposes, a variation in the apparent diameter of the Sun: cf. Heath 1913, 223—224.

302 505.9–11: these lines concern the Moon and conclude the argument that began in 504.30; they are not a remark about the planets in general (as Mueller [2005, 44] supposes): cf. 505.11–17.

303 Simplicius has thus far proposed that the observable variation in the size of the Moon is to due a variation in its distance from the Earth. He then says this variation ought by rights to be visible in the case of the other planets as well. Allowing for the objection that it is not (in some cases at least), he considers whether the

is noticed[304] because their variation in altitude and its opposite (which scientists[305] used also to call motion in depth)[306] is negligible. Thus, [the scientists] did not try at all to save this [phenomenon]; consequently, they did not display the changing daily [motion of the planets], although [Plato's] question requires this.

But yet it is not admissible to say that the inequality of the distances of each [planet] at different times really escaped their notice. For Polemarchus of Cyzicus evidently recognizes it, but evidently dismisses it as not being perceptible because he prefers more the positioning of the spheres themselves in the universe about its very center.[307] And even Aristotle in his *Problemata physica*[308] clearly sets forth further problems for the astronomers' hypotheses[309] based on the fact that the sizes of the planets do not appear to be the same.[310] Thus, he was not completely satisfied with his turning [spheres],[311] even if [the thesis] that they are homocentric with the universe and move about its center won him over. And, further, from what he says in *Metaphysics* Λ, he is evidently not one

---

other planets also vary in size albeit imperceptibly, which would presumably mean that they too vary in their distance from the Earth. He concludes that they do, and adduces as proof the fact that the other planets vary in their daily motion, that is, in the number of degrees of longitude that each travels day by day. Though he does not say how he knows this in each instance—it is a claim most easily established for the Sun—the phenomenon is, he assumes, to be explained by positing a variation in the distance of the planet from the Earth. Thus, Geminus [*Intro. ast.* 1.13–41], for example, supposes that the Sun moves on a circle that is eccentric to the Earth in order to explain the variation in the length of the seasons and the zodiacal months.

[304] 505.15 οὐ προσπίπτει τις διαφορά: lit. 'it is not the case that any difference befalls [sight]'.

[305] 505.17 οἱ ἀπὸ τῶν μαθημάτων: cf. 58n208.

[306] 505.16 κατὰ βάθος: the earliest occurrence of the usage that Simplicius alludes to seems to be in the Keskintos Inscription (*ca* −100), though its significance there is admittedly not well understood [cf. Neugebauer 1975, 698–705; Jones 2006]. Cf. Pliny, *Hist. nat.* 2.68; Plutarch, *De facie* 937f, 939a–b.

[307] See Comment 20, p. 107 below.

[308] 505.24 τοῖς Φυσικοῖς προβλήμασι. The *Problemata* (= *Quaestiones physicae*) that has come down under Aristotle's name is a compilation of texts written in the Peripatetic school made perhaps as late as the fifth and sixth centuries AD, though there is modest reason to think it may include sections of a book of the same name written by Aristotle himself [cf. Louis 1991–1994, 1.xi–xxxv]. Precisely which sections these may be is a matter of scholarly concern that lacks a credible means of resolution. In any case, I will put this issue aside for now, since no problem in the treatise as it has come down to us raises any difficulties involved in positing fixed planetary distances. The only one that even seems to suggest the possibility of variable planetary distance is *Prob.* 15.4, but it does this counterfactually. So, if this were the text Simplicius is alluding to, he has certainly read it against the grain in order to support his story.

[309] 505.24–25 ταῖς τῶν ἀστρολόγων ὑποθέσεσιν.

[310] Aujac, Brunet, and Nadal [1979, 181n2] think that the passage Simplicius has in mind was a false report that was inserted into a version of the *Problemata* now lost, and was intended to excuse Aristotle from his adherence to homocentric theory.

[311] 505.26 ταῖς ἀνελιττούσαις: cf. 44n116.

who thinks that the [features] of the motions of the wandering [stars] have been stated adequately by the astronomers[312] up to and during his time. At any rate, he *says* [this] in the following:[313]

> Thus, to give [some] conception [of the problem], we now state what some of the scientists[314] say, that is, in order that there be some definite number for thought to grasp. But, [506.1] as for the rest, as we investigate some things ourselves and learn other things from those who conduct investigations, if anything is revealed to [us] in engaging with these matters in conflict with what has been stated now,[315] we must treat both [accounts] kindly but believe the more accurate.[316]

But also in the same book, after he has enumerated all the motions together, he remarks:

> Let the number of the motions be this great, so that it is reasonable to suppose that the substances, that is, the unmoved and perceptible first principles, are as numerous. Let what is actually necessary be left for the more vigorous to say.[317]

His 'let. . . be', 'reasonable', and 'leave for others more vigorous',[318] show his uncertainty about them.

Thus, while giving credence to Aristotle, we must follow more those who come later, on the grounds that they save the phenomena more [effectively] even if they do not save them completely, since [those who adopted homocentric hypotheses] neither knew so many phenomena because the observations sent by Callisthenes[319] from Babylon, when

---

[312] 505.29 ἀστρολόγων.

[313] 505.30 λέγει γοῦν ὧδέ πως. There is no uncertainty here: the quotation makes Simplicius' point. See Comment 13, p. 96 below.

[314] 505.31 τῶν μαθηματικῶν.

[315] 506.2 παρὰ τὰ νῦν εἰρημένα τοῖς ταῦτα πραγματευομένοις. See Comment 21, p. 107 below.

[316] 505.30–506.3: *Meta*. 1073b11–17. Simplicius omits a clause [*Meta*. 1073b10–11] immediately before the lines that he quotes. This is why he writes νῦν μὲν οὖν ἡμεῖς where the received text has only νῦν μὲν ἡμεῖς. Heiberg's text also has ὑπολαμβάνειν, τῶν ζητούντων, and ἐάν instead of ὑπολαβεῖν, παρὰ τῶν ζητούντων, and ἄν, respectively [cf. Ross 1953, *ad loc*.].

Heath [1913, 223] rightly follows Schiaparelli in rejecting Simplicius' imputation of doubts to Aristotle about homocentric theory as an attempt to excuse later Peripatetics from abandoning homocentric spheres in favor of epicyclic and eccentric spheres [cf. 506.8–16].

[317] 506.4–7: *Meta*. 1074a14–17. Modern editions of Aristotle's text have τὸ μὲν οὖν πλῆθος (Simplicius omits οὖν); moreover, they follow [Alexander] [Hayduck 1891, 706.16-17, 23–24] and athetize Simplicius' καὶ τὰς αἰσθητάς (and perceptible) [cf. Ross 1953, *ad loc*.], though these words do appear in all the mss of the *Meta*.

[318] 506.7–8: here Simplicius inserts a paraphrase of text that he has just quoted [506.6–7].

[319] Callisthenes was Aristotle's nephew and a historian who traveled to Babylon in Alexander's entourage: see Bosworth 1966.

Aristotle required this of him, had not yet arrived in Greece (Porphyry reports that these [observations] were preserved for 31,000 years up to the times of Alexander of Macedon[320]) nor were able to demonstrate by means of their hypotheses all [the phenomena] which they did know.

Ptolemy[321] too criticizes them[322] on the grounds that they introduce a great multitude of spheres for the sake of only the joint return of the seven planets in relation to the rotation of the fixed [sphere], as well as for saying that [the spheres] contained by the containing [spheres], that is, the innermost [spheres],[323] are causes of the joint return for the [spheres] above them, although nature always makes higher things causes of motion for things that are lower. Certainly, even in human beings, it is from on high, that is, from our ruling part,[324] that the impulses for motion are distributed through the nerves[325] to all the organs.[326]

And I do not understand *why* they ever set the first sphere for each [wandering] star as moving similarly and at the same speed as the fixed [sphere], and as making all the

---

[320] See Comment 22, p. 108 below.

[321] Ptolemy was active in the middle parts of the second century AD [cf. Toomer 1978, 186–187].

Simplicius' references to Ptolemy are quite complimentary and, indeed, he mentions a number of Ptolemy's works, including the *Almagest*, *Geographia*, *Hypotheses planetarum*, *Canones manuales*, and *Optica* [see Heiberg 1894, 774 *s.v.* Πτολεμαῖος]. On the interest in Ptolemy's astronomical works shown by Simplicius, and his predecessors, colleagues, and successors in the Neoplatonic school, see Heiberg 1898–1907, 3.xxxv–xxvii; Heiberg 1894, 462.20–30 with Neugebauer 1975, 1031–1054 and Pingree 1994. Given Simplicius' frequent citation of Proclus [see, e.g., Heiberg 1894, 773 *s.v.* Πρόκλος], it seems that Simplicius' understanding of Ptolemaic astronomy, though based perhaps in part on direct acquaintance with Ptolemy's writings, was also dependent on Proclus' writings, particularly Proclus' *Hyp. ast* and his later commentary on Plato's *Timaeus* [cf. Pingree 1994, 89–92]. Mendell's reconstructions [1998, 2002] of the solar and lunar theories described in Simplicius' digression, do not, I think, give sufficient weight to Ptolemy's impact on Simplicius' understanding of matters in technical astronomy.

[322] 506.16 αὐτοῖς: *scil.* those who adopt homocentric hypotheses.

[323] 506.18–19 τὰς περιεχόμενας ταῖς περιεχούσαις καὶ ἐσχατάς: Mueller [2005, 44] has 'contained and last spheres', thus missing the instrumental dative and the epexegesis.

[324] 506.23 τοῦ ἡγεμονοῦντος μορίου: *scil.* from our controlling part or command center.

[325] 506.22 διὰ τῶν νευρῶν. By Ptolemy's time, there had been substantial advances in the understanding of the anatomy and physiology of the nerves and brain. Indeed, as Galen (AD 129–199/216) and others report, Herophilus (−330/320 to −260/250: cf. von Staden 1989, 43–50) was the first to investigate the anatomy of the nerves, and to distinguish motor and sensory nerves. Moreover, he was the first to suppose that the ruling faculty or command center was located in the hind brain (that is, in the cerebellum or fourth ventricle), a view Galen accepted. See von Staden 1989, 155–160, 247–259 with textual evidence at 313–319. On the larger question of the role of medicine in the commentaries on Aristotle's works, see Todd 1984.

[326] 6.16–22: Simplicius is here summarizing criticisms that Ptolemy makes in book 2 of his *Hypoth. plan.*, a text that survives only in Arabic and in a Hebrew translation of the Arabic.

spheres after it up to the [sphere] that has the [wandering] star return jointly with the fixed
[sphere].[327] To explain: if the [sphere] above passes on to the [spheres] below the form of
its proper motion, why do we not say that the fixed [sphere], which is the most powerful
and strongest sphere of all, causes all the spheres beneath it to return jointly to the same
position by itself? Of course, it was necessary that the [spheres] performing the motion
[30] in longitude and in latitude be different, since these were different [motions] for each
[507.1] [wandering] star. But how did the joint return with the fixed [sphere] (which is the same
for all the spheres) not be satisfied by the rotation of the fixed [sphere]? How instead
did it, according to Aristotle, need [spheres] performing this motion for each [wandering]
star as well as for spheres unwinding those ones?[328] They might perhaps say[329] that, even
[5] if [the spheres] return jointly with the fixed [sphere] by performing the same motion
westwards as it, since they are instead different in size, they are also utterly different in
speed of motion:[330] how, then, was it reasonable that [spheres] which are set free (that
is, not bound together) perform different motions at the agency of a single [sphere], the
fixed [sphere]?[331]

[10] In giving judgment against the hypothesis of turning [spheres] especially because it
does not preserve the difference in depth (that is, the anomaly)[332] of the [planetary] motions, those who came later rejected the homocentric turning [spheres] and hypothesized eccentric and epicyclic ones—unless the hypothesis of eccentric circles was conceived by the Pythagoreans,[333] as Nicomachus and some others say as well as Iamblichus[334] (who

---

[327] 506.23–25: Mueller [2005, 45] misses the fact that κινουμένην and συναποκαθιστῶσαν are participles modifying τὴν πρώτην σφαῖραν.

[328] 507.2 ἠρκέσθη... ἐδεήθη: Mueller [2005, 46] incorrectly supposes that the subject of these verbs is Aristotle. 507.3 ἐκείνας (those ones): *scil.* the spheres producing motion in longitude and latitude. As Taïeb Farhat has emphasized in correcting an earlier version of my translation, these spheres must be unwound if the diurnal motion of the planet beneath is to be preserved.

[329] 507.4 λέγοιεν δὲ ἂν ἴσως: the verb is plural not singular as Mueller [2005, 46] supposes.

[330] The angular velocity of the spheres is the same: it is the linear velocity that varies with the radius.

[331] 507.4–10: this is not a particularly compelling objection, trading as it does on a difference in linear velocity even when angular velocity is the same. Simplicius is trying to make the case for what he regards as a bad argument.

[332] 507.10 τὴν ἀνωμαλίαν. This is first use of ἀνωμαλία in its technical sense to signify the mean motion of a planet on its epicycle: see Evans 1998, 337 for the terminology in the case of a simple epicyclic model [cf. Toomer 1984, 21]. (Epicyclic) anomaly, which is measured from the apogee of the epicycle, incidentally accounts for what was known as motion 'in depth'. Cf. 44n115 above.

[333] It *ought* to be the case that Simplicius understands not the Pythagoreans whom Plato and Aristotle mention in their works, but those intellectuals who revived Pythagoreanism during the time of Cicero both in Rome and Alexandria, more specifically, those (e.g., Nigidius Figulus) who were interested in horoscopic astrology and apparently pursued questions about the planets [see O'Meara 1996: Hudson-Williams and Spawforth 1996;

follows Nicomachus).[335] But, in order that we get some conception of the use of these hypotheses in producing a comprehensive study[336] of the heavens,[337] let the eccentric hypothesis be set out first in comparison with the homocentric [hypothesis] in a diagram.

Let the circle through the middle of the zodiacal [constellations], *ABCD*, be conceived of as homocentric about the center *E* (at which let it be supposed our eye is) and the [line] *AEC* as a diameter.[338] Then, if the [wandering] star makes smooth progress from *A* to *B* on the circle *ABCD*, it is evident that, since our eye happens to be at the center *E*, if we conceive of the ray that falls from [our eye] to the [wandering] star as the straight [line] *AE*, this [line] too will be brought around smoothly with it. And, of course, the [wandering] star will be plainly evident both making its progress smoothly and keeping away from us at a distance that is always the same. But, since [the planets] are not observed in this way but as always making their progress unsmoothly and standing apart [from us] at different distances at different times (as is clear from the difference in their sizes), let the circle *ABCD* no longer be supposed as homocentric to the zodiacal [circle] so that, for example, the center of the zodiacal [circle] (on which we say our eye is) no longer happens to be at *E* but at *F*.[339] That is, [let it be supposed] that the [circle] *ABCD* is no longer homocentric to the circle through the middle of the zodiacal [constellations] but eccentric to it, and that *A* is the farthest [point] of it from the Earth (this is the [point] which is at the greatest distance from our eye at *F*) while *C* is the [point] nearest the Earth (the [point] which is at the least distance from our eye at *F*). Then, if we conceive of the [wandering] star in the same way as traveling the arc *AB* smoothly from apogee *A*

Bowen 2007, 332–333]. But Simplicius is probably referring to Pythagoreans of the earlier period and not of the later. At least, this reading yields a proper distinction between the Pythagoreans and 'those who came later' (than Eudoxus, Callippus, Polemarchus, Aristotle, and Autolycus).

334 Nicomachus of Gerasa was a Pythagorean who was active *ca* 100: see Tarán 1974; O'Meara 1989, 14–23. Iamblichus of Chalcis (*ca* 245 to *ca* 325) was a Platonist philosopher who may have studied with Porphyry [cf. O'Meara 1989, 30n1].

335 507.13–14 ἄλλοι τέ τινες... καὶ... καὶ. The locution, (οἱ) ἄλλοι τε καὶ P, ('others and P' or 'P, besides others') occurs fairly often. In general, it serves to single out P as member of a group. Whether this locution should be rendered along the lines of 'the others and especially P' as a rule seems to me unlikely, given the number of occurrences in which 'P' is modified by some intensive pronominal adjective or in which an adverb such as μάλιστα ('especially') is added in order to achieve this sort of emphasis. In the same vein, it does not always hold that the true subject of the locution is P alone, that any mention of others is perhaps merely a mark of politeness and urbanity or the like. Certainly, in the present instance, this does not seem to be the case. Cf. Bowen 2001, 22. See Comment 23, p. 108 below.

336 507.15 τὴν πραγματείαν.

337 Cf. 492.28–31.

338 See Figure 14.

339 507.27–29: Mueller [2005] gets into difficulty because he does not see that τὸ τοῦ ζῳδιακοῦ κέντρον is the subject of the subordinate clause ἵνα... τυγχάνῃ....

[508.1] to *B* on the eccentric circle *ABCD* and of some straight [line] from the center [*E*][340] as being brought around with it, this [line] too will be brought around smoothly. Then, let it be the [line] *EB*.

Then, the result will be that, when the [line] *FB* is joined from our eye at *F* to the [wandering] star, the [wandering] star has traveled the angle *AEB* smoothly, but that it has appeared [to have traveled] a smaller [angle], *AFB*. To explain: since the angle at *E* is an exterior angle of the triangle *BEF*, it is greater than the interior and opposite angle at *F*.[341] But, if [the planet] in making its progress from the perigee *C* travels the arc *CD* smoothly (so that the straight [line] *ED* is also brought around smoothly with it), and if we join in turn the straight [line] *FD* from our eye at *F*, the smooth progress from the perigee will be contained by the angle *CED* and the unsmooth or apparent [progress] by the angle *CFD*. And the apparent [progress] along the [arc] from the perigee *C*[342] will clearly be farther than the smooth [progress], because the angle at *F* is greater than the [angle] at *E*. And, in the case of the [wandering] star's position at *B*, angle *AEB* is smooth, but angle *AFB* is apparent, and angle *EBF* is the difference.[343] Whereas, in the case of the star's position at *D*, angle *CED* is smooth, but angle *CFD* is apparent, and angle *EDF* is the difference.

Now, though this [eccentric] hypothesis fits the stated goal of the scientist[344] in respect of greater simplicity, they[345] also sought out another which could demonstrate the same things as the aforementioned [hypothesis], that is, the result that, though the [wandering] stars move smoothly, they appear to traverse arcs of the circle through the middle of the zodiacal [constellations] unsmoothly.[346]

That is to say, once more let the circle *ABCD* be conceived of as homocentric with the [circle][347] through the middle [of the zodiacal constellations] about a center *E* where again our eye is. And let the [wandering] star be conceived of not as making its motion on [*ABCD*] but along *FGHJ*, a small circle (called an epicycle) which always has its center *A* on the circumference of the circle *ABCD*, so that the star is likewise farthest from the

---

340 507.35–508.1 ἀπὸ τοῦ ἐκκέντρου: as Grosseteste's translation indicates, the text should read ἀπὸ τοῦ Ε κέντρου [cf. Bossier 1987, 297].

341 508.4–6: *scil.* $\angle AEB > \angle EFB$. Cf. Euclid, *Elem.* 1 prop. 16.

342 508.12: reading Γ rather than Z: cf. Aujac, Brunet, and Nadal 1979, 186. Mueller [2005, 47 and n213] chooses instead to athetize περιγείου.

343 508.13–15: cf. Euclid, *Elem.* 1 prop. 32 with prop. 13.

344 508.17 τοῦ μαθηματικοῦ: cf. 81n351 below.

345 Cf. 507.9 οἱ μεταγενέστεροι.

346 Cf. Comment 23, p. 108 below. Note that at this point in this story, the mathematical equivalence of the epicyclic and eccentric hypotheses is unknown: cf. Bowen 2007, 339n40.

347 508.22 Reading τῷ with F instead of πρὸς τὸ with A: cf. 493.10; 491.11; 507.30, 510.5; Aujac, Brunet, and Nadal 1979, 186.

Earth at *F* and nearest at *H*.[348] It is also clear, when the epicycle has smoothly traveled
the arc *AB* and is at *B*—the [straight line] *EB* being brought round with it smoothly in
turn too—when the star by making its progress from the apogee *F* to *G* has traveled the [30]
[arc] *FG* smoothly in turn, and when we join the straight [line] *EG* from our eye at *E*,
that the star will in turn have been brought smoothly round the arc *AB* (that is, the angle [509.1]
AEB) by the epicycle, that [the star] is evidently [brought round] the [angle] *AEG* which
is greater than the smooth [angle, *AEB*], and that the angle *BEG* is the difference of [the
angles]. But, when the [planet] makes its progress from the apogee *F* not to *G* but to
J, the angle *AEB* will once more belong to the smooth progress and the [angle] *AEJ* [5]
to the apparent [progress] which is smaller than the smooth one, and [angle] *JEB* is the
difference of [the angles].

Consequently, this sort of hypothesis can demonstrate the progress of the [wandering]
stars at [positions] nearer the apogee as both greater and smaller—clearly greater when the
star makes its progress from the epicycle's apogee in the same direction as the [deferent] [10]
circle, and smaller when [the star makes its progress] in the opposite direction.[349] (The
eccentric [hypothesis] always [makes] the apparent [passage], at a point nearer the apogee,
smaller than the smooth [progress], since the apparent [angle] *AFB* is in fact always
smaller than the smooth [angle] AEB.)[350]

Either one of these hypotheses will afford the astronomical goal[351] when taken by
itself, except that in the case of the Moon they need both [hypotheses] compounded. That
is to say, they hypothesize that the epicycle carrying the Moon is brought round on an [15]
eccentric circle in order that the phenomena be saved by it.[352] These hypotheses are in
fact simpler than the earlier ones in that they do not require fabricating so many heavenly
bodies, and they save the rest of the phenomena and especially the ones concerning depth
or anomaly.

But [these hypotheses] do not maintain Aristotle's axiom, the one that wants every [20]
body moving in a circle to move about the center of the universe. Instead, not even the

---

348 See Figure 15.

349 509.8–10 μείζονας μὲν δηλονότι... ἐπὶ τὰ ἐναντία: *scil.* when the planet has moved less than 180° or more than 180° on its epicycle.

350 See Figure 16. According to Simplicius [36.22–24: cf. 32.1–11], Philoponus, Simplicius' contemporary and great rival [see Sorabji 1996], adopted the epicyclic hypothesis.

> And as the [deferent] sphere of Mercury rotates, he [*scil.* Philoponus] says, the star, by moving on its characteristic epicycle, is sometimes nearer the Earth and sometimes farther from it; and the same holds for the remaining wandering [stars]. [= Wildberg 1987, Fr. 15: cf. Fr. 7.]

351 509.13 τὸν ἀστρονομικὸν σκόπον: cf. 80n344.

352 509.16: ὑπ' αὐτῆς: *scil.* this composite hypothesis. See, e.g., Neugebauer 1975, 84–88.

stated solution of [Aristotle's second] problem[353] because of which all these arguments were raised has any standing[354] finally. The reason is that equalization does not still have any standing, since what was said is no longer true, namely, that the first motion, though one in number, causes many divine bodies to move; whereas the [motions] which are many in number each [cause] only one [body to move]. For the [motions] before the last (that is, the one that has one star) do not move many bodies.[355] Sosigenes brought these absurdities as well against these hypotheses, though he was not satisfied by the [hypothesis] of turning [spheres] for the reasons stated before.

But those who think that the [wandering] stars have their characteristic motion because they are in fact ensouled must object to the first [axiom of Aristotle]: for [the planets] are not only parts of the heavens, each is also a whole by itself. Thus, a truer axiom would be the one stating that every body which moves in a circle moves about its *own* center. This is why it is true to say that all the heavenly bodies which have the center of the universe
[510.1] as a center move about the center of the universe, whereas all [those bodies] which are outside that center (since they are more particular)[356] move about their own center, just as the [wandering] stars [do] as well as their epicycles and their eccentrics[357] (if there are indeed such bodies in the heavens).[358] These [bodies] do move about the center of the universe, even if [they are] not [performing] their characteristic motion [about this center] but the [motion] of the sphere carrying them, [a sphere] which is homocentric with the universe. And in this way at least, Aristotle's claim that every body that moves in a circle moves about the center of the universe would in fact be true, unless one adds that it is moving in accordance with its characteristic motion.

The solution of [Aristotle's second] problem will have standing in part even in the case of these hypotheses, since it is in a sense true as well to say in these instances that '*nature equalizes and produces a certain order by assigning many bodies to one motion and many motions to one body*'.[359] The reason is that, even if each [body] performs its own motion

[353] Cf. *De caelo* 292a10–14, b25–27.

[354] 509.21 χώραν: lit. 'place or room'.

[355] 509.25–26: The point is that the deferent (sphere) should be said to move only the epicyclic sphere and not the planet on the epicyclic sphere, because it does not affect the motion of the planet itself only its observed position. But see 510.9–15, where Simplicius abandons this strict claim and allows that the motion of the deferent sphere and of the celestial sphere may be said to affect the motion of the planet in the sense that [note πως] they change the planet's apparent position.

[356] 510.1 μερικώτερα: Aujac, Brunet, and Nadal [1979, 189n1] have '*plus « particuliers »*', and suggest that Simplicius is borrowing the term from logic and intends a contrast with the universal. In any case, it is clear that he is referring to the wandering stars.

[357] 510.2 [cf. 32.5–10 with Comment 16, p. 101, below; Mueller 2005, 49]. Simplicius accepts the thesis that the stars rotate or spin: cf. *De caelo* 2.5; Heiberg 1894, 454.23–456.27.

[358] 510.2–3: recall Simplicius' remarks at 488.10–14.

[359] *De caelo* 293a2–4.

as a single [motion], all [the bodies] beneath the fixed [sphere], furthermore,[360] perform its motion—that is, the epicycles perform this [motion] as well as the [motion] of the homocentric or eccentric [deferent circles], and the [wandering] star (which he called one body)[361] [performs] the [motion] of the epicycle and of the homocentric or eccentric [deferent circle] as well as the [motion] of the fixed [sphere]. Still,[362] the eccentric circles would not be ones moving in a circle, since they do not move about the center but about what is outside the center: that is, since, as [these circles] occupy and leave behind place in revolving, they necessitate that there be a void, and since the shape of these circles[363] will be strange in that what is inside always cuts off a part of what is outside.[364]

We will perhaps escape all these [problems] if we fit eccentric spheres in homocentric ones and say that the homocentric [sphere] by moving about its own center causes the eccentric [sphere] (which itself also moves about its own center) to revolve. And we will call all [these pairs of] spheres complete without fearing that in those cases 'body goes through body'.[365]

Sosigenes cleverly raises as well no small number of other astronomical problems for these hypotheses too, problems which would belong to another lecture to examine. But now it seemed that, by investigating the arguments about the heavens and the heavenly motions and by having reinforced the demonstrations through which [these motions] are proved to be circular, smooth, and ordered (since they appear unsmooth and evidently have ascents and descents), he has provided a conception of what things have been hypothesized by the ancient astronomers[366] and those who came after [them] in order to save the phenomena by means of smooth, circular, and ordered motions.

---

[360] 510.12 ἀλλὰ καὶ: cf. Denniston 1966, 21.

[361] *De caelo* 293a3–4.

[362] Simplicius now considers what happens to an eccentric circle when it is made to go round with the daily rotation.

[363] 510.18 τό τε σχῆμα αὐτῶν: *scil.* the shape that these eccentric circles describe as they revolve.

[364] 510.15–19: Simplicius is here assuming that motion at a fixed distance about a point is circular only if that point is the center of the universe.

[365] 510.23 τὸ σῶμα διὰ σώματος χωρεῖν. Simplicius is alluding to a well known problem in physical theory that was first raised by the Stoic doctrine of total mixture: cf. Todd 1976, 29–88. Here the (tangential) point seems to be that if each of a number of eccentric spheres is enclosed in a rotating homocentric sphere or, better, a rotating homocentric spherical shell, there is no longer any danger that they will come into contact [cf. Aujac, Brunet, and Nadal 1979, 190]. Mueller's 'not fearing to say that in their case a body passes through a body' [2005, 49] misses the point.

[366] 510.31 ἀστρονόμοι.

Now, if this is more fitting to chapters[367] about the heavens than to ones about first philosophy, no one of our [school] will criticize the rather lengthy digression[368] from the [present] chapter, if it has come about at an opportune moment. But we must return to
[35] what comes next in Aristotle's chapters.

---

367 510.31–32 τοῖς. . . λόγοις: *scil.* the sections of a treatise.

368 510.33 μηδεὶς ἡμῶν αἰτιάσεται τὴν πλείονα τοῦ λόγου παρέκβασιν: lit. 'none of us will criticize the rather lengthy digression'). Mueller's 'no one will accuse us of turning the discussion aside' [2005, 50] misconstrues the syntax. On the philosophical schools in Athens and Alexandria, see Watts 2006 and Wildberg 2006.

Commentary

Comment 1: *De caelo* 291b35–292a1 ref. 31n12

Commentators have been troubled because this does not seem to be true in the account of the homocentric spheres that Aristotle relates in *Meta.* Λ 8. Ross [1953, 2.394] follows pseudo-Alexander [see 55n190] in proposing that Aristotle returns to Eudoxus' theory that the Sun and the Moon each have three spheres, and thus understands Aristotle to hold that the Sun and the Moon have fewer motions than any of the other planets since these each have four spheres. To explain why Aristotle says that they have fewer motions than *some* of the planets, however, Ross argues that Aristotle asserts only that the Sun and Moon have fewer motions because Aristotle is concerned only to introduce what is sufficient to establish the problem at hand—namely, the problem that the number of motions increases and decreases as one goes from the celestial sphere towards Earth rather than increasing steadily.

Easterling [1961, 138–141] counters that Aristotle really does mean that the Sun and Moon have fewer motions than some of the planets, and proposes instead that Aristotle is thinking of a version of the homocentric theory in which the planetary systems in Eudoxus' account are supplied with unwinding spheres. On this view, the Sun and the Moon do indeed perform fewer motions than some of the planets, since they each have fewer spheres than Jupiter, Mars, Venus, and Mercury but not Saturn. That is, if we follow Easterling [1961, 139n1] and reckon the unwinding spheres with the planet whose motions they influence rather than with the planet whose spheres they unwind [cf. Elders 1966, 240 on *De caelo* 293a5–6], the arrangement would be as in Table 1 [p. 85 below]. As Easterling remarks, this proposal entails that, prior to Callippus' revision of Eudoxan theory, Aristotle had already applied his unwinding spheres to the Eudoxan planetary systems; and, thus, that *Meta.* Λ 8 does not present a historical account of the development of homocentric theory. But see Pellegrin and Dalimier 2004, 42–44.

Planet	Winding Spheres	Unwinding Spheres	Total
Saturn	4	0	4
Jupiter	4	3	7
Mars	4	3	7
Mercury	4	3	7
Venus	4	3	7
Sun	3	3	6
Moon	3	2	5

Table 1. Easterling's Conjecture

Dicks [1970, 204–205: cf. Leggatt 1995, 246], however, suggests that Aristotle is not thinking of homocentric spheres so much as of observable motions. Thus, for Dicks, Aristotle here recognizes that the Sun and the Moon do not exhibit retrogradation but has not yet seen that Mars and Venus do: as Dicks [1970, 187] notes, in the original Eudoxan system, Mars and Venus do not go retrograde. The problem with this interpretation is its assumption that Aristotle and his colleagues were aware of planetary stations and retrogradations [see Bowen 2001, 2002].

Still, Dicks may be pointing in the right direction. After all, it is possible that Aristotle is thinking of the planetary theory in Plato's *Timaeus* [see Bowen 2001, 814–816]. In this account, though all the planets have the motion of the Different, the Sun is apparently assigned this motion *simpliciter* and the other planets have powers that modify it. Thus, the Moon has a power that augments the motion of the Different; whereas Mars, Jupiter, and Saturn have powers that diminish it. Venus and Mercury, however, have powers that alternately increase and decrease the motion of the Different. In this sense, then, one might well say that the Sun and Moon perform fewer motions than some of the planets.

Comment 2: *De caelo* 292a3–6 ref. 32n16

Dave Herald of the International Occultation Timing Association has very kindly computed for me that, of all the occultations of Mars by the Moon visible in Athens (37;35°N, 23;26°E) during Aristotle's lifetime (−383 to −321), there are but two that fit Aristotle's report, those of −360 Mar 20 [see Figure 4] and −356 May 4 [See Figure 5].[369] Moreover, in his view, the first of these fits the report better than the second. According to Herald's computations, there was an occultation on −360 Mar 21 at 20;24 hr U(niversal) T(ime), that is, at 21;58 L(ocal) M(ean) T(ime), when the Moon was 34% illuminated, which lasted 64 minutes; and another, on −356 May 4 at 18;24 UT, that is, at 19;58 LMT, when the Moon was 44% illuminated, which lasted 13 minutes. The greatest source of uncertainty in these computations derives from the variation in rate of the Earth's rotation, which at these times involves a correction of 5;08,24 hrs (with an uncertainty in the order of half an hour).

In light of these computations and of the fact that Aristotle spent much of his adult life in Athens, and granted that he actually saw the occultation, I would say that he may well be reporting one of these two occultations; and that, if so, I agree with Herald that it is more likely the occultation of −360 Mar 20: see Figure 4. Clearly, the occultation of −356 is almost a complete miss for an observer at Athens: see Figure 5. But see Stephenson 2000 for the claim that only the occultation of −356 May 4 was visible at Athens (which he locates at 37;58°N, 23;43°E); and Savoie 2003 for an excellent account of the difficulties in making such computations.

---

[369] In these Figures, which were prepared by Dave Herald, the dotted white lines indicate daytime; the thin white lines, evening twilight; and the thick white lines, nighttime. A pairs of lines of the same sort defines the region in which the occultation was 'visible'.

Comment 3: *In de caelo* 481.12–15 ref. 32n19

According to Simplicius [117.24–27], the Egyptians kept written observations of the stars for at least 630,000 years and the Babylonians for 1,440,000 years; but this is sheer fantasy. As matters stand now, there does not seem to be any record in Egyptian of an interest in occultations. Fortunately, as Christopher Walker of the British Museum has very kindly informed me, such an interest is amply attested in Mesopotamia by a Letter and Reports deriving from the royal archives at Nineveh that were formed during the 8th and 7th centuries BC. This Letter [see No. 84 in Parpola and Reade 1993] and the Reports [see Hunger, Reade, and Parpola 1992, Nos. 30, 100, 166, 351, 351, 399, 408, 438, 443, 455, and 469] specifically concern the Moon's occulting a planet (Jupiter or Saturn) or some fixed star. (Note that Reports Nos. 100 and 438 concern the occultation anticipated in Letter No. 84: cf. Parpola 1970–1983, 2.20.) There is, so far as I am aware, no observational record in which some planet other than the Moon is said to occult another planet, though there are Letters [see Parpola and Reade 1993, Nos. 47,[370] 63, 67,[371] 340,[372] and Reports[373] about planetary conjunctions. The Diaries do not add much to this. The earliest record of an observation of an occultation in a Babylonian Diary is the entry for −277 VII 16 [see Sachs and Hunger 1989, 1.327: A26 + C5] and it concerns the Moon's occulting Jupiter. There are also Diary entries mentioning the conjunction of one planet with another for −567 III 1 and XII 12, −391 VIII 10, −380 XII 11, −346 IX 20, −333 III 26, −330 VII 2, −324 I 13 and VI 21, −322 VI 21 and XII 11, −321 I 27 [cf. II 2] and VI 23, 26.

It is interesting that Ptolemy reports several observations in Alexandria by Timocharis during the early 3rd century BC of the Moon's occulting various fixed stars [see Goldstein and Bowen 1991, Comment 1, Nos. 12–15 with §2]. (Regarding Ptolemy's account of Timocharis' observation of Venus and η Vir, there is doubt that this should be read as an observation of an occultation: see Goldstein and Bowen 1991, Comment 1, No. 18 with §3.) Ptolemy also reports observations of Mars' and Jupiter's occulting different fixed stars in −271 and −240, respectively [see Goldstein and Bowen 1991, Comment 1, Nos. 17 and 27].

One might suppose, in the light of what Aristotle and Simplicius say, that the early Greek interest in occultations derived from a concern to establish the order of the 7 planets. But this is not necessarily what either Aristotle or Simplicius means to suggest: the immediate context is the claim that the Moon is the planet closest to the Earth and, like the observation of the Moon's occultation of Mars, the Egyptian and Babylonian reports

[370] Cf. Parpola 1970–1983, 2.60–62.

[371] Cf. Parpola 1970–1983, 2.73–74.

[372] Cf. Parpola 1970–1983, 2.260–261.

[373] See Hunger, Reade, and Parpola 1992, Nos. 44, 48, 82, 212, 214, 244, 288, 350, 491.

may have been cited to buttress this point only. This would, of course, be consistent with the surviving Babylonian reports of occultations.

Comment 4: *De caelo* 292a18–21 **ref. 33n26**

As Thomas Johansen [2009] has pointed out, there is ample evidence earlier in the *De caelo* that Aristotle regards the heavenly bodies as ensouled. Indeed, it would be difficult to explain the difference in the periods and directions of their motions if they were not, given that their material composition is the same and accounts only for the bare fact that their motion is circular by nature. Accordingly, some have set out to translate this passage in a way that avoids any indication of doubt about this on Aristotle's part: see, e.g., Lennox 2009. But such translations founder on the fact that Aristotle writes ὡς μετεχόντων... ὑπολαμβάνειν, that in such cases ὡς with a participle typically indicates the thought of the subject of the main verb and not that of the writer [see Smyth 1971, §§2086, 2996], and that ὡς μετεχόντων means 'as though sharing' or the like.

To begin, Johansen's claim [2009, n23] that the occurrences of ὡς at 292a18, 20 are linguistically parallel is, I think, mistaken. At 292a18, the syntax is <περὶ> τούτων διανοούμεθα ὡς περὶ σωμάτων... διανοούμεθα, where ὡς is a comparative conjunction and means 'as' [cf. Heiberg 1894, 482.6–9]. (Many translators take this ὡς with περὶ and have 'as if/though about' but still seem to understand περὶ τούτων [cf., e.g., Moraux 1965, 81; Mueller 2005, 22], effectively construing ὡς as a coordinating conjunction all the while translating it as a part of the subordinating complex ὡς περί. Moreover, ὑπολαμβάνειν at 292a21 is intransitive—which is difficult to capture in English, but note '*se mettre dans l'esprit*' [Moraux 1965, 81]—and ὡς μετεχόντων is a genitive absolute with ὡς serving adverbially.

Let us grant that Aristotle holds that the heavenly bodies are ensouled and is disinclined to treating them as mere units with position. The fact is that in these lines Aristotle is speaking as one of a number of people who either do not believe the heavens are ensouled or who have for various reasons carried on as though they are not ensouled. (Elders [1966, 234] suggests that Aristotle has in mind Eudoxus' treatment of the planets as purely geometrical units in *Meta.* Λ 8 [cf. Leggatt, 1995, 248] and thus construes the 'we' in question rather narrowly. As Simplicius' paraphrase suggests, however, Aristotle may instead be thinking of a more general tendency to treat the heavenly bodies as though they were unit-points in figurate number [cf., e.g., Heath 1921, 1.76–84] when talking of the constellations formed by grouping these bodies into shapes, for example.) As a member of this group, Aristotle voices the recommendation that they consider the heavenly bodies as though ensouled. In formulating his recommendation, Aristotle *does* bring to the fore the possibility that they are not ensouled. But does this constitute or entail doubt that the heavenly bodies are ensouled? If it does—and I am not convinced of this—this doubt is inseparable from doubt that the ἀπορίαι can in fact be solved: as Aristotle makes clear, *if* we are to address the ἀπορίαι, then we *should* (or *must*) treat the heavenly bodies as living entities. (Simplicius [482.9–10] makes clear that there is no solution to the ἀπορίαι if we conceive of the them as soulless point-magnitudes with position only.) Accordingly, it is unnecessary to torture the Greek so that it reads in a way that is consistent with earlier indications that the heavenly bodies are living beings.

In sum, even when faithfully rendered, 292a18–21 does not suggest any real doubt on Aristotle's part that the heavenly bodies are ensouled [cf. 139n48, above]. This does not mean, of course, that Aristotle's discussion in 2.12 is still not tentative [cf. Bolton 2009, n17]. Still, it does bring to light an important question: Why does Aristotle think that these two ἀπορίαι deserve an answer and take them up in the *De caelo*?

Comment 5: *In de caelo* 488.20 ref. 45n123

It is customary to cite Proclus, *Hyp. ast.* 4.98 in support of the claim that Sosigenes wrote a treatise entitled *On the Unwinding Spheres*.[374] The same passage has also been cited by modern scholars [e.g., Neugebauer 1975, 104n1] as evidence that Sosigenes observed an annular eclipse, which they then go on to compute to be the annular eclipse of 164 Sep 4, the only such eclipse visible, they claim, in Greece during the relevant period. But this is wishful thinking on both counts. Consider Proclus, *Hyp. ast.* 4.97–99:

> Thus, the diameter of the Sun (since [the Sun] is itself extended), [I mean] its apparent diameter, is always ascertained to be the same by means of the dioptra whether the Sun is at apogee or at perigee.[375] But the apparent diameter of the Moon is greater and smaller at different distances [from Earth]; and only when the Moon is in the [points] of its own circle farthest from the Earth,[376] when it is plainly full and in conjunction as it is in solar eclipses, is its apparent diameter the same as the Sun's [apparent] diameter. [130.9]
>
> It is in fact clear to [Ptolemy][377] that, if this is true, what Sosigenes the Peripatetic has recorded in his [discussions] of the unwinding spheres is not true, [namely], that during eclipses near the Earth,[378] the Sun was observed not to be entirely covered but to extend beyond the disk of the Moon with the extremes of its own circumference and to cast light unimpeded [by the Moon]. Certainly, if one accepts this, either the Sun will exhibit

---

374 περὶ τῶν ἀνελιττουσῶν <σφαιρῶν>: I am assuming that the work which Proclus mentions here is the same one that Simplicius uses in his commentary. Given that Simplicius' citations from this work plainly concern unwinding spheres, I have taken ἀνελιττουσῶν to mean 'unwinding' rather than 'turning'. But one might just as well suppose that the title should be *On the Turning Spheres*. See 44n116 above.

375 εἴτε ἀπογείου τοῦ ἡλίου ὄντος εἴτε περιγείου.

376 *Hyp. ast.* 4.97 ἐν τοῖς ἀπογείους... τοῦ ἑαυτῆς κύκλου.

377 Cf. *Hyp. ast.* 4.95. The reference is to *Alm.* 5.14. Ptolemy allows that the solar distance varies in his *Hypoth. plan.* [cf. Goldstein 1967, 7; Morelon 1993, 66].

378 *scil.* eclipses when both bodies are near the Earth and, hence, when the Moon is apparently larger than it is in eclipses far from the Earth.

> different apparent diameters; or the Moon, in respect to the [diameter] that is apparent from the dioptra when [the Moon] is at [points] farthest from the Earth,[379] will not be identical to the [apparent] diameter of the Sun. [Manitius 1909, 130.9–26]

The remark attributed to Sosigenes offers a middle ground between Ptolemy's view that no total solar eclipses are annular and the view found in P. Par. 1 col. 19.16–17 (first half of second century BC)[380] and Cleomedes, *Cael.* 2.4.108–115 that all such eclipses are annular. The key point for our purposes is that Sosigenes' remark stands as a claim about a whole class of observations that are not necessarily his own—note 'during eclipses near the Earth' and the absence of any indication that Sosigenes actually observed one himself. Moreover, if Sosigenes *is* perchance reporting real observations, we should still hesitate to follow Proclus in supposing that these were observations of annular eclipses rather than observations of the solar corona during a total eclipse [cf. Philostratus, *Vita Apoll.* 8.23.1–4 and Plutarch, *De facie* 932b–c with Newton 1972, 99–100, 601 and Grant 1852, 367, 371–372, 376–383]. There was, after all, no theory in antiquity to explain the light that sometimes appears around the Moon during total solar eclipses and, hence, no way to distinguish such eclipses from annular eclipses. As Grant [1852, 371] remarks:

> Among the various eclipses of the sun recorded as having happened in ancient times, some were, in all probability, annular: but in no instance is the description of the writer sufficiently clear to establish, beyond all doubt, the actual occurrence of an eclipse of this nature.

As for my 'in his [discussions] of the turning spheres', the Greek is ἐν τοῖς + gen. This locution is found without any substantive specified for τοῖς 10 times in the corpus of Proclus' writings. Of these occurrences two [Kroll 1899–1901, 2.167.10–11; Friedlein 1873, 71.18–19] involve what proves to be a reference by title to treatises or books still extant [respectively, Aristotle, *De sensu*; Archimedes, *De sph. et cycl.*]. And four others, which are found in commentaries on particular treatises, either involve reference to a passage in the treatise being commented on [Kroll 1899–1901, 1.41.11–12; Diehl 1903–1906, 3.58.24–25; Manitius 1909, 220.7–15] or to a passage in some other work by the author of the treatise [Kroll 1899–1901, 1.170.15–16 with Plato, *Crat.* 392b1–393b6]. The remaining four occurrences (including the one currently under consideration) are, in my view, uncertain: given the locution Proclus uses, they may involve reference to passages on a certain subject or to treatises by title or by subject. And so any decision about the specific intent of any of these occurrences should be based on independent evidence. Unfortunately, in the case of Sosigenes and his purported treatise, no such evidence is forthcoming. Accordingly, it is more prudent, I think, to avoid positing a treatise otherwise unattested

379 ἐν τοῖς ἀπογείοις.

380 See Bowen 2008b.

and to suppose instead that he is referring to discussions. Such caution will seem warranted if one considers the 35 instances in which Proclus actually does supply a substantive to go with τοῖς, since, for Proclus, the substantive of choice (30 occurrences) is λόγοις and it typically signifies a passage (literally, words), discussions, accounts, or arguments. Indeed, there is but one occurrence [Diehl 1903–1906, 2.105.32–106.2] which seems to involve the citation of a work by its title—the fact that this locution is balanced by another construction designating Plato's *Phaedrus* suggests this. Otherwise, in the remaining five instances, Proclus uses γράμμασι (writings), δόγμασι (doctrines), παραδεδομένοις (views handed down), πλάσμασι (images or figures), and τύποις (outlines). Clearly, only one of these, γράμμασι [Kroll 1899–1901, 2.113.8–9], would entail reference to a treatise, though not necessarily by title.

Comment 6: *In de caelo* 493.15–17 ref. 54n184

This claim about the Sun's motion, a claim which the author of the commentary on *Meta. E–N* extends to the Moon too [see Hayduck 1891, 703.23–34], is first found in Hipparchus, *In Arat.* 2.9.1. Here it is ascribed to Attalus, who reportedly argued that one should follow the manuscript variant for Aratus, *Phaen.* 467 asserting that the tropic and equinoctial circles have breadth rather than the one stating that they are without breadth. As Hipparchus [*In Arat.* 1.9.2] writes:

> The reason is that the astronomers (ἀστρολόγοι) too, [Attalus] says, hypothesize that the tropic, equinoctial, and zodiacal circles possess breadth because the Sun does not always make its solstices on the same circle, but sometimes farther north and sometimes farther south. [Manitius 1894, 88.13–18]

and then adds:

> And Eudoxus too claims that this occurs. At any rate (γοῦν), he says the following in his *Enoptron*: 'Even the Sun is observed making a deviation in the positions of its solstices, a deviation that is rather unclear to many and utterly insignificant.' [Manitius 1894, 88.18–22]

What has passed unnoticed about these lines is that Hipparchus is inferring that Eudoxus would agree with Attalus about the Sun's motion on the basis of a few lines from Eudoxus' *Enoptron*, and that he is not in fact certain that these lines do indeed support this inference. (This, I take it, is the force of the particle γοῦν: cf. Smyth 1971, §2820.) In other words, Hipparchus leaves open the question as to whether Eudoxus actually thought that the observed variation in the position of the solstices on the horizon entailed that the solstitial and equinoctial circles have breadth. Hipparchus then goes on in *In Arat.* 1.9.3–13 to refute Attalus by arguing that the center of the Sun does not stray from the zodiacal circle, and that neither Aratus nor the astronomers (μαθηματικοί) suppose the tropic, zodiacal, and equinoctial circles to have breadth.

This refutation likewise challenges the assumption that Eudoxus (always?) held that the Sun had three motions. If I understand Mendell [1998, 188–189; 2000, 95–100], the citation of Eudoxus at *In Arat.* 1.9.2 should mean that, while the second and third spheres combine to produce an annual solar motion which is not quite circular, the deviations are very small and virtually unobservable. But, this is not how Hipparchus attacks Attalus' thesis: he does not proceed by pointing out that there are no observable deviations in the Sun's course from a great circle. Instead, to make the case that the fundamental circles defined on the celestial circle are without breadth (and so exactly circular), Hipparchus adduces the fact that eclipses occur when the bodies involved are on the zodiacal circle, the practice of the μαθηματικοί, the fact that the equinoxes and solstices each take place during the course of a single day, and Aratus' own words. His conclusion is, in effect, that no 'proper' astronomer (μαθηματικός) [cf. *In Arat.* 1.1.8, 1.9.9]–as opposed to an ἀστρολόγος—holds that the solstitial and equinoctial circles do have breadth and, therefore, that the Sun's path was not *exactly* the zodiacal circle. That he demonstrates this of Aratus, who, he says, followed the μαθηματικοί, a group which included Eudoxus [see *In Arat.* 2.2.19], in versifying the latter's *Phaenomena*, is telling [cf. *In Arat.* 2.1.19–22].

Comment 7: *In de caelo* 494.9–12 ref. 55n194

The claim that the westward motion of the second sphere is faster than that of the third and smallest sphere—which means that the period of the third sphere's rotation is longer than that of the second sphere's—is not in Aristotle's account. As Heath [1913, 198] sees it, if the period of the motion of the second sphere is a year, and if the third sphere is the one with the much slower motion, the Sun will spend more than half a year above the zodiacal circle and then more than half a year below. Thus, Heath (and others) propose to correct Simplicius by supposing that, for Eudoxus, the Sun's slow motion belongs to the second sphere and its annual motion to the third. Mendell [1998, 2000] has recently disputed the validity of this criticism and has offered an alternative reconstruction. See Comment 11, p. 94 below.

Comment 8: *In de caelo* 494.20–22 ref. 56n195

While Simplicius is right so far as he goes, his allusion to the fact that the day is longer than one complete revolution of the celestial sphere is, under the circumstances, unsophisticated. The problem is that he treats the day as the interval from one rising of the Sun to the next, that is, from one horizon crossing to the next solar crossing of the same horizon. Such an account does not isolate the contribution made by the observer's latitude to the length of the day. It is for this reason that Ptolemy [*Alm.* 3.9] defined the day as the interval from one solar crossing of the meridian (*scil.* the great circle though the celestial poles and the observer's zenith point) to the next solar crossing of the same limb of the meridian. Ptolemy's definition of the day permits quantification of the equation of time, that is, the amount by which the length of any given day differs from one full revolution of the celestial sphere. In effect then, Simplicius takes recourse to a crude understanding of the day that is found in Geminus, *Intro. ast.* 6.1–4 and Cleomedes, *Cael.* 1.4.72–89, for example.

Comment 9: *In de caelo* 495.5–8 **ref. 56n197**

Simplicius' exposition here is less than careful. Up to this point and afterwards [see especially 497.4–5], πλάτος in phrases such as κατὰ πλάτος and εἰς πλάτος is, to use the technical term, latitude, a vertical distance above (or below) a reference circle, specifically, the zodiacal circle. (If the reference circle were the celestial equator, πλάτος would be declination.) In effect, Simplicius is following usage that had been in place from at least the first century BC and is clear in the works of Proclus [see e.g., *Hyp. plan.* 3.26–28, 4.12: cf. Hiller 1878, 134.13–135.6; Cleomedes, *Cael.* 2.4.1–5]. Thus, in 495.4–5, the distance between the poles of the two spheres is said to be equal to the Moon's greatest displacement in latitude, that is, in its motion above (or below) the zodiacal circle. Yet, in 495.5–8, Simplicius calls the *sum* of these maximum displacements πλάτος and affirms that the distance between the poles of the second and third lunar spheres is one half of it. Plainly, he is using πλάτος in another sense to designate the distance between two latitudes (hence, 'breadth [of latitude]'. Though such usage in talking of the planetary motions is with precedent [see, e.g., Aujac 1975, 291 *s.v.*. πλάτος on Geminus' usage; Hiller 1878, 135.12–21; Cleomedes, *Cael.* 1.2.49 and 74, 2.6.9 and 96], it is also unhelpful in this context.

Comment 10: *In de caelo* 495.10–13 **ref. 57n199**

In writing of the westward motion in longitude of the points of the Moon's greatest latitude, Simplicius is at the same time describing the motion of the lunar nodes (points where its orbit passes through the ecliptic). Understanding this westward motion is essential to the theory of eclipses. That Simplicius talks of the longitudinal motion of the points of the Moon's greatest displacement in latitude rather than of the motion of the lunar nodes may indicate that he has been influenced by Ptolemy's practice [*Alm.* 5.8–9] of computing a planet's argument of latitude starting from its northern limit (the place on the zodiacal circle that is reached when the Moon is at its farthest latitude north of this circle), a practice that has several advantages over taking one of the nodes as a starting point in computing the occurrences of eclipses [cf. *Alm.* 6.5]. In any case, in introducing his own descriptive account of eclipses, Theon of Smyrna [Hiller 1878, 194.13–195.4] writes of the regression of the lunar nodes, except that he has the nodes going in the wrong direction (εἰς τὰ ἑπόμενα τῶν ζῳδίων); and it appears to be how a scholiast also read Cleomedes, *Cael.* 2.5.141–147 [cf. Bowen and Todd 2004, 152n32].

For some scholars, the question has been whether one should rely on this passage and ascribe to Eudoxus knowledge of the regression of the lunar nodes. Thoren [1971] rightly treats the question as one about eclipses, specifies it as one about whether Eudoxus knew that they can occur at any point of the zodiacal circle, and argues (in support of Ideler and Schiaparelli) that we should. Dicks [1970, 178–181], however, argues quite sensibly that we should not: see also Bowen 2001, 2002. On Mendell's interpretation of these lines, see Comment 11, p. 94 below.

Comment 11: *In de caelo* 495.13–16 ref. 57n201

According to Heath [1913, 197] (who is following Ideler) Simplicius' is again in error about the second and third spheres: if the period of this slow westward motion of the nodes is 223 synodic months, say, it follows in Simplicius' account not only that the Moon will only pass through each node once in this period but also that it will spend half of this period (roughly 9 years) above the zodiacal circle and then half below. Heath's 'solution' is to suppose that, for Eudoxus, the third sphere is for the Moon's return to a given node (the draconitic month) along a circle that is inclined to the zodiacal circle at an angle equal to the Moon's greatest latitude, and the second is for the slow motion of the nodes along the zodiacal circle from east to west [cf. Comment 7, p. 92 above]. For objections to such interference with the transmitted text, see Dicks 1970, 181; Bowen 2001 and 2002.

Recently, Henry Mendell [1998, 191–194; 2000, 100–104] has proposed that modern critics have erred in assuming that the motion of the second lunar sphere is for the Moon's *mean* sidereal or zodiacal motion. As he sees it, Simplicius does not in fact go astray at all in his description of the second and third lunar spheres: for Mendell, Simplicius error, such as it is, lies in not explaining that the eastward motion of the second lunar sphere accounts for the Moon's westward motion but not its period, and that the period of the third sphere's eastward motion is distinct from the effect of this third sphere in causing the eastward motion of the points of the Moon's greatest latitude. Mendell's alternative reconstruction has charm; but, as I see it, there is a critical problem with its dependence on his finding that 'the hippopede is implicit in any model of celestial motion involving two or more spheres rotating at some angle to each other' [1998, 188], and with its taking it for granted that this was known to Simplicius (to say nothing of Eudoxus). It is surely significant that Simplicius himself mentions the hippopede *only* in reference to the fourth and third planetary spheres [496.23–497.5], a very special case in which the two inclined spheres rotate in opposite directions at the same speed. In short, Mendell's alternative reconstruction is liable to the charge of committing the fallacy of implication, that is, the fallacy of attributing to Simplicius a mathematical consequence of what he writes [cf. Robinson 1966, 3–4]; and until this is properly resolved, it is unusable.[381]

---

[381] For criticism in other terms of the reconstructions offered by Heath and Mendell, see Yavetz 2003.

Incidentally, I would not concede that, if it is possible to read Simplicius' words in a way which avoids an error that he seems to make or not to comprehend, this better reading of what he says derives from another source [so Mendell 2000, 60]. This 'principle', which Mendell labels '*lectio indocti doctior potior*' is hardly compelling as a general rule: moreover, in this instance at least, it is, I think, no more than a pretext for reading a reconstruction into the past. To put it baldly, *even if* Simplicius makes an avoidable mistake in his account of the second and third solar/lunar spheres, this would hardly license the claim that someone earlier got it right. Now, Mendell [2000, 95] *does* believe that 493.11–498.1[382] derives from Eudemus (or a 'synthesis of Theophrastus and Eudemus'), though he offers no good argument in support of this beyond the tendentious claim that his interpretation of this passage is consistent with this assumption. Note, however, that this passage does not fit with the explicit citations of Eudemus' *History of Astronomy* that we find elsewhere: these other citations indicate a digest organized by person listing their contributions to astronomy without explanation or criticism [cf. 488.18–24; Bowen 2003a, 315–318]. Furthermore, so far as his explanation of *Meta.* Λ 8 is concerned, Simplicius explicitly turns to an authority (Sosigenes) for guidance only with regard to the question of the unwinding spheres: in 493.11–498.1, he is *ostensibly* speaking *propria voce*.[383]

Comment 12: *In de caelo* 495.23–29 ref. 57n205

These are values for the zodiacal or sidereal periods of the five planetary bodies. Except in the case of Mars, the values which Simplicius reports are the same as those found in Geminus, *Intro. ast.* 1.24–30 and Cleomedes, *Cael.* 1.2.22–36:[384]
The claim that the sidereal periods of Venus and Mercury are each 1 year is found as early as Plato, *Resp.* 617a4–b2 and *Tim.* 38d2–4. It is interesting that P. Par. 1 col. 5 reports the same values as Simplicius for the periods of Mars, Jupiter, and Saturn. Yet, as Neugebauer [1975, 688] remarks, since these values for these outer planets are so

[382] Actually, Mendell says that the text at issue runs from 493 to 499 in Heiberg's edition, But this overlooks the fact that Simplicius explicitly introduces Sosigenes at 498.2 and cites him extensively in what follows.

[383] I will pass over the vexed questions of the relation Simplicius' commentary on *Meta.* Λ 8 and the commentary on the same text edited by Hayduck [see 1891, 702.36–706.15], and of whose commentary it is that the author of the latter refers to in 703.14–16. For present purposes, it is important to distinguish those passages in which Simplicius explicitly mentions or quotes the views of others from those where he tacitly draws on previous work. The burden of proof lies heavily on those who wish to maintain that the latter occurs, especially when the work putatively used in this way is no longer extant. Still, should one imagine that anyone has made such a case regarding 493.11–498.1, this merely pushes back my criticism of Mendell's 'principle' and reconstruction.

[384] Both Cicero [*De nat. deor.* 2.53] and Theon of Smyrna [Hiller 1878, 136.8] assign Mars a sidereal period of less than two years.

Planet	Geminus	Cleomedes	Simplicius
Mercury	1^y	1^y	1^y
Venus	1^y	1^y	1^y
Mars	$2^y\ 6^m$	$2^y\ 5^m$	2^y
Jupiter	12^y	12^y	12^y
Saturn	30^y	30^y	30^y

Table 2. Planetary Sidereal Periods

widely accepted, we should draw no conclusion about the connection between Simplicius' commentary and the papyrus.

Comment 13: *In de caelo* 495.29 ref. 58n206

The indefiniteness of the adverb πως (somehow, in some way) often shades into uncertainty (presumably, I suppose). In effect, this particle, when combined with the demonstrative adverb ὧδε serves to indicate varying sorts of distance between the speaker and what he is going to say. When one looks at the nine occurrences of ὧδέ πως in Simplicius' authentic writings, it is apparent that there are some instances in which this distance is wholly an artifact of urbanity and that it does not signify any real indefiniteness or uncertainty at all. His usage of ὧδέ πως in introducing quotations [see 104.5, 505.30: cf. Kalbfleisch 1907, 121.13, 331.27, 394.12] is of this sort. (Similar to these occurrences is the one in which Simplicius introduces what is effectively a paraphrase rather than a quotation [cf. Diels 1882, 276.7].) In neither case does the usage of πως translate easily into contemporary English [cf. Hankinson 2002, 76; Fleet 1997, 30] precisely because it is an alien form of polite expression.[385]

But, when ὧδέ πως introduces what is not a quotation or paraphrase, πως has real force. On one occasion, it is indefinite in that it presents what follows as *a* way of doing or accomplishing something; and so it simply means 'in a way as follows' [see Kalbfleisch 1907, 22.15]. The implication that what follows could be formulated differently to make the same general point is, I think, real. This leaves two instances in which πως in ὧδέ πως *may* go farther than this by suggesting uncertainty. After all, this is possible at Diels 1882, 524.21 and, as I shall argue, likely at 495.29.[386]

[385] Mueller's 'At least he says the following sort of thing' [2005, 45] for λέγει γοῦν ὧδέ πως [505.30] is misleading.

[386] Cf. τάχα ἄν ᾧδέ πως ἐπιχειροίη at Diels 1882, 619.20, where πως indicates uncertainty and means something like 'I suppose' or 'I presume'. This is the only occurrence of ᾧδέ πως in the editions of Simplicius' writings and one wonders whether it should not be emended to ὧδέ πως.

Up to 495.29, Simplicius has interpreted Aristotle's account in *Meta.* Λ 8 of the reportedly Eudoxan view of the homocentric models for the Sun, Moon, and of the first two motions of the five planets, by supplementing this account with information not found in Aristotle's text itself; and he has done this confidently, with no sign of reservation. At 495.29, however, πως in ὧδε πως ἔχουσιν would seem to signal a measure of uncertainty in making sense of what Aristotle reports about the motion of the last two planetary spheres.

The alternative view that πως entails that what follows is but one account among others which Simplicius knows of or believes possible is implausible: though Simplicius does mention divergent accounts of *Meta.* Λ 8, this comes later and seems restricted to the question of the unwinding spheres. Certainly, the criticism of the hippopede generated by the third and fourth spheres at 497.5 concerns whether the hippopede duly represents the planet's motion in latitude, and not whether a hippopede is generated in the first place as Simplicius has explained.

Thus, Simplicius' position is, I take it, that while what follows is not what Aristotle actually said, it is nevertheless a good guess at what he understood. Of course, whether Simplicius is right in this is a critical question in interpreting Simplicius' astronomical digression.

Comment 14: *In de caelo* 496.6–9 ref. 58n212

The values that Simplicius reports for the five planetary synodic periods are roughly those reported by Cleomedes at *Cael.* 2.7.8–10, except in the case of Mars where the difference is substantial.

Planet	Cleomedes	Simplicius*
Mercury	116	110
Venus	584	570
Mars	780	260
Jupiter	398	390
Saturn	378	390

Table 3. Planetary Synodic Periods in Days

*Months are assumed to be of 30 days.

Clemency Williams [2007, 478] has noted that Cleomedes' values ultimately derive from Babylonian Goal-Year texts.[387] I am not aware, however, of any earlier Greek source that reports or entails the same synodic periods as the ones reported by Simplicius.[388] But,

387 A planet's Goal Year is that integral number of (sidereal) years in which it makes its return to the same star *and* in which there is a whole number of synodic events of the same sort. The synodic period is, thus, the result of dividing the Goal Year by the number of synodic events.

388 See Neugebauer 1975, 782–785 for a survey of values found in ancient sources for the planetary synodic periods.

in a private communication, Williams has called my attention to a cuneiform tablet, BM 35402, which puts the synodic period for Mars at 6 months and 20 days (= 200 days).

Comment 15: *In de caelo* 497.24–504.3 ref. 62n234

Aristotle's aim in *Meta.* Λ 6–7 is to show that there are immaterial, non-sensible, unmoving/unchanging substances; that these substances are purely active, eternal intellects; and that they are ultimate principles of motion/change in the world. In Λ 8, he argues that there are as many of these ultimate causes or unmoved movers as there are motions in the heavens, and then proposes to determine just how many these are. As Jonathan Beere [2003, 1–3] rightly points out, this project is an essential supplement to Aristotle's account of physical theory or science of nature,[389] and its real novelty lies in the thesis that this number can be decided in a non-arbitrary, systematic way by consulting astronomical theory.

Obviously, it is important for this project to distinguish between an intrinsic motion, a motion that is forced or imposed, and a resultant motion, since only the former will have its own unmoved mover. For example, consider the question of the diurnal revolution of the planets. If one looks to Plato's *Timaeus*, there would be but one unmoved mover for this, since the motion of the Same (viz. of the celestial sphere) is *imposed* on all the planetary motions beneath the celestial sphere. Now, if one were to focus solely on the language of *Meta.* 1073b17–32—the first sphere of the five planetary systems is said to be the sphere of the fixed stars and to perform its motion—one might think that the same is true for Aristotle, namely, that he too thinks that the diurnal rotation of the celestial sphere is imposed on the planets [cf. Yavetz 1998, 225]. However, in 1073b37–1074a12, when Aristotle comes to forming a single, complete structure of all the celestial motions, he includes the first carrying sphere in the system for each of the seven planets, thereby treating each planet's diurnal revolution as an intrinsic motion and not as an imposed or a resultant motion. This is surprising and it makes one wonder what has happened to the celestial sphere itself. Moreover, it has the important consequence that the last unwinding sphere of a given planet cannot serve as the first carrying sphere of the planet below precisely because the diurnal rotation of the last unwinding sphere around the celestial axis from east to west is a *resultant* motion. For Aristotle, then, each of the seven diurnal planetary revolutions must have its own unmoved mover [cf. Beere 2003, 12–14], and, as Simplicius says, to discount these motions is to depart significantly from his analysis [cf. 503.35–504.3]. So, when Simplicius [506.23–507.8] asks why the celestial sphere was not sufficient for Aristotle, the question perhaps ought to have been, Why did Aristotle suppose that the diurnal revolution of each planet was a *intrinsic* motion in the first place?

[389] I pass over for now the question of the epistemological status of the argument in *Meta.* Λ 8, and whether it is a boundary argument connecting metaphysics and physical theory.

When Aristotle assembles the planetary systems into a single structure of nested rotating homocentric spheres,[390] he evidently assumes that a containing sphere can affect a contained sphere (that is, a sphere which has its poles fixed in/on the containing sphere) *only if* the axis of the containing sphere's (resultant) rotation is oblique to the axis of the contained sphere's intrinsic rotation.[391] Were this not the case, given that the first carrying spheres of the planetary systems all share the axis and motion of the celestial sphere [cf. 494.1–3, 495.20–22], Aristotle would have been obliged to unwind the first carrying sphere of each planetary system, since it is this sphere which imposes a diurnal rotation on the system's last unwinding sphere. For instance, if the (resultant) diurnal rotation from east to west of Saturn's last unwinding sphere could affect the rotation of Jupiter's first carrying sphere about the same axis, in the same direction, and in the same time-interval, the latter sphere would have a resultant motion from east to west about the celestial axis that was twice as fast as the motion of the celestial sphere itself—an adverse outcome for all the lower spheres, to be sure. Yet, Aristotle does not unwind any planet's first carrying sphere.

Furthermore, though Aristotle does not include the celestial sphere in his reckoning in Λ 8, the second ἀπορία of *De caelo* 2.12 requires that this sphere and its motion not be identified with the first carrying sphere of Saturn and its motion. But, if the celestial sphere is to be included in the single structure of homocentric spheres, the only way to do this without introducing an unwinding sphere for the celestial sphere, would be to hold that, given two homocentric spheres rotating in the same direction about the same axis, the containing sphere does not impose any motion on the contained sphere [cf. Bechler 1970, 119–120].

In an analysis that certainly rewards study, István Bodnár appears to suppose that it is a fundamental or major presupposition of homocentric theory that 'the way revolutions of two consecutive homocentric spheres are combined does not depend on external factors' [2005, §3: cf. n3], such as, I take it, the orientation of their axes. It is not clear whose presupposition this is and one should certainly like to see the argument that it is one which Aristotle makes or needs to make. But Bodnár's contention [2005, §3] to the effect that the first carrying sphere of Jupiter will have the combined motion of the last two unwinding spheres of Saturn in addition to its own because

> once the axis of rotation is not stationary, the rotation around this axis gets transmitted to the embedded sphere, and hence the motion of the innermost sphere, performed under

[390] On the question of why he does this, see Bechler 1970 which, in spite of some missteps, argues interestingly that Aristotle's aim in assembling the spheres was not to accommodate new phenomena but to preserve the phenomena already addressed by Eudoxus and Callippus in a system that used their hypotheses without introducing a void into the cosmos. Aristotle's aim, as Bechler sees it, was not to develop a unified mechanism in which motion is transmitted from the celestial sphere to the spheres beneath it.

[391] On the question of friction, see Beere 2003, 9.

> the causal influence of the mover of its own, will be added to the composite motion of the preceding sphere. . .

is a misfire, since he fails to distinguish intrinsic, imposed, and resultant motion. The *intrinsic* motion of Saturn's last unwinding sphere is about the poles of the zodiacal circle and in the direction opposite to that of Saturn's second carrying sphere. The *resultant* motion of this last unwinding sphere, however, is a diurnal rotation about the axis of the celestial sphere. This resultant motion, which is the outcome of the motion *imposed* by the sphere immediately above the last unwinding sphere—a motion that is itself a resultant motion—and its own intrinsic motion, does not affect Jupiter's first carrying sphere because the axis of rotation is the same. In other words, Bodnár takes for granted the evidently false proposition that, for Aristotle, *whenever* the containing sphere and the contained sphere have different axes, the motion of the containing sphere *must* affect the motion of the contained sphere. This would certainly be true in a two-sphere system. But in more complicated structures such as Aristotle envisages, one should look to the resultant motion of the containing sphere and not just to the motion that it imposes because of its intrinsic motion—assuming that one is to 'save' Aristotle's account of the unified structure of celestial motions.

One consequence of this interpretation, then, is that the theorems which Simplicius reports on the authority of Sosigenes at 500.5–14 and 500.22–501.2 are inappropriate and misguided, since they take for granted that the outer of two rotating homocentric spheres with a common axis will affect the motion of the inner sphere.[392]

The actual count of the motions and, hence, of the unmoved movers was controversial. To judge from what Simplicius writes, most commentators understood how Aristotle reached 55, though some were troubled that this entailed counting seven motions that were the same as the motion of the celestial sphere. (None apparently inquired about what had happened to the celestial sphere itself.) Moreover, their main difficulty, it seems, was figuring out how Aristotle got 47 in a way that did not contravene sense or basic tenets; and the best that they came up with was the suggestion that the '47' was a scribal error.

Yet, the simplest explanation of that number involves noticing Hipparchus' doubt that Eudoxus actually did posit a third solar motion [see Comment 6, p. 91], and conceding that Aristotle could in fact countenance removing this third sphere for the Sun in addition to the two spheres for the Sun and for the Moon added by Callippus. This would, of

[392] For discussion of Alexander's remark in *Quaestio* 1.25 [see Bruns 1887, 40.23–30: cf. Sharples 1992, 85] about the diurnal motion of the heavenly bodies below the celestial sphere, see Bodnár 1997.

course, entail removing three of the unwinding spheres which Aristotle himself adds. And, thus, there would be 47 spheres in all.[393]

It is curious that this solution did not strike Simplicius, given what he writes at 493.23–31 and 501.12–21. It would hardly have been the first instance in which he departs from a strict reading of Aristotle's texts. In any case, there is ample evidence suggesting that Aristotle himself held that the Sun actually has but two motions. See *Meta.* 1072a9–18 where it is argued that the ultimate cause of corruption and generation must have two motions, *Meta.* 1072a21–24 where it is clear that this cause is not the celestial sphere but a wandering star, and *De gen. et corr.* 336a15–b24 which identifies these motions as the daily rotation and the motion κατὰ τὸν λοξὸν κύκλον) and the wandering star as the Sun [cf. *Meteor.* 1.9, 2.4; *De caelo* 289a26–35].

Comment 16: *In de caelo* 32.12–33.16 ref. 72n292

One of Simplicius' targets in his commentary is Philoponus' *Against Aristotle on the Eternity of the World.*[394] According to Simplicius [32.1–11 (= Wildberg 1987, F7): cf. Rescigno 2004, f8c with 178–182],

> If Alexander was right, says this man[395] in his seventh chapter, that Aristotle says that [32.1] this motion in a circle is in the strict sense [motion] which is about the center of the universe, but if all [motions] which are not about about [the center] of the universe are neither circular nor simple in the strict sense, and if the stars (which perform a motion in accordance with their spheres) move about their own centers, just as the astronomers[396] think, neither the stars nor their epicycles nor, clearly, the spheres called eccentric perform a motion that is circular or simple in the strict sense, because both downward and upward [motion] are observed. Indeed, even if these [phenomena] conflict with Aristotle's hypotheses, he says, the stars evidently have perigees and apogees.

Simplicius begins his response by advancing the idea that circular motion is simple by virtue of its being about *a* center rather than by virtue of its being about the center of the

---

393 T. H. Martin [1881, 268] agrees that Aristotle certainly *could* have proposed this and even asserts that he *ought* to have proposed it. Dryer [1906, 114n2] regards this as the simplest explanation, but doubts that Aristotle had this in mind. Heath [1913, 220n1] allows that it is possible that Aristotle had this in mind, but is persuaded that he lacked the knowledge needed to make this improvement.

394 See 5.22–26.31 [cf. Wildberg 1987, 39–40] for Simplicius' explanation of why he decided to refute the arguments offered by Philoponus in this book.

395 32.1 οὗτος [cf. 32.34]: *scil.* Philoponus. The use of the demonstrative without the name may indicate strong contempt [cf. Wildberg 1991, 107n1] or it may derive from the language of the law-courts and serve to present Philoponus formally as an opponent.

396 32.6 τοῖς ἀστρονόμοις.

universe, a thesis that requires clarifying Aristotle's commitment to the more restrictive notion of simple circular motion. Then, Simplicius attacks Philoponus. The factual claim in his attack is that in Ptolemy's *Handy Tables*, there are included two columns, one giving the location of the epicenter at regular intervals in the planet's sidereal period, and the other listing corrections to these positions that are due to the planet's motion on its epicycle. His polemic consists in wondering if Philoponus learned that the planetary bodies move about their own centers or rotate (a thesis that Simplicius endorses) by misinterpreting the second column.

This attack is very peculiar, and sorting it out is difficult because Simplicius' report is colored by strong animus and may not be fully accurate. Given that axial rotation has nothing to do with apogees and perigees, the ostensible basis offered for challenging Alexander's reading of Aristotle, it would appear that Philoponus was talking only of the eccentric and epicyclic hypotheses. If this is the case, it is difficult to rescue Simplicius' attack from its apparent silliness: after all, by introducing it, Simplicius actually adds support to Philoponus' criticism. Still, as Christian Wildberg has pointed out to me, *if* Philoponus did have axial rotation in mind too—the mention of stars in 'neither the stars nor their epicycles nor, clearly, the spheres called eccentric' [32.7–8] may come from Philoponus and not just be Simplicius' addition—perhaps he was thinking that each planet must, like the Moon, perform one rotation in the course of one revolution on its epicycle or, equivalently, during one circuit of its eccentric circle. In this case, Simplicius' question about how Philoponus came to know this is pertinent, and his remark that the astronomer's tables for determining the daily progress of a planet in longitude have no bearing on the question of axial rotation is more on target: these tables do not support any claims about axial rotation—not even the assumption that the planet rotates once in one circuit of the zodiacal circle.[397] Indeed, if this criticism were coupled with the conviction that Philoponus has no good argument in his physical theory for holding that the planets do indeed rotate, that is, a reason of the sort found at *Timaeus* 40a2–b8 for instance, Simplicius' real point would be that Philoponus' acceptance of the planetary axial rotation is irrational.

[32.12] I say, then, that in these [lines][398] Aristotle is only saying this much, that motion in a circle is [motion] about a center, since this befits *every* circular motion. But if he elsewhere says that bodies moving in a circle move about the center of the universe, one should understand that he is making his case in accordance with the hypotheses of

[397] In attacking Proclus and the idea that the world is eternal, Philoponus mentions an unobservable conjunction of the seven planets in Taurus in AD 529 [Rabe 1899, 579.14–18]. His pupil, Severus Sebokht, has a fuller account which indicates that Philoponus used Ptolemy's *Handy Tables* [see Neugebauer 1959].

[398] 32.12 ἐν τούτοις: *scil. De caelo* 1.2 esp. 268b14–269a9.

earlier astronomers.[399] For the Eudoxans and the Callippans[400] (that is, those up to Aristotle who hypothesized turning spheres homocentric to the universe), tried by those means to save the phenomena, saying that all the spheres are about the center of the universe. But [they tried] to explain [the phenomena] in accordance with these hypotheses without mastering the causes of apogees, perigees, apparent direct motions, and [apparent] retrogradations,[401] that is, [the causes] of the unsmoothnesses apparent in the motions of [the wandering stars]. For this reason, you know, the Hipparchans (and if there was anyone earlier than [Hipparchus])[402] and after him Ptolemy hypothesized eccentric spheres and epicycles, without taking notice through these [hypotheses] that all the heavenly bodies move about the center of the universe, but giving in accordance with these hypotheses their explanations of the [phenomena] stated earlier, though they had received explanations [of these phenomena] by [the earlier astronomers].[403] Now, Aristotle says nothing here about these matters; but, in [passages] in which he does say [something], he is evidently following the hypotheses of his predecessors.

It is clear that differing about these hypotheses is not a matter of reproach, since what is set forth is [the question]: By hypothesizing what can the phenomena be saved? So, it is not at all surprising if different people have tried to the save the phenomena on the basis of different hypotheses. If the [wandering] stars move about their own centers, they also move in that they are brought round the [center] of the universe by their spheres.[404]

---

399 32.15 τῶν πρεσβυτέρων ἀστρονόμων.

400 32.16: for the locution, see 72n288 above.

401 32.20: cf. 44n114 and 43n106 above.

402 32.23 εἴ τις πρὸ τούτου: Simplicius is allowing that there might have been either someone before (earlier than) Hipparchus or a non-Hipparchan contemporary with Hipparchus [cf. Moerbeke's *si quis contemporaneus ipsi*: Bossier, Vande Veire, and Guldentops 2004, 4.92] who hypothesized eccentric spheres and epicycles.

403 32.26 τὰς ὑπ᾽ ἐκείνων παραλειφθείσας.

404 In *De caelo* 1.2, Aristotle maintains that there are but two forms of simple motion, motion in a straight line and motion in a circle; and much of his cosmology follows from this. As Simplicius makes clear, Alexander took this to be a fundamental fact in physical theory by construing the center in question to be the center of the universe. Thus, it would follow that motions, when so construed in relation to the same single reference point, can either (a) approach or depart from this point or (b) stay at the same distance from it. Obviously, the simplest form of (a) is motion in a straight line (along a radius), whereas the simplest form of (b) is motion in a circle. (This proposal is presumably intended to give a physical, that is, a non-mathematical, explanation of Aristotle's claim that the straight and the circular are the only simple magnitudes.) All other motions would plainly be composites of these two motions. To Alexander, we may imagine, Simplicius' redefining of circular motion to accommodate motion on an epicycle or eccentric circle as simple motions would undermine Aristotle's dichotomy that lies at the distinction between the sublunary and supralunary elements; and it would effectively put into doubt the validity of the Aristotelian cosmology/physical theory as a fundamental science that does not depend on any other science for the truth of its own hypotheses. Cf. Bowen 2007.

From which of the astronomers did this man find out that the [wandering] stars [33.1] move about their own centers? Did he in fact misunderstand what is in Ptolemy's *Tables*,[405] namely, that there are different numbers for the center of the epicycle and for the [wandering] star itself, and think that the latter numbers are for the motion of the star about its proper center? [That is, did he think this] because he did not know that these [latter] numbers are for the star as it changes place [in longitude],[406] whereas its motion about the center [of the universe] does not occur with its changing place [in longitude]?[407] But the numbers for the center of the epicycle show the motion of the homocentric or eccentric [circle] on which the epicycle moves, whereas the [numbers] for the [wandering] star [show] the motion of the epicycle on which the star moves.[408]

Yet, it is impossible to ascertain the motion of the star itself about its own center [I mean], the length of time in which[409] the star makes a complete rotation, since it does not change from place to place [in longitude] in accordance with this motion. This is why none of the astronomers tried to deduce the complete rotation of the star about its own center, that is, the length of time in which it occurs, since it is not ascertainable. Plato, of course, knew this motion of the [wandering] stars.[410] But what Aristotle believes about the motion of the [wandering stars], he will say in the second [book] of this treatise.

Comment 17: *In de caelo* 504.28–29 ref. 73n293

Simplicius is mistaken: Venus is *invisible* to the naked eye at inferior conjunction, that is, when it is in the middle of its retrograde arc. But even if we allow that he is referring to Venus when it is *near* inferior conjunction, his claim is still badly flawed.

First, a clarification. It is one of the peculiarities of the human eye that when it looks up unaided at point sources of light in the heavens, it construes their brightness as a matter of size. (To appreciate the distinction between their brightness and their size, a distinction which was not actually made until the invention of the telescope, just look at the heavens through a pinhole.) Next, it is important to know that neither the apparent

---

405 33.1 Κανόσι: the tables in the *Almagest* were revised with an eye to making them easier to use and published separately as the *Handy Tables*. There is, admittedly, the possibility that Simplicius is referring to the *Almagest*: but see 102n397 above; Neugebauer 1975, 838–839 and note 6.

406 33.5 μεταβαίνοντός... τοῦ ἀστέρος: *scil.* they are a correction to the motion of the center of the epicycle on the deferent.

407 33.6 μεταβαίνοντος αὐτοῦ: Simplicius' point is that the motions are independent, that the rotational motion makes no contribution to the motion in longitude [cf. 33.9–13].

408 33.6–8 ἀλλ' οἱ μὲν τοῦ κέντρου... φέρεται ὁ ἀστήρ; I have not followed Heiberg's punctuation here; instead, I have treated this sentence as a positive statement in its own right and not as part of Simplicius' very rhetorical question [cf. Moerbeke in Bossier, Vande Veire, and Guldentops 2004, 45 *ad loc.*].

409 33.10 ἐν πόσῳ χρόνῳ.

410 33.13–14: cf. *Timaeus* 40a2–b8.

diameter nor the brightness of Venus vary much at all during its synodic period. Indeed, the apparent diameter of Venus varies from 0;0.10°to 0;1° of arc, which is well below the threshold (0;1°) of our ability to discern angular distance with the naked eye. Further, Venus has phases which compensate its varying distance from Earth so that the magnitude of its brightness ranges only from −3.9 to −4.7, which is equally difficult to detect [see Goldstein 1996, 1–2].

So, given that, in contrast, Mars is visible at the middle of its retrograde arc and that it is noticeably brighter at this point, it seems that Simplicius' thesis here may be no more than a misguided inference based on astronomical theory that postdates Aristotle. After all, no one before Ptolemy appears to have paid any attention to the fact that the stars (both fixed and wandering) differ in size (brightness), if they noticed it at all [see, e.g., Aristotle, *Meteor.* 343b2–34; Pliny, *Hist. nat.* 2.39]. For his part, in his *Hypotheses planetarum*, Ptolemy puts the five planets at varying distances from the Earth but makes nothing of the variation in size (brightness) that this might entail. Indeed, at one key point, he does not even seem to recognize any variation in the apparent diameter of Venus [see Goldstein 1967, 8b]. It is difficult, then, to hold that prior to the second century AD there was any real concern with the apparent size (brightness) of the five planets, though this is a claim that it is essential to Simplicius' 'history'. Still Ptolemy does treat Venus and Mars as alike in that he assigns to them very nearly the same ratio of their farthest distance from Earth to their nearest distance. So, one possibility is that, given that size (brightness) *ought* to vary with distance from Earth, Simplicius simply inferred that such variation would be especially noticeable in the case of Venus and Mars because their ratios are roughly 7:1. What is amusing is that he would have been right (albeit accidentally) in the case of Mars and very wrong in the case of Venus, which is significantly unlike Mars in that it is an inner planet—this is why Venus (unlike Mars) has phases and is invisible at the middle of its retrograde arc. (Notice that at no point does Simplicius distinguish inner and outer planets in his astronomical digression.)

Comment 18: *In de caelo* 504.30–32 ref. 73n296

To the learned reader even of Simplicius' time, this first argument in support of the thesis that the planets vary in distance to the Earth would not be construed as about the fact that the Moon (like the Sun) often appears larger (nearer) at the horizon than at the zenith, a phenomenon explained physically by Ptolemy in his *Almagest* [Heiberg 1898–1907, 1.13.3–9: cf. Toomer 1984, 39n24][411] but psychologically in his *Optica* [Lejeune 1989, 115.15–116.8], as well as by Proclus [*Hyp. ast.* 7.13–15] who follows the account in the *Almagest*. For, if it were about the Moon illusion,[412] there would be little point in the subsequent argument, given that observation by means of instruments does *not* confirm

[411] Cf. Cleomedes, *Cael.* 2.1.26–44; Bowen and Todd 2004, 101n11.

[412] It is called an illusion because it suggests that the Moon's day-circle is not in fact circular.

the existence of such a variation, as Ptolemy apparently discovered. (The reader may verify this by looking through a pinhole at the Full Moon when it is at the horizon and at the zenith.)[413]

So what is Simplicius' point in the first argument? If the syntax of his remarks at 504.33 [see 73n297, above] is a guide, he has doubts that any true variation in the Moon's apparent size is in fact discernible by the naked eye. Perhaps, then, he is either still unclear himself about the nature of the Moon illusion, or he is supposing, somewhat tentatively (and wrongly), that the very small variation seen with instruments can be seen with the naked eye. If the latter, then we have yet again an instance in which Simplicius formulates his expectations based on theory as easy observations [cf. Comment 17, p. 104 above].

For Bate's denial of the claim that atmospheric conditions are identical on the different occasions or in different places, and his rejection of the validity of any claims that a difference in the size of the heavenly bodies has been observed, see Bossier 1987, 319nn41–42.

Comment 19: *In de caelo* 504.33–505.1 ref. 74n299

Greco-Latin astronomers defined the finger or digit (δάκτυλος) in various ways; but some are irrelevant in the present context and others lead to results at odds with the phenomena. Thus, the digit of eclipse which is 1⁄12 the diameter of the eclipsed luminary [cf. Ptolemy, *Alm.* 6. 7: Heiberg 1898–1907, 2.500.19–501.1] is not at issue here; whereas the digit of arc which is 1⁄12 of 1° or 1⁄24 of a cubit (= 2°) [cf. Neugebauer 1975, 530, 591; Toomer 1984, 322n5] yields a value for the diameter of the Moon that is much too large. (Aujac, Brunet, and Nadal [1979, 180n1] assume that the digit in question here is the angular measure; but I see no reason to suppose that Simplicius thinks that the apparent diameter of the Moon is even close to 1°.)

Perhaps Simplicius is assuming that the diameter of the lunar disk is 12 digits when the Moon is at its mean distance from the Earth. This type of digit is mentioned elsewhere only in the *De facie* 935d, so far as I know, where Plutarch writes 'The diameter of the moon measures 12 digits in apparent size at her mean distance' [Cherniss 1957, 143]. Cleomedes, *Cael.* 2.3.15–43 [cf. Bowen and Todd 12004, 131n7] also asserts that the Moon's diameter is 12 digits but does not specify any distance.

For Bate's denial of the claim that there are instruments sufficiently precise to allow the infallible determination of a difference in the apparent size of the heavenly bodies, see Bossier 1987, 319n43.

413 For a very useful discussion of the Moon illusion, and of how it has been understood and is still being studied, see Ross and Plug 2002.

Comment 20: *In de caelo* 505.21–23 **ref. 75n307**

One should not rule out the possibility that what is here attributed to Polemarchus (who is otherwise unknown except for the additional mention at 493.6: cf. 53n179) is a product of wishful thinking. Certainly, it is striking that, in Simplicius' story, there is first Eudoxus who sets out to answer Plato's challenge by displaying the planetary phenomena using homocentric models. (Whether Eudoxus himself recognized that his hypotheses left certain relevant phenomena unaccounted for is not clarified.) Next there is Aristotle who, contrary to any evidence in his own extant writings, supposedly recognized the deficiencies of the Eudoxan hypotheses and was not satisfied with these hypotheses, though he nevertheless adopted them. Then, there is Polemarchus who prefers the homocentric hypotheses, a preference apparently taken (perhaps by later writers) to entail that he recognized the recalcitrant phenomena but did not think them significant. Next, comes Callippus who tinkered with the homocentric hypotheses in order to accommodate other phenomena with unclear success. (Simplicius inclines to the possibility that these phenomena included the variations in planetary distances [504.19–22]). And finally, we have Autolycus who recognized the phenomena, thought that they were important, and tried to develop new hypotheses. In short, Simplicius' story may be too good to be true: the 'logical progress' from positing some hypotheses, adopting these hypotheses with reservations, adopting the same hypotheses but dismissing the reservations, and acknowledging the reservations and tinkering with the hypotheses, to acknowledging the reservations and trying to develop new hypotheses seems more than just a little artificial.

Comment 21: *In de caelo* 506.2 **ref. 76n315**

It is customary to take τοῖς ταῦτα πραγματευομένοις as a reference to other people [cf., e.g., Aujac, Brunet, Nadal 1979, 182; Mueller 2005, 45]. The problem is the scope of ταῦτα. It appears to have τὰ νῦν εἰρημένα as its antecedent, and thus to be a reference to the determination of the number of the carrying and unwinding spheres. But it seems to me unlikely that Aristotle would imagine that this is a project to engage astronomers *per se*—it was obviously not something that he picked up from Eudoxus—or philosophers of another school, say the Platonists. As I understand the text, though Aristotle allows that there may be something to learn from others, presumably astronomers (τὰ δὲ πυνθανομένοις τῶν ζητούντων), he takes for granted that the question of the count is a matter for further research only by members of his own philosophical school. Still, the problem with my translation is that one must supply λόγους (accounts) with ἀμφοτέρους in 506.2–3.

Of course, however one understands τοῖς ταῦτα πραγματευομένοις, the underlying question is how this passage and, indeed, the argument of *Meta.* Λ 8 fits into Aristotle's remarks elsewhere about the various sorts of knowledge and their interrelations. For Aristotle, astronomy is one of the more physical mathematical sciences. So does his reckoning of the number of unmoved moved in Λ 8 belong to astronomy, physical theory more generally, or to metaphysics? The first is unlikely given Aristotle's understanding of what mathematical science is and how it proceeds and the fact that the items being counted are unique substances devoid of matter.

Comment 22: *In de caelo* 506.11–15 **ref. 77n320**

For some reason Neugebauer [1975, 608] supposes that these observations concerned eclipses, though there is no such specification in Simplicius' report. In any case, the '31,000' years is a fantasy, based perhaps on a reading of some Babylonian Goal Year Texts. As for Callisthenes' sending reports of astronomical observations back to Aristotle, this is a difficult question. One possibility is that the Babylonian observations which Aristotle mentions at *De caelo* 292a7–9 and *Meteor*. 343b28–30 [see pp. 31, 32n19, above] were among those sent back by Callisthenes. Granted, the *De caelo* and *Meteorologica* were at one time thought to antedate Alexander's campaign in Babylonia (−330) [cf., e.g., Ross 1964, 18–19; Rist 1989, 16–17, 284–285]; but such claims are difficult to maintain in the light of what scholars now surmise about the nature and composition of Aristotle's works [cf. Leggatt 1995, 3–4]. Indeed, one should not discount the possibility that the references to the Babylonians were inserted later into the texts that became known as the *De caelo* and *Meteorologica*. Still, such worry is rendered moot by the real possibility that Simplicius' report about Callisthenes is no more than an inference based primarily on Callisthenes' relation to Aristotle, Aristotle's demonstrable interest in collecting and analyzing empirical data, and on Aristotle's reference to Babylonian astronomical observations in his treatises.

Comment 23: *In de caelo* 507.12–14 **ref. 79n335**

This particular claim about the Pythagoreans is not found in any extant work by either Nicomachus or Iamblichus. But Proclus [*Hyp. ast*. 1.34–35] suggests, on the basis of some unnamed historical account (ὡς ἐκ τῆς ἱστορίας παρειλήφαμεν), that the Pythagoreans came up with the eccentric and epicyclic hypotheses in response to *Pythagoras*' requirement that they seek ways to account for the phenomena using the fewest and simplest hypotheses.

As the evidence stands right now, it seems that, contrary to Simplicius' account here, neither the eccentric nor the epicyclic hypotheses was developed in order to explain any variation in the apparent sizes (brightness) of the planets. Rather, the eccentric hypothesis seems to have been developed in order to account for the different lengths of the seasons; and the epicyclic hypothesis, in order to account for the fact that Venus and Mercury are limited in the distance that they travel from the Sun.

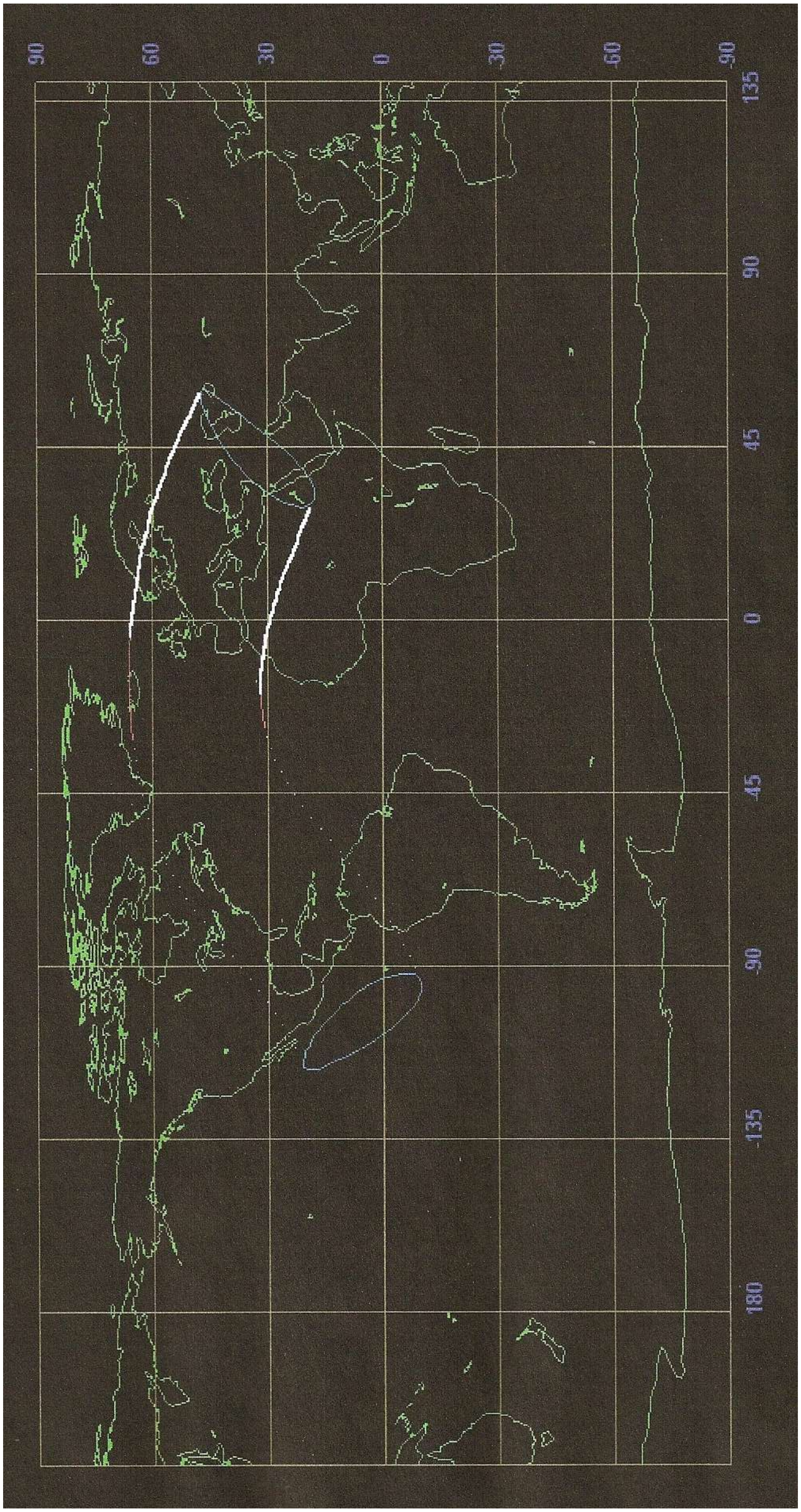

Figure 4. The Occultation of Mars (–360 Mar 20)
(Courtesy of Dave Herald)
The dotted white lines indicate daytime; the thin white lines, evening twilight; and the thick white lines, nighttime. A pair of lines of the same sort defines the region in which the occultation was 'visible'.

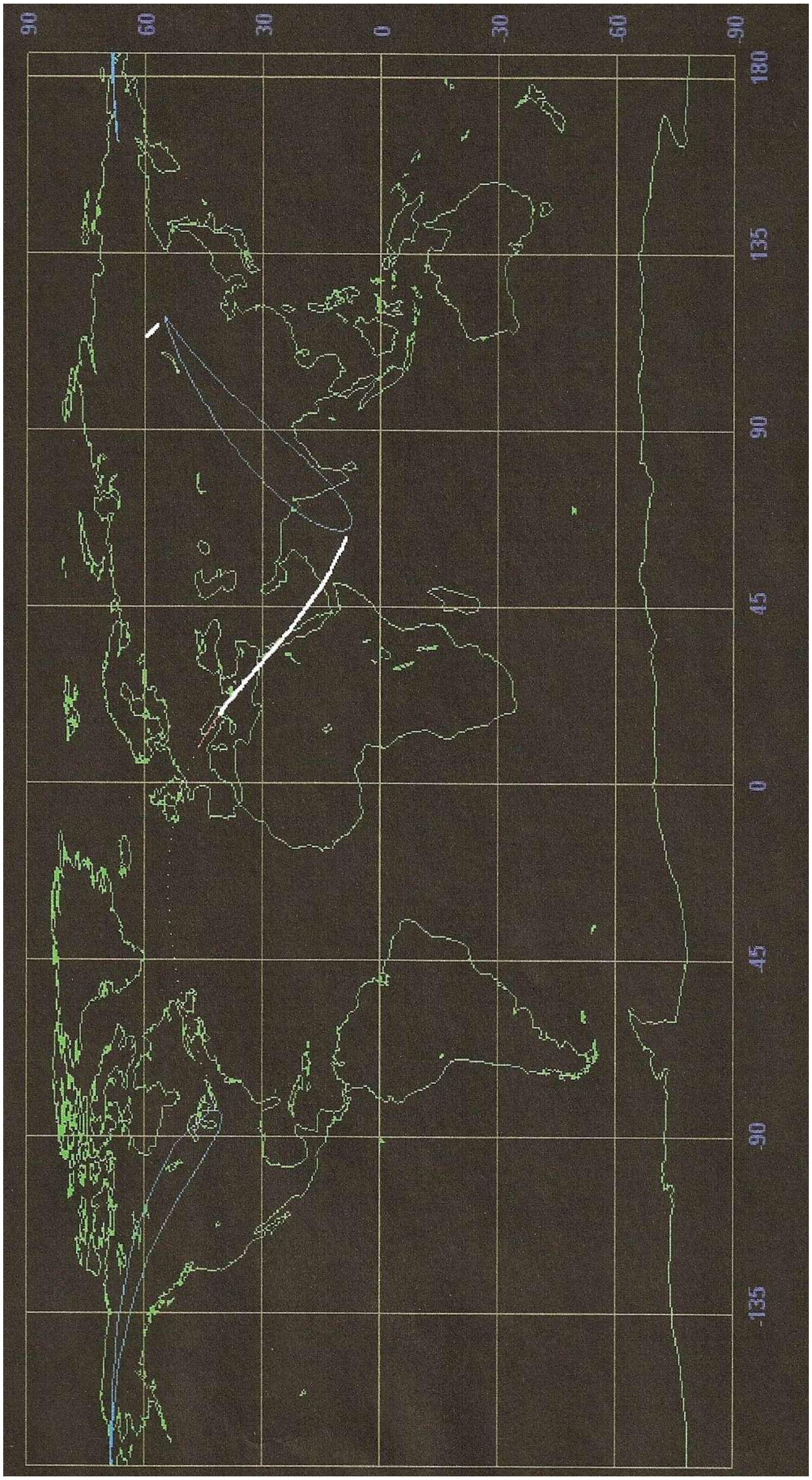

Figure 5. The Occultation of Mars (−356 May 4)
(Courtesy of Dave Herald)
The dotted white lines indicate daytime; the thin white lines, evening twilight; and the thick white lines, nighttime. A pair of lines of the same sort defines the region in which the occultation was 'visible'.

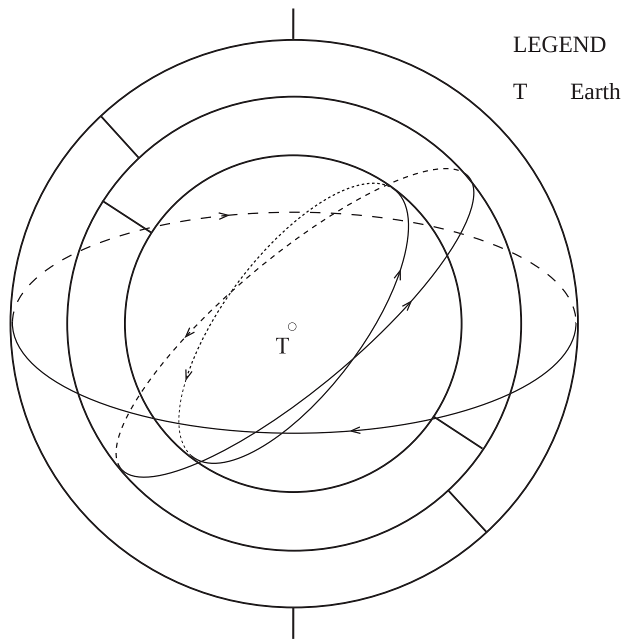

Figure 6. The Hypotheses for the Sun

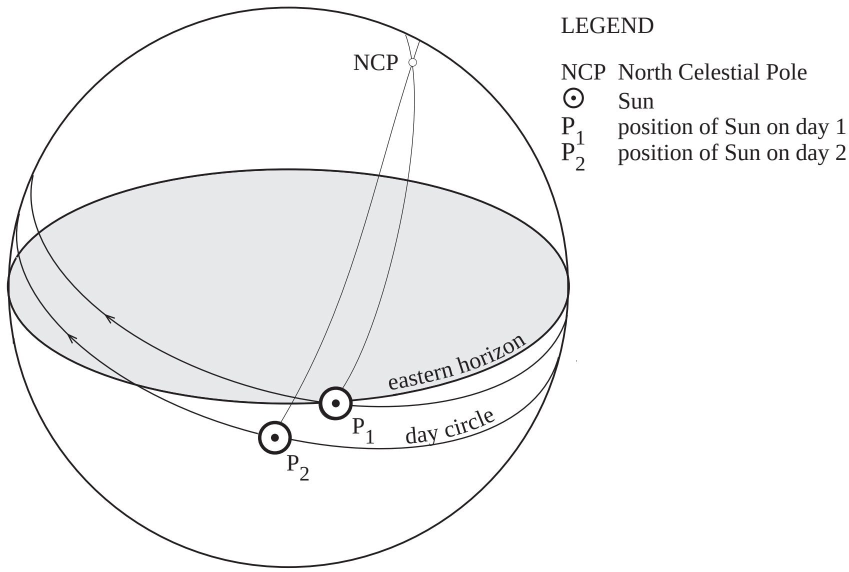

Figure 7. The Length of the Day
The interval from sunrise to sunrise takes longer than one full revolution of the cosmos: P_1 crosses the eastern horizon before P_2.

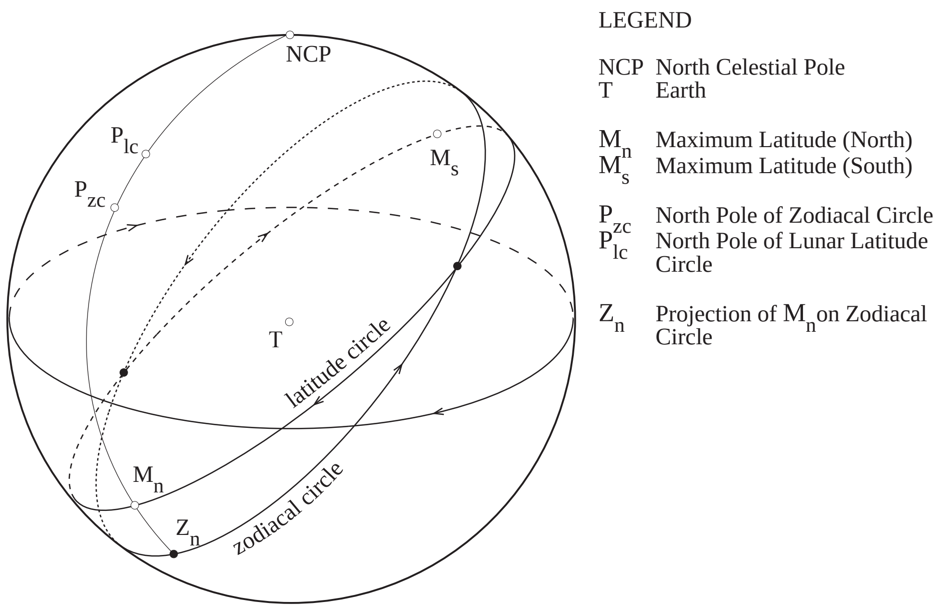

Figure 8. The Motions of the Moon

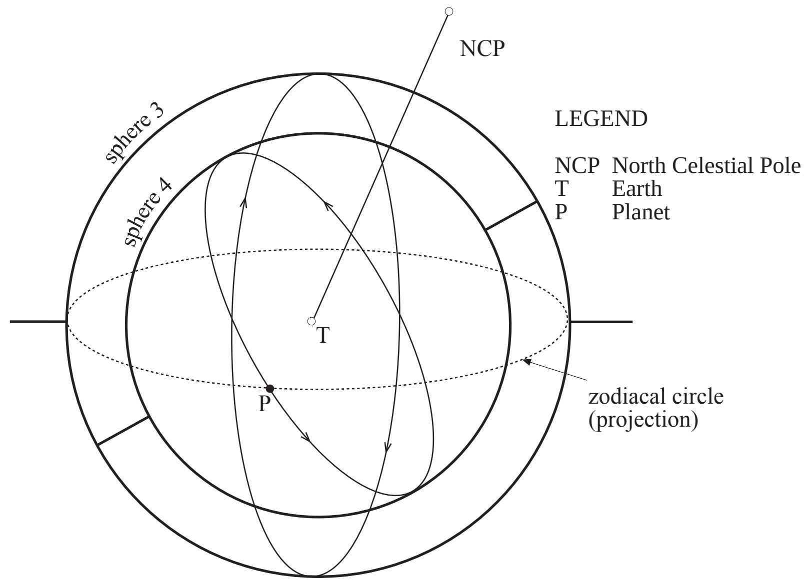

Figure 9a. Placement of the Third and Fourth Planetary Spheres

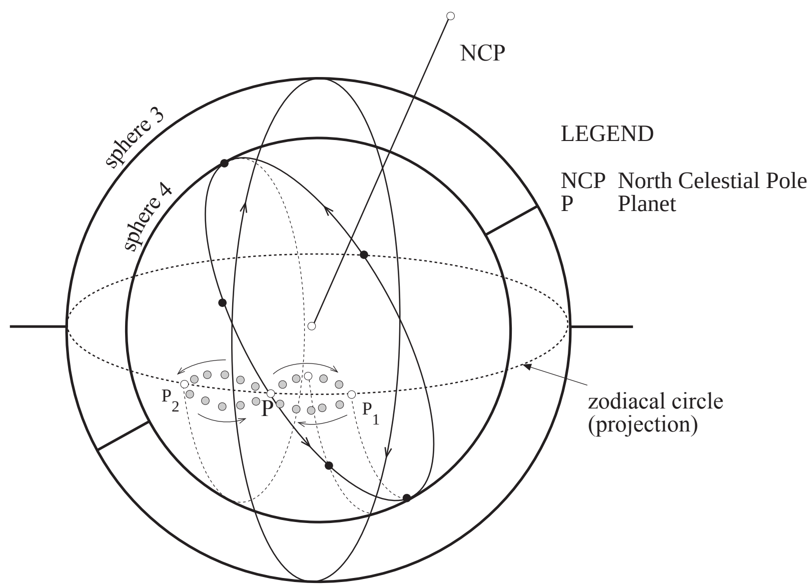

Figure 9b. Generation of the Hippopede
The distances P_2P and PP_1 are equal to the planet's greatest displacement in latitude.

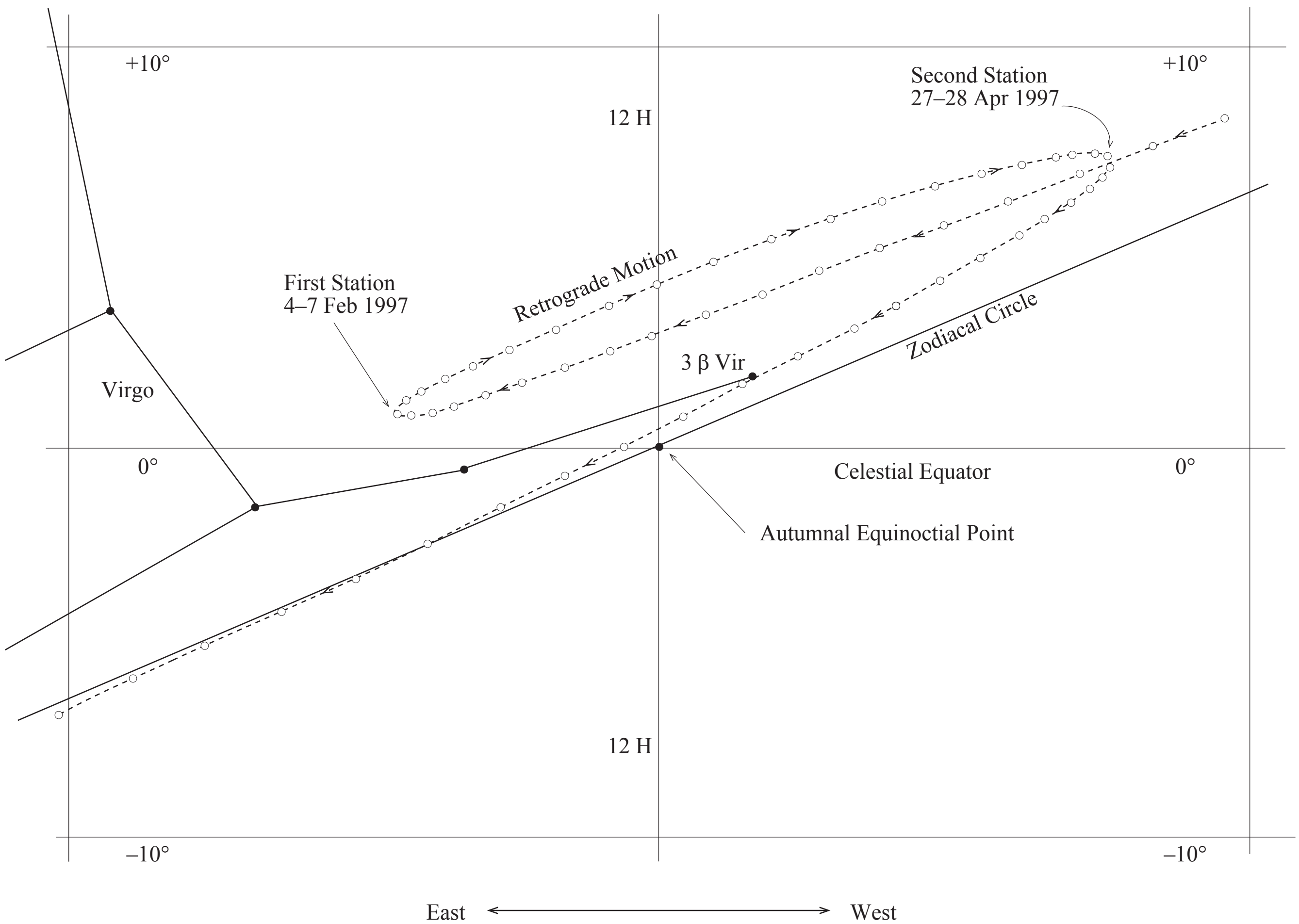

Figure 10. The Retrogradation of Mars in 1997
(as seen from northern latitudes)

The original plot was made using a special version of MPj Astro supplied by the developer Darryl Robertson of Microprojects Inc. (Toronto, ON, Canada). The dates of the first and second stations were computed using Planet C 6.2 FPU developed by Lars Gislén (University of Lund, Sweden). The inclination of Mars' orbit to the zodiacal circle (ecliptic) and, hence, its maximum latitude, is 1.9°.

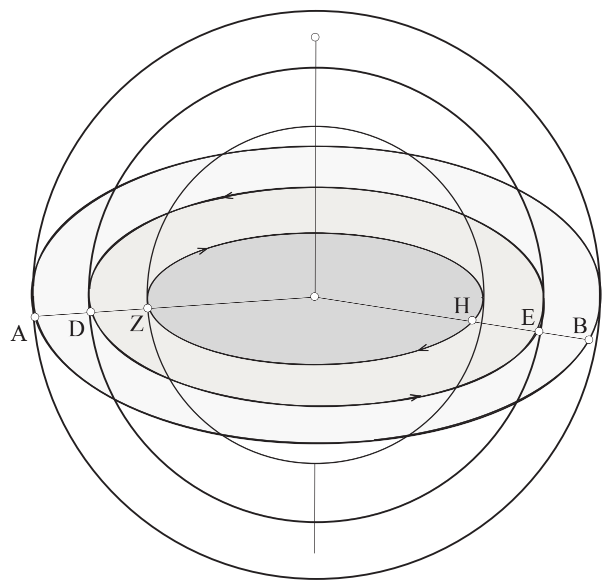

Figure 11. Homocentric Motion (1)

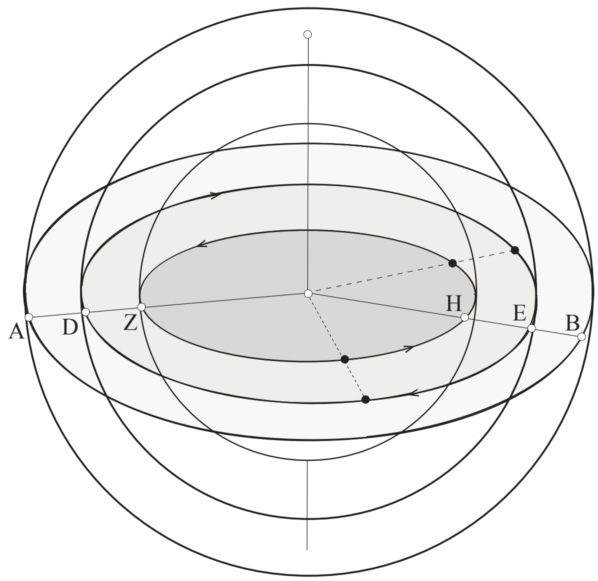

Figure 12. Homocentric Motion (2)

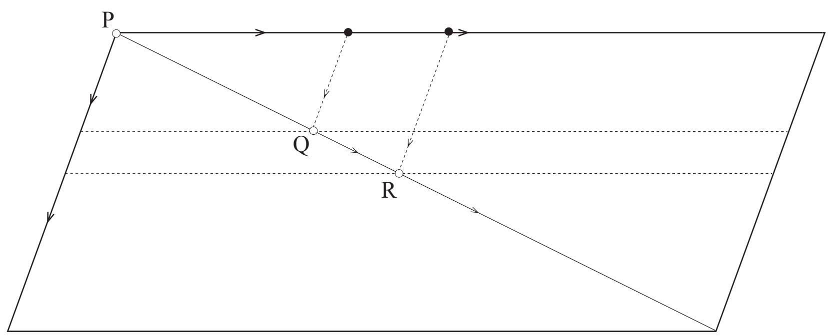

Figure 13. An Analysis of Compound Motion

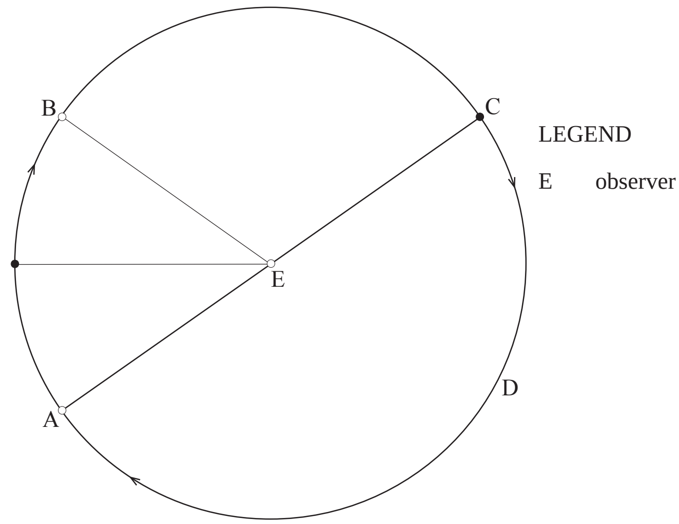

Figure 14a. Motion on a Circle Homocentric to the Observer

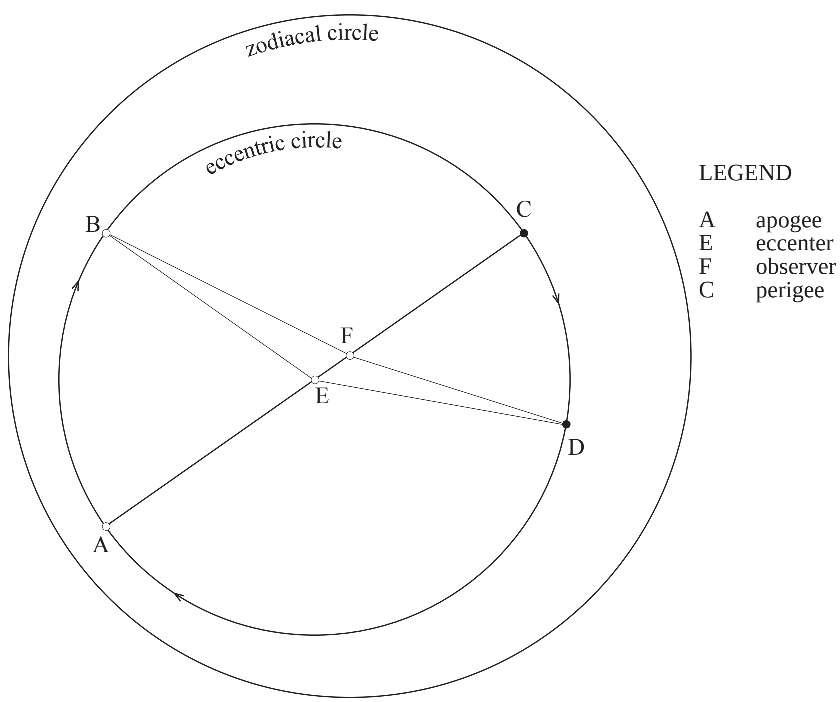

Figure 14b. Motion on a Circle Eccentric to the Observer

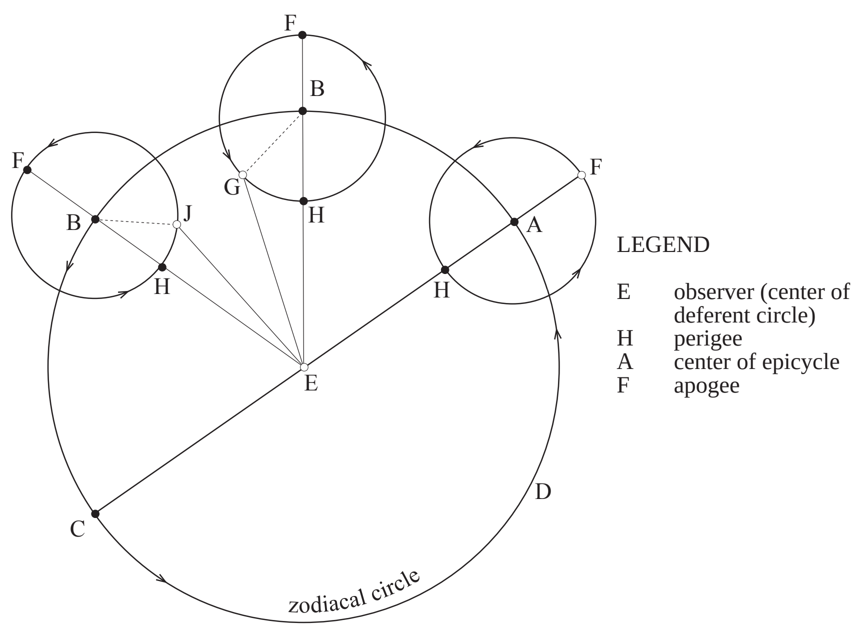

Figure 15. Motion on an Epicycle with Deferent Homocentric to the Observer

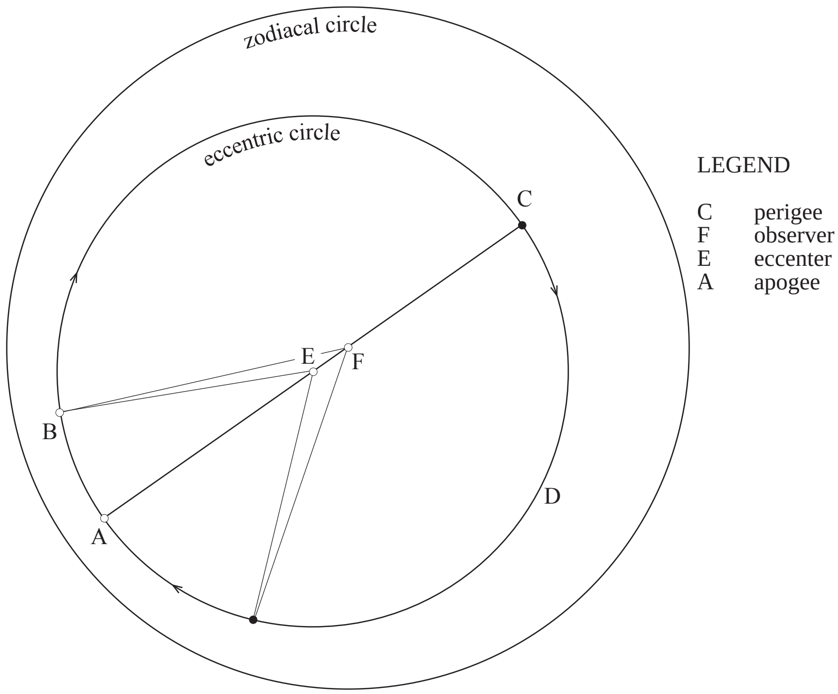

Figure 16. Apparent Motion near Apogee
on a Circle Eccentric to the Observer

Bibliography

Pre-Modern Authors and Texts

Alexander of Aphrodisias. *De anima*. See Bruns 1887.

________ *In Aristotelis meteorologica*. See Hayduck 1899.

________ *Quaestiones*. See Bruns 1887, Sharples 1992.

[Alexander of Aphrodisias]. *In Aristotelis metaphysica E–N*. See Hayduck 1891.

Aratus. *Phaenomena*. See Mair 1955, Kidd 1997.

Aristarchus. *De magnitudinibus et distantiis solis et lunae*. See Heath 1913.

Aristotle. *Analytica posteriora*. See Ross and Minio-Paluello 1968.

________ *Analytica priora*. See Ross and Minio-Paluello 1968.

________ *De caelo*. See Allan 1955, Longo 1962, Moraux 1965, Leggatt 1995, Pellegrin and Dalimier 2004.

________ *De generatione et corruptione*. See Rashed 2005.

________ *Fragmenta*. See Ross 1955.

________ *Meteorologica*. See Louis 2002.

[Aristotle]. *Mechanica*. See Hett 1936.

[Aristotle]. *Problemata*. See Louis 1991–1994.

Autolycus. *Opera et testimonia*. See Aujac, Brunet, and Nadal 1979.

Cleomedes. *Caelestia*. See Todd 1990, Bowen and Todd 2004.

Euclid. *Elementa*. See Heiberg and Stamatis 1969–1973.

________ *Optica*. See Heiberg 1895.

Galenus Grammaticus (Ioannes Galenus Grammaticus). *Allegoriae in Hesiodi theogoniam*. See Flach 1876, 295–365.

Geminus. *Introductio astronomiae*. See Aujac 1975, Manitius 1898.

Guillelmus de Moerbeka (William of Moerbeke). *Simplicii in Aristotelis de caelo*. See Bossier, Vande Veire, and Guldentops 2004.

Heron Alexandrinus. *Mechanica*. See Nix and Schmidt 1900.

Hippiatrica Berolensia. See Oder and Hoppe 1924.

Kepler, J. 1596. *Mysterium cosmographicum*. See Duncan and Aiton 1981.

MUL.APIN. See Hunger and Pingree 1989.

Pappus. *Collectio 7*. See Hultsch 1877, Ver Eecke 1982, Jones 1986.

________ *In Ptolemaei syntaxin mathematicam*. See Rome 1931–1943.

Papyrus Parisinus Graecus 1. See Letronne 1865, Blass 1877.

Philoponus, Ioannes. *De aeternitate mundi contra Proclum*. See Rabe 1899.

Plato. *Leges*. See Burnet 1900–1905. vol. 5.

________ *Respublica*. See Slings 2003.

________ *Timaeus*. See Burnet 1900–1905, vol. 4.

Pliny. *Historia naturalium*. See Mayhoff 1892–1909.

Plutarch. *De facie in orbe lunae*. See Cherniss 1957.

[Plutarch]. *Placita philosophorum*. See Mau 1971.

Proclus. *Hypotuposis astronomicarum positionum*. See Manitius 1909.
________ *In Platonis rem publicam*. See Kroll 1899–1901.
________ *In Platonis Timaeum*. See Diehl 1903–1906.
________ *In primum Euclidis elementorum*. See Friedlein 1873.
Ptolemy. *Almagest*. See Heiberg 1898–1903, Toomer 1984.
________ *Hypotheses planetarum*. See Goldstein 1967, Morelon 1993.
________ *Optica*. See Lejeune 1989.
________ *Tetrabiblos*. See Robbins 1940.
Simplicius. *In Aristotelis de caelo*. See Heiberg 1894, Aujac, Brunet, and Nadal 1979, Bossier, Vande Veire, and Guldentops 2004.
________ *In Aristotelis physica*. See Diels 1882.
Stobaeus (Ioannes). *Anthologium*. See Wachsmuth and Hense 1884.
Themistius. *In libros Aristotelis de caelo paraphrasis*. See Landauer 1902.
Theodosius. *Sphaerica*. See Heiberg 1927, Ver Eecke 1959.
Theon of Smyrna. *De utilitate mathematicae*. See Martin 1848, Hiller 1878.

Modern Authors

Allan, D. J. 1955. ed. *Aristotelis de caelo*. Oxford.
Aujac, G. 1975. ed. and trans. *Géminos. Introduction aux phénomènes*. Paris.
Aujac, G.; Brunet, J.-P.; and Nadal, R. 1979. ed. and trans. *Autolycos de Pitane.* La sphère en mouvement, Levers et couchers héliaques, *Testimonia*. Paris.
Barnes, J. 1975. *Aristotle's Posterior Analytics. Translated with Notes*. Oxford.
Bechler, Z. 1970. 'Aristotle Corrects Eudoxus: *Met*. 1073b39–1074a16'. *Centaurus* 15: 113–123.
Beere, J. B. 2003. 'Counting the Unmoved Movers: Astronomy and Explanation in Aristotle's *Metaphysics* XII.8'. *Archiv für Geschichte der Philosophie* 85:1–20.
Blass, F. W. 1877. *Eudoxi ars astronomica*. Kiel.
Blomqvist, J. 1969. *Greek Particles in Hellenistic Prose*. Lund.
Bodnár, I. M. 1997. 'Alexander of Aphrodisias on Celestial Motions'. *Phronesis* 42:190–205.
________ 2005. 'Aristotle's Rewinding Spheres: Three Options and Their Difficulties'. *Apeiron* 38:257–275.
Bolton, R. 2009. 'Two Standards for Inquiry in Aristotle's *De caelo*'. In Bowen and Wildberg 2009.
Bossier, F. 1975. *Filologisch-historische navorsingen over die middeleeuwse en humanistische Latijnse vertalingen van den commentaren van Simplicius*. 3 vols. Leuven. Doctoral dissertation.
________ 1987. 'Traductions latines et influences du *Commentaire in de caelo* en occident (XIIIe–XIVe s.)'. Pp. 288-325 in I. Hadot ed. *Simplicius, sa vie, son oeuvre, sa*

survie. Actes du Colloque International de Paris (28 Sept.–1er Oct. vol. 1. 1985). Berlin/New York.

Bossier, F.; Vande Veire, C.; and Guldentops, G. 2004. ed. *Simplicius. Commentaire sur le traité du ciel d'Aristote. Traduction de Guillaume de Moerbeke*. Leuven.

Bosworth, A. B. 1966. 'Callisthenes'. P. 278 in Hornblower and Spawforth 1996.

Bouché-Leclerq, A. 1899. *L'astrologie grecque*. Paris.

Bowen, A. C. 1999. 'The Exact Sciences in Hellenistic Times: Texts and Issues'. Pp. 287–319 in D. J. Furley ed. *Routledge History of Philosophy: 2. From Aristotle to Augustine*. London/New York.

________ 2001. 'La scienza del cielo nel periodo pretolemaico'. Pp. 806–839 in S. Petruccioli ed. *Storia della scienza: I. La scienza antica*. Rome.

________ 2002. 'Simplicius and the Early History of Greek Planetary Theory'. *Perspectives on Science* 10:155–167.

________ 2003a. 'Eudemus' History of Early Greek Astronomy: Two Hypotheses'. Pp. 307–322 in I. M. Bodnár and W. W. Fortenbaugh edd. *Eudemus of Rhodes*. New Brunswick, NJ.

________ 2003b. 'Simplicius' Commentary on Aristotle, *De caelo* 2.10–12: An Annotated Translation (Part 1)'. *SCIAMVS* 4:23–58.

________ 2007. 'The Demarcation of Physical Theory and Astronomy by Geminus and Ptolemy'. *Perspectives on Science* 15:327–358.

________ 2008a. 'Aristotheros'. P. 154 in Keyser and Irby-Massie 2008.

________ 2008b. 'Papyrus Parisinus graecus 1 (now P. Louvre 2388 Ro + Paris, Louvre 2329 Ro)'. P. 629 in Keyser and Irby-Massie 2008.

________ 2008c. 'Sosigenes II'. P. 761 in Keyser and Irby-Massie 2008.

Bowen, A. C. and Goldstein, B. R. 1988. 'Meton of Athens and Astronomy in the Late Fifth Century B.C.' Pp. 39–81 in E. Leichty, E. Erle, M. de J. Ellis, and P. Gerardi edd. *A Scientific Humanist: Studies in Memory of Abraham Sachs*. Philadelphia, PA.

________ 1991. 'Hipparchus' Treatment of Early Greek Astronomy: The Case of Eudoxus and the Length of Daytime'. *Proceedings of the American Philosophical Society* 135:233–254.

Bowen, A. C. and Todd, R. B. 2004. *Cleomedes' Lectures on Astronomy: A Translation of* The Heavens *with Introduction and Commentary*. Berkeley.

Bowen, A. C. and Wildberg, C. 2009. ed. *New Perspectives on Aristotle's* De caelo. Leiden. (in press)

Bruns, I. 1887. ed. *Alexandri Aphrodisiensis praeter commentaria scripta minora*. Commentaria in Aristotelem Graeca 2.1. Berlin.

Burnet, J. 1900–1905. ed. *Platonis opera*. 5 vols. Oxford.

Cherniss, H. F. 1957. ed. and trans. *Plutarch: Concerning the Face which Appears in the Orb of the Moon*. London.

De Santillana, G. 1940. 'Eudoxus and Plato: A Study in Chronology'. *Isis* 32:248–262.

Denniston, J. D. 1966. *The Greek Particles*. 2nd edn. Oxford.

Dicks, D. R. 1970. *Early Greek Astronomy to Aristotle*. Ithaca, NY.

Diehl, E. 1903–1906. ed. *Procli Diadochi in Platonis Timaeum commentaria*. 3 vols. Leipzig.

Diels, H. 1882. ed. *Simplicii in physicorum libros quattuor priores commentaria*. Commentaria in Aristotelem Graeca 9. Berlin.

Dreyer, J. L. E. 1906. *History of the Planetary Systems from Thales to Kepler*. Cambridge.

Duncan, A. M. and Aiton, E. J. 1981. trans. *Johannes Kepler: The Secret of the Universe*. New York.

Easterling, H. J. 1961. 'Homocentric Spheres in the *De caelo*'. *Phronesis* 6:138–153.

Elders, L. 1966. *Aristotle's Cosmology: A Commentary on the* De caelo. Assen.

Evans, J. 1998. *The History and Practice of Ancient Astronomy*. New York/Oxford.

Falcon, A. 2008. *Aristotle and the Science of Nature: Unity without Uniformity*. Cambridge.

Flach, H. 1876. ed. *Glossen und Scholien zur hesiodischen Theogonie*. Leipzig.

Fleet, B. 1997. *Simplicius: On Aristotle's* Physics 2. Ithaca, NY.

Fortenbaugh, W. W.; Huby, P. M.; Sharples, R. W.; and Gutas, D. 1992. edd. and trans. *Theophrastus of Eresus: Sources for His Life, Writings, Thought and Influence*. Philosophia Antiqua 54.1–2. 2 vols. Leiden.

Friedlein, G. 1873. ed. *Procli Diadochi in primum Euclidis elementorum librum commentarii*. Leipzig.

Gillispie, C. 1970–1990. ed. *Dictionary of Scientific Biography*. 18 vols. New York.

Goldstein, B. R. 1967. ed. and trans. *The Arabic Version of Ptolemy's Planetary Hypotheses*. Transactions of the American Philosophical Society n.s. 57.4. Philadelphia.

________ 1985. *The Astronomy of Levi ben Gerson (1288–1344)*. New York/Berlin.

________ 1996. 'The Pre-Telescopic Treatment of the Phases and Apparent Size of Venus'. *Journal for the History of Astronomy* 27:1–12.

Goldstein, B. R. and Bowen, A. C. 1991. 'The Introduction of Dated Observations and Precise Measurements in Greek Astronomy'. *Archive for History of Exact Sciences* 43:93–132.

Grant, R. 1852. *History of Physical Astronomy from the Earliest Ages to the Middle of the Nineteenth Century Comprehending a Detailed Account of the Establishment of the Theory of Gravitation by Newton with an Exposition of the Progress of Research on All Other Subjects of Celestial Physics*. London.

Guthrie, W. K. C. 1960. *Aristotle: On the Heavens*. Cambridge, MA/London.

Hadot, I. 1987. 'Recheches sur les fragments du commentaire du Simplicius sur la *Métaphysique* d'Aristote'. Pp. 225–245 in I. Hadot ed. *Simplicius, sa vie, son oeuvre, sa survie*. Berlin/New York.

Hall, J. J. 1971. ' "Planets" in Simplicius *De caelo* 471.1 ff'. *The Journal of Hellenic Studies* 91:138–139.

Hankinson, R. J. 2002. trans. *Simplicius: On Aristotle's* On the Heavens 1.1–4. Ithaca, NY.

Hayduck, M. 1891. ed. *Alexandri Aphrodisiensis in Aristotelis metaphysica commentaria*. Commentaria in Aristotelem Graeca 1. Berlin.

________ 1899. ed. *Alexandri Aphrodisiensis in Aristotelis meteorologicorum libros commentaria*. Commentaria in Aristotelem Graeca 3.2. Berlin.

Heath, T. L. 1913. *Aristarchus of Samos: The Ancient Copernicus*. Oxford.

________ 1921. *A History of Greek Mathematics*. 2 vols. Oxford.

Heiberg, J. L. 1894. ed. *Simplicii in Aristotelis de caelo commentaria*. Commentaria in Aristotelem Graeca 7. Berlin.

________ 1895. ed. *Euclidis opera omnia*. vol. 7. Leipzig.

________ 1898–1903. ed. *Claudii Ptolemaei opera quae exstant omnia*. vol. 1 (in 2 parts). Leipzig.

________ 1927. ed. *Theodosius Tripolites: Sphaerica*. Berlin.

Heiberg, J. L. and Stamatis, E. S. 1969–1973. edd. *Euclides: Elementa*. 4 vols. Leipzig.

Heglmeier, F. 1996. 'Die greichische Astronomie zur Zeit des Aristoteles: ein neuer Ansatz zu den Sphärenmodellen des Eudoxus und des Kallippos'. *Antike Naturwissenschaft und ihre Rezeption* 6:51–72.

Herschell, J. F. W. 1849. *Outlines of Astronomy*. Philadelphia.

Hett, W. S. 1936. trans. *Aristotle: Mechanical Problems*. In vol. 14 of Loeb Classical Library: Aristotle. Cambridge, MA/London.

Hiller, E. 1878. ed. *Theonis Smyrnaei philosophi platonici expositio rerum mathematicarum ad legendum Platonem utilium*. Leipzig.

Hoffman, P. 1987. 'Simplicius' Polemics: Some Aspects of Simplicius' Polemical Writings against John Philoponus: From Invective to a Reaffirmation of the Transcendency of the Heavens'. Pp. 57–83 in R. R. K. Sorabji ed. *Philoponus and the Rejection of Aristotelian Science*. London.

Hornblower, S. and Spawforth, A. J. S. 1996. edd. *The Oxford Classical Dictionary*. 3rd edn. Oxford/New York.

Hudson-Williams, A. H. and Spawforth, A. J. S. 1996. 'Nigidius Figulus, Publius'. P. 1044 in Hornblower and Spawforth 1996.

Hultsch, F. 1877. ed. and trans. *Pappi Alexandrini collectio*. vol. 2. Berlin.

Hunger, H. and Pingree, D. 1989. *MUL.APIN: An Astronomical Compendium in Cuneiform*. Horn, Austria.

Hunger, H.; Reade, J.; and Parpola, S. 1992. *Astrological Reports to Assyrian Kings*. State Archives of Assyria 8. Helsinki.

Johansen, T. K. 2009. 'From Plato's *Timaeus* to Aristotle's *De caelo*: The Case of the Missing World Soul'. In Bowen and Wildberg 2009.

Jones, A. 1986. ed. and trans. *Pappus of Alexandria: Book 7 of the* Collection. New York/ Berlin.

Jones, A. 2006. *The Keskintos Astronomical Inscription: Text and Interpretations*. *SCIAMVS* 7:3–41.

Kalbfleisch, K. 1907. ed. *Simplicii in Aristotelis categorias commentarium*. Commentaria in Aristotelem Graeca 8. Berlin.

Keyser, P. T. and Irby-Massie, G. L. 2008. edd. *The Encyclopedia of Ancient Natural Scientists*. London.

Kidd, D. 1997. *Aratus: Phaenomena, Edited with Introduction, Translation and Commentary*. Cambridge Classical Texts and Commentaries 34. Cambridge.

Kirk, G. S.; Raven, J. E.; and Schofield, M. 1983. *The Presocratic Philosophers: A Critical History with a Selection of Texts*. Cambridge.

Knorr, W. R. 1990. 'Plato and Eudoxus on the Planetary Motions'. *Journal for the History of Astronomy* 21:313–329.

Kroll, W. 1899–1901. ed. *Procli Diadochi in Platonis rem publicam commentaria*. 2 vols. Leipzig.

Landauer, S. 1902. ed. *Themistii in libros Aristotelis de caelo paraphrasis hebraice et latine*. Commentaria in Aristotelem Graeca 5. Berlin.

Lasserre, F. 1966. *Die Fragmente des Eudoxos von Knidos*. Berlin.

Leggatt, S. 1995. trans. *Aristotle: On the Heavens I and II*. Warminster, England.

Lejeune, A. 1989. *L'optique de Claude Ptolémée dans la version latine d'après de l'émir Eugène de Sicile: Édition critique et exégétique augmentée d'une traduction française et de compléments*. Leiden/New York.

Lennox. J. G. 2009. '*De caelo* 2.2 and Its Debt to *De incessu animalium*'. In Bowen and Wildberg 2009.

Letronne, M. 1865. 'Traité d'astronomie d'après Eudoxe'. *Notices et extraits des manuscrits de la Bibliothèque impériale* 18.2:25–76.

Leunissen, M. E. M. P. J. 2009. 'Why Stars Have No Feet: Explanation and Teleology in Aristotle's Cosmology'. In Bowen and Wildberg 2009.

Liddell, H. G.; Scott, R.; and Jones, H. S. 1968. *A Greek-English Lexicon*. Oxford.

Longo, O. 1962. ed. and trans. *Aristotele. De caelo*. Florence.

Louis, P. 1991–1994. ed. and trans. *Aristote. Problèmes*. Paris.

——— 2002. ed. and trans. *Aristote. Météorlogiques*. Paris.

Mair, G. W. 1955. *Aratus*. London.

Manitius, C. 1898. ed. *Gemini elementa astronomiae*. repr. 1974. Stuttgart.

——— 1909. ed. *Procli Diadochi hypotuposis astronomicarum positionum*. Stuttgart.

Martin, J. 1956. *Histoire du texte des phénomènes d'Aratos*. Paris.

——— 1974. ed. *Scholia in Aratum vetera*. Leipzig.

Martin, T. H. 1848. ed. and trans. *Theonis Smyrnaei platonici liber de astronomia cum Sereni fragmento*. Paris.

——— 1881. *Mémoire sur l'histoire des hypothèses astronomiques chez les grecs et les romains: Première partie. Hypothèses astronomiques des grecs avant l'époque* *alexandrine*. Mémoires de l'Institut National de France, Academie des Inscriptions et Belles-Lettres 30.1. Paris.

Matthen, M. 2009. 'Why Does the Earth Move to the Center? An Examination of Some Methodological Strategies in Aristotle's Cosmology'. In Bowen and Wildberg 2009.

Mau, J. 1971. ed. *Plutarchi moralia*. vol. 5.2.1. Leipzig.

Maula, E. 1974. *Studies in Eudoxus' Homocentric Spheres*. Commentationes Humanarum Litterarum 50. Helsinki.

Mayhoff, C. 1892–1909. ed. *C. Plinii secundi naturalis historiae libri xxxvii*. Leipzig.

Mendell, H. 1998. 'Reflections on Eudoxus, Callippus, and Their Curves: Hippopedes and Callippopedes'. *Centaurus* 40:177–275.

________ 2000. 'The Trouble with Eudoxus'. Pp. 59–138 in P. Suppes and J. M. Moravscik, H. Mendell edd. *Ancient and Medieval Traditions in the Exact Sciences: Essays in Memory of Wilbur Knorr*. Stanford, CA.

Moore, P. 1961. *The Planet Venus*. London/New York.

Moraux, P. 1954. 'Notes sur la tradition indirecte du "de Caelo" d'Aristote'. *Hermes* 82: 145–182.

________ 1965. ed. *Aristote.* Du ciel. Paris.

Morelon, R. 1993. ed. and trans. 'Le traité 1 du livres des hypothèses de Ptolémée'. *Mideo* 21:7–85.

Mueller, I. 2004. *Simplicius: On Aristotle's* On the Heavens 2.1–9. Ithaca, NY.

________ 2005. *Simplicius: On Aristotle's* On the Heavens 2.10–14. Ithaca, NY.

Neugebauer, O. 1953. 'On the "Hippopede" of Eudoxus'. *Scripta Mathematica* 19:225–229.

________ 1959. 'Regula Philippi Arrhidaei'. *Isis* 50:477–478.

________ 1975. *A History of Ancient Mathematical Astronomy*. Berlin/Heidelberg/New York.

Newton, R. R. 1972. *Medieval Chronicles and the Rotation of the Earth*. Baltimore/London.

Nix, L. and Schmidt, W. 1900. edd. *Heroni Alexandrini opera quae supersunt omnia*. vol. 2.1. Leipzig.

North, J. D. 1995. *The Norton History of Astronomy and Cosmology*. New York/London.

Oder, E. and Hoppe, K. 1924. *Corpus hippiatricorum graecorum*. Leipzig.

O'Meara, D. J. 1989. *Pythagoras Revived: Mathematics and Philosophy in Late Antiquity*. Oxford.

________ 1996. 'Neopythagoreanism'. Pp. 1035–1036 in Hornblower and Spawforth 1996.

Parpola, S. 1970–1983. *Letters from Assyrian Scholars to the Kings Esarhaddon and Assurbanipal*. Alter Orient un Altes Testament 5/1–2. Neukirchen-Vluyn.

Parpola, S. and Reade, J. 1993. *Letters from Assyrian and Babylonian Scholars*. State Archives of Assyria 10. Helsinki.

Pellegrin, P. 2009. 'The Argument for the Sphericity of the Universe in Aristotle's *De caelo*: Astronomy and Physics'. In Bowen and Wildberg 2009.

Pellegrin, P. and Dalimier, C. 2004. *Aristote. Traité du ciel*. Paris.

Pingree, D. 1994. 'The Teaching of the *Almagest* in Late Antiquity'. Pp. 75–98 in T. D. Barnes ed. *The Sciences in Greco-Roman Society*. *Apeiron* 27.4.

Price, D. J. 1957. 'Precision Instruments to 1500 with a Section (VII) on Hero's Instruments by A. G. Drachmann'. Pp. 582–619 in vol. 3 of C. J. Singer *et alii* edd. *A History of Technology*. Oxford.

Rabe, H. 1899. ed. *Ioannes Philoponus: De aeternitate mundi contra Proclum*. Leipzig.

Rashed, M. 2005. ed. and trans. *Aristote.* De la génération et de la corruption. Paris.

Rehm, A. 1949. '*Parapegma*'. 18.4: cols 1295–1366 in Pauly, A.; Wissowa, G.; Kroll, W.; *et alii* edd. *Paulys Real-Encyclopädie der classischen Altertumswissenschaft*. 1894–. Stuttgart.

Rescigno, A. 2004. *Alessandro di Afrodisia. Commentario al de caelo di Aristotele: Frammenti del primo libro*. Amsterdam.

Rist, J. M. 1985. 'The End of Aristotle's *In Prayer*'. *American Journal of Philology* 106: 110–113.

________ 1989. *The Mind of Aristotle: A Study on Philosophical Growth*. Toronto.

Robbins, F. E. 1940. ed. and trans. *Ptolemy: Tetrabiblos*. London.

Robinson, R. 1966. *Plato's Earlier Dialectic*. 2nd edn. Oxford.

Rome, A. 1931–1943. *Commentaires de Pappus et de Théon d'Alexandrie sur l'Almageste*. 3 vols. Rome.

Ross, H. E. and Plug, C. 2002. *The Mystery of the Moon Illusion: Exploring Size Perception*. Oxford/New York.

Ross, W. D. 1953. *Aristotle's Metaphysics: A Revised Text with Introduction and Commentary*. 2 vols. Oxford.

________ 1955. ed. *Fragmenta selecta*. Oxford.

________ 1964. *Aristotle*. London/New York.

Ross, W. D. and Minio-Paluello, L. 1968. edd. *Aristotelis analytica priora et posteriora*. Oxford.

Sachs, A. and Hunger, H. 1989. edd. *Astronomical Diaries and Related Texts from Babylonia*. vol. 1. Österreichische Akademie der Wissenschaften: Philosophisch-historishe Klasse Denkschriften 195. Vienna.

Savoie, D. 2003. 'Problèmes de datation d'une occultation observée par Aristote'. *Revue d'histoire des sciences* 56:493–504.

Sharples, R. W. 1976, 'Responsibility and the Possibility of More than One Course of Action: A Note on Aristotle *De caelo* II.12'. *Bulletin of the Institute of Classical Studies* 23:69–72.

________ 1992. *Alexander of Aphrodisias:* Quaestiones *1.1–2.15*. Ithaca, NY.

Schiaparelli, G. 1925–1927. *Scritti sulla storia dell astronomia antica*. 3 vols. Bologna.

Slings, S. R. 2003. ed. *Platonis respublica*. Oxford.

Smith, A. 1996. ‘Porphyry’. P. 1226 in Hornblower and Spawforth 1996.

Smyth, H. W. 1971. *Greek Grammar. Revised by G. W. Messing*. Cambridge, MA.

Sorabji, R. R. K. 1996. ‘Philoponus, John’. Pp. 1168–1169 in Hornblower and Spawforth 1996.

Steavenson, W. H. 1956. ‘Shadows Cast by Venus’. *Journal for the British Astronomical Association* 66:264–265.

Stephenson, F. R. 2000. ‘A Lunar Occultation of Mars Observed by Aristotle’. *Journal for the History of Astronomy* 31:342–344.

Tarán, L. 1974. ‘Nicomachus of Gerasa’. Pp. 112–114 in vol. 9 of Gillispie 1970–1990.

________ 1975. *Academica: Plato, Philip of Opus, and the Pseudo-Platonic* Epinomis. Philadelphia, PA.

________ 1987. ‘Syrianus and Pseudo-Alexander’s Commentary on *Metaph. E–N*’. Pp. 215–232 in Weisner, J. 1987. ed. *Aristoteles—Werk und Werkung*. vol. 2. Berlin/New York.

Taylor, A. E. 1928. *A Commentary on Plato’s* Timaeus. Oxford.

Thoren,V. E. 1971. ‘Anaxagoras, Eudoxus and the Regression of the Lunar Nodes’. *Journal for the History of Astronomy* 2:23–38.

Todd, R. B. 1972. ‘*Epitêdeiotês* in Philosophical Literature: Towards an Analysis’. *Acta Classica* 15:25–35.

________ 1976. *Alexander of Aphrodisias on Stoic Physics: A Study of the* De mixtione *with Preliminary Essays, Text, Translation, and Commentary*. Leiden.

________ 1984. ‘Philosophy and Medicine in John Philoponus’ Commentary on Aristotle’s *De Anima*’. Pp. 103–110 in J. Scarborough ed. *Symposium on Byzantine Medicine*. Dumbarton Oaks Papers 38. Washington, DC.

________ 1990. ed. *Cleomedis caelestia*. Leipzig.

Toomer, G. J. 1978. *Hipparchus*. Pp. 207–224 in vol. 15 of Gillispie 1970–1990.

________ 1984. *Ptolemy’s Almagest*. New York/Berlin/Heidelberg.

Ver Eecke, P. 1959. *Les sphériques de Théodose de Tripoli: Oeuvres traduites pour la première fois en franąis avec une introduction et notes*. Paris.

________ 1982. *Pappus d’Alexandrie. La collection mathématique. Oeuvre traduite pour la première fois du grec en franąis avec une introduction et notes*. vol. 2. Paris.

von Staden, H. 1989. *Herophilus: The Art of Medicine in Early Alexandria*. Cambridge/New York.

Wachsmuth, C. and Hense, O. 1884. edd. *Ioannis Stobaei anthologium*. vols. 1–2. Berlin.

Watts, E. J. 2006. *City and School in Late Antique Athens and Alexandria*. Berkeley/Los Angeles/London.

Wildberg, C. 1987. *Philoponus: Against Aristotle on the Eternity of the World*. London.

________ 1991. *Simplicius: Against Philoponus on the Eternity of the World*. Ithaca, NY.

________ 2006. ‘Philosophy in the Age of Justinian’. Pp. 316–340 in M. Maas ed. *The Cambridge Companion to the Age of Justinian*. Cambridge.

Williams, C. 2007. rev. Bowen and Todd 2004. *International Journal of the Classical Tradition* 13:476–479.

Yavetz, I. 1998. 'On the Homocentric Spheres of Eudoxus'. *Archive for History of Exact Sciences* 51:221–278.

________ 2001. 'A New Role for the Hippopede of Eudoxus'. *Archive for History of Exact Sciences* 56:69–93.

________ 2003. 'On Simplicius' Testimony Regarding Eudoxan Lunar Theory'. *Science in Context* 16:319–329.

(Received: February 10, 2008)

(Revised: December 4, 2008)